

Old World Fruit Bats

An Action Plan for their Conservation



Compiled by

Simon P. Mickleburgh, Anthony M. Hutson and Paul A. Racey
IUCN/SSC Chiroptera Specialist Group



IUCN Species Survival Commission: A Global Network for Species Survival

Habitats and their living natural resources are under increasing pressure everywhere from humankind. Species, the basic biotic units, are consequently increasingly threatened with extinction. To protect and conserve biodiversity from species level to ecosystem requires management based on understanding of not just biological sciences, but also of local cultures, environmental economics, and governmental structures and dynamics.

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Foreword

The Old World fruit bats play an important role as pollinators and seed dispersers. They are responsible for the propagation of many plants useful to man, including fruit trees, timber trees and favoured amenity trees. In some areas they may be key species in the maintenance of the natural vegetation. They are certainly primary dispersers of plants which begin the process of recolonization of cleared forest land.

The loss of original tropical forests is a prime concern for the conservation of bats. Forest cover is particularly at risk on islands where the pressure for land may be intense. On many oceanic islands, the damage done by man leaves relict forest particularly vulnerable to the effect of cyclones, which can strip it of food and safe roosting sites for bats.

Fruit bats also face other problems of a special kind. Their feeding behaviour has led them into conflict with domestic and commercial fruit growers. They are regarded as pests in many cases, particularly where fruit farming has been developed at the expense of native vegetation or where orchards enable the fruit bats to spread into otherwise unsuitable areas.

Throughout much of their range, these bats themselves are considered good eating. Over-exploitation, particularly for commercial trade, has threatened species. Disturbance to cave roosts is a problem for some species. On the other hand careful control of cave disturbance can allow the long-term harvesting of guano for fertilizer, and hence favour the conservation of roosting colonies.

As a result of pressures such as these, seven species are believed to have become extinct and a further seventeen species are considered endangered.

These and other issues are discussed in this book. Fifty members of the Chiroptera Specialist Group of IUCN's Species Survival Commission have contributed to bring together, for the first time, all available information on the biology, populations and hazards for the entire family. Species accounts detail available information and identify the current conservation needs. Priorities are assigned to species according to their populations, distribution and vulnerability. These elements, together with an identification of key areas of diversity using the phylogenetic relationships of genera and the species groups of the genus *Pteropus*, have enabled country by country statements of the conservation requirements. Action is recommended where its need is identified, the seeking of information on species where relevant knowledge is lacking.

The pooling of information and opinion from the world's specialists has resulted in a landmark for bat conservation. For this achievement, I congratulate the Chiroptera Specialist Group and the compilers. The Action Plan identifies the way forward. The next step is to see that its recommendations are implemented.

Earl of Cranbrook DSc DL

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We are responsible for any errors or omissions that may occur in this document. In a few cases, there have been conflicting views from experts and in such situations we have had to make our own decisions, for which we accept responsibility.

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Chapter 1. Introduction

Bats: Order Chiroptera

Bats belong to the Order Chiroptera. At present there are about 950 recognized species worldwide, making up almost a quarter of all known mammal species. Bats are divided into two sub-orders, the Megachiroptera and the Microchiroptera. The Megachiroptera (consisting of a single family, the Pteropodidae or Old World fruit bats) are found throughout the Old World tropics and sub-tropics from Africa through southern Asia to Australia and on islands in the Indian and western Pacific Oceans. Microchiropteran bats are found in all areas of the world apart from the Arctic and Antarctica and some isolated oceanic islands.

The Megachiroptera (Old World fruit bats)

The Megachiroptera are distinguished from the Microchiroptera by having a simple external ear with its edge forming an unbroken ring and by having a second finger that is relatively independent of the third finger and which usually bears a small claw. They do not possess any noseleaf (often well-developed in the Microchiroptera) or tragus (a small structure inside the ear). The tail membrane is usually narrow and the tail generally short or absent, although it is moderately long in *Notopterus*. Where a tail is present, it is not integral with the tail membrane.

The eyes are generally large, and sight and smell appear to be the major locational senses, in contrast to the Microchiroptera, which have small eyes. Echolocation, a method of orientation using ultrasonic sounds emitted through the nose or mouth, is universal among the Microchiroptera but is, with a few exceptions, unknown in the Megachiroptera. Where it is present (in some *Rousettus* and perhaps *Epomophorus* species), the acoustic orientation signals produced are rather crude and are made by a different mechanism from those in the Microchiroptera.

All of the Megachiroptera consume fruits, flowers and/or flower products. The grinding teeth of most species are large and flat to allow them to chew fruit. Nectar and flower feeders have relatively lighter jaws and smaller teeth, and usually have narrow, elongated muzzles and long tongues to allow them to probe deep into flowers. The majority of the Microchiroptera are insect feeders, although other food sources include fish, amphibians, small mammals (including bats), blood, fruit and flowers. In the Family Phyllostomidae the majority of species feed on fruit, nectar and pollen. It is suggested that this behaviour was derived from an insectivorous ancestor; there is no suggestion of such a derivation among the Megachiroptera (Hill and Smith, 1984).

Evolution of bats

The origin and evolution of bats is poorly understood. The earliest fossil bats come from the Eocene (approximately 60 million years ago), and were fully developed fliers. Thus, there is little information on the transition from their terrestrial ancestors. The Megachiroptera are first represented in the fossil record in the Oligocene (35 million years ago). All of the Eocene fossils are well-developed microchiropterans and undoubtedly do not include the ancestors of the Megachiroptera. It has been suggested that the Megachiroptera and Microchiroptera do not have a common ancestor and that wings and flight have developed twice, independently, in these two groups (Smith and Madkour, 1980; Pettigrew, 1986). Pettigrew *et al.* (1989) and Pettigrew (1991) suggested that the Megachiroptera evolved from an early branch of the primate lineage and that the Microchiroptera probably evolved much earlier from small, agile insectivores whose forelimbs had long metacarpals in relation to the phalanges. Megachiroptera share with primates a variety of complex details in the organization of neural pathways, which have not been found in any other mammalian group, particularly not in Microchiroptera (Pettigrew *et al.*, 1989). This interpretation is challenged by Baker, Novicek and Simmons (1991).

Distribution

The single megachiropteran family, the Pteropodidae, ranges from Africa, the eastern Mediterranean, Madagascar and the Indian Ocean islands in the west, across mainland southern Asia, throughout the islands of the western Pacific from the Ryukyu Archipelago and Ogasawara-shato in the north, to coastal eastern Australia, New Caledonia and the Loyalty Islands in the south, and east to Fiji, Tonga, Samoa and the Cook Islands (Figure 1). There are 41 genera containing a total

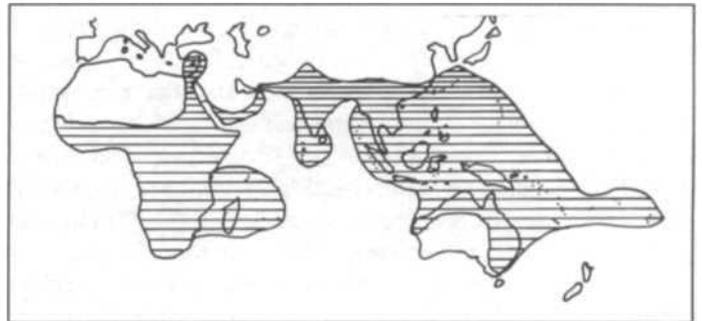


Figure 1. World distribution of the Old World fruit bats. Fruit bats have been recorded from within the hatched area.

of 161 species (K. Koopman, pers. comm.). The largest and best known genus, *Pteropus*, with 57 species, is primarily an island taxon, with 55 species (96.5%) having some or all of their distribution on islands. In this genus levels of endemism are extremely high, with 35 species (61.4%) confined to single islands or small island groups. Only nine species are found in continental areas (five in Asia and four in Australia), and only two (*P. lylei* and *P. poliocephalus*) are restricted to continents.

Ecology

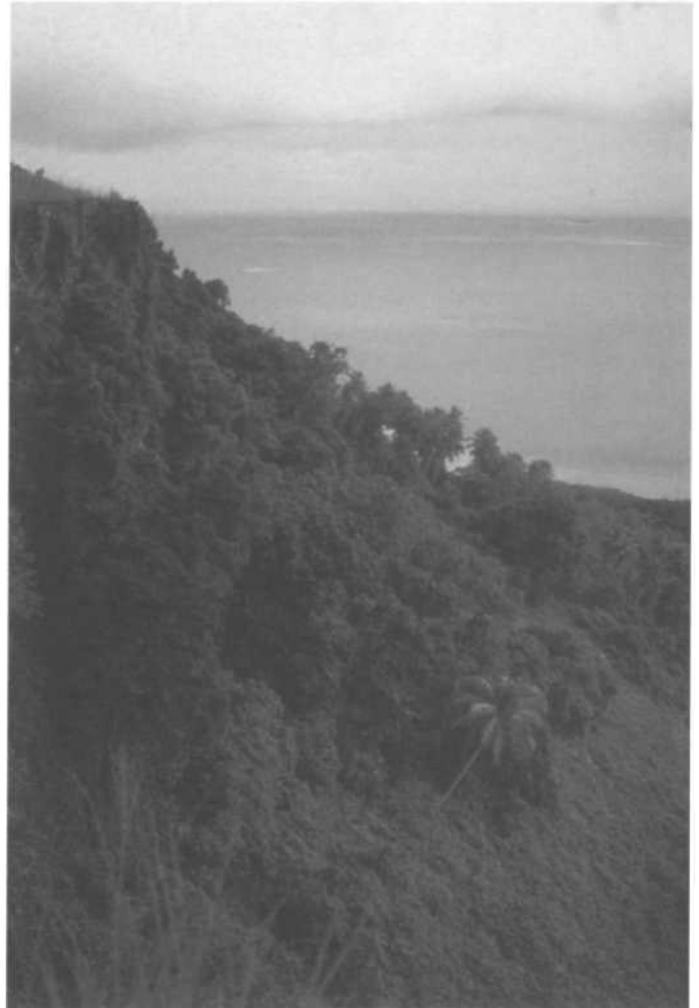
Habitat use

The habitats used by fruit bats vary. Many taxa are dependent to a greater or lesser extent on primary or well-regenerated secondary forest. A few utilize areas of savannah. While forest destruction or degradation threaten many taxa, a few appear to accommodate such activities. For example, in the Philippines, *Pteropus hypomelanus cagayanus* and *Rousettus (Rousettus) amplexicaudatus* are most commonly found in disturbed habitats. Bats sometimes use habitats in large conurbations, as shown by the colony of *Eidolon helvum* in the campus of the University of Ife in Nigeria (Halstead, 1977). Some taxa are found in a great variety of habitats. For example, *Cynopterus brachyotis* has been recorded from montane forest, gardens, mangroves and strand vegetation in Borneo.

There have been few attempts to estimate population densities. Heideman and Heaney (1989) estimated densities of between 0.2 and 3.7 individuals per hectare for six small-bodied species on Negros.

Roosts

Knowledge of roosting behaviour is fragmentary (Pierson and Rainey, 1992). A. G. Marshall (pers. comm.) has examined the published information on roosting sites of Megachiroptera. Twenty nine out of 41 genera roost in trees, 11 roost in caves, and six in various other sites (under eaves, in mines, rock shelters, crevices, buildings and amongst boulders). There is no information available for 10 genera. In trees, roost size varies from one to greater than 1 million, while in caves groups of between ten and several thousand have been found. Members of the genus *Pteropus* often form large aggregations on exposed tree branches. Large emergent trees such as banyan (**Moraceae**: *Ficus benghalensis*) are frequently used. Bats that roost singly or in small groups may use a variety of sites, such as crowns of epiphytic ferns or old termite nests in trees (*Balionycteris maculata seimundi* in Peninsular Malaysia), under dead palm leaves (*Cynopterus brachyotis brachyotis* in the Philippines), rock shelters (*Cynopterus horsfieldii persimilis* in Borneo), and in tree hollows or aerial roots of banyan (*Cynopterus sphinx gangeticus* in India). Cave-roosting bats may be found in light areas close to the entrance (*Penthetor lucasi* in Peninsular Malaysia, *Eidolon helvum* in Madagascar (Wilson, 1987)) or in



Agroforest habitat utilized by *Pteropus insularis* on Chuuk, Federated States of Micronesia. (Photo by W. E. Rainey)

the darker areas (*Rousettus (Rousettus) lanosus kempfi* in East Africa). In Africa, *Rousettus (Lissonycteris) angolensis* roosts in small loose groups in cave entrances and cave-like habitats, and under dead palm fronds hanging down the sides of palm stems (Bergmans, 1979).

Roost site fidelity is generally high in those genera that roost communally. Thus, cave roosts of *Eonycteris*, *Notopteris* and *Rousettus* may be occupied for many years (Marshall, 1983) as may tree roosts of *Eidolon*, *Epomophoms* and *Pteropus* (Rosevear, 1965; Lim, 1966; Funmilayo, 1976; Wickler and Seibt, 1976; Marshall, 1983). Those genera roosting singly or in small groups show less site fidelity but may use the same perch for considerable periods (Start, 1974; Marshall, 1983). Tree-roosting bats obtain protection from inclement weather and from predation by the dense foliage in which they roost, by their cryptic colouration (hair patterns and wrapped wings make them resemble dead leaves), and perhaps by heterothermy (identified in small *Nyctimene* and *Paranyctimene* by Bartholomew *et al.*, 1970), which, although it may inhibit rapid escape, may reduce odour.

For some taxa there can be dramatic seasonal changes in

roost composition. Most colonies of *Eidolon helvum helvum* use the same roosts for many years, but because of local fluctuations in food availability, some colonies make regular seasonal migrations, returning after a few months to their former roosting sites (Happold, 1987). In *Pteropus poliocephalus* colonies in Australia, the largest numbers are present in early summer when food is plentiful. In the southern part of the range, copulation takes place at the end of March or April, after which the camps break up and disperse because of scarcity of food.



Regular use by fruit bats can result in the denuding of the main branches used for roosting. (Photo by P. A. Morris)

Food

Fruit bats feed almost exclusively on plants, taking floral resources (largely nectar and pollen but also petals and bracts), fruit (i.e. any plant material surrounding seeds), and often the seeds themselves and leaves (Marshall, 1985). Specialist seed-eaters have not evolved as they have in birds (Snow, 1971). Insect remains have been found in the alimentary canal or intestine of megachiropteran bats (e.g. Lim, 1973; Start and Marshall, 1976) but their ingestion is perhaps accidental. However, Roberts and Seabrook (1989) observed *Pteropus seychellensis aldabrensis* on Aldabra Atoll feeding on 'honeydew' exuded by coccoids (*Icerya sechellarum*) present on a fig tree (**Moraceae**: *Ficus lutea*). They considered this to be an important food source and the bats to be an important control on numbers of coccoids. In the Sikkim province of India. *Rousettus (Rousettus) leschenaulti* has been recorded as feeding on fish (S. Mistry, pers. comm). Fruit bats may also require extra water and have been observed drinking, sometimes taking seawater (Kock, 1972; Kingdon, 1974; Bergmans, 1978a).

Certain genera have remarkably catholic feeding habits. Marshall (1983) recorded that *Eidolon helvum* fed on flowers of 10 genera, fruit of 34 and leaves of 4. Similarly, the genus *Pteropus* used flowers of 26 genera, fruit of 62 and leaves of 3

(Marshall, 1983). Racey and Nicoll (1984) recorded *Pteropus seychellensis seychellensis* as feeding on 27 plant species from 14 genera (Table 1). In some cases, food preference and availability varies with place and season, but there are a number of indications that fruit bats may show food preferences if choice is available (Start, 1974; Marshall, 1985). For example, in West Africa, *Eidolon helvum* appears to favour *Ceiba* flowers (**Bombacaceae**) to *Parkia* flowers (**Leguminosae**), and *Chlorophora* fruit (**Moraceae**) to *Solanum* fruit (**Solanaceae**). As our knowledge increases, most megachiropteran bats will probably be seen not to be true generalists but rather 'sequential specialists', favouring at any one time and place one or a few plant species amongst the group of potential food plants available at that season (Marshall, 1985).

Plant genera are visited by a wide variety of bats. Thus the flowers of *Ceiba* attract at least 11 genera of Megachiroptera, and the fruit of *Ficus* at least 13 genera. Bats will feed upon both flowers and fruit of certain genera such as *Musa* (**Musaceae**). The generally catholic nature of the bat/plant relationship is supported by the fact that New World plants attract Megachiropteran bats, and Old World bat plants attract New

Table 1. Food plants of *Pteropus seychellensis seychellensis* (after Racey and Nicoll, 1984).

Family	Species	Source of food	
		flower	fruit
			+
Anacardiaceae	<i>Anacardium occidentale</i>		+
	<i>Mangifera indica</i>		+
	<i>Spondias dulcis</i>		+
Apocynaceae	<i>Neisosperma oppositifolia</i>		+
Bombacaceae	<i>Ceiba penlandra</i>	+	
Caricaceae	<i>Carica papaya</i>		?
Combretaceae	<i>Terminalia catappa</i>		+
Flacourtiaceae	<i>Aphloia</i> sp.		?
Guttiferae	<i>Penladesma butyracea</i>	+	
	<i>Calophyllum inophyllum</i>		+
Meliaceae	<i>Sandoricum indicum</i>		+
Moraceae	<i>Artocarpus heterophyllus</i>		+
	<i>Artocarpus allilis</i>		+
	<i>Ficus benghalensis</i>		+
	<i>Ficus nautarium</i>		+
	<i>Ficus avi-avi, F.reflexa</i>		+
Musaceae	<i>Musa</i> spp.		?
Myrtaceae	<i>Eugenia jambos</i>		?
	<i>Eugenia javanica</i>	+	
	<i>Eugenia malaccensis</i>	+	+
	<i>Psidium guajava</i>		+
	<i>Psidium littorale</i>		+
Palmae	<i>Cocos nucifera</i>	+	
Sapotaceae	<i>Mimusops sechellarum</i>		+
	<i>Northea hornei</i>		+
Sonneratiaceae	<i>Sonneratia caseolaris</i>		?

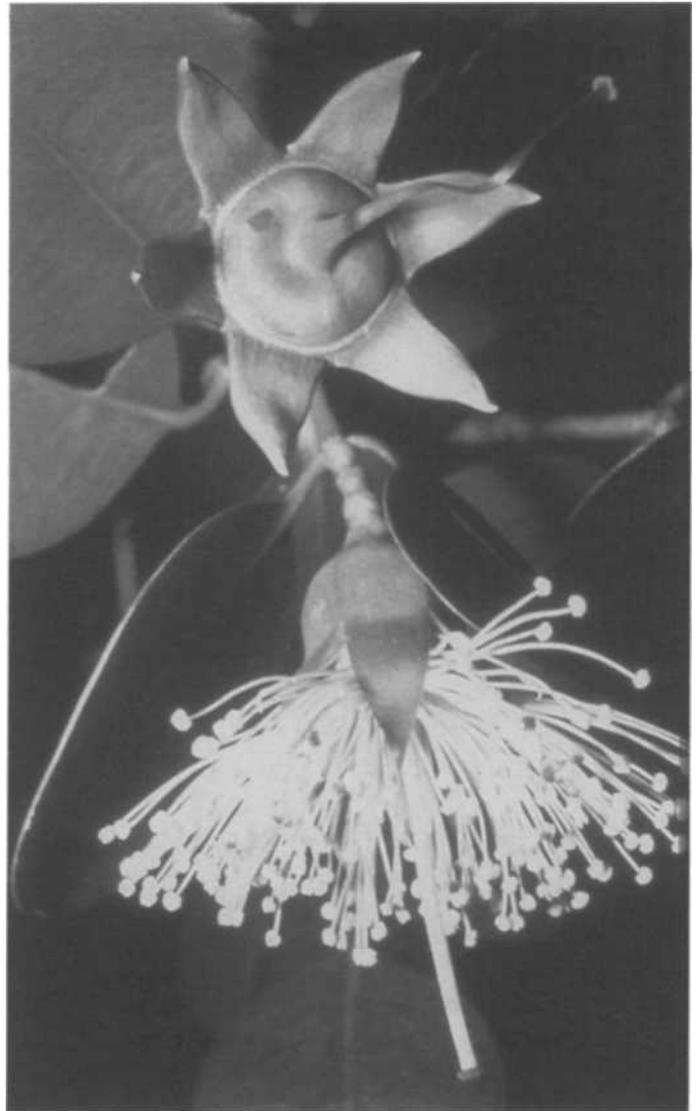
World phyllostomids (e.g. flowers of *Durio zibethinus* (**Bombacaceae**) and *Musa* species) (Gardner, 1977).

A few flower or fruit species are largely associated with a single bat species. Thus Gould (1978) has shown that *Oroxylum* flowers (**Bignoniaceae**) are morphologically adapted for pollination by *Eonycteris spelaea*, although both *Cynopterus* and *Rousettus* have also been reported as visitors to these flowers (McCann, 1940).

The actual quantities of food consumed each night are difficult to ascertain. For some African frugivores it seems likely that they ingest about their own weight of fruit each night (Jacobsen and Du Plessis, 1976; Marshall and McWilliam, 1982; Wolton *et al.*, 1982). Fortheneectarivorous *Macroglossus sobrinus* (18-26 g) Start (1974) estimated that one individual required the nectar produced by two inflorescences of *Musa malaccensis* each night. As each inflorescence produced at least 1.8 ml of nectar this means at least 3.6 ml of nectar was consumed per bat per night.

The distribution of bats is largely dependent on the spatial and temporal variation of their food resources. In equatorial regions food may be available within a small area throughout the year, whereas in more seasonal regions food may be relatively scarce for months. Some bat species may roost singly close to their food, whereas others may roost in great colonies (camps) from which they must fly long distances to feed. For example, McWilliam (1985-86) found that the feeding behaviour of three highly colonial species of *Pteropus* in Australia was dominated by the establishment and subsequent defence of long-term feeding territories. Investigation using radio-tagging showed that such visits to feeding sites spanned at least 29, 37 and 23 consecutive days for *P. poliocephalus*, *P. alecto* and *P. scapulatus* respectively. Mean straight line distances between roost sites and feeding locations for the same species were 10, 21 and 29 km respectively. Refuging species frequently forage in flocks and may travel considerable distances to feed. Flock foraging is particularly effective for the exploitation of a rich ephemeral and widely spaced food source. Such foraging has been observed in a number of bat species. Mixed species flocks (*Epomophorus gambianus*, *Micropteropus pusillus* and *Nanonycteris veldkampii*) have been observed around bat flowers in West Africa (Baker and Harris, 1957, 1959; Marshall and McWilliam, 1982) and single species flocks of *Eonycteris spelaea* have been seen in Malaysia, and of *Rousettus (Rousettus) aegyptiacus* in East Africa (Start, 1972; Start and Marshall, 1974).

The food of megachiropteran bats tends to be conspicuous, often clumped, and generally abundant and easily harvested within the clumps. Interspecific competition may be limited by spatial and temporal separation. Thomas (1982) studied a savannah community in the Ivory Coast, West Africa. Analysis of the diets of the resident species (*Epomops buettikoferi*, *Hypsignathus monstrosus*, *Rousettus (Lissonycteris) angolensis* and *Micropteropus pusillus*) showed they selected fruits from three mutually exclusive foraging zones and had little dietary overlap, with one exception. Each of these zones was associated with a particular forest height and the habitat (rather than the



The flowers of *Sonneratia alba*, an important mangrove timber tree, are especially "designed" to attract bats for pollination. (Photo by W. E. Rainey)

food resource) was partitioned. Analyses of the feeding behaviour, population sizes and fruit biomass available in the habitat, suggested that the two species with the highest diet overlap (*E. buettikoferi* and *M. pusillus*) could coexist only because fruit biomass was superabundant through most of the year. Migrant species (*Eidolon helvum*, *Myonycteris torquata* and *Nanonycteris veldkampii*) passed through the community at the onset of the rainy season. When they were part of the community, *E. helvum* shared the canopy foraging zone with *H. monstrosus* and *M. torquata* shared its foraging zone with *R. angolensis*. In the first case there was low overlap in diet species since *E. helvum* selected smaller fruits. In the second case there was more overlap in the diet, but coexistence appeared to be possible because *R. angolensis* could not fully exploit the peak in fruit productivity associated with the wet season.

Populations of four genera, *Eidolon*, *Epomophorus*, *Pteropus* and *Rousettus*, undertake seasonal migrations in those parts of their ranges where there are distinctive wet and dry seasons. For

example, *Epomophorus wahlbergi* is not migratory in Kenya but may be so in South Africa (Allen, 1939; Wickler and Seibt, 1976). *Eidolon helvum* is present throughout the year in the tropical forest zone of Africa, but its colonies apparently vary greatly in size with season. Thus in Kampala, Uganda, a large colony numbered about 250,000 bats from September-October through the wet season to the breeding season in April. The colony dispersed in the dry period of July-August, many bats forming small, scattered roosts within 80 km of Kampala, but others presumably moving great distances north or south of the equator (Mutere, 1966, 1980). This species was entirely unknown at El Obeid, over 1400 km north of Kampala in the semi-arid central Sudan, until neem trees (**Meliaceae**: *Azadirachta indica*) were planted there, a tree whose fruit is favoured by many bats (Ayensu, 1974).

Certain plants play a major role in bat nutrition. The most obvious are the figs (*Ficus* spp.), a genus of the greatest importance to frugivorous animals throughout the world. One critical feature of the biology of certain figs is the unusual fruiting phenology, fruiting occurring asynchronously, and each tree fruiting every 6-12 months (Medway, 1972). Most other bat plants are more synchronous and more seasonal in their production of fruit, and we may expect to find a sequential series of flowering and fruiting within a plant assemblage that supports a megachiropteran bat community (Marshall, 1985).

Predators

Fruit bats, particularly on islands, have few natural predators. A variety of birds of prey, both Falconiformes and Strigiformes, various reptiles including snakes and large lizards, and some carnivorous mammals prey upon them (Nelson, 1965a; McClure *et al.*, 1967; Kingdon, 1974; Wolf, 1984; Heideman *et al.*, 1987; White *et al.*, 1988; Pierson and Rainey, 1992). Although predators may influence both feeding and roosting behaviour, they seldom cause serious loss to populations (Marshall, 1983). On the islands of Guam in the Pacific and Christmas Island in the Indian Ocean, introduced arboreal snakes have had, or are likely to have, a devastating effect on the resident bat populations. On Guam, the brown tree snake (*Boiga irregularis*) attacks juvenile fruit bats. Observations of bat colonies between 1984 and 1988 indicated virtually zero survival of juveniles beyond 1-2 months, because of snake predation (Wiles, 1987b). In recent years on Christmas Island, the colubrid snake *Lycodon aulicus capucinus* appears to have established itself, posing a serious future threat (Smith, 1988).

Movements

In the genus *Pteropus*, many species are island forms, either being confined to oceanic islands or, like *P. hypomelanus*, roosting only on islands but flying to the mainland to feed. Mobility must vary greatly from species to species. On isolated islands *Pteropus* must have all its food requirements met by the plants of that island, although food sources will vary with season (Baker and Baker, 1936; van der Pijl, 1956; Perez, 1973;

Wodzicki and Felten, 1975; Cheke and Dahl, 1981). On mainland areas *Pteropus* is certainly highly mobile and may be nomadic rather than migratory. Of the four Australian species, *P. conspicillatus* does not migrate, the coastal *P. poliocephalus* undertakes local seasonal movements up and down the coast, *P. alecto* undertakes more restricted seasonal movements than *P. poliocephalus* and only the inland *P. scapulatus* undertakes major movements, although these are of an erratic nature, largely following the flowering of *Eucalyptus* (**Myrtaceae**) (Ratcliffe, 1932; Nelson, 1965b).

Relationship with other species

Bats are very important pollinators and seed dispersers in tropical forests throughout the world ((Marshall, 1983, 1985; Fleming *et al.*, 1987; Fleming, 1988; Cox *et al.*, 1991, 1992; Pierson and Rainey, 1992) and have shared a long evolutionary history with angiosperms. Angiosperms possibly arose in the South East Asian region, around 130 million years ago, and achieved worldwide dominance over the gymnosperms about 90 million years ago. The first formations that we might recognize as tropical rain forests date from perhaps 60 million years ago. Megachiropteran bats have been in existence for at least 35 million years. Frugivory amongst the Megachiroptera arose before nectarivory (Marshall, 1983).

The visits by Megachiroptera to flowers for food may result in the pollination of those flowers. This is known to be the case for 31 genera in 14 families, with members of the **Bigoniaceae** (8 genera) and **Bombacaceae** (6 genera) being particularly prominent (Marshall, 1985). Many so-called 'bat flowers' are notably well-adapted for bat pollination (Faegri and van der Pijl, 1979), but other animals may also be significant pollinators: for example, *Banksia* (**Proteaceae**) is pollinated by *Pteropus* but also by a rodent (*Rattus* sp.) and a marsupial mouse (*Antechinus* sp.) (Recher, 1981).

Megachiropteran bats feed upon at least 145 genera of fruit in 30 families of plants widely distributed throughout the angiosperms (Marshall, 1985). The most important families are the **Palmae** (16 genera), **Anacardiaceae** (10 genera) and **Sapotaceae** (8 genera). Generally, fruits are consumed when ripe, but this is not always so; for example *Cocos* (**Palmae**) fruits are eaten when small and immature. Large fruits, such as mango (**Anacardiaceae**: *Mangifera indica*), must be consumed *in situ*, but smaller fruits may be carried away from the parent tree before being devoured and the seeds ejected through the mouth or anus. The distance a seed is carried will depend on its size and the size of the bat: tiny seeds which pass through the alimentary canal of a large bat will be carried furthest. *Cynopterus brachyotis* (30 g) can carry a fruit of up to 75 g, but it will seldom carry it more than 200 m (van der Pijl, 1957). On the other hand, *Pteropus vampyrus* (800 g) can carry fruits over 200 g (van der Pijl, 1957; Marshall and McWilliam, 1982). *Pteropus vampyrus* can travel about 50 km each night to feed so that long-distance dispersal may sometimes occur. Many fruits eaten by bats are also favoured by other animals, in particular man.



Macroglossus sobrinus, a South East Allan blossom bat, helps pollinate the flowers of a wild banana plant (*Musa* sp.) (Photo by K. G. Heller).

In the Philippines, an increased germination rate was recorded for fig seeds (*Ficus chrysolepis*) taken from bat faecal masses. It is suggested that this was due to differential ingestion of viable over non-viable seeds (parasitized by wasps of the Family Agaonidae). Because long distance seed dispersal by fruit bats is primarily through faecal deposition, this makes bat dispersal much more effective than previously suggested (Utzurum and Heideman, 1991)

On many oceanic islands, with their limited faunas, fruit bats are the only animals capable of carrying large-seeded fruits. In such ecosystems, fruit bats can be the single most important pollinators and seed dispersers. In island ecosystems in the south-west Pacific, fruit bats are considered to be 'keystone species', because significant declines in forest regeneration rates and diversity would accompany their extinction (Cox *et al.*, 1991, 1992). Many Pacific plant species are assumed to be exclusively dependent on fruit bats for successful pollination (Marshall, 1983; Cox, 1984a; Marshall, 1985; Elmquist *et al.*, in press). P. Cox (pers. comm.) has estimated that at least 30% of forest trees on Samoa are bat-dependent. In Samoa during the dry season, 80-100 % of the seeds deposited on the ground (seed rain) in lowland forest are transported by fruit bats (Cox *et al.*, 1992). The role of fruit bats in more complex ecosystems has been the subject of limited attention (Thomas, 1983).

Economic importance of fruit bats

Many of the plants that benefit from pollination or seed dispersal by bats are economically important to man (Fujita and Tuttle, 1991; Wiles and Fujita, 1992). At least 443 products useful to man derive from 163 plant species that rely to some degree on bats for pollination or seed dispersal (Fujita and Tuttle, 1991). These products include timber, fruits, fibres and tannins that contribute significantly to world markets as well as less well known products, such as medicines and food items important in local economies. The increasingly popular durian fruit (*Durio zibethinus*) depends on bats for pollination, as does petai (*Parkia speciosa* and *P. javanica*) whose seeds are a popular food item in South East Asia. Fujita and Tuttle (1991) estimate

the monetary value of these and a third product (the fruit of duku - **Meliaceae:** *Lansium domesticum*) to exceed \$US4 million annually in Indonesia. Annual sales of petai are estimated to exceed \$US 1 million in Peninsular Malaysia alone (Ng, 1980). Twelve tree species dependent on bats for dispersal are major timber species in Malaysia, one of the largest timber exporters in the world. The kapok or silk-cotton tree (*Ceiba pentandra*), the fibre, bark and seeds of which are economically important, is pollinated by a large number of bat species in Africa and South America (Baker and Harris, 1959; Toledo, 1977) but pollinated solely by *Pteropus tonganus* in Samoa (Elmqvist *et al.*, in press).

Population Biology

Reproduction and longevity

The reproductive biology of fruit bats is reviewed by Pierson and Rainey (1992). Fruit bats are long-lived animals with low reproductive rates. In general, females do not give birth for the first time until they are one or two years old (Asdell, 1964; Nelson, 1965a, 1965b; Thomas and Marshall, 1984), although some small species (e.g. *Macroglossus minimus* and *Eonycteris spelaea*) may give birth before they are one year old (P. D. Heideman, pers. comm). Females generally give birth to one young at a time after a 4-6 month gestation (Marshall, 1947; Neuweiler, 1969; Racey, 1973). In *Pteropus*, although the young may fly at three months they usually are not weaned until they are 4-6 months old, and may remain dependent on their mothers for a year. Lifespan in the wild is not well-documented. Heideman and Heaney (1989) undertook a capture-mark-recapture study of fruit bats on Negros in the Philippines. For three species (*Cynopterus brachyotis*, *Haplonycteris fischeri* and *Ptenochirus jagorii*), animals marked as yearlings were recaptured at least three years following first marking and from this data minimum longevities were estimated to be four to five years. In contrast, captive *Pteropus giganteus* have lived over 30 years (Nowak, 1991). Minimum mortality rates for juvenile *H. fischeri* were estimated at 10-30% during the first two-thirds of lactation and combined sub-adult and adult survival at 60% to 80%.

Breeding seasons

All wild populations of *Pteropus* that have been studied, except those of *P. mariannus yapensis* (Falanruw, 1988a), *P. mariannus mariannus* (Wiles, 1987b) and *P. pumilus* (Heideman, 1987) have a well-defined breeding season, with one young per adult female per year (Pierson and Rainey, 1992). In some species, there is a period of delayed implantation, as shown in *Eidolon helvum* where copulation occurs in June or July but gestation does not begin until November, with the young born in mid- to late-March (Mutere, 1967; Fayenuwo and Halstead, 1974). In *Haplonycteris fischeri* there is an 8-month post-implantation

delay in embryonic development (Heideman, 1988). Some other pteropodid genera follow the same general pattern as *Pteropus* (Mutere, 1967; Dwyer, 1975; Heideman, 1987), but most breed aseasonally or exhibit two birth peaks a year (Thomas and Marshall, 1984; Heideman, 1987). Females of these pteropodid species often copulate in a post-partum oestrus and, as a result, are capable of producing two young per year (Thomas and Marshall, 1984; Falanruw, 1988a; Makin, 1990).

The population biology of fruit bats is remarkably similar to that of primates and their limited reproductive capacity makes them especially vulnerable to catastrophic events, such as cyclones and typhoons, and unnatural predation such as overhunting (Pierson and Rainey, 1992). When subjected to drastic declines, bat populations take several years to recover. In particular, island taxa, with restricted distributions, are at risk of extinction (MacArthur and Wilson, 1967).

Recorded declines

Available data on the status of many fruit bats suggest serious population declines throughout the range, due principally to habitat loss, overhunting, and, on islands, tropical storms (Pierson and Rainey, 1992).

Reports by early explorers and scientists suggested that densities of fruit bats were once high throughout the Old World tropics. For example, Peale of the US Exploring Expedition in the 1840s described the forest of Samoa as being infused with the odour of bats (Cassin, 1858). Today there is no odour of bats in the forest, and it is possible to visit Samoa and never see a fruit bat (E. D. Pierson, pers. comm.). In the Philippines, roosts of up to 150,000 bats (*Pteropus vampyrus* and *Acerodon jubatus*) were common as late as the 1920s, but the largest colonies now number no more than a few hundred individuals (Heaney and Heideman, 1987; Diamond, 1988). In Australia in 1930, Ratcliffe (1932) reported *Pteropus* 'camps' of up to 10 km long and 1.3 km wide, with estimated numbers of up to 30 million. Now, many colonies have disappeared entirely, and only a few are reported to contain more than 100,000 individuals (Pierson, 1984). In a recently completed survey of bat utilization in Indonesia and Malaysia, Fujita (1988) reported that for the past 10 years hunters have been finding it increasingly difficult to locate *Pteropus* roosts.

Threats

Introduction

Man's activities are the most important threat to fruit bats. Many species are dependent on primary forest and thus threatened by the large-scale destruction of rain forest in many tropical areas. Disturbance of roosts may be incidental or deliberate. Many fruit bats are hunted both at a local or

commercial level. Commercial hunting of species in the Pacific area to satisfy the demands of consumers on the island of Guam has resulted in the decline of many populations and the extinction of at least one species. In some areas there has been conflict between bats and commercial fruit growers.

Bats are also threatened by natural factors. Tropical storms are an ever present hazard and can have devastating effects, particularly where populations are already under pressure from human activities. Disease is a factor whose importance is not yet fully understood.

Major threats to fruit bats

Destruction of habitat by man

Habitat loss has been cited by a number of authors as a major factor contributing to declines in fruit bat populations (Wodzicki and Felten, 1975; Racey, 1979; Cheke and Dahl, 1981; Carroll, 1984; Pernetta and Hill, 1984; Diamond, 1988; Fujita and Tuttle, 1991; Pierson and Rainey, 1992). Although information on habitat requirements is limited for some species, it is evident that there is considerable ecological variation within the family. Some species, like *Pteropus gilliardi* on New Britain and *P. livingstonii* on the Comoros, for example, appear to be confined to montane forests; others, like *Pteropus conspicillatus* in Australia or *P. tonganus*, frequent agricultural areas.

Deforestation, widespread in almost all tropical areas of the world, has had several identifiable consequences for fruit bat populations (US Fish and Wildlife Service and National Environmental Protection Board, 1989). Many species, particularly those inhabiting mangrove swamps (e.g. *Pteropus vampyrus* in Malaysia and Indonesia) and lowland forest, have lost critical roosting areas. Mangrove swamps are being destroyed by the woodchipping industry, for mariculture, firewood, and coastal development, and lowland forest is felled for agriculture and timber.

Loss of forest results in the loss of critical food resources for many species. The loss of tamarind trees (**Leguminosae: *Tamarindus indica***), a favourite food of *Pteropus rodricensis*, has been identified as one factor in the decline of this species (Cheke and Dahl, 1981). Even *Pteropus tonganus*, which appears adaptable to agricultural conversion, greatly preferred native to cultivated fruits in a recent feeding trial (E. D. Pierson, pers. comm.).

Urbanization involves road building and easier access to remote roosting areas (Falanruw, 1988a). This means it has been easier to hunt animals at their roosts. Such disturbance can cause animals to abandon roost sites (Wiles, 1987b), with serious consequences, particularly during the maternity season.

On many islands forest loss due to human depredation is exacerbated by tropical storms, because remnant forest is particularly prone to damage by high winds.

Disturbance at roost sites by man

Many fruit bat species are strongly colonial and this makes populations vulnerable to disturbance at their roost sites. In the case of cave-dwelling fruit bats, populations are threatened by over-exploitation for bat guano (originating mainly from the insectivorous bats with whom the frugivores share these caves), by mining and quarrying of the caves themselves or of the adjacent environment, and other uses to which caves are put (such as religious worship, tourist attractions, or even as human habitation). Examples can be found where visitors to temple caves are not a major problem to the bats (such as in Bali), but this has proved a problem in others. Improved education about bats can also result in conservation problems: tourists now want to see spectacular bat colonies and there is already evidence of unacceptable levels of disturbance caused to cave-dwelling bats by uncontrolled visits to well-known bat caves. In Thailand there have been reports of deliberate disturbance of cave-roosting bats by tour guides (Hutson, 1990). Similarly, the colony of *Pteropus vampyrus* in the Botanical Garden at Bogor in Indonesia is protected but nevertheless often disturbed (and sometimes even hunted) by the guards, to please the tourists (W. Bergmans, pers. comm.). It should be stressed, however, that careful use of colonies as educational tools has proved very successful, as shown in Australia with the Gordon fruit bat colony in Sydney.



Logging is a special problem for the many fruit bat species that are restricted to small blands. (Photo by W. E. Rainey)

Conflict with fruit growers

Interactions between bats and commercial fruit: In some areas of the world (for example, Australia, Israel and South Africa) large-scale commercial fruit growing has led to conflicts between fruit growers and bats (Jacobsen and Du Plessis, 1976; Loebel and Sanewski, 1987; Makin and Mendelsohn, 1987). Many cultivars have been developed from wild species that are dependent upon bats for pollination or seed dispersal, or both (van der Pijl, 1957; Marshall, 1983). The same characteristics (colour, smell, taste) that attract bats to wild species may also attract them to cultivated ones, although in the latter case they

can rarely be beneficial as pollinators or seed-dispersers as this role has largely been supplanted by the fruit grower. One exception to this is the durian, which still relies heavily on bats for its pollination. The most serious conflicts may occur where the supply of native fruits has been reduced through forest loss (Fleming and Robinson, 1987; Tidemann and Nelson, 1987) or where there has been a mass failure of native plants to flower, as has happened with *Eucalyptus* in Australia, whose blossoms provide the predominant food for *Pteropus* species there (Ratcliffe, 1931; Nelson, 1965a).

In most cases bats feed on fruit that is too ripe to be marketable. Many fruits are picked when they are unripe and allowed to ripen off the tree. The ripening of fruit is mediated by the action of ethylene (Burg and Burg, 1965), which is produced naturally in the plant, and which is produced in increasing quantities as ripening progresses (Burg, 1962). Any trauma to the plant tissue (e.g. bites or scratches) can also lead to increased ethylene production (Yang, 1981) and in some cases premature ripening. Thus damage can be caused indirectly by bats clambering over unripe fruit or through 'test bites' (Ratcliffe, 1931; van der Pijl, 1957). The relative perceived scale of damage has also increased through increased market demands for unblemished fruit.

The level of damage varies considerably with locality and is generally greatest in the summer when females are lactating and have greater energy requirements.

Crop protection and management of fruit bats: In the 1930s in Australia, Ratcliffe (1931) concluded that the impact of fruit bats on fruit-growing was insignificant. As available natural habitat declined and the fruit-growing industry expanded, so the problem became economically more important (Tidemann and Nelson, 1987) and resulted in protective legislation for fruit bats being repealed in 1984 in Queensland.

Destructive management methods such as shooting have been favoured in the past and persist today. However, a growing body of opinion favours non-destructive methods, and a thorough investigation of the effectiveness of such methods is a high priority.

The methods of protection and control can be grouped into three main categories: management at roosts, protection at orchards and management of farms.

1. Fruit bat roost management.

Dispersing daytime roosts is still the most common approach to management. Shooting is the most popular method though other forms of harassment have included the use of helicopters, bird-scare guns, dense smoke and loud noise. In these cases the colony may simply end up moving to a nearby location (Palmer, 1987).

More drastic methods of management include the total removal of trees and draining of swamps. Again, this may not necessarily move bats from the general area. Fruit bats can travel 40 to 50 km in a night to reach feeding areas, as has been shown for *Eonycteris spelaea* (Start, 1974), and have a well-



Bus advertising control of fruit bats, Harare, Zimbabwe. (Photo by A. M. Hutson)

developed memory of the landscape they utilize (G. C. Richards, pers. comm.).

In Israel, campaigns were undertaken against *Rousettus (Rousettus) aegyptiacus* by fumigation of their cave roosts. As well as killing the target species it also resulted in heavy losses amongst insectivorous bats that shared the cave roosts (Makin and Mendelsohn, 1987).

In the Maldives, drastic control measures have been instigated that could threaten the resident bats, *Pteropus giganteus anel*, and *P. hypomelanus maris*, with extinction (see relevant species accounts). Accurate estimates of crop damage and population numbers were not made before netting started, reducing some island populations by up to 80% (Dolbeer *et al.*, 1988).

If considered necessary, roost management can be carried out on a sustainable basis, as has been shown by Halstead (1977), who detailed the management programme at the University of Ife, Nigeria. There, controlled culling of the resident colony successfully provided income through the sale of bat meat, and animals that were used for teaching and research.

In general destructive roost management methods are at best ineffective and at worst highly damaging to target and non-target bat species.

2. Crop protection in orchards

Many techniques and devices have been used in attempts to protect orchards against fruit bat raids.

A number of techniques have met with initial success, but proved unsuccessful in the longer term. Scare guns probably deter bats from making an initial visit but could end up attracting bats. Similarly the efficacy of ultrasonic scarecrows is doubtful (Fleming and Robinson, 1987). Other sonic devices have been tried but their use is limited (Calford and McAnally, 1987). Flashing strobe lights and bright light grids over orchards have been initially successful, but it appears that bats become accustomed to the lights and will feed in a fully illuminated orchard as they will in suburban fruit trees. Bright lights may also attract bats, sometimes acting as a beacon to guide them to

the orchard each evening. Harassment by random shooting, beating metal drums and smokey fires have all been used with some success, but depend upon regular use throughout the night. The unpredictable nature of fruit bat raids and the long man-hours involved make these techniques unattractive for fruit-growers.

Other techniques have met with more success. Replaying recorded sounds of bat distress calls has shown some promising results, but further studies are required. The smell of carbide has been claimed to be successful in deterring bats from litchi trees (**Sapindaceae: *Litchi chinensis***) in northern Queensland (Watson, 1982). Fruit bats have a highly developed sense of smell and observations on captive bats (H. Luckhoff, pers. obs.) show they have an extreme aversion to the smell of fresh meat, particularly liver. Tests on a bird-repellent, Methiocarb, indicate that this may be suitable for fruit bats (M. Tuttle, pers. obs.). It is a short-lived carbonate, which breaks down in sunlight and is a powerful emetic. Birds soon associate its effects with the fruit they eat. No long-term effects, or deaths, have occurred during trials. Netting is the most effective method of protecting trees from fruit bats (Loebel and Sanewski, 1987). It has the added advantage of keeping out other pests such as birds and possums, although it is expensive and needs regular maintenance. Similarly, electric wires may be effective for small orchards. To be effective for fruit bats the wires must be no more than 25-30 cm apart with additional dangling wires forming a circular curtain around each tree (Anon., 1983).

Out of all of these techniques, netting is the most effective, though it is expensive to erect and maintain.

3. Farm management

The careful management and siting of fruit farms may yield the most effective results.

Decoy trees are showing promising results in several areas where rows or buffer zones of other fruit trees such as native figs are used. More research is required on the species of tree used, the time they take to produce fruit and their season of fruiting in relation to the commercial crop.

Early picking of the fruit crop is an effective management strategy (Tuttle, 1985) but may not be suitable for all fruit. Bats may damage quite small and green fruits (e.g. peaches [**Rosaceae: *Prunus persica***]) if natural food sources are scarce, and developing fruit when visiting blossoms for nectar or when visiting early ripened fruit (e.g. bananas [*Musa* spp.]).

The removal of early ripened and over-ripe fruit left after picking should be considered in farm management. Both these situations are known to attract fruit bats and in the latter case, may attract fruit bats to nearby orchards, which may not yet have picked their fruit.

Damaged fruit can be used for juicing and canning, but, depending on the crop, cuts the fruit-growers' profits considerably. Fruits such as mangoes, still intact but rendered unmarketable because of teeth marks, are one example where income could be gained by alternative uses.

Growing alternative crops and shifting the locality of the farm may be the best solution in areas where fruit bats are a

problem. New fruit farms should be sited with care. There are still regular examples of new orchards being established in close proximity to large permanent fruit bat colonies, even where natural food supplies are reduced by the removal of native forests. Crops that need to ripen on the tree should be avoided in known fruit bat areas. If seasonal movements of fruit bats are known to occur in an area, fruit species that will crop while fruit bats are absent would be more suitable to grow. Orchards should be laid out in blocks or segments of a size that facilitates techniques for crop protection, such as netting. In conclusion, there is no cheap or simple answer to the problem of fruit bat damage to crops. The major cause of the problem is related to loss of natural habitat coupled with a growth in the fruit-growing industry. Destructive management techniques should be banned and research into the effectiveness of other non-destructive methods stepped up. Above all, no management scheme should be instigated without first assessing the level of damage and the likely long-term threat to the target species. This can be achieved only through closer cooperation between fruit growers and conservationists.

Hunting and Trade

Bats as a food item: In many areas bats have for a long time been important as food for local people. There are records of fruit bats as a major dietary item from most of their range, from Guam (Wiles, 1987a, 1987b), Vanuatu (Chambers and Esrom, 1991), Samoa (Cox, 1983), the Cook Islands (Wodzicki and Felten, 1980), the Philippines (Heaney and Heideman, 1987), the Togian Islands (Owen *et al.*, 1987; Hill, in press), Irian Jaya (Craven, 1988), Thailand (Lekagul and McNeely, 1977), Indonesia and Malaysia (Fujita, 1988) and the Seychelles (Racey, 1979; Cheke and Dahl, 1981). In South East Asia, fruit bat meat is also valued as a remedy for asthma, kidney ailments, and 'tiredness', especially among people of Chinese origin (Fujita and Tuttle, 1991). In Nigeria, bats are occasionally found in ju-ju stalls because they are thought to cure barrenness (and to promote fertility) in women (Shoga, 1974).

In some areas, such as in the Marianas in the western Pacific, fruit bats are considered a delicacy and are served at social occasions such as village fiestas, weddings, christenings and holiday celebrations (Wiles and Payne, 1986). In many local markets, bats have a considerable commercial value (Wiles and Payne, 1986). In north Sulawesi, up to 16 species of bats were found to be available in local markets, including some species hitherto considered rare (Bergmans and Rozendaal, 1988). Fruit bats are a luxury item on restaurant menus in many parts of their range (Anon., 1988b, 1988c; Fujita and Tuttle, 1991). In the Seychelles, restaurants advertise bat curry, and Racey (1979) estimated that one restaurant could use up to 1500 bats a year.

Hunting and the decline in bat populations: Traditionally, fruit bats have been hunted using methods such as thorny vines, nets or fish hooks (Cox, 1983; Fujita and Tuttle, 1991). The introduction of firearms and the transition from subsistence to



A flying fox (*Pteropus tonganus*) packed for sale in a Saipan supermarket. (Photo by G. J. Wilts)

commercial harvesting has resulted in declines in bat populations in many parts of their range (Wodzicki and Felten, 1975; Engbring, 1985; Wiles, 1987b). In 1988, several Samoan chiefs indicated that declines in local bat populations began with the introduction of guns (P. Cox, T. Elmqvist, E. D. Pierson and W. E. Rainey, pers. comm.). Overhunting has been depleting fruit bat populations since 1930 (Wiles and Payne, 1986), and any cultural limitation on the exploitation of this resource has long since been forgotten (Falanruw, 1988a).

The level of hunting in Malaysia and Indonesia is difficult to estimate but a survey in 1985-86 revealed that hunting for human consumption was quite common (Fujita and Tuttle, 1991). Fujita and Tuttle (1991) reported that figures provided by many bat vendors suggest that the annual sales of a single vendor could be about 10,000 bats a year, enough to eliminate an average sized colony each year.

In northern Thailand, R. E. Stebbings (pers. comm.) reported that hunters from large towns made trips to known bat caves in order to net bats (both fruit-eating and insectivorous) with serious effects on populations.

In Africa the hunting of bats is known to occur in Guinea (J. R. Wilson, pers. comm.) and Nigeria (Happold, 1987). The degree to which hunting affects bat populations, whether in these two sites or elsewhere, is unknown.

In addition, the most intense hunting for local use seems to occur during the bats' reproductive season. Hunters in Indonesia, Malaysia, Samoa and the Cook Islands (Wodzicki and Felten, 1980; Fujita and Tuttle, 1991; La Mositele, pers. comm.) identify a 'bat season', which coincides with the main fruiting or flowering peaks. During this time, females are often caught pregnant or with attached young. This seasonality of hunting has important implications for the ability of populations to recover from intense hunting pressure.

Guam and the trade in the Pacific: A comprehensive overview of the history of the Pacific bat trade is given in Wiles (1992).

By far the most serious threat to bat populations has come

from the trade in fruit bats centred on Guam. Archaeological evidence indicates that the Chamorro people of Guam and the other Mariana Islands have been eating fruit bats for over 1000 years (Lemke, 1986). While traditional hunting methods were used, the harvest had little impact on bat populations (Lemke, 1986). However, with the introduction of firearms and a cash economy populations declined, with the endemic species, *Pteropus tokudae*, becoming extinct. Because of these declines, Guam's residents began importing fruit bats from elsewhere in the Pacific as early as the late 1960s (Wiles and Payne, 1986). Statistics on annual imports of fruit bats have been compiled by the Guam Division of Aquatic and Wildlife Resources since 1975 (Table 2). Between 1975 and 1989, a total of 220,899 fruit bats were imported into Guam.

The main species involved in trade is *Pteropus mariannus*. However, other species have been seen in trade. *Pteropus vampyrus*, *P. hypomelanus* and *Acerodon jubatus* have been

exported from the Philippines, and *P. samoensis* from Western Samoa. In the last case, this species is the much less common of the two resident Western Samoan species (P. Cox, E. D. Pierson and W. E. Rainey, pers. comm.).

Many countries have supplied Guam with fruit bats (Table 2). The pattern of trade has shifted in response to changes in legislation and political status of the countries concerned. The political map of the western Pacific is complex (see Figure 2) and trade between countries and Guam (an unincorporated US Territory) has been classed as internal or international depending on the political status of the exporting country. This has had serious implications because CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora) covers only international trade. For example, the Commonwealth of the Northern Mariana Islands (CNMI) is a US Commonwealth, and trade between the CNMI and Guam is classed as internal and not covered by CITES, while the

Table 2. Summary of numbers of fruit bats imported into Guam in the period Financial Years 1975-1989. Data are largely lacking for 1987. After Wiles, 1992.

Country of origin	Total imports	Period of import	Peak annual import and year	
American Samoa	4155	1980-86, 1989	1632	(1984)
Belau	112,184	1975-89	18,606	(1979)
Commonwealth of the Northern Mariana Islands				
Pagan	190	1976	190	(1976)
Rota	7145	1975-82, 1986-88	1893	(1975)
Saipan	7813	1975-82, 1985-89	1841	(1976)
Tinian	1366	1975-81	433	(1978)
Federated States of Micronesia				
Chuuk	5795	1978, 1980-82, 1985-89	2507	(1989)
Kosrae	69	1980, 1984, 1989	27	(1980,1984)
Pohnpei	15,223	1976, 1979-89	6478	(1989)
Ulithi	50	1980, 1989	37	(1989)
Yap	23,410	1975-81, 1987-89	879	(1980)
Fiji	6	1980	6	(1980)
Indonesia	7	1986	7	(1986)
Papua New Guinea	1789	1977, 1983-84	1539	(1984)
Philippines	3092	1982, 1986-88	2571	(1986)
Solomons	1	1979	1	(1979)
Tonga	5080	1983-84	3050	(1983)
Vanuatu	12	1984	12	(1984)
Western Samoa	33,341	1981-88	8350	(1983)
Unknown	171	1986-89	84	(1987)
Total imports:	220,899			

Notes

1. Import figures for financial year 1980 cover a 15-month period.
2. Figures for 1976, 1978 and 1980 are extrapolations based on data collected for 8-11 month periods.
3. Import figures were not tabulated in 1981 but were extrapolated by G. Wiles using the number of requests and the request-import ratio for each island group in 1980, 1982 and 1983.

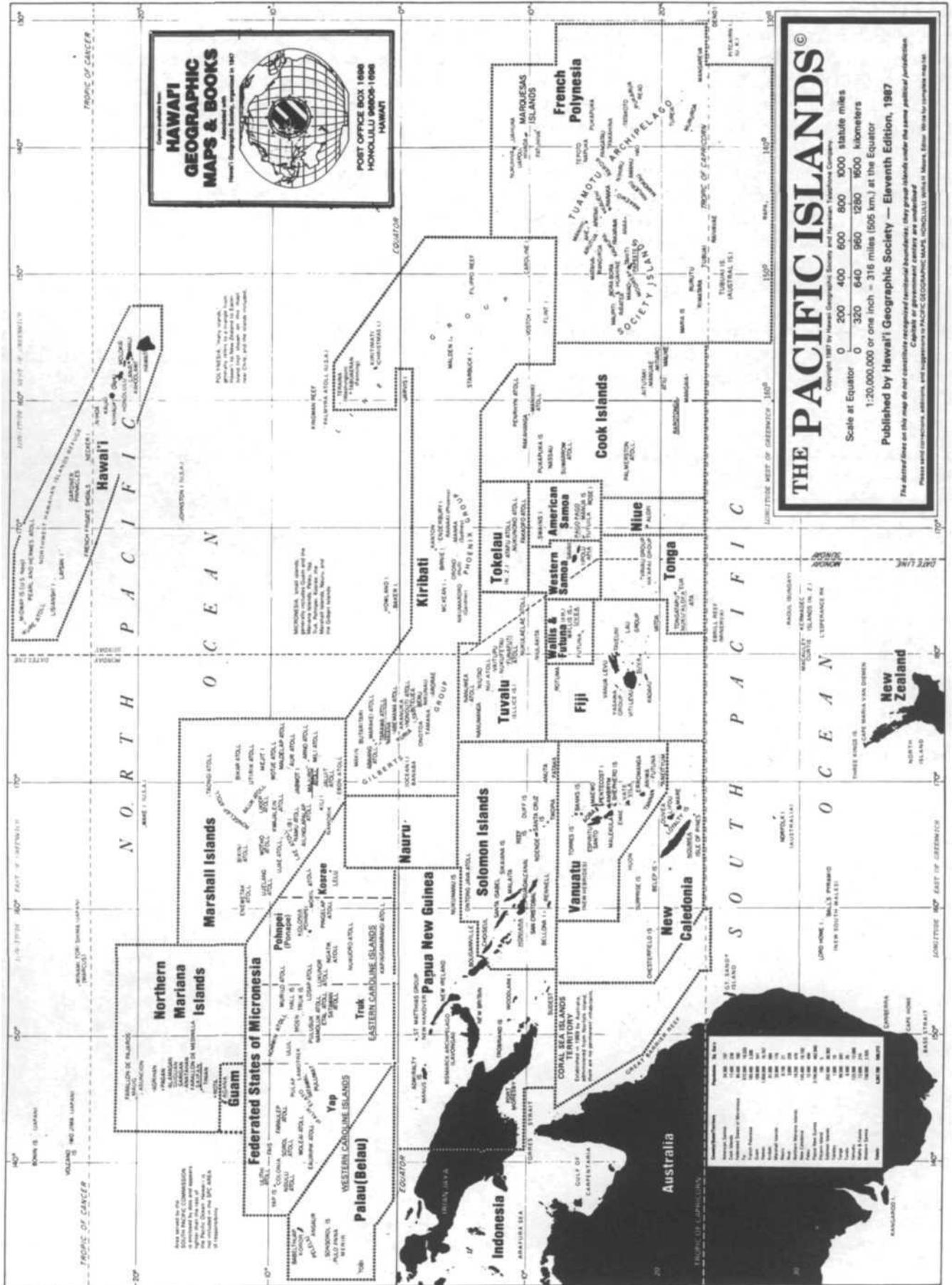


Figure 2. Political map of Pacific Islands. (Reproduced with kind permission of the Hawaii Geographic Society)

Federated States of Micronesia (FSM), formerly part of the US Pacific Trust Territory, is now independent and thus trade is covered by CITES. Changes in legislation have not necessarily curbed the trade in fruit bats. In the CNMI, despite a series of one- and two- year hunting moratoria first established in 1977, trade has continued, mostly from the southern, heavily populated islands of Saipan, Tinian and Rota. This has resulted in declines in numbers of resident bats. Exports from Pohnpei and Chuuk in the FSM have continued since independence in 1986, despite the trade being covered by CITES. However, in other countries, enactment of legislation has curbed trade, as in Yap (FSM, legislation enacted in 1981), American Samoa (legislation enacted in 1986) and Western Samoa (legislation enacted 1989). In 1989, the CITES regulations were amended so that all *Pteropus* and *Acerodon* species were on either Appendix I or II. Appendix I prohibits trade in all but a few exceptional circumstances, while Appendix II controls, but does not prohibit, international trade. During the first three months of 1990 (before enforcement) Guam imported an estimated 3989 fruit bats, while in May and June imports dropped to 292 (Wiles, 1990). However, there remains one significant loophole. Belau, a trust territory of the US, has continued to export fruit bats legally to Guam and Saipan because of this being internal trade. Belau has been the major supplier to the Guam market since 1975, exporting over 110,000 bats between 1975-89 (Table 2). A decline in shipments in mid-1990 was short-lived, and between October 1990 and February 1991, Belau sent about 3800 bats to Guam and continued to send bats to Saipan in the CNMI (G. Wiles, pers. comm.).

There is also a continuing illegal trade in fruit bats into Guam. In the period 1986-88 Guam Customs and Quarantine Division confiscated 1580 bats in 118 shipments (Wiles, 1986, 1987c, 1988). Bats are reported to be smuggled in coolers filled with fish from Rota to Guam (Lemke, 1986), and similarly from Western Samoa to American Samoa and then on to Guam.

Finally, while the trade has centred on Guam, there has been trade in other countries in the Pacific. M. S. Fujita (pers. comm.) reports that both *Pteropus vampyrus* and *P. hypomelanus* are traded extensively in South East Asia. Malaysian bats

appear in markets in Singapore and probably Jawa; bats from Irian Jaya may be traded in Jawa. Vanuatu exported 365 *Pteropus tonganus* to Noumea, New Caledonia in 1989 and early 1990 (E. Banei, pers. comm.).

Future problems and needs: Amendment of the CITES regulations has helped to curb the trade significantly, although the situation in Belau remains worrying. The enforcement of CITES regulations is critical to the survival of many endangered Pacific species. In the past the trade has shifted rapidly from country to country in response to changes in regulations and supply (i.e., depletion of stocks), and there are a number of countries (for example in South East Asia) that might enter into trade should other sources close down (G. Wiles, pers. comm.). Determining the source of some bats is made difficult by problems of identification and there is an urgent need for an identification key to those animals in trade.

Destruction of habitat by tropical storms

In addition to the threats introduced by humans, bats on small islands are also vulnerable to natural pressures. The endemic *Pteropus rodricensis* was brought to the edge of extinction in Rodrigues by a combination of deforestation, hunting for food, and cyclones. In 1979 Cyclone Celine II reduced the number of animals from 151 to 70 (Jones, 1980; Carroll, 1984).

The effects of the typhoon that hit Western Samoa and American Samoa in February, 1990 on *Pteropus tonganus* and *P. samoensis* are still being evaluated. After the typhoon the bats were foraging for fruit on the ground or at fallen trees in villages, not always at night. Since they were often unable to take flight from the ground they were extremely vulnerable to predation. Domestic animals (dogs, cats and pigs) were reported to have killed large numbers of *P. tonganus*. Since cats and pigs also forage extensively in agroforest, the mortality was probably greater than that directly observed (E. D. Pierson pers. comm.).

For nearly a week in 1986, Malaita, an island in the southern end of the Solomon Islands, was pounded by Cyclone Namu, causing a significant loss of human life. During the cyclone's passage over the southern islands, considerable damage was done; landslides denuded large areas, and vast tracts of forest were stripped of leaves and fruit. Flannery (1989) visited Sinalaggu harbour, off Malaita's east coast in December 1987, and was shown hundreds of lower jaw bones of fruit bats that had been collected in the few months following the cyclone. The great majority of the bones were of *Pteropus rayneri* but a few were *P. tonganus*.

Evidence from the Marianas, Samoa and Vanuatu suggests, however, that a major cause of storm-related mortality of fruit bats is intense post-storm hunting (Pierson and Rainey, 1992). Defoliation reduces concealment of roosting animals, so they are more readily hunted. Because of decreased food availability, bats may forage diurnally and become less cautious, increasing the risk of opportunistic killing. Perhaps more important is the long-term damage to already damaged forests and the time that it may take for forests to recover, if they are indeed allowed to.



Fruit bat advert from *Pacific Daily Newt*. (Photo by G. J. Wiles)



Forest re-sprouting after typhoon damage on Saval'i, Western Samoa.
(Photo by W. E. Rainey)

The long-term survival of bats depends on the status of populations and the storm intensity. Forests on Rota (in the CNMI) recovered after being hit by a storm but the bat population dropped to a new low, further increasing the risk of extinction (E. D. Pierson, pers. comm.).

Epidemic disease

What little is known about disease in fruit bat populations is summarized by Pierson and Rainey (1992). The first evidence of severe epidemics decimating wild populations comes from the Whitney Expeditions in the 1930s. In a 2-month survey of Kosrae in the Federated States of Micronesia, researchers located only four bats (*Pteropus mariannus ualanus*) and learned from local residents that the other animals had all died in a recent epidemic associated with an outbreak of measles in the human population (Coultas, 1931). Degener (1949) reports on a similar epidemic depleting *P. tonganus* populations near Savu Savu, Fiji, sometime prior to 1949. More recently, Flannery (1989) described epidemics in two bat populations. In June 1988 Flannery visited Manus, the largest of the Admiralty

Islands, north of the New Guinean mainland. During a week of searching in central Manus, he failed to find *P. neohibernicus*, although the smaller *P. admiralitatum* was abundant. Local people reported that in 1985 many *P. neohibernicus* were found dead and dying, presumably from disease, under large and well-known roosts. The deaths occurred throughout the island over a period of a few weeks, and afterward no large fruit bats were seen for several years. Just before the time of Flannery's 1988 expedition, several hunters reported having seen an occasional large fruit bat, suggesting that the entire population had not been wiped out. Flannery (1989) reports on a similar incident on the islands of Bougainville and Buka in the northern Solomons in 1987. In this case, the dead bats were largely or entirely *P. rayneri grandis*. Populations of *P. neohibernicus* on the islands of New Ireland and New Britain, which lie between Manus and Bougainville, were examined in 1988 and 1989 and had suffered no such decline.

On Manus and Bougainville the high fatality rate and exceptional nature of the epidemics suggest that the organism responsible was not endemic, and indeed may have been newly introduced into these populations by domestic animals (Flannery, 1989).

Protection status

Bats receive protection both at national and international levels. Full details of national legislation can be found in International Union for the Conservation of Nature and Natural Resources Environmental Law Centre (1986) (for Africa), and Nichols *et al.* (1991) (for Asia and Oceania). Details of international legislation can be found in Lyster (1985).

National

There is a great variation in how fruit bats are treated under national legislation and the sections below are arranged according to the level of protection, or otherwise, that bats receive.

Countries giving full protection: Only **Ethiopia** protects all members of the Family Pteropodidae. Other countries give full protection to certain species. Thus *Rousettus (Rousettus) leschenaulti seminudus* is fully protected in **Sri Lanka**, as is *Pteropus niger* on **Réunion**, *P. rodricensis* in **Mauritius** and *P. mariannus mariannus* on **Guam**.

Countries giving partial protection: **Madagascar** lists the resident *Pteropus rufus* as noxious, but charges a fee for holders of commercial permits to allow them to take bats. **Malaysia** (federal), under its Protection of Wildlife Act of 1972, partially protects and prohibits or regulates possession or national trade and international trade of *Pteropus hypomelanus* and *P. vampyrus*. **New Caledonia** gives partial protection to fruit bats by the regulation of hunting. In **Papua New Guinea** the use of mist nets to take bats is prohibited without prior permission of the conservator. In **Burkina Faso** there is partial protection for

Epomophorus and *Myonycteris* species, although other bats are exempted from the wildlife regulations. In **Fiji** *Pteropus tonganus* and *Notopteris macdonaldii* are protected through regulation of international trade. In the **Commonwealth of the Northern Mariana Islands (CNMI)** 1- and 2- year moratoria on hunting have been established. In **Yap** there is a ban on the taking and exporting of bats. Similarly, in **American Samoa** no commercial harvest of bats is allowed and export and hunting are regulated. In **Western Samoa**, commercial export of bats is banned. In **Belau** the only protection given is that bats must be harvested using nets. **Nepal** gives partial protection to all fruit bats.

Countries exempting bats from wildlife regulations: Benin, Ivory Coast and Togo exempt bats from their wildlife regulations, as does **Burkina Faso**, although here two genera are given partial protection (see above). **Pakistan** exempts bats from the regulation of international trade, while the **Punjab** area of **Pakistan** specifically excludes *Pteropus giganteus* from protection. **South Africa** exempts fruit bats from its regulations. In **Australia** a number of species are not protected, although in some cases national and international trade is regulated. Thus, *Pteropus alecto* is unprotected in **Queensland** and **Western Australia**, *P. poliocephalus* is unprotected in **Queensland**, *P. scapulatus* is unprotected in **Queensland, New South Wales** and **Western Australia** and *Macroglossus minimus* is unprotected in **Western Australia**.

Countries listing bats as 'noxious': India, Indonesia and Israel specifically list fruit bats as 'noxious', although in the case of **Indonesia** this refers to 'fruit-eating bats'. In the **Northern Territory of Australia**, *Pteropus alecto* and *P. scapulatus* are listed as 'noxious'.

It can be seen that the national laws protecting bats are very varied and in some cases very complex. There are also some anomalies. For instance, *Pteropus rodricensis* is given full protection under **United States** regulations, and partial protection by **Natal** in **South Africa**. Similarly, *Aproteles bulmerae* (from New Guinea) is given full protection under **United States** regulations, but under the Lacey Act bats of the genus *Pteropus* are listed as injurious animals.

International

CITES (The Convention on International Trade in Endangered Species of Wild Fauna and Flora)

Full details of the structure of CITES are given by Lyster (1985).

In October 1989, CITES member states approved proposals to include seven species of fruit bats in CITES Appendix I (Table 3) and all six species of the genus *Acerodon* and the remaining *Pteropus* species in CITES Appendix II. The Appendix I listing provides for a prohibition on international trade in the most threatened species, while the Appendix II listing provides for regulation of international shipments

Table 3. *Pteropus* specks included in CITES Appendix I as of 18 January 1990.

<i>Pteropus insularis</i>	Chuuk fruit bat
<i>Pteropus mariannus</i>	Marianas fruit bat
<i>Pteropus molossinus</i>	Pohnpei fruit bat
<i>Pteropus phaeocephalus</i>	Mortlock fruit bat
<i>Pteropus pilosus</i>	Belau fruit bat
<i>Pteropus samoensis</i>	Samoan fruit bat
<i>Pteropus tonganus</i>	Insular fruit bat

containing other *Pteropus* and *Acerodon* species. This decision was a major achievement for conservationists and promises substantive international protection for these species for the first time.

Belau's status as the last remnant of the US Pacific Trust Territory has allowed for exports to Guam to bypass CITES requirements because the trade is viewed as internal under CITES. This continues to cause concern. The major challenge in the future will be the enforcement of the new CITES regulations. The US Fish and Wildlife Service is responsible for enforcement of CITES and it is encouraging that after a period of uncertainty money was allocated in the 1991-92 federal budget to fund the post of enforcement officer for one further year. The importance of making this post permanent cannot be over-stressed. While effective enforcement of CITES has obvious implications for the species transferred to Appendix I, there must be equally concerted action to monitor the trade in Appendix II species, which may become subject to trade pressure as a result of the Appendix I listing. Such action will be possible only through increased involvement of federal resources.



Confiscated dead fruit bats from American Samoa (Photo by G. J. Wiles)

The Convention for the Protection, Management and Development of the Marine and Coastal Environment of the Eastern African Region

The Protocol on Protected Areas and Wild Fauna and Flora of the Eastern African Region is open to the contracting parties to the above convention. It was adopted in 1985 and as of the beginning of 1992, it was not yet in force. The protocol provides for the protection of threatened and endangered species of flora and fauna and important natural habitats in the Eastern African region. *Pteropus niger* and *P. rodricensis* are covered under this protocol.

The African Convention (The African Convention on the Conservation of Nature and Natural Resources)

This convention was signed in 1968, and as of 1985 28 states were Parties to the Convention with a further 14 having signed but not ratified (Lyster, 1985). The Convention is primarily concerned with wildlife but also embraces the conservation of other natural resources such as soil and water. It emphasizes the need for protected areas and special conservation measures for species listed in an Annex. It also covers topics such as conservation education, research and the need to integrate conservation into development plans. Unfortunately, it has not established an administrative structure to oversee its enforcement and as a result little has been done to encourage Parties to

implement its provisions (Lyster, 1985). No further progress on implementation had been made by the beginning of 1992.

The World Heritage Convention (The Convention Concerning the Protection of the World Cultural and Natural Heritage)

This Convention was adopted in 1975 with an objective of protecting natural and cultural areas of 'outstanding universal value'. In 1989, 315 sites were on the World Heritage List including some that are known to be or potentially could be of significance for bats. One such site is Aldabra Atoll in the Indian Ocean.

The Bonn Convention (The Convention on the Conservation of Migratory Species of Wild Animals)

The Bonn Convention was concluded in 1975, although it did not come into force until 1983. As of the beginning of 1992, there were 39 Parties to the Convention. The Convention aims to protect migratory species through imposing regulations on range states that exercise jurisdiction over any part of the range of a migratory species. Migration is taken to include any regular cross-border movements. This Convention may have future relevance for fruit bats, particularly in Africa, where movements are regularly recorded.

Chapter 2. A Catalogue of the Family Pteropodidae

Layout

In the following catalogue, genera and subgenera are listed alphabetically. The reference to genus includes original status and type species. Species and subspecies are also arranged alphabetically, with reference to original description, original genus/status if different from that given here, type locality followed by the rest of the known distribution with localities arranged in alphabetical order. Localities within states or island groups are given in parentheses. Where a taxon's occurrence in a particular locality is not confirmed, the locality name is preceded by a question mark. Synonyms (in italics) are listed chronologically and include reference to original description and type locality.

The taxonomy is based on that in Honacki et al. (1982) and Corbet and Hill (1991) but is considerably influenced by recent published and unpublished information and judgement, especially of W. Bergmans (Netherlands), J. Edwards Hill (UK) and K. F. Koopman (USA). Sometimes these authorities do not agree on the status of particular taxa, in which case the responsibility for what appears here rests with the authors.

Localities

In general, locality names are those shown in The Times Atlas of the World (8th edition, 1990) and Motteler (1986), although there may be slight variations in spelling. To avoid confusion, the list below shows alternative names for certain localities given in the catalogue.

Present name	Alternative name(s)
Ambon	Amboina
Anatom	Aneiteum
Bacan	Batchian
Belau	Palau
Bioko	Fernando Poo
Burkina Faso	Upper Volta
Chuuk	Truk
Con Son	Pulau Condor
Gebe	Ghebi
Halmahera	Gilolo
Irian Jaya	Netherlands New Guinea
Jawa	Java
Kai Islands	Kei or Key Islands
Kazan-retto	Volcano Islands
Logeia	Heath
Manam, Manumuder	Vulcan
Mbini	Mainland Equatorial Guinea
Misima	St. Aignan
Misool	Mysol
Muyua	Woodlark
N'Dai	Gower
New Georgia = Kansagi	Rubiana, Rendova, Rovianna, Roviana
Nggela Sule	Florida
Ogasawara-shato	Bonin Islands
Ontong Java Atoll	Lord Howe Atoll
Panaeati Island	Panniet Island
Peninsular Malaysia	Malaya, West Malaysia
Pohnpei	Ponape
Simbo	Narovo
Simalue Islands	Simalur Islands
Sulawesi	Celebes
Tenimber Islands	Timor Laut
Uki Ni Masi	Ugi
Umboi	Ruk or Rooke
Vanuatu	New Hebrides

Genus ACERODON Jourdan

ACERODON Jourdan, 1837. *L'Echo du Monde Savant*. **4,275**: 156.
Type-species: *Pteropus jubatus* Eschscholtz 1831.

celebensis Peters, 1867. *Mber. K. preuss. Akad. Wiss.* **1867**: 333
(*Pteropus*). Sulawesi; Salayar, Sangir Islands, Sula Islands.
arquatus Miller & Hollister, 1921. *Proc. Biol. Soc. Wash.* **34**: 100.
Sulawesi.

humilis Andersen, 1909. *Ann. Mag. nat. Hist.* (8) **3**: 24-25. Talaud
Islands.

jubatus Eschscholtz, 1831. *Zool. Atl.* **4**: 1 (*Pteropus*). Luzon,
Philippines; Philippines (except Palawan chain).

ssp. **jubatus** s.str. Luzon, Philippines; Philippines (except Palawan
chain and Mindanao).

pyrrhocephalus Meyen, 1833. *Nova Acta Acad. Caesar. Leop.
Carol.* **16(2)**: 604 (*Pteropus*). Luzon.

aurinuchalis Elliot, 1896. *Publ. Field Mus., Zool.* **1**: 77 (*Pteropus*).
Leyte.

ssp. **mindanensis** Andersen, 1909. *Ann. Mag. nat. Hist.* (8) **3**: 24.
Mindanao, Philippines.

leucotis Sanbom, 1950. *Proc. Biol. Soc. Wash.* **63**: 189 (*Pteropus*).
Busuanga, Calamian Group, Philippines; Philippines.

ssp. **leucotis** s.str. Busuanga, Calamian Group, Philippines;
Philippines (except Palawan).

ssp. **obscurus** Sanbom, 1950. *Proc. Biol. Soc. Wash.* **63**: 190
(*Pteropus*). Palawan, Philippines.

lucifer Elliot, 1896. *Publ. Field Mus., Zool.* **1**: 78 (*Pteropus*). Panay,
Philippines (extinct).

macklotii Temminck, 1837. *Monographes de Mammalogie.* **2**: 69
(*Pteropus*). Timor; Alor, Flores, Lombok, Sumba, Sumbawa.

ssp. **alorensis** Andersen, 1909. *Ann. Mag. nat. Hist.* (8) **3**: 24, 25.
Alor.

ssp. **floresii** Gray, 1870. *Cat. Monkeys, Lemurs etc. in British
Museum* 106 (*Pteropus*, as sp.). Flores; Sumbawa.

ssp. **gilvus** Andersen, 1909. *Ann. Mag. nat. Hist.* (8) **3**: 24, 25 (as
sp.). Sumba.

ssp. **macklotii** s. str. Timor.

ochraphaeus Jentink, 1887. *Cat. Ost. Mamm.* 262 (*Pteropus*).
Timor.

ssp. **prajae** Sody, 1936. *Natuurk. Tijdschr. Ned.-Indië* **90**: 51 (as
sp.). Lombok.

Genus AETHALOPS Thomas

AETHALOPS Thomas, 1923. *Ann. Mag. nat. Hist.* (9) **11**: 178.
Type-species: *Aethalodes alecto* Thomas, 1923.

alecto Thomas, 1923. *Ann. Mag. nat. Hist.* (9) **11**: 251 (*Aethalodes*).
Sumatra; Borneo, Jawa, Lombok, Peninsular Malaysia.

ssp. **aequalis** Allen, 1938. *J. Mammal.* **19**: 497. Borneo.

ssp. **alecto** s.str. Sumatra; Lombok, Peninsular Malaysia.

ssp. **ocypete** Boeadi & Hill, 1986. *Mammalia* **50(2)**: 264. Jawa.

Genus ALIONYCTERIS Kock

ALIONYCTERIS Kock, 1969. *Senckenberg. biol.* **50(5-6)**: 319.
Type-species: *Alionycteris paucidentata* Kock, 1969.

paucidentata Kock, 1969. *Senckenberg. biol.* **50(5-6)**: 322.
Mindanao, Philippines.

Genus APROTELES Menzies

APROTELES Menzies, 1977. *Aust. J. Zool.* **25(2)**: 330. Type-
species: *Aproteles bulmerae* Menzies, 1977.

bulmerae Menzies, 1977. *Aust. J. Zool.* **25(2)**: 331. New Guinea.

Genus BALIONYCTERIS Matschie

BALIONYCTERIS Matschie, 1899. *Die Fledermäuse der Berl.
Mus. für Natur. I. Megachir.* 72, 80. Type-species: *Cynopterus
maculata* Thomas, 1893.

maculata Thomas, 1893. *Ann. Mag. nat. Hist.* (6) **11**: 341
(*Cynopterus*). Sarawak, Borneo; Borneo, Peninsular
Malaysia, Riau Archipelago, Thailand.

ssp. **maculata** s.str. Sarawak, Borneo; Borneo.

ssp. **seimundi** Kloss, 1921. *J. fed. Malay St. Mus.* **10**: 229.
Peninsular Malaysia; Riau Archipelago, Thailand.

Genus CASINYCTERIS Thomas

CASINYCTERIS Thomas, 1910. *Ann. Mag. nat. Hist.* (8) **6**: 111.
Type-species: *Casinycteris argynnis* Thomas, 1910.

argynnis Thomas, 1910. *Ann. Mag. nat. Hist.* (8) **6**: 111. Cameroun;
Zaire.

Genus CHIRONAX Andersen

CHIRONAX Andersen, 1912. *Cat. Chiroptera in British Museum*
658. Type-species: *Pteropus melanocephalus* Temminck, 1825.

melanocephalus Temminck, 1825. *Monographes de Mammalogie.*
1: 190 (*Pteropus*). Jawa; Borneo, Nias, Peninsular Malaysia,
Sulawesi, Sumatra, Thailand.

ssp. **melanocephalus** s.str. Jawa; Borneo, Nias, Peninsular
Malaysia, Sumatra, Thailand.

ssp. **tumulus** Bergmans and Rozendaal, 1988. *Zool. Verh. Leiden*
248: 46. Sulawesi.

Genus CYNOPTERUS Cuvier

CYNOPTERUS Cuvier, 1824. *Des Dents de Mammifères* 248. Type-
species: *Vespertilio sphinx* Vahl, 1797.

brachyotis S. Muller, 1838. *Tijdschr. Natuurl. Gesch. Physiol.* **5(1)**:
146 (*Pachysoma*). Borneo; Andaman Islands, Bali, Bangka,
Belitung, Enggano, Jawa, Kangean Islands, Laut Kecil
Islands (off south Borneo), Lombok, Madura, Nias, Nicobar
Islands, Penida, Peninsular Malaysia, Philippines, Riau
Archipelago, Singapore, Sri Lanka, Sulawesi, Sumatra,

- Talud Islands and adjacent small islands, Thailand, Vietnam.
- ssp. **altitudinis** Hill, 1961. *Proc. zool. Soc. Lond.* **136**: 631. Peninsular Malaysia.
- ssp. **brachyotis** s.str. Borneo; Bangka, Belitung, Lombok, Nicobar Islands, Peninsular Malaysia, Philippines, Riau Archipelago, Singapore, Sulawesi, Sumatra, Talud Islands and adjacent small islands, Thailand.
- luzoniense* Peters, 1861. *Mber. K. preuss. Akad. Wiss.* **1861**: 708. Luzon.
- grandidieri* Peters, 1869. *Mber. K. preuss. Akad. Wiss.* **1869**: 394 (*Cynonycteris*). "Zanzibar".
- cumingi* Gray, 1870. *Cat. Monkeys, Lemursetc. in British Museum* 123 (as var.). Philippines.
- montanoi* Robin, 1881. *Bull. Soc. philomath. Paris* (7) **5**: 90. Peninsular Malaysia.
- minor* Revilliod, 1911. *Zool. Am.* **37**: 517. Sulawesi.
- archipelagus* Taylor, 1934. *Philippine Land Mamm. Philippine Bur. Sci. Monogr.* 30: 182 (as sp.). Polillo, Philippines.
- ssp. **brachysoma** Dobson, 1871. *J. Asiat. Soc. Beng.* **42**: 105 (as sp.). Andaman Islands.
- andamanensis* Dobson, 1873. *Proc. Asiat. Soc. Beng.* **1873**: 148 (as var.). Andaman Islands.
- ssp. **ceylonensis** Gray, 1870. *Cat. Monkeys, Lemurs etc. in British Museum* 122 (as var.). Sri Lanka.
- ssp. **concolor** Sody, 1940. *Treubia* **17**: 393. Enggano.
- ssp. **hoffeti** Bourret, 1944. *Notes Trav. Ec. sup. Sci. Hanoi* **3**:4. Vietnam.
- ssp. **insularum** Andersen, 1910. *Ann. Mag. nat. Hist.* (8) **6**: 624. Kangean Islands; Laut Kecil Islands.
- ssp. **javanicus** Andersen, 1910. *Ann. Mag. nat. Hist.* (8) **6**: 624. Jawa; Bali, Madura, Penida.
- ssp. **minutus** Miller, 1906. *Proc. biol. Soc. Wash.* **19**: 63 (assp.). Nias.
- horsfieldii** Gray, 1843. *List Mammals in British Museum* 38. Jawa; Borneo, Lombok, Nias, Peninsular Malaysia, Pinang, Sumatra, Thailand.
- ssp. **harpax** Thomas & Wroughton, 1909. *Ann. Mag. nat. Hist.* (8) **3**: 439. Peninsular Malaysia; Pinang, Sumatra, Thailand.
- lyoni* Andersen, 1912. *Cat. Chiroptera in British Museum* 827. Sumatra.
- minor* Lyon, 1908. *Proc. U.S. natn. Mus.* **34**: 665 (*Niadias*, as sp., nec Trouessart, 1878). Sumatra.
- ssp. **horsfieldii** s.str. Jawa; Lombok.
- ssp. **persimilis** Andersen, 1912. *Cat. Chiroptera in British Museum* 640 (as sp.). Sarawak, Borneo; Borneo.
- ssp. **princeps** Miller, 1906. *Proc. biol. Soc. Wash.* **19**: 61 (as sp.). Nias.
- sphinx** Vahl, 1797. *Skr. Naturh.-Selsk. Kjøbenhavn* (4) **1**: 123 (*Vespertilio*). India; Babi Island (off Simalue, west Sumatra), Bangladesh, Borneo, Burma, China, Mentawai Islands, Natuna Islands, Nicobar Islands, Peninsular Malaysia, Sri Lanka, Sumatra, Thailand.
- ssp. **angulatus** Miller, 1898. *Proc. Acad. nat. Sci. Philad.* 316 (as sp.). North Thailand; Borneo, China, Peninsular Malaysia, Sumatra.
- ssp. **babi** Lyon, 1916. *Proc. U.S. natn. Mus.* **52**: 438 (as sp.). Babi Island.
- ssp. **gangeticus** Andersen, 1910. *Ann. Mag. nat. Hist.* (8) **6**: 623. India; north-west India.
- ssp. **pagensis** Miller, 1906. *Proc. biol. Soc. Wash.* **19**: 62 (as sp.). North Pagai, Mentawai Islands; Mentawai Islands.
- ssp. **scherzeri** Zelebor, 1869. *Säug. Reiseder Fregatte "Novara"* 13 (*Pachysoma*). Car Nicobar, Nicobar Islands; Nicobar Islands.
- ssp. serasani Paradiso, 1971. *Proc. biol. Soc. Wash.* **84(36)**: 296. Serasan, Natuna Islands.
- ssp. **sphinx** s.str. India; Bangladesh, Burma, north-east and peninsular India, Sri Lanka, Thailand.
- fibulatus* Vahl, 1797. *Skr. Naturh.-Selsk. Kjøbenhavn* (4) **1**: 124 (*Vespertilio*). India.
- pusillus* Geoffroy, 1803. *Cat. Mamm. Mus. Nat. Hist. Nat.* 49 (*Pteropus*). India.
- marginatus* Geoffroy, 1810. *Annls Mus. Hist. nat. Paris* **15**:97 (*Pteropus*). India.
- brevicaudatum* Temminck, 1837. *Monographes de Mammalogie* **2**: 92 (*Pachysoma*). India.
- elliotti* Gray, 1870. *Cat. Monkeys, Lemurs etc. in British Museum* 122. India.
- tithaecheilus** Temminck, 1825. *Monographes de Mammalogie* **1**: 198 (*Pteropus*). Jawa; Bali, Krakatau Islands, Lombok, Nias, Sebesi, Sumatra, Timor.
- ssp. **major** Miller, 1906. *Proc. biol. Soc. Wash.* **19**: 62 (as sp.). Nias.
- ssp. **terminus** Sody, 1940. *Treubia* 17: 404. Timor.
- ssp. **tithaecheilus** s.str. Jawa; Bali, Krakatau Islands, Lombok, Sebesi, Sumatra.
- ?*diardi* Geoffroy, 1828. *Hist. Nat. Mamm.* **13**: 705 (*Pachysoma*, as sp.). Sumatra.

Genus DOBSONIA Palmer

- DOBSONIA** Palmer, 1898. *Proc. biol. Soc. Wash.* **12**: 114. Type-species: *Cephalotes peronii* Geoffroy, 1810.
- beauforti** Bergmans, 1975. *Beaufortia* **23(295)**: 3. Waigeo; Biak and Owii (off north-west New Guinea).
- chapmani** Rabor, 1952. *Chicago Acad. Sci. nat. Hist. Misc.* 96: 2. Negros, Philippines; Philippines.
- emersa** Bergmans & Sarbini, 1985. *Beaufortia* **34(6)**: 185. Biak, off north-west New Guinea; ?Numfoor and Owii (off north-west New Guinea).
- exoleta** Andersen, 1909. *Ann. Mag. nat. Hist.* (8) **4**: 531, 533. Sulawesi.
- inermis** Andersen, 1909. *Ann. Mag. nat. Hist.* (8) **4**: 532. San Cristobal, Solomon Islands; Bougainville, New Guinea, Solomon Islands.
- ssp. **inermis** s.str. San Cristobal, Solomon Islands; Bougainville, New Guinea, Solomon Islands (except Choiseul and Santa Isabel).
- nesea* Andersen, 1909. *Ann. Mag. nat. Hist.* (8) **4**: 532. Alu (near Shortland), Solomon Islands.

- ssp. **minimus** Phillips, 1968. *Univ. Kans. Publs Mus. nat. Hist.* **16(8)**: 809. Choiseul, Solomon Islands; Solomon Islands (Santa Isabel).
- minor** Dobson, 1879. *Proc. zool. Soc. Land.* **1878**:875 (*Cephalotes*). North-west New Guinea; Bagabag, New Guinea, Sulawesi, Yapen.
- moluccense** Quoy and Gaimard, 1830. *Voy. "Astrolabe", Zool.* **1**: 86 (*Hypoderma*). Ambon; Aru Islands, Australia, Batanta (south of Waigeo), Burn, Halmahera, Kai Islands, Misool, New Guinea, Seram, Waigeo.
- ssp. **magna** Thomas, 1905. *Ann. Mag. nat. Hist.* (7) **16**: 423. New Guinea; Australia, Batanta, Misool, Waigeo.
- ssp. **moluccense** s.str. Ambon; Aru Islands, Buru, Halmahera, Kai Islands, Seram.
- pannietensis** De Vis, 1905. *Ann. Qd. Mus.* **6**: 36 (*Cephalotes*). Panaeati Island, Louisiade Archipelago; Bismarck Archipelago, D'Entrecasteaux Islands, Louisiade Archipelago, Muyua, Trobriand Islands, Umboi.
- ssp. **anderseni** Thomas, 1914. *Ann. Mag. nat. Hist.* (8) **13**: 434, 435. Manus Island, Admiralty Islands, Bismarck Archipelago; Bismarck Archipelago, Umboi.
- ssp. **pannietensis** s.str. Panaeati Island, Louisiade Archipelago; D'Entrecasteaux Islands, Louisiade Archipelago, Muyua.
- ssp. **remota** Cabrera, 1920. *Boln R. Soc. esp. Hist. nat.* **20**: 107. Kiriwina Island, Trobriand Islands; Trobriand Islands.
- peronii** Geoffroy, 1810. *Annls Mus. Hist. nat. Paris* **15**: 104 (*Cephalotes*). Timor; Alor, Babar, Flores, Komodo, Lombok, Penida, Sumba, Sumbawa, Wetar.
- ssp. **grandis** Bergmans, 1978. *Senckenberg. biol.* **59(1-2)**: 6. Sumbawa; Komodo, Lombok, Penida.
- ssp. **peronii** s.str. Timor.
- ssp. **sumbana** Andersen, 1909. *Ann. Mag. nat. Hist.* (8) **4**: 531. Sumba.
- ssp. **incertae sedis** Bergmans, 1978. *Senckenberg. biol.* **59(1-2)**: 9. Alor; Babar, Flores, Wetar.
- praedatrix** Andersen, 1909. *Ann. Mag. nat. Hist.* (8) **4**: 532. "Duke of York Group", Bismarck Archipelago; Bismarck Archipelago.
- viridis** Heude, 1896. *Mem. Hist. nat. Emp. Chin.* **3**: 176 (*Cephalotes*). Kai Islands; Ambon, Bacan, Banda Islands, Banggai Islands, Buru, Halmahera, Misool, Morotai, Rau, Sangir Islands, Seram, Sulawesi, Ternate, Trogian Islands, Waigeo.
- ssp. **crenulata** Andersen, 1909. *Ann. Mag. nat. Hist.* (8) **4**: 532 (as sp.). Waigeo; Bacan, Banggai Islands, Halmahera, Morotai, Rau, Sulawesi, Ternate, Trogian Islands.
- ssp. **viridis** s.str. Kai Islands; Ambon, Banda Islands, Buru, Misool, Sangir Islands, Seram.

Genus DYACOPTERUS Andersen

DYACOPTERUS Andersen, 1912. *Cat. Chiroptera in British Museum* 651. Type-species: *Cynopterus spadiceus* Thomas, 1890.

spadiceus Thomas, 1890. *Ann. Mag. nat. Hist.* (6) **5**: 235 (*Cynopterus*). Borneo; Peninsular Malaysia, Philippines

- (populations not identified subspecifically), Sumatra.
- ssp. **brooksi** Thomas, 1920. *Ann. Mag. nat. Hist.* (9) **5**: 284. Sumatra.
- ssp. **spadiceus** s.str. Borneo; Peninsular Malaysia.

Genus EIDOLON Rafinesque

EIDOLON Rafinesque, 1815. *Analyse de la Nature* 54. Type-species: *Pteropus stramineus* Geoffroy, 1803 (= *Vespertilio vampyrus helvus* Ken, 1792).

dupreanum Pollen in Schlegel, 1867. *Proc. zool. Soc. Lond.* **1866**: 419 (*Pteropus*, as sp.). North-west Madagascar, Madagascar and offshore islets.

helvum Kerr, 1792. *Animal Kingdom, 1, part 1* 91 (*Vespertilio*). Senegal; Angola, Benin, Burkina Faso, Burundi, Cameroun, Central African Republic, Chad, Congo, Equatorial Guinea (Bioko, Mbini, Pagalu), Ethiopia, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Ivory Coast, Kenya, Liberia, Malawi, Mali, Mozambique, Namibia, Niger, Nigeria, Rwanda, São Tomé and Príncipe, Saudi Arabia, Sierra Leone, ?Somalia, South Africa, Sudan, Tanzania (mainland, Mafia, Pemba, Zanzibar), Togo, Uganda, Yemen, Zaire, Zambia, Zimbabwe.

ssp. **helvum** s.str. Senegal; Angola, Benin, Burkina Faso, Burundi, Cameroun, Central African Republic, Chad, Congo, Equatorial Guinea (Bioko, Mbini, Pagalu), Ethiopia, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Ivory Coast, Kenya, Liberia, Malawi, Mali, Mozambique, Namibia, Niger, Nigeria, Rwanda, São Tomé and Príncipe, Sierra Leone, ?Somalia, South Africa, Sudan, Tanzania (mainland, Mafia, Pemba, Zanzibar), Togo, Uganda, Zaire, Zambia, Zimbabwe.

stramineus Geoffroy, 1803. *Cat. Mamm. Mus. Nat. Hist. Nat.* 48 (*Pteropus*). Sudan.

paleaceus Peters, 1861. *Mber. K. preuss. Akad. Wiss.* **1861**:423 (*Pterocyon*) (as sp.). Sudan.

palmarum Heuglin, 1865. *Leopoldina* **5(3-4)**: 34 (*Pteropus*, as sp.). Sudan.

leucomelas Fitzinger, 1866. *Sber. Akad. Wiss. Wien* **54**: 544 (*Xantharpyia*, as sp.). Sudan.

buettikoferi Jentink, 1881. *Notes Leyden Mus.* **3**: 59 (*Leiponyx*, as sp.). Liberia.

ssp. **sabaeum** Andersen, 1907. *Ann. Mag. nat. Hist.* (7) **19**: 505 (*Pterocyon*, as sp.). Yemen; Saudi Arabia.

Genus EONYCTERIS Dobson

EONYCTERIS Dobson, 1873. *Proc. Asiat. Soc. Beng.*:148 (preliminary note), *J. Asiat. Soc. Beng.* **42(2)**: 204. Type-species: *Macroglossus spelaea* Dobson, 1871.

major Andersen, 1910. *Ann. Mag. nat. Hist.* (8) **6**: 625. Borneo; Philippines.

ssp. **major** s.str. Borneo.

ssp. **robusta** Miller, 1913. *Proc. Biol. Soc. Wash.* **26**: 73. Luzon, Philippines; Philippines.

longicauda Taylor, 1934. *Philippine Land. Mamm., Philippine Bur. Sci. Monogr.* **30**: 131. Luzon, Philippines.

spelaea Dobson, 1871. *Proc. Asiat. Soc. Beng.* **1871**:105, 106

(preliminary note), *J. Asiat. Soc. Beng.* **40**: 261. (*Macroglossus*). Burma; Andaman Islands, Bali, Borneo, China, India, Jawa, Lombok, Muna (offsouth-east Sulawesi), Peninsular Malaysia, Philippines, Singapore, Sulawesi, Sumatra, Sumba, Thailand, Timor, Vietnam.

ssp. **glandifera** Lawrence, 1939. *Bull. Mus. comp. Zool. Harv.* **86**: 38. Luzon, Philippines; Bali, Borneo, east Jawa, Lombok, Muna, Philippines, south-east Sulawesi, Sumba, Timor.

ssp. **rosenbergii** Jentink, 1889. *Notes Leyden Mus.* **11**: 210 (*Callinycteris*, as sp.). North Sulawesi.

ssp. **spelaea** s.str. Burma; Andaman Islands, China, India, west Jawa, Peninsular Malaysia, Singapore, Sumatra, Thailand, Vietnam.

Genus EPOMOPHORUS Bennett

EPOMOPHORUS Bennett, 1836. *Proc. zool. Soc. Lond.* **1835**: 149. Type-species: *Pteropus gambianus* Ogilby, 1835.

angolensis Gray, 1870. *Cat. Monkeys, Lemurs etc. in British Museum* 125. Angola; Namibia.

gambianus Ogilby, 1835. *Proc. zool. Soc. Lond.* **1835**: 100 (*Pteropus*). Gambia; Angola, Benin, Botswana, Burkina Faso, Cameroun, Central African Republic, Chad, Ethiopia, Ghana, Guinea, Guinea-Bissau, Ivory Coast, ?Liberia, Malawi, Mali, Mozambique, Namibia, Niger, Nigeria, Senegal, Sierra Leone, South Africa, Sudan, Tanzania, Togo, Zaire, Zambia, Zimbabwe.

ssp. **crypturus** Peters, 1852. *Naturwiss. Reisenach Mossambique, Säug.* 26 (as sp.). Mozambique; Angola, Botswana, Malawi, Namibia, South Africa, Tanzania, Zaire, Zambia, Zimbabwe.

parvus Ansell, 1960. *Rev. Zool. Bot. afr.* **61**: 160. Zambia.

ssp. **gambianus** s.str. Gambia; Benin, Burkina Faso, Cameroun, Central African Republic, Chad, Ethiopia, Ghana, Guinea, Guinea-Bissau, Ivory Coast, ?Liberia, Mali, Niger, Nigeria, Senegal, Sierra Leone, Sudan, Togo.

reii Aellen, 1950. *Revue suisse Zool.* **57(23)**: 559. Cameroun.

ssp. **pousarguesi** Trouessart, 1904. *Cat. mamm. viv.foss. Quinq. suppl. 1-2: i-iv* 55 (as sp.). Central African Republic.

grandis Sanborn, 1950. *Publções cult. Co. Diam. Angola* **10**: 55 (*Micropteropus*). Angola; Congo.

labiatus Temminck, 1837. *Monographes de Mammalogie* **2**: 83 (*Pteropus*). Ethiopia; Burundi, Chad, Congo, Kenya, Malawi, Nigeria, Rwanda, Sudan, Tanzania, Uganda, Zaire.

anurus Heuglin, 1864. *Nova Acta Acad. Caesar. Leop. Carol.* **31(7)**: 12. Sudan.

minor Dobson, 1880. *Proc. zool. Soc. Lond.* **1879**: 715. Zanzibar, Tanzania; Ethiopia, Kenya, Malawi, Rwanda, Somalia, Sudan, Tanzania, Uganda, Zaire, Zambia.

wahlbergi Sundevall, 1846. *Ofvers. K. VetenskAkad. Förk Stockh.* **3(5)**: 118 (*Pteropus*). South Africa; Angola, Burundi, Cameroun, Congo, Equatorial Guinea (Mbini), ?Ethiopia, Gabon, Kenya, Malawi, Mozambique, Namibia, Somalia, Swaziland, Tanzania (mainland, Pemba, Zanzibar), Uganda, Zaire, Zambia, Zimbabwe.

haldemani Hallowell, 1846. *Proc. Acad. nat. Sci. Philad.* **3(3)**: 52

(*Pteropus*). "West Africa".

neumanni Matschie, 1899. *Die Fledermäuse der Berl. Mus. für Natur. I. Magachir.* 50. Kenya.

Genus EPOMOPS Gray

EPOMOPS Gray, 1866. *Proc. zool. Soc. Lond.* **1866**:65. Type-species: *Epomophorus franqueti* Tomes, 1860.

buettikoferi Matschie, 1899. *Die Fledermäuse der Berl. Mus. für Natur. I. Megachir.* 45 (*Epomophorus*). Liberia; Ghana, Guinea, Ivory Coast, Nigeria, Sierra Leone.

dobsonii Bocage, 1889. *Jorn. Sci. math. phys. nat.* (2) **1**: 1 (*Epomophorus*). Angola; Botswana, Malawi, Rwanda, Tanzania, Zaire, Zambia, Zimbabwe.

franqueti Tomes, 1860. *Proc. zool. Soc. Lond.* **1860**: 54 (*Epomophorus*). Gabon; Angola, Benin, Cameroun, Central African Republic, Congo, Equatorial Guinea (Mbini), Ghana, Ivory Coast, Nigeria, Sudan, Tanzania, Togo, Uganda, Zaire, Zambia.

streptitans Andersen, 1910. *Ann. Mag. nat. Hist.* (8) **5**: 106. Nigeria.

Genus HAPLONYCTERIS Lawrence

HAPLONYCTERIS Lawrence, 1939. *Bull. Mus. Comp. Zool. Harv.* **86**: 31. Type-species: *Haplonycteris fischeri* Lawrence, 1939.

fischeri Lawrence, 1939. *Bull. Mus. Comp. Zool. Harv.* **86**: 33. Mindoro, Philippines; Philippines.

Genus HARPYIONYCTERIS Thomas

HARPYIONYCTERIS Thomas, 1896., *Ann. Mag. nat. Hist.* (6) **18**: 243. Type-species: *Harpyionycteris whiteheadi* Thomas, 1896.

whiteheadi Thomas, 1896. *Ann. Mag. nat. Hist.* (6) **18**: 244. Mindoro, Philippines; Philippines, Sulawesi.

ssp. **celebensis** Miller and Hollister, 1921. *Proc. biol. Soc. Wash.* 34: 99. Sulawesi.

ssp. **negrosensis** Peterson and Fenton, 1970. *Life. Sci. Occ. Pap. R. Ont. Mus.* **17**: 12. Negros, Philippines.

ssp. **whiteheadi** s.str. Mindoro, Philippines; Philippines (except Negros).

Genus HYPYSIGNATHUS Allen

HYPYSIGNATHUS Allen, 1861. *Proc. Acad. nat. Sci. Philad.* **1861**: 156. Type-species: *Hypsignathus monstrosus* Allen, 1861.

monstrosus Allen, 1861. *Proc. Acad. nat. Sci. Philad.* **1861**: 157. Gabon; Angola, Burkina Faso, Cameroun, Central African Republic, Congo, Equatorial Guinea (Bioko, Mbini), ?Gambia, Ghana, Ivory Coast, Kenya, Liberia, Nigeria, Sierra Leone, Sudan, Togo, Uganda, Zaire.

labrosus Murray, 1862. *Proc. zool. Soc. Lond.* **1862**:8 (*Zygaenocephalus*, *Sphyrocephalus*). Nigeria.

Genus LATIDENS Thonglongya

LATIDENS Thonglongya, 1972. *J. Bombay nat. Hist. Soc.* **69(1)**: 151. Type-species: *Latidens salimalii* Thonglongya, 1972.

salimalii Thonglongya, 1972. *J. Bombay nat. Hist. Soc.* **69(1)**: 153. India.

Genus MACROGLOSSUS Cuvier

MACROGLOSSUS Cuvier, 1824. *Des Dents de Mammifères* 248. Type-species: *Pteropus minimus* Geoffroy, 1810.

minimus Geoffroy, 1810. *AnnlsMus.Hist.nat.Paris* **15**: 97 (*Pteropus*). Jawa; Ambon, Aru Islands, Australia, Bali, Banda Islands, Bismarck Archipelago, Borneo, Bougainville, Buru, D'Entrecasteaux Islands, Kai Islands, Kangean Islands, Lombok, Madura, Misool, Natuna Islands, New Guinea, Nias, Peleng, Peninsular Malaysia, Philippines, Sangir Islands, Seram, Singapore, Solomon Islands, Sulawesi, Thailand, Timor, Vietnam.

ssp. **lagochilus** Matschie, 1899. *Die Fledermause de Berl. Mus. für Natur. I. Megachir.* 95 (as sp.). Buru; Ambon, Banda Islands, Borneo, Natuna Islands, Nias, Peleng, Peninsular Malaysia, Philippines, Sangir Islands, Seram, Singapore, Sulawesi, Thailand, Timor, Vietnam

meyeri Jentink, 1902. *Notes Leyden Mus.* **23**: 131, 140 (*Odontonycteris*). Sangir, Sangir Islands.

fructivorus Taylor, 1934. *Philippine Land. Mamm., Philippine Bur. Sci. Monogr.* **30**: 125. Mindanao, Philippines.

ssp. **microtus** Andersen, 1911. *Ann. Mag. nat. Hist.* (8) **7**: 642. Guadalcanal, Solomon Islands; Bougainville, D'Entrecasteaux Islands, Solomon Islands.

ssp. **minimus** Geoffroy, 1810. *AnnlsMus. Hist. nat. Paris* **15**: 97 (*Pteropus*, as sp.). Jawa; Bali, Kangean Islands, Lombok, Madura.

rostratus Horsfield, 1821. *Zool. Res. Java. fasc. 3*, p.- Jawa.

kiodotes Lesson, 1827. *Manuel de Mammalogie*. 115 (generic name misspelt "Macroglossa"). Jawa.

horsfieldii Lesson, 1827. *Manuel de Mammalogie* 115 (generic name misspelt "Macroglossa"). Jawa.

ssp. **nanus** Matschie, 1899. *Die Fledermäuse de Berl. Mus. für Natur. I. Megachir.* 98 (as sp.). New Britain, Bismarck Archipelago; Aru Islands, Bismarck Archipelago, Kai Islands, Misool, New Guinea.

ssp. **pygmaeus** Andersen, 1911. *Ann. Mag. nat. Hist.* (8) **7**: 642. Murray Island, Torres Strait, Australia; Australia.

sobrinus Andersen, 1911. *Ann. Mag. nat. Hist.* (8) **7**: 642. Peninsular Malaysia; Burma, Jawa, Krakatau Islands, Mentawai Islands, Nias, Sumatra, Thailand.

ssp. **fraternus** Chasen and Kloss, 1927. *Proc. zool. Soc. Lond.* **1927**: 836. Sipura, Mentawai Islands; Mentawai Islands.

ssp. **sobrinus** s.str. Peninsular Malaysia; Burma, Jawa, Krakatau Islands, Nias, Sumatra, Thailand.

Genus MEGAEROPS Peters

MEGAEROPS Peters, 1865. *Mber. K. preuss. Akad. Wiss.* **1865**: 256. Type-species: *Pachysoma ecaudatum* Temminck, 1837.

ecaudatus Temminck, 1837. *Monographes de Mammalogie* **2**: 94 (*Pachysoma*). Sumatra; Borneo, Peninsular Malaysia, Thailand, Vietnam.

kusnotoi Hill & Boeadi, 1978. *Mammalia* **42(4)**: 427. Jawa.

niphanae Yenbutra & Felten, 1983. *Senckenberg. biol.* **64**: 2. India; Thailand, Vietnam.

wetmorei Taylor, 1934. *Philippine Land. Mamm., Philippine Bur. Sci. Monogr.* **30**: 191. Mindanao, Philippines; Borneo, Peninsular Malaysia.

ssp. **albicollis** Francis, 1989. *Can. J. Zool.* **67**: 2878. Peninsular Malaysia; Borneo.

ssp. **wetmorei** s.str. Mindanao, Philippines.

Genus MEGALOGLOSSUS Pagenstecher

MEGALOGLOSSUS Pagenstecher, 1885. *Zool. Anz.* (8) **193**: 245. Type-species: *Megaloglossus woermanni* Pagenstecher, 1885.

woermanni Pagenstecher, 1885. *Zool. Anz.* (8) **193**: 245. Gabon; Angola, Cameroun, Central African Republic, Congo, Equatorial Guinea (Bioko, Mbini), Ghana, Guinea, Ivory Coast, Liberia, Nigeria, Togo, Uganda, Zaire.

prigoginei Hayman *et al.*, 1966. *Annls Mus. r. Afr. Cent. serie 8 zool.* **154**: 26. Zaire.

Genus MELONYCTERIS Dobson

MELONYCTERIS Dobson, 1877. *Proc. zool. Soc. Lond.* **1877**: 119. Type-species: *Melonycteris melanops* Dobson, 1877.

aurantius Phillips, 1966. *J. Mammal.* **47**: 24. Nggela Sule, Solomon Islands; Solomon Islands.

melanops Dobson, 1877. *Proc. zool. Soc. Lond.* **1877**: 119. "Duke of York Island", Bismarck Archipelago; Bismarck Archipelago, ?New Guinea.

alboscapulatus Ramsay, 1877. *Proc. Linn. Soc. N.S.W.* **2**: 17 (*Pteropus*). Duke of York Island, Bismarck Archipelago.

woodfordi Thomas, 1887. *Ann. Mag. nat. Hist.* (5) **19**: 147 (*Nesonycteris*). Alu (near Shortland Island), Solomon Islands; Bougainville, Solomon Islands.

Genus MICROPTEROPUS Matschie

MICROPTEROPUS Matschie, 1899. *Die Fledermause der Berl. Mus. für Natur. I. Megachir.* 36,57. Type-species: *Epomophorus pusillus* Peters, 1867.

intermedium Hayman, 1963. *Publções cult. Co. Diam. Angola* **66**: 100. Angola; Zaire.

pusillus Peters, 1867. *Mber. K. preuss. Akad. Wiss.* **1867**: 870 (*Epomophorus*). Nigeria; Angola, Benin, Burkina Faso, Burundi, Cameroun, Central African Republic, Chad, Congo, Equatorial Guinea (Mbini), Ethiopia, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Ivory Coast, Kenya, Liberia,

Mali, Senegal, Sierra Leone, Sudan, Tanzania, Togo, Uganda, Zaire, Zambia.

Genus MYONYCTERIS Matschie

MYONYCTERIS Matschie, 1899. *Die Fledermäuse der Berl. Mus. für Natur. I. Megachir.* 61,63. Type-species: *Cynonycteris torquata* Dobson, 1878.

brachycephala Bocage, 1889. *Jorn. Sci. math. phys. nat.* (2) **1**:198 (*Cynonycteris*). São Tomé, São Tomé and Príncipe.

relicta Bergmans, 1980. *Zool. Meded. Leiden* **55**(4): 126. Kenya; Tanzania.

torquata Dobson, 1878. *Cat. Chiroptera in British Museum* 71,76 (*Cynonycteris*). Angola; Cameroun, Central African Republic, Congo, Equatorial Guinea (Bioko, Mbini), Gabon, Ghana, Guinea, Ivory Coast, Liberia, Nigeria, Sierra Leone, Togo, Uganda, Zaire, Zambia.

collaris Gray, 1870. *Cat. Monkeys, Lemurs etc. in British Museum* 123 (*Cynopterus*, nec Peters, 1852). "West Africa".

leptodon Andersen, 1908. *Ann. Mag. nat. Hist.* (8) **2**: 450. Sierra Leone

wroughtoni Andersen, 1908. *Ann. Mag. nat. Hist.* (8) **2**: 450. Zaire; Uganda.

Genus NANONYCTERIS Matschie

NANONYCTERIS Matschie, 1899. *Die Fledermäuse der Berl. Mus. für Natur. I. Megachir.* 36,58. Type-species: *Epomophorus veldkampii* Jentink, 1888.

veldkampii Jentink, 1888. *Notes Leyden Mus.* **10**: 51. (*Epomophorus*). Liberia; Cameroun, Central African Republic, Ghana, Guinea, Ivory Coast, Nigeria, Sierra Leone, Togo.

Genus NEOPTERYX Hayman

NEOPTERYX Hayman, 1946. *Ann. Mag. nat. Hist.* (11) **12**: 569. Type-species: *Neopteryx frosti* Hayman, 1946.

frosti Hayman, 1946. *Ann. Mag. nat. Hist.* (11) **12**: 571. Sulawesi.

Genus NOTOPTERIS Gray

NOTOPTERIS Gray, 1859. *Proc. zool. Soc. Lond.* **1859**: 36. Type-species: *Notopteris macdonaldii* Gray, 1859.

macdonaldii Gray, 1859. *Proc. zool. Soc. Lond.* **1859**: 38. Viti Levu, Fiji; Fiji, New Caledonia, Vanuatu.

ssp. **macdonaldii** s.str. Viti Levu, Fiji; Fiji, Vanuatu.

ssp. **neocaedonica** Trouessart, 1908. *Bull. Mus. natn. Hist. nat. Paris* 6: 257. New Caledonia.

Genus NYCTIMENE Borkhausen

NYCTIMENE Borkhausen, 1797. *Deutsche Fauna oder Kurz. Natur. der Thiere Deutsch.* **1**: 86. Type-species: *Vespertilio cephalotes* Pallas, 1767.

alio Thomas, 1900. *Ann. Mag. nat. Hist.* (7) **5**: 216 (*Cephalotes*). New Guinea; Misool.

albiventer Gray, 1862. *Proc. zool. Soc. Lond.* **1862**: 262 (*Cynopterus*). Morotai; Bismarck Archipelago, Halmahera, Kai Islands, New Guinea, Ternate.

ssp. **albiventer** s.str. Morotai; Halmahera, Ternate.

ssp. **papuanus** Andersen, 1910. *Ann. Mag. nat. Hist.* (8) **6**: 621 (as sp.). New Guinea; Bismarck Archipelago, Kai Islands.

celaeno Thomas, 1922. *Nova Guinea* **13**: 262. New Guinea.

cephalotes Pallas, 1767. *Spicilegia Zoologica* **3**: 10 (*Vespertilio*). Ambon; Australia, Buru, Numfoor (off north-west New Guinea), New Guinea, Seram, Sulawesi, Tenimber Islands, Timor, Umboi.

ssp. **melinus** Kerr, 1792. *Animal Kingdom, 1, part 7*:98 (*Vespertilio*) (as ssp.). Ambon.

ssp. **pallasi** Geoffroy, 1810. *Annls Mus. Hist. nat. Paris* **15**: 107 (*Cephalotes*). Ambon.

cyclotis Andersen, 1910. *Ann. Mag. nat. Hist.* (8) **6**: 623. West New Guinea; Bismarck Archipelago, New Guinea.

ssp. **certans** Andersen, 1912. *Ann. Mag. nat. Hist.* (8) **9**: 95 (as sp.). New Guinea; Bismarck Archipelago, central and eastern New Guinea.

ssp. **cyclotis** s.str. New Guinea; western New Guinea.

draconilla Thomas, 1922. *Nova Guinea* **13**: 725. New Guinea.

major Dobson, 1877. *Proc. zool. Soc. Lond.* **1877**: 117 (*Harpyia*). Duke of York Island, Bismarck Archipelago; Bismarck Archipelago, D'Entrecasteaux Islands, Louisiade Archipelago, Muyua, Solomon Islands, Trobriand Islands.

ssp. **geminus** Andersen, 1910. *Ann. Mag. nat. Hist.* (8) **6**: 623 (as sp.). "South of Huon Gulf (Fergusson Island, D'Entrecasteaux Islands); D'Entrecasteaux Islands, Louisiade Archipelago, Trobriand Islands.

ssp. **lullulae** Thomas, 1904. *Ann. Mag. nat. Hist.* (7) **14**: 197. Muyua.

ssp. **major** s.str. Duke of York Island, Bismarck Archipelago; Bismarck Archipelago.

ssp. **scitululus** Andersen, 1910. *Ann. Mag. nat. Hist.* (8) **6**: 623 (as sp.). Guadalcanal, Solomon Islands; Solomon Islands.

malaitensis Phillips, 1968. *Univ. Kans. Publs Mus. nat. Hist.* **16**(8): 822. Malaita, Solomon Islands.

masalai Smith & Hood, 1983. *Occ. Pap. Mus. Texas Tech Univ.* **81**: 1. New Ireland, Bismarck Archipelago.

minutus Andersen, 1910. *Ann. Mag. nat. Hist.* (8) **6**: 622. Sulawesi; Buru.

ssp. **minutus** s.str. Sulawesi.

ssp. **varius** Andersen, 1910. *Ann. Mag. nat. Hist.* (8) **6**: 622 (as sp.). Buru.

rabori Heaney & Peterson, 1984. *Occ. Pap. Mus. Zool. Univ. Mich.* **708**: 1. Negros, Philippines.

robinsoni Thomas, 1904. *Ann. Mag. nat. Hist.* (7) **14**: 196. Queensland, Australia; Australia.

sanctacrucis Troughton, 1931. *Proc. Linn. Soc. N.S.W.* **56**: 206. Santa Cruz Islands, Solomon Islands.

vizcaccia Thomas, 1914. *Ann. Mag. nat. Hist.* (8) **13**: 436. Umboi; Australia, Bismarck Archipelago, Bougainville, ?New Guinea, Solomon Islands.

ssp. **bougainville** Troughton, 1936. *Rec. Aus. Mus.* **19**(5): 349 (as sp.). Bougainville; Solomon Islands.

minor Phillips, 1968. *Univ. Kans. Publ. Mus. nat. Hist.* **16**: 819. Choiseul, Solomon Islands.

ssp. **vizcaccia** s.str. Umboi; Australia, Bismarck Archipelago, ?New Guinea.

Genus OTOPTEROPUS Kock

OTOPTEROPUS Kock, 1969. *Senckenberg. biol.* **50**(1-2): 329. Type-species: *Otopteropos cartilagonodus* Kock, 1969.

cartilagonodus Kock, 1969. *Senckenberg. biol.* **50**(1-2): 333. Luzon, Philippines.

Genus PARANYCTIMENE Tate

PARANYCTIMENE Tate, 1942. *Am. Mus. Novit.* **1204**: 1. Type-species: *Paranyctimene raptor* Tate, 1942.

raptor Tate, 1942. *Am. Mus. Novit.* **1204**: 1. New Guinea.

Genus PENTHETOR Andersen

PENTHETOR Andersen, 1912. *Cat. Chiroptera in British Museum* 665. Type-species: *Cynopterus lucasi* Dobson, 1880.

lucasi Dobson, 1880. *Ann. Mag. nat. Hist.* (5) **6**: 163 (*Cynopterus*). Borneo; Peninsular Malaysia, Riau Archipelago, Singapore, Sumatra.

Genus PLEROTES Andersen

PLEROTES Andersen, 1910. *Ann. Mag. nat. Hist.* (8) **5**: 97. Type-species: *Epomophorus anchietae* Seabra, 1900.

anchietae Seabra, 1900. *Jorn. Sci. math. phys. nat.* (2) **6**: 116 (*Epomophorus*). Angola; Zaire, Zambia.

Genus PTENOCHIRUS Peters

PTENOCHIRUS Peters, 1861. *Mber. K. preuss. Akad. Wiss.* **1861**: 707. Type-species: *Pachysoma jagorii* Peters, 1861.

jagorii Peters, 1861. *Mber. K. preuss. Akad. Wiss.* **1861**: 707 (*Pachysoma*). Luzon, Philippines; Philippines.

minor Yoshiyuki, 1979. *Bull. natn. Sci. Mus. Tokyo, ser. A (zool.)* **5**: 75. Mindanao, Philippines; Philippines.

Genus PTERALOPEX Thomas

PTERALOPEX Thomas, 1888. *Ann. Mag. nat. Hist.* (6) **1**: 155. Type-species: *Pteralopex atrata* Thomas, 1888.

acrodonta Hill & Beckon, 1978. *Bull. Br. Mus. nat. Hist. Zool.* **34**(20): 68. Taveuni, Fiji; Fiji.

anceps Andersen, 1909. *Ann. Mag. nat. Hist.* (8) **3**: 266. Bougainville; Solomon Islands.

atrata Thomas, 1888. *Ann. Mag. nat. Hist.* (6) **1**: 155. Guadalcanal, Solomon Islands; Solomon Islands.

Genus PTEROPUS Brisson

PTEROPUS Brisson, 1762. *Regn. Anim. 2nd. edn.* **13**: 153-155. Type-species: *Vespertilio vampyrus niger* Kerr, 1792.

admiralitatum Thomas, 1894. *Ann. Mag. nat. Hist.* (6) **13**: 293. Admiralty Islands, Bismarck Archipelago; Bismarck Archipelago, Solomon Islands.

ssp. **admiralitatum** s.str. Admiralty Islands, Bismarck Archipelago; Bismarck Archipelago.

ssp. **colonus** Andersen, 1908. *Ann. Mag. nat. Hist.* (8) **2**: 363 (as sp.). Shortland, Solomon Islands; Solomon Islands (Choiseul, Mono).

ssp. **goweri** Tate, 1934. *Am. Mus. Novit.* **718**: 1 (as sp.). N'Dai, Solomon Islands.

ssp. **solomonis** Thomas, 1904. *Novit. zool.* **11**: 597 (assp.). Ghizo, Solomon Islands; Solomon Islands (Guadalcanal, Kolombangara, Malaita, Ranongga, Russell Islands: Mbanika and Simbo, Vella Lavella).

alecto Temminck, 1837. *Monographes de Mammalogie* **2**: 75. Sulawesi; Australia, Bawean (north of Jawa), Kangean Islands, Lombok, New Guinea, Salayar, Savu, Sumba.

ssp. **alecto** s.str. Sulawesi; Lombok, Salayar.

nicobaricus Heude, 1896. *Mem. Hist. nat. Emp. Chin.* **3**: 176 (*nec Zelebor*, 1869). Sulawesi.

ssp. **aterrimus** Matschie, 1899. *Die Fledermäuse der Berl. Mus. für Natur. I. Megachir.* 17. Bawean; Kangean Islands.

baveanus Miller, 1906. *Proc. biol. Soc. Wash.* 19: 63. Bawean.

ssp. **gouldi** Peters, 1867. *Mber. K. preuss. Akad. Wiss.* **1867**: 703 (as sp.). Queensland, Australia; Australia, New Guinea.

ssp. **morio** Andersen, 1908. *Ann. Mag. nat. Hist.* (8) **2**: 369 (as sp.). Sumba; Savu.

anetianus Gray, 1870. *Cat. Monkeys, Lemurs etc. in British Museum* 101. Anatom, Vanuatu; Vanuatu.

ssp. **anetianus** s.str. Anatom, Vanuatu; Vanuatu (Erromango).

ssp. **aorensis** Lawrence 1945. *Proc. New Engl. zool. Club* **23**: 66. Espiritu Santo, Vanuatu; Vanuatu (Aore).

ssp. **bakeri** Thomas, 1925. *Ann. Mag. nat. Hist.* (9) **16**: 240. Efate, Vanuatu; Vanuatu (Emao, Nguna).

ssp. **banksiana** Sanborn, 1930. *Am. Mus. Novit.* **435**: 1. Ureparapara, Banks Islands, Vanuatu; Vanuatu (Banks Islands: Vanua Lava).

ssp. **eotinus** Andersen, 1913. *Ann. Mag. nat. Hist.* (8) **11**: 469. Vanuatu; Vanuatu (Aoba, Maewo, Malakula, Malo, Pentecost).

- ssp. **motalavae** Felten and Kock, 1972. *Senckenberg. biol.* **53(3-4)**: 182. Mota Lava, Banks Islands, Vanuatu.
- ssp. **pastoris** Felten and Kock, 1972. *Senckenberg. biol.* **53(3-4)**: 185. Tongoa, Vanuatu; Vanuatu (Emae).
- argentatus** Gray, 1844. *List. Mamm. in British Museum* 1843, 194 (*nomen nudum*), *Voy. "Sulphur", zool.* **1**: 30. ?Ambon.
- brunneus** Dobson, 1878. *Cat. Chiroptera in British Museum* 37. Percy Island, Queensland, Australia.
- caniceps** Gray, 1870. *Cat. Monkeys, Lemurs etc. in British Museum* 107. Bacan; Halmahera, Morotai, Sula Islands, Sulawesi, Ternate.
- ssp. **caniceps** s.str. Bacan; Halmahera, Morotai, Sula Islands, Ternate.
- affinis* Gray, 1870. *Cat. Monkeys, Lemurs etc. in British Museum* 108 (as sp.). Halmahera.
- batchiana* Gray, 1870. *Cat. Monkeys, Lemurs etc. in British Museum* 110 (as var. of *P. macklotii*). Bacan.
- ssp. **dobsoni** Andersen, 1909. *Ann. Mag. nat. Hist.* (8) **2**: 370 (as sp.). Sulawesi.
- fuscus* Dobson, 1878. *Cat. Chiroptera in British Museum* 552 (preoccupied). Sulawesi.
- chrysoproctus** Temminck, 1837. *Monographes de Mammalogie* **2**: 67. Ambon; Asilulu, Buru, Gorong Islands, Keffing (off south-east Seram), Seram, Watubela Islands.
- conspicillatus** Gould, 1849. *Proc. zool. Soc. Lond.* **1849**: 109. Fitzroy Island, north-east Queensland, Australia; Alcester Island, Australia, Bacan, D'Entrecasteaux Islands, Gebe, Louisiade Archipelago, Misool, Morotai, Muyua, New Guinea, Obi, Salawati, Schouten Islands, Ternate, Trobriand Islands.
- ssp. **chrysauchen** Peters, 1862. *Mber. K. preuss. Akad. Wiss.* **1862**: 576 (as sp.). Bacan; Gebe, Misool, Morotai, New Guinea, Obi, Salawati, Schouten Islands, Ternate.
- mysolensis* Gray, 1870. *Cat. Monkeys, Lemurs etc. in British Museum* 105 (as sp.). Misool.
- ssp. **conspicillatus** s.str. Fitzroy Island, north-east Queensland, Australia; Alcester Island, Australia, D'Entrecasteaux Islands, Louisiade Archipelago, Muyua, New Guinea, Trobriand Islands.
- dasymallus** Temminck, 1825. *Monographes de Mammalogie* **1**: 180. Kuchinoerabujima, Oosumi Group, Ryukyu Archipelago; Ryukyu Archipelago, Taiwan.
- ssp. **daitoensis** Kuroda, 1921. *J. Mammal.* **2(4)**: 210 (as sp.). Kita-daitojima, Ryukyu Archipelago; Ryukyu Archipelago (Minami-daitojima).
- ssp. **dasymallus** s.str. Kuchinoerabujima, Oosumi Group, Ryukyu Archipelago; Ryukyu Archipelago (Tokara Group).
- yamagata* Kishida, 1933. *Lansania* **8**: 125 (as sp.) Kuchinoerabujima.
- ssp. **formosus** Selater, 1873. *Proc. zool. Soc. Lond.* **1873**: 193. Kashoto, Taiwan.
- ssp. **inopinatus** Kuroda, 1933. *J. Mammal.* **14(4)**: 314. Okinawajima, Ryukyu Archipelago; Ryukyu Archipelago (Minajima, off Okinawajima).
- ssp. **yayeyamae** Kuroda, 1933. *J. Mammal.* **14(4)**: 315. Ishigakijima, Yaeyama Group, Ryukyu Archipelago; Ryukyu Archipelago (Miyako Group, Yaeyama Group).
- faunulus** Miller, 1902. *Proc. U.S. natn. Mus.* **24**: 785. Car Nicobar, Nicobar Islands; Nicobar Islands.
- fundatus** Felten and Kock, 1972. *Senckenberg. biol.* **53(3-4)**: 186. Mota Lava, Banks Islands, Vanuatu; Vanuatu.
- giganteus** Brunnich, 1782. *Dyrenes Historie* 1: 45 (*Vespertilio*). Bengal, India; Andaman Islands, Bangladesh, Burma, China, India, Maldives, Nepal, Pakistan, Sri Lanka.
- ssp. **ariel** Allen, 1908. *Bull. Mus. comp. Zool. Harv.* **52(3)**: 28 (as sp.). Maldives.
- ssp. **chinghaiensis** Wang and Wang, 1962. *Acta. zool. Sin.* **14**: 494. North-west China.
- ssp. **giganteus** s.str. Bengal, India; Andaman Islands, Bangladesh, Burma, India (except north-east), Pakistan, Sri Lanka.
- medius* Temminck, 1825. *Monographes de Mammalogie* **1**: 176 (as sp.). India.
- kelaarti* Gray, 1870. *Cat. Monkeys, Lemurs etc. in British Museum* 104 (as sp.) Sri Lanka.
- ssp. **leucocephalus** Hodgson, 1835. *Proc. zool. Soc. Lond.* **1834**: 700 (as sp.). Nepal; north-east India.
- assamensis* M'Clelland 1839. *Proc. zool. Soc. Lond.* **1839**: 148 (as sp.). Assam, India.
- gilliardi** Van Deusen, 1969. *Am. Mus. Novit.* **2371**: 5. New Britain, Bismarck Archipelago.
- griseus** Geoffroy, 1810. *AnnlMus. Hist. nat. Paris* **15**: 94. Timor, Banda Islands, Bonerate, Jampea, ?Philippines (Luzon), Salayar, Semau, Sulawesi.
- ssp. **griseus** s.str. Timor, Bonerate, Jampea, Semau.
- ssp. **minus** Andersen, 1908. *Ann. Mag. nat. Hist.* (8) **2**: 364 (as sp.). Sulawesi; ?Philippines (Luzon), Salayar.
- ssp. **pallidus** Temminck, 1825. *Monographes de Mammalogie* **1**: 184 (as sp.). Banda Islands.
- howensis** Troughton, 1931. *Proc. Linn. Soc. N.S. W.* **56**: 204. Ontong Java Atoll, Solomon Islands.
- hypomelanus** Temminck, 1853. *Esq. Zool. Cdte de Guine 1. Mammiferes* 61. Ternate; Anamba Islands, Berhala (Straits of Malacca), Bismarck Archipelago, Borneo, Cambodia, D'Entrecasteaux Islands, Enganno, Halmahera, Louisiade Archipelago, Maldives, Manam, Mentawai Islands, Mergui Archipelago, Natuna Islands, New Guinea, Peninsular Malaysia, Philippines, Sangir Islands, Simalue Islands, Solomon Islands, Sulawesi, Talaud Islands, Tambelan Islands, Thailand, Trobriand Islands, Vietnam.
- ssp. **annectens** Andersen, 1908. *Ann. Mag. nat. Hist.* (8) **2**: 361. Serasan, Natuna Islands; Natuna Islands (Subi Besar).
- ssp. **cagayanus** Meams, 1905. *Proc. U.S. natn. Mus.* **28**: 433 (as sp.). Cagayan Sulu, Philippines; Philippines (except Sibutu).
- ssp. **canus** Andersen, 1908. *Ann. Mag. nat. Hist.* (8) **2**: 361. Pandak, Natuna Islands; Natuna Islands (Laut, Panjang).
- ssp. **condorensis** Peters, 1869. *Mber. K. preuss. Akad. Wiss.* **1869**: 393 (as sp.). Con Son, Vietnam; Cambodia, Thailand, Vietnam.

- ssp. **enganus** Miller, 1906. *Proc. U.S. natn. Mus.* **30**: 822, 824. Enggano; Mentawai Islands.
- ssp. **fretensis** Kloss, 1916. *J. fed. Malay St. Mus.* **6**: 247. Jerak, Peninsular Malaysia; Berhala.
- ssp. **geminorum** Miller, 1903. *Smithson. Misc. Collns* **45**: 60 (as sp.). South Twin Island, Mergui Archipelago, Burma; Peninsular Malaysia, Thailand.
- ssp. **hypomelanus** s.str. Ternate; Halmahera.
tricolor Gray, 1870. *Cat. Monkeys, Lemurs etc. in British Museum* 108 (as sp.). Ternate.
- ssp. **lepidus** Miller, 1900. *Proc. wash. Acad. Sci.* **2**: 237 (as sp.). Saddle Island, Tambelan Islands; Anamba Islands, Peninsular Malaysia, Tambelan Islands.
- ssp. **luteus** Andersen, 1908. *Ann. Mag. nat. Hist.* (8) **2**: 362. Kiriwina Island, Trobriand Islands; Bismarck Archipelago, D'Entrecasteaux Islands, Louisiade Archipelago, New Guinea, Solomon Islands, Trobriand Islands.
- ssp. **macassaricus** Heude, 1896. *Mem. Hist. nat. Emp. Chin.* **3**: 177 (as sp.). Sulawesi; Sangir Islands, Talaud Islands.
- ssp. **maris** Allen, 1936. *Rec. Indian Mus.* **38**: 343. Maldives.
- ssp. **robinsoni** Andersen, 1909. *Ann. Mag. Nat. Hist.* (8) **4**: 534. Sembilan Islands, Peninsular Malaysia.
- ssp. **simalurus** Thomas, 1923. *Ann. Mag. nat. Hist.* (9) **12**: 592. Taped Islet, Simalue Islands; Simalue Islands.
- ssp. **tomesi** Peters, 1868. *Mber. K. preuss. Akad. Wiss.* **1868**: 626 (as var. of *P. hypomelanus*). Labuan, Borneo; Borneo, Philippines.
- ssp. **vulcanius** Thomas, 1915. *Ann. Mag. nat. Hist.* (8) **15**: 388. Manam.
- insularis Hombron & Jacquinot, 1842. *Voy. Pole. Sud., Mamm.* **3**: 24. Chuuk Islands; Chuuk.
- lanigera* Allen, 1896. *Proc. Am. phil. Soc.* **28**: 70. Samoa (in error).
- leucopterus** Temminck, 1853. *Esq. Zool. Cote de Guine* 60. Philippines.
- livingstonii** Gray, 1866. *Proc. zool. Soc. Lond.* **1866**: 66. Anjouan, Comoros; Comoros.
- lombocensis** Dobson, 1878. *Cat. Chiroptera in British Museum* 34. Lombok; Alor, Flores.
- ssp. **lombocensis** s.str. Lombok; Flores.
tricolor Heude, 1896. *Mem. Hist. nat. Emp. Chin.* **3**: 177 (as sp., nec Gray, 1870). Flores.
- heudei* Matschie, 1899. *Die Fledermäuse der Berl. Mus. für Natur. I. Megachir.* 32. (Nom. nov. for *tricolor* Heude, 1869).
- ssp. **solitarius** Andersen, 1908. *Ann. Mag. nat. Hist.* (8) **2**: 367. Alor.
- temmincki* Hartert, 1898. *Novit. zool.* **5**: 456 (as sp., nec Peters, 1867). Alor.
- lylei** Andersen, 1908. *Ann. Mag. nat. Hist.* (8) **2**: 367. Thailand; Cambodia, Vietnam.
- macrotis** Peters, 1867. *Mber. K. preuss. Akad. Wiss.* **1867**: 327. Wokam, Aru Islands; Aru Islands, Australia, New Guinea.
- ssp. **epularius** Ramsay, 1878. *Proc. Linn. Soc. N.S.W.* **2**: 8. New Guinea; Australia.
- ssp. **macrotis** s.str. Wokam, Aru Islands; Aru Islands.
insignis Rosenberg, 1867. *Reis. Zuidoostereilanden* 31. Wokam.
- mahaganus** Sanborn, 1931. *Fld. Mus. News Publ.* 286 (*Zool. Sec.*) **18(2)**: 19. Santa Isabel, Solomon Islands; Bougainville.
- mariannus** Desmarest, 1822. *Mammalogie, ii, Suppl.* 547. Guam, Mariana Islands; Belau, Kosrae, Mariana Islands (populations on Agrihan, Anatahan, Ascuncion, Farallon de Medinilla, Guguan, Maug and Sarigan not identified subspecifically), Ryukyu Archipelago, Ulithi Atoll, Yap.
- ssp. **lochoensis** Gray, 1870. *Cat. Monkeys, Lemurs etc. in British Museum* 106 (as sp.). Okinawajima, Ryukyu Archipelago.
- ssp. **mariannus** s.str. Guam, Mariana Islands; Mariana Islands (Aguijan, Rota, Saipan, Tinian).
keraudren Quoy and Gaimard, 1824. *Voy. "Uranie", Zool.* **2**: 51. Guam.
- vanikorensis* Quoy and Gaimard, 1830. *Voy. "Astrolabe", Zool.* **1**: 77. "Vanikoro" (in error).
- ssp. **paganensis** Yamashina, 1932. *Trans. nat. Hist. Soc. Formosa* **22(121)**: 241. Pagan, Mariana Islands; Mariana Islands (Almagan).
- ssp. **pelewensis** Andersen, 1908. *Ann. Mag. nat. Hist.* (8) **2**: 364 (as sp.). Belau.
- ssp. **ualanus** Peters, 1883. *Sber. Ges. naturf. Freunde Berlin* **1883(1)**: 1 (as sp.). Kosrae.
- ssp. **ulthiensis** Yamashina, 1932. *Trans. nat. Hist. Soc. Formosa* **22(121)**: 241. Ulithi Atoll, Yap.
- ssp. **yapensis** Andersen, 1908. *Ann. Mag. nat. Hist.* (8) **2**: 365 (as sp.). Yap (except Ulithi Atoll).
- mearnsi** Hollister, 1913. *Proc. biol. Soc. Wash.* **26**: 112. Basilan, Philippines; Philippines.
- melanopogon** Peters, 1867. *Mber. K. preuss. Akad. Wiss.* **1867**: 330. Ambon; Aru Islands, Banda Islands, Boano, Buru, Gorong Islands, Kai Islands, Manawoka, Saparua, Seram, Tenimber Islands.
- ssp. **aruensis** Peters, 1867. *Mber. K. preuss. Akad. Wiss.* **1867**: 330. Aru Islands.
- argentatus* Gray, 1858. *Proc. zool. Soc. Lond.* **1858**: 107 (nec Gray, 1844). Aru Islands.
- rubiginosus* Rosenberg, 1867. *Reis. Zuidoostereilanden* 31. Aru Islands.
- fumigatus* Rosenberg, 1867. *Reis. Zuidoostereilanden* 31. Aru Islands.
- ssp. **keyensis** Peters, 1867. *Mber. K. preuss. Akad. Wiss.* **1867**: 330. Kai Islands.
- chrysargyrus* Heude, 1896. *Mem. Hist. nat. Emp. Chin.* **3**: 177. Little Kai, Kai Islands.
- ssp. **melanopogon** s.str. Ambon; Banda Islands, Boano, Buru, Gorong Islands, Saparua, Seram, Tenimber Islands.
- melanotus** Blyth, 1863. *Cat. Mam. Mus. As. Soc.* 20. Nicobar Islands; Andaman Islands, Christmas Island, Enggano, Nias.
- ssp. **melanotus** s.str. Nicobar Islands.
nicobaricus Zelebor, 1869. *Saug. Reise der Fregatte "Novara", Zool.* i 11. Car Nicobar.
- ssp. **modiglianii** Thomas, 1894. *Annali Mus. civ. Stor. nat. Genova* (2) **14**: 106 (as sp.). Enggano.

- ssp. **natalis** Thomas, 1887. *Proc. zool. Soc. Lond.* **1887**: 511 (as sp.). Christmas Island.
- ssp. **niadicus** Miller, 1906. *Proc. biol. Soc. Wash.* **19**: 64 (as sp.). Nias.
- ssp. **satyrus** Andersen, 1908. *Ann. Mag. nat. Hist.* (8) **2**: 362 (as sp.). Narcondam Island, North Andaman Islands; North Andaman Islands.
- ssp. **tytleri** Mason, 1908. *Rec. Indian Mus.* **2(2)**: 162 (as sp.). South Andaman Islands.
- molossinus** Temminck, 1853. *Esq. Zool. Côte de Guinée* 62. Pohnpei; ?Chuuk (Mortlock Islands)
- breviceps* Thomas, 1882. *Proc. zool. Soc. Lond.* **1882**: 756. Chuuk (Mortlock Islands).
- neohibernicus** Peters, 1876. *Mber. K. preuss. Akad. Wiss.* **1876**: 317. New Ireland, Bismarck Archipelago; Bismarck Archipelago, Gebe, Karkar Island, Misool, New Guinea, Sakar, Umboi.
- ssp. **hilli** Felten, 1961. *Senckenberg. biol.* 42:417. Admiralty Islands, Bismarck Archipelago.
- ssp. **neohibernicus** s.str. New Ireland, Bismarck Archipelago; Bismarck Archipelago, Gebe, Karkar Island, Misool, New Guinea, Sakar, Umboi.
- degener* Peters, 1876. *Mber. K. preuss. Akad. Wiss.* **1876**: 318. Aru Islands (in error).
- papuanus* Peters and Doria, 1881. *Annali Mus. civ. Stor. nat. Genova* **16**: 690. North-west New Guinea.
- coronatus* Thomas, 1889. *Proc. zool. Soc. Lond.* **1888**: 471. Mioko, near Duke of York, Bismarck Archipelago.
- rufus* Ramsay, 1891. *Rec. Aust. Mus.* **1(6)**: 105 (nec Geoffroy, 1803). New Britain, Bismarck Archipelago.
- sepikensis* Sanborn, 1931. *Fld. Mus. News publ.* 286 (*Zool. Sec.*) **18(2)**: 14. North-west New Guinea.
- niger** Kerr, 1792. *Animal Kingdom.* **1(1)**: 90 (*Vespertilio*). Reunion (now extinct); Mauritius.
- caninus* Blumenbach, 1797. *Handbuch der Naturg.* 5th edn. 73 (*Vespertilio*). Reunion.
- fuscus* Geoffroy, 1803. *Cat. Mam. Mus. Nat. d'Hist. Nat.* 46. Reunion.
- mauritanus* Hermann, 1804. (ex Commerson, MS) *Observationes Zoologicae* 19. Mauritius.
- vulgaris* Geoffroy, 1810. *Annl. Mus. Hist. nat. Paris* **15**: 92. Réunion.
- nitendiensis** Sanborn, 1930. *Am. Mus. Novit.* **435**: 2. Nendo, Santa Cruz Islands, Solomon Islands; Solomon Islands.
- ocularis** Peters, 1867. *Mber. K. preuss. Akad. Wiss.* **1867**: 326. Seram; Buru.
- ceramensis* Gray, 1870. *Cat. Monkeys, Lemurs etc. in British Museum* 105 (as var. of *P. mysolensis*). Seram.
- ornatus** Gray, 1870. *Cat. Monkeys, Lemurs etc. in British Museum* 105. New Caledonia, New Caledonia; New Caledonia.
- ssp. **auratus** Andersen, 1909. *Ann. Mag. nat. Hist.* (8) **3**: 233 (as sp.). Lifou, Loyalty Islands, New Caledonia; New Caledonia (Loyalty Islands).
- ssp. **ornatus** s.str. New Caledonia (New Caledonia).
- personatus** Temminck, 1825. *Monographes de Mammalogie* **1**: 189. Ternate; Bacan, Halmahera, Morotai, ?Sulawesi.
- phaeocephalus** Thomas, 1882. *Proc. zool. Soc. Lond.* **1882**: 756. Mortlock Islands, Chuuk.
- pilosus** Andersen, 1908. *Ann. Mag. nat. Hist.* (8) **2**: 369. Belau (extinct).
- pohlei** Stein, 1933. *Z. Saugetierk* **8**: 93. Yapen.
- poliocephalus** Temminck, 1825. *Monographes de Mammalogie* **1**: 179. Australia.
- pselaphon** Lay, 1829. *Zool. J. Lond.* **4**: 457. Ogasawara-shato, Japan; Japan (Kazan-retto).
- ursinus* Temminck, 1837. (ex Kittlitz, MS) *Monographes de Mammalogie* **2**: 70. Ogasawara-shato, Japan.
- pumilus** Miller, 1911. *Proc. U.S. natn. Mus.* **38**: 394. Miangas, Philippines (now in Indonesia); Philippines.
- balutus* Hollister, 1913. *Proc. biol. Soc. Wash.* **26**: 111. Sarangani Islands, Philippines.
- tablasi* Taylor, 1934. *Philippine Land. Mamm., Philippine Bur. Sci. Monogr.* **30**: 169. Tablas, Philippines.
- rayneri** Gray, 1870. *Cat. Monkeys, Lemurs etc. in British Museum* 108. Guadalcanal, Solomon Islands; Bougainville, Buka, Solomon Islands.
- ssp. **cognatus** Andersen, 1908. *Ann. Mag. nat. Hist.* (8) **2**: 365 (as sp.). San Cristobal, Solomon Islands; Solomon Islands (Uki Ni Masi).
- ssp. **grandis** Thomas, 1887. *Ann. Mag. nat. Hist.* (5) **19**: 147 (as sp.). Shortland, Solomon Islands; Bougainville, Buka, Solomon Islands (Alu, Choiseul, Santa Isabel).
- ssp. **lavellanus** Andersen, 1908. *Ann. Mag. nat. Hist.* (8) **2**: 366 (as sp.). Vella Lavella, Solomon Islands; Solomon Islands (Ghizo, Ranongga).
- ssp. **monoensis** Lawrence, 1945. *Proc. New Engl. zool. Club* **23**: 63. Mono, Solomon Islands.
- ssp. **rayneris**.str. Guadalcanal, Solomon Islands; Solomon Islands (Malaita).
- ssp. **rennelli** Troughton, 1929. *Rec. Aust. Mus.* **17**: 193 (as sp.). Rennell, Solomon Islands.
- ssp. **rubianus** Andersen, 1908. *Ann. Mag. nat. Hist.* (8) **2**: 366 (as sp.). New Georgia, Solomon Islands; Solomon Islands (Kolombangara, Simbo).
- rodricensis** Dobson, 1878. *Cat. Chiroptera in British Museum* 36. Rodrigues, Mauritius (now extinct).
- mascarinus* Mason, 1907. *Ann. Mag. nat. Hist.* (7) **20**: 220. Round Island, Mauritius.
- rufus** Geoffroy, 1803. *Cat. Mamm. Mus. d'Hist. Nat.* 47. Madagascar.
- edwardsi* Geoffroy, 1810. *Annl. Mus. Hist. nat. Paris* **15**: 92 (as sp.). Madagascar.
- phaiops* Temminck, 1825. *Monographes de Mammalogie* **1**: 178 (as sp.) Madagascar.
- princeps* Andersen, 1908. *Ann. Mag. nat. Hist.* (8) **2**: 367. Madagascar.

- samoensis** Peale, 1848. *U.S. Exploring Expedition viii Mammalia and Ornithology* 20. Tutuila, American Samoa; American Samoa, Fiji, Western Samoa.
- ssp. **nawaiensis** Gray, 1870. *Cat. Monkeys, Lemurs etc. in British Museum* 107 (as sp.). Fiji.
- vitiensis** Gray, 1870. *Cat. Monkeys, Lemurs etc. in British Museum* 109. Fiji.
- ssp. **samoensis** s.str. Tutuila, American Samoa; American Samoa, Western Samoa.
- whitmeei** Alston, 1874. *Proc. zool. Soc. Lond.* **1874**: 96. Samoa.
- sanctacrucis** Troughton, 1930. *Rec. Aust. Mus.* **18(1)**: 3. Santa Cruz Islands, Solomon Islands.
- scapulatus** Peters, 1862. *Mber. K. preuss. Akad. Wiss.* **1862**: 574. Queensland, Australia; Australia, New Guinea.
- elseyi** Gray, 1866. *Proc. zool. Soc. Lond.* **1866**: 67. Queensland, Australia.
- seychellensis** Milne-Edwards, 1877. *Bull. Soc. philomath. Paris* (7) **2**:221. Seychelles; Aldabra Atoll, Comoros, Tanzania (Mafia).
- ssp. **aldabrensis** True, 1893. *Proc. U.S. natn. Mus.* **16**: 533. Aldabra Atoll.
- ssp. **comorensis** Nicoll, 1908. *Three Voy. of a Naturalist* 87,88,90 (as sp.) Comoros; Tanzania (Mafia).
- ssp. **seychellensis** s.str. Seychelles.
- speciosus** Andersen, 1908. *Ann. Mag. nat. Hist.* (8) **2**: 364. Malanipa, Philippines; Laut Kecil Islands, Masalembu Besar, Philippines.
- subniger** Kerr, 1792. *Animal Kingdom* **1(1)**: 91 (*Vespertilio*). Reunion (extinct); Mauritius (extinct).
- rubidum** Daudin, 1802. in *Buffon Histoire Naturelle*, Didot ed., *Quadr.* **14**: 188 (*Spectrum*). Reunion.
- ruber** Geoffroy, 1803. *Cat. Mamm. Mus. Nat. Hist. Nat.* 48. Madagascar (in error).
- fuscus** Desmarest, 1803. *Nouveau Dict. d'Hist. Nat.* **19**: 544. Réunion.
- rubricollis** Geoffroy, 1810. *Annl's Mus. Hist. nat. Paris* **15**: 93. Réunion.
- torquatus** Fischer, 1814. *Zoognosia* **3**: 553. Reunion.
- collaris** Illiger, 1815. *Abh. Akad. Berlin* **1804-11**: 78, 84. Réunion.
- temmincki** Peters, 1867. *Mber. K. preuss. Akad. Wiss.* **1867**: 331. Ambon; Bismarck Archipelago, Buru, Seram.
- ssp. **capistratus** Peters, 1876. *Mber. K. preuss. Akad. Wiss.* **1876**: 316 (as sp.). New Ireland, Bismarck Archipelago; Bismarck Archipelago.
- ssp. **Hops** Thomas, 1910. *Ann. Mag. nat. Hist.* (8) **5**: 383 (as sp.). Buru.
- ssp. **temmincki** s.str. Ambon; Seram.
- petersi** Matschie, 1899. *Die Fledermäuse der Berl. Mus. für Natur. 1. Megachir.* 31 (as sp.). Ambon.
- tokudae** Tate, 1934. *Am. Mus. Novit.* **713**: 1. Guam, Mariana Islands (extinct).
- tonganus** Quoy and Gaimard, 1830. *Voy. "Astrolabe", Zool.* **1**: 74. Tonga; American Samoa, Cook Islands, Fiji, Karkar Island, New Caledonia, Niue, Schouten Islands, Solomon Islands, Vanuatu, Wallis and Futuna, Western Samoa.
- ssp. **basiliscus** Thomas, 1915. *Ann. Mag. nat. Hist.* **15**: 387 (as sp.). Karkar Island; Schouten Islands.
- ssp. **geddiei** MacGillivray, 1860. *Zoologist* **18**: 7134 (as sp.). Anatom, Vanuatu; New Caledonia, Solomon Islands, Vanuatu.
- heffentani** Troughton, 1930. *Rec. Aust. Mus.* **18(1)**: 3. Santa Cruz Islands, Solomon Islands.
- ssp. **tonganus** s.str. Tonga; American Samoa, Cook Islands, Fiji, Niue, Wallis and Futuna, Western Samoa.
- flavicollis** Gray, 1870. *Cat. Monkeys, Lemurs etc. in British Museum* 107. Fiji.
- tuberculatus** Peters, 1869. *Mber. K. preuss. Akad. Wiss.* **1869**: 393. Vanikoro, Santa Cruz Islands, Solomon Islands.
- vampyrus** Linnaeus, 1758. *Syst. Nat. 10th edn.* **1**: 31 (*Vespertilio*). Jawa; Anamba Islands, Balambangan (off north Borneo), Bali, Banggi (off north Borneo), Bangka, Borneo, Burma, Krakatau Islands, Lingga Islands, Lombok, Mentawai Islands, Natuna Islands, Peninsular Malaysia, Philippines, Riau Archipelago, Savu, Singapore, Sumatra, Sumbawa, Thailand, Timor, Vietnam.
- ssp. **edulis** Geoffroy, 1810. *Annl's Mus. Hist. nat. Paris* **15**: 90 (as sp.). Timor; Savu.
- funereus** Temminck, 1837. *Monographes de Mammalogie* **2**: 63 (as sp.). Timor.
- ssp. **intermedius** Andersen, 1908. *Ann. Mag. nat. Hist.* (8) **2**: 368 (as sp.). Burma; Thailand.
- ssp. **lanensis** Mearns, 1905. *Proc. U.S. natn. Mus.* **28**: 432 (as sp.). Mindanao, Philippines; Philippines.
- ssp. **malaccensis** Andersen, 1908. *Ann. Mag. nat. Hist.* (8) **2**: 368. Peninsular Malaysia; Anamba Islands, Bangka, Lingga Islands, Mentawai Islands, Riau Archipelago, Singapore, Sumatra, Thailand, Vietnam.
- ssp. **natunae** Andersen, 1908. *Ann. Mag. nat. Hist.* (8) **2**: 369. Natuna Islands; Balambangan, Banggi, Borneo.
- ssp. **pluton** Temminck, 1853. *Esq. Zool. Cote de Guine* 56 (as sp.). Bali; Lombok, Sumbawa.
- kopangi** Kuroda, 1933. *J. Mammal.* **14**: 339. Lombok.
- ssp. **vampyrus** s.str. Jawa; Krakatau Islands.
- celaeno** Hermann, 1804. *Observationes Zoologicae* 13 (*Vespertilio*) (as sp.). Jawa.
- javanicus** Desmarest, 1820. *Mammalogie* 1: 109 (as sp.). Jawa.
- pteronotus** Dobson, 1878. *Cat. Chiroptera in British Museum* 48 (as sp.). Jawa.
- vetulus** Jouan, 1863. *Mem. Soc. Imp. Sci. nat. Cherbourg* **9**: 90. New Caledonia.
- macmillani** Tate, 1942:1. *Am. Mus. Novit.* **1213**: 1. New Caledonia.
- voeltzkowi** Matschie, 1909. *Sber. Ges. naturf. Freunde Berlin* **1909**: 486. Pemba, Tanzania.
- woodfordi** Thomas, 1888. *Ann. Mag. nat. Hist.* (6) **1**: 156. Guadalcanal, Solomon Islands; Solomon Islands.
- austini** Lawrence, 1945. *Proc. New Engl. zool. Club* **23**: 59. Nggela Sule, Solomon Islands.

Genus ROUSETTUS Gray

Subgenus BONEIA Jentink

BONEIA Jentink, 1879. *Notes Leyden Mus.* **1**: 117. Type-species: *Boneia bidens* Jentink, 1879.

bidens Jentink, 1879. *Notes Leyden Mus.* **1**: 117. Sulawesi.
menadensis Thomas, 1896. *Ann. Mag. nat. Hist.* (6) **18**: 242. Sulawesi.

Subgenus LISSONYCTERIS Andersen

LISSONYCTERIS Andersen, 1912. *Cat. Chiroptera in British Museum* 23. Type-species: *Cynonycteris angolensis* Bocage, 1898.

angolensis Bocage, 1898. *Jorn. Sci. math. phys. nat.* (2) **5**: 133 (*Cynonycteris*). Angola; Burkina Faso, Cameroun, Central African Republic, Congo, Equatorial Guinea (Bioko, Mbini), Ethiopia, Gabon, Ghana, Guinea, Guinea-Bissau, Ivory Coast, Kenya, Liberia, Mozambique, Nigeria, Rwanda, Senegal, Sierra Leone, Sudan, Tanzania, Togo, Uganda, Zaire, Zambia, Zimbabwe.

ssp. **angolensis** Angola; Cameroun, Central African Republic, Congo, Equatorial Guinea (Bioko, Mbini), Gabon, eastern Nigeria, western Zaire.

crypticola Cabrera, 1920. *Boln R. Soc. esp. Hist. nat.* **20**: 106. Bioko.

ssp. **ruwenzorii** Eisentraut, 1965. *Bonn. zool. Beitr* **16(1-2)**: 3. Uganda; Ethiopia, Kenya, Mozambique, Rwanda, Sudan, Tanzania, eastern Zaire, Zambia, Zimbabwe.

ssp. **smithii** Thomas, 1908. *Ann. Mag. nat. Hist.* (8) **2**: 375 (as sp.). Sierra Leone; Burkina Faso, Ghana, Guinea, Guinea-Bissau, Ivory Coast, Liberia, western Nigeria, Senegal, Togo.

Subgenus ROUSETTUS Gray

ROUSETTUS Gray, 1821. *London Medical Repository* **15**: 299. Type-species: *Pteropus aegyptiacus* Geoffroy, 1810.

aegyptiacus Geoffroy, 1810. *Annl. Mus. Hist. nat. Paris* **15**: 96 (*Pteropus*). Egypt; Angola, Burundi, Cameroun, Congo, Cyprus, Equatorial Guinea (Bioko, Mbini), Ethiopia, Gabon, Gambia, Ghana, Guinea, Iran, Israel, Ivory Coast, Kenya, Lebanon, Liberia, Malawi, Mozambique, Nigeria, Oman, Pakistan, Rwanda, São Tomé and Príncipe, Saudi Arabia, Senegal, Sierra Leone, Sudan, South Africa, Syria, Tanzania (mainland, Mafia, Pemba, Zanzibar), Togo, Turkey, Uganda, Yemen, Zaire, Zambia, Zimbabwe.

ssp. **aegyptiacus** s.str. Egypt; Cyprus, Israel, Lebanon, Syria, Turkey.

geoffroyi Temminck, 1825. *Monographes de Mammalogie* **1**: 197 (nom. nov. for *aegyptiacus*).

ssp. **arabicus** Anderson & de Winton, 1902. *Zool. Egypt, Mamm.* 86, 88-90. Yemen; ?eastern Ethiopia, Iran, Oman, Pakistan, Saudi Arabia.

ssp. **leachii** Smith, 1829. *Zool. J. Lond.* **4**: 433 (*Pteropus*, as sp.). South Africa; Burundi, Ethiopia, Kenya, Malawi, Mozambique, Rwanda, southern Sudan, Tanzania (mainland,

Mafia, Pemba, Zanzibar), Uganda, eastern Zaire, Zambia, Zimbabwe.

collaris Lichtenstein, 1823. *Verz. Doubl. Mus. Berlin*, **5** (*Pteropus*, as sp., nec Illiger, 1815). South Africa.

hottentotus Temminck in Smuts, 1832. *Dissertatio Zoologica, enum. Mamm. Capens.* 3 (*Pteropus*, as sp.). South Africa.

ssp. **unicolor** Gray, 1870. *Cat. Monkeys, Lemurs etc. in British Museum* 117 (*Eleutherura*). Gabon; Angola, Cameroun, Congo, Equatorial Guinea (Bioko, Mbini), Gambia, Ghana, Guinea, Ivory Coast, Liberia, Nigeria, São Tomé and Príncipe, Senegal, Sierra Leone, Togo, western Zaire.

occidentalis Eisentraut, 1960. *Zool. Beitr.* **10**: 231. Cameroun.

amplesicaudatus Geoffroy, 1810. *Annl. Mus. Hist. nat. Paris* **15**: 96 (*Pteropus*). Timor, Alor, Ambon, Bagabag, Bali, Bismarck Archipelago, Borneo, Bougainville, Burma, Cambodia, Enggano, Flores, Halmahera, Jawa, Kisar (north-east of Timor), Krakatau Islands, Lombok, Mentawai Islands, Ndao (south-west of Rote), New Guinea, Peleng, Penida, Peninsular Malaysia, Philippines, Rote, Savu, Seram, Solomon Islands, Sulawesi, Sumatra, Sumba, Ternate, Thailand, Yapen.

ssp. **amplesicaudatus** s.str. Timor; Alor, Ambon, Bagabag, Borneo, Burma, Cambodia, Enggano, Halmahera, Kisar, Lombok, Mentawai Islands, Ndao, New Guinea, Peleng, Peninsular Malaysia, Philippines, Rote, Savu, Seram, Sulawesi, Sumba, Ternate, Thailand, Yapen.

philippinensis Gray, 1870. *Cat. Monkeys, Lemurs etc. in British Museum* 119 (*Eleutherura*, as sp.). Luzon, Philippines.

bocagei Seabra, 1898. *Jorn. Sci. math. phys. nat.* (2) **5**: 160, 169 (*Cynonycteris*, as sp.). Timor.

stresemanni Stein, 1933. *Z. Säugtierk* **8**: 91. Yapen.

ssp. **brachyotis** Dobson, 1877. *Proc. zool. Soc. Lond.* **1877**: 116 (*Cynonycteris*, as sp.). Duke of York, Bismarck Archipelago; Bismarck Archipelago, Bougainville, ?Halmahera, Solomon Islands.

hedigeri Dobson, 1873. *J. Asiat. Soc. Beng.* **42(2)**: 203 (*Cynonycteris*, as sp.). Bougainville.

ssp. **infumatus** Gray, 1870. *Cat. Monkeys, Lemurs etc. in the British Museum* 118 (*Eleutherura*, as sp.). Flores; Bali, Jawa, Krakatau Islands, Penida, Sumatra.

minor Dobson, 1873. *J. Asiat. Soc. Beng.* **42(2)**: 203 (*Cynonycteris*, as sp.). Jawa.

celebensis Andersen, 1907. *Ann. Mag. nat. Hist.* (7) **19**: 509. Sulawesi; Sangir Islands.

lanosus Thomas, 1906. *Ann. Mag. nat. Hist.* (7) **18**: 137. Uganda; Burundi, Ethiopia, Kenya, Rwanda, Sudan, Tanzania, Zaire.

ssp. **kempi** Thomas, 1909. *Ann. Mag. nat. Hist.* (8) **4**: 543. Kenya; Ethiopia, Sudan, Tanzania.

ssp. **lanosus** s.str. Uganda; Burundi, Rwanda, Zaire.

leschenaulti Desmarest, 1820. *Encycl. Meth. Mamm.* 110 (*Pteropus*). India; ?Aru Islands, Bali, Bangladesh, Burma, Cambodia, China, Hong Kong, Jawa, Laos, Lombok, Nepal, Pakistan, Simalue Islands, Sri Lanka, Sumatra, Thailand, Vietnam.

ssp. **leschenaulti** s.str. India; Bangladesh, Burma, Cambodia, China, Hong Kong, Laos, Nepal, Pakistan, Thailand, Vietnam.

pyrivorius Hodgson, 1835. *J. Asiat. Soc. Beng.* **4**: 700 (*Pteropus*, as sp.). Nepal.

affinis Gray, 1843. *List. Mamm. in British Museum* 39 (*Cynopterus*, as sp.). Himalayas.

fuliginosa Gray, 1870. *Cat. Monkeys, Lemurs etc. in British Museum* 118 (*Eleutherura*, as sp.). Thailand.

fuscus Gray, 1870. *Cat. Monkeys, Lemurs etc. in British Museum* 119 (*Eleutherura*, as sp.). ?India.

infuscata Peters, 1873. *Mber. K. preuss. Akad. Wiss.* **1873**: 487 (*Cynonycteris*, as sp.). India.

ssp. **seminudus** Gray, 1870. *Cat. Monkeys, Lemurs etc. in British Museum* 115 (*Xantharpi*). Sri Lanka.

ssp. **shortridgei** Thomas & Wroughton, 1909. *Proc. zool. Soc. Lond.* **1909**: 374. Jawa; ?Aru Islands, Bali, Lombok, Simalue Islands, Sumatra.

madagascariensis Grandidier, 1928. *Bull. Acad. malgache* **1928**: 91. Madagascar.

obliviosus Kock, 1978. *Proc. Int. Bat. Res. Conf.* 4: 208. Comoros.

spinalatus Bergmans & Hill, 1980. *Bull. Br. Mus. nat. Hist. Zool* **38(1)**: 95. Sumatra; Borneo.

Genus SCOTONYCTERIS Matschie

SCOTONYCTERIS Matschie, 1894. *Sber. Ges. naturf. Freunde Berl.* **1894**: 200. Type-species: *Scotonycteris zenkeri* Matschie, 1894.

ophiodon Pohle, 1943. *Sber. Ges. naturf. Freunde Berl.* **1943**: 76. Cameroun; Congo, Ghana, Liberia.

cansdalei Hayman, 1946. *Ann. Mag. nat. Hist.* (11) **11**: 766. Ghana.

zenkeri Matschie, 1894. *Sber. Ges. naturf. Freunde Berl.* **1894**: 202. Cameroun; Central African Republic, Congo, Equatorial Guinea (Bioko, Mbini), Gabon, Ghana, Ivory Coast, Liberia, Nigeria, Zaire.

occidentalis Hayman, 1947. *Ann. Mag. nat. Hist.* (11) **13**: 503. Ghana.

Genus SPHAERIAS Miller

SPHAERIAS Miller, 1906. *Proc. biol. Soc. Wash.* **19**: 83. Type-species: *Cynopterus blanfordi* Thomas, 1891.

blanfordi Thomas, 1891. *Annali Mus. civ. Stor. nat. Genova* (2) **10**: 884 (*Cynopterus*). Burma; Bhutan, China, India, Thailand, Tibet.

Genus STYLOCTENIUM Matschie

STYLOCTENIUM Matschie, 1899. *Die Fledermäuse der Berl. Mus. für Natur. I. Megachir.* 33. Type-species: *Pteropus wallacei* Gray, 1866.

wallacei Gray, 1866. *Proc. zool. Soc. Lond.* **1866**: 65 (*Pteropus*). Sulawesi.

Genus SYCONYCTERIS Matschie

SYCONYCTERIS Matschie, 1899. *Die Fledermäuse der Berl. Mus. für Natur. I. Megachir.* 94,95,98 (as subgenus). Type-species: *Macroglossus australis* Peters, 1867.

australis Peters, 1867. *Mber. K. preuss. Akad. Wiss.* **1867**: 13 (*Macroglossus*). Queensland, Australia; Ambon (?and nearby islands), Aru Islands, Australia, Bagabag, Bismarck Archipelago, ?Buru, Crown, D'Entrecasteaux Islands, Kai Islands, Long, Louisiade Archipelago, Misool, Muyua, New Guinea, Sakar, Seram, Tolokiwa, Trobriand Islands, Umboi.

ssp. **australis** s.str. Queensland, Australia; Australia.

ssp. **crassa** Thomas, 1895. *Novit. zool.* **2**: 163 (*Carponycteris*). Fergusson, D'Entrecasteaux Islands; D'Entrecasteaux Islands, Trobriand Islands.

ssp. **finschi** Matschie, 1899. *Die Fledermäuse de Berl. Mus. für Natur. I. Megachir.* 100 (*Macroglossus*). New Britain, Bismarck Archipelago; Bismarck Archipelago.

ssp. **keyensis** Andersen, 1911. *Ann. Mag. nat. Hist.* (8) **7**: 643. Kai Islands.

ssp. **major** Andersen, 1911. *Ann. Mag. nat. Hist.* (8) **7**: 643. Ambon; ?small islands near Ambon, ?Buru, Seram.

ssp. **naias** Andersen, 1911. *Ann. Mag. nat. Hist.* (8) **7**: 643. Muyua.

ssp. **papuana** Matschie, 1899. *Die Fledermäuse der Berl. Mus. für Natur. I. Megachir.* 99 (*Macroglossus*, as sp.). New Guinea; Aru Islands, Bagabag, Crown, Long, Louisiade Archipelago, Misool, Sakar, Tolokiwa, Umboi.

carolinae Rozendaal, 1984. *Zool. Med. Leiden* **58**: 200. Halmahera.

hobbit Ziegler, 1982. *Occ. Pap. Bernice P Bishop Mus.* **22(5)**: 5. New Guinea.

Genus THOOPTERUS Matschie

THOOPTERUS Matschie, 1899. *Die Fledermäuse der Berl. Mus. für Natur. I. Megachir.* 72,73,77 (as subgenus). Type-species: *Cynopterus nigrescens* Gray, 1870.

nigrescens Gray, 1870. *Cat. Monkeys, Lemurs etc. in British Museum* 123 (*Cynopterus*). Morotai; ?Philippines, Sangir Islands, Sulawesi.

latidens Dobson, 1878. *Cat. Chiroptera in British Museum* 86 (*Cynopterus*, based on type of *nigrescens* Gray). Morotai.

Chapter 3. Species Accounts

Introduction to the species accounts

In the following accounts genera, species and subspecies are all arranged in alphabetical order. The number of species currently recognized in each genus is given at the beginning of each genus account. Each species account begins with the currently recognized scientific name and any vernacular names. Any appropriate information on the present or past taxonomic status of species/subspecies is given at this point. Each account is then divided into the following sections, which are only shown if information is available:

Priority Grade: Priority grades have been allocated to taxa to reflect their conservation status. These grades are used to prioritize recommended action (see Recommended Action section). The grades are as follows:

Grade	Conservation status
1	Extinct
1	Extinct? (taxa thought to have become extinct recently)
1	Endangered (Limited Distribution)
2	Endangered
3	Vulnerable (Limited Distribution)
4	Vulnerable
3	Rare (Limited Distribution)
6	Rare
7	Indeterminate (Limited Distribution)
8	No Data (Limited Distribution)
9	Indeterminate
10	No Data
11	Not Threatened

Number of subspecies: If appropriate.

Distribution: Current known distribution. Localities are listed in alphabetical order. The distribution within countries or islands/island groups is given in parentheses. The geographical location of areas mentioned is shown in the accompanying locality maps (Figures 3 to 10).

Status: Information on current status if available. This section also includes any information on past status or declines and ends with information on any known threats.

Ecology: This includes information on the habitats used, on roost sites, feeding ecology and behavioural ecology. The food plants are listed in alphabetical order by family. Where known, the part of the plant that is utilized is listed thus:

FL	Flowers
FR	Fruits
LV	Leaves
LB	Leaf bracts
B	Bark
S	Seed Pods
C	Cones
T	Twigs

Population biology: Includes information on timing of copulation, length of lactation and gestation, the number of young born, the time to sexual maturity, longevity and survivorship.

Occurrence in protected areas: Information is listed in alphabetical order by country.

Summary of threats: A brief summary of the known major threats.

Recommended action: A list of suggested action that would assist in the conservation of this species/subspecies.

Principal authors: Where individuals other than the authors of this Action Plan have contributed specific information on species or subspecies, they have been credited.



Figure 3. Locality map for Africa. Political boundaries are indicated by heavy solid lines.

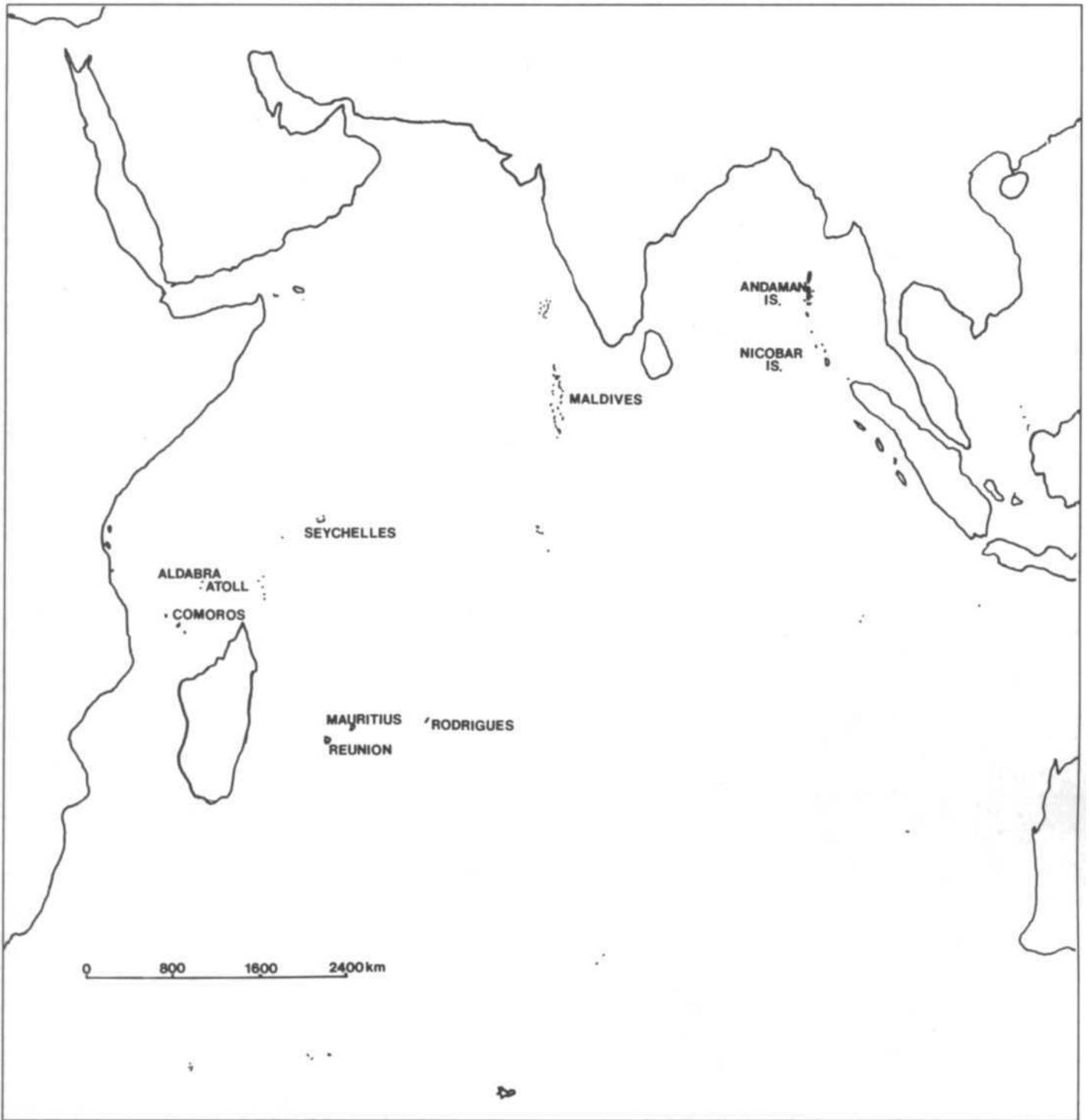


Figure 4. Locality map for the Indian Ocean.

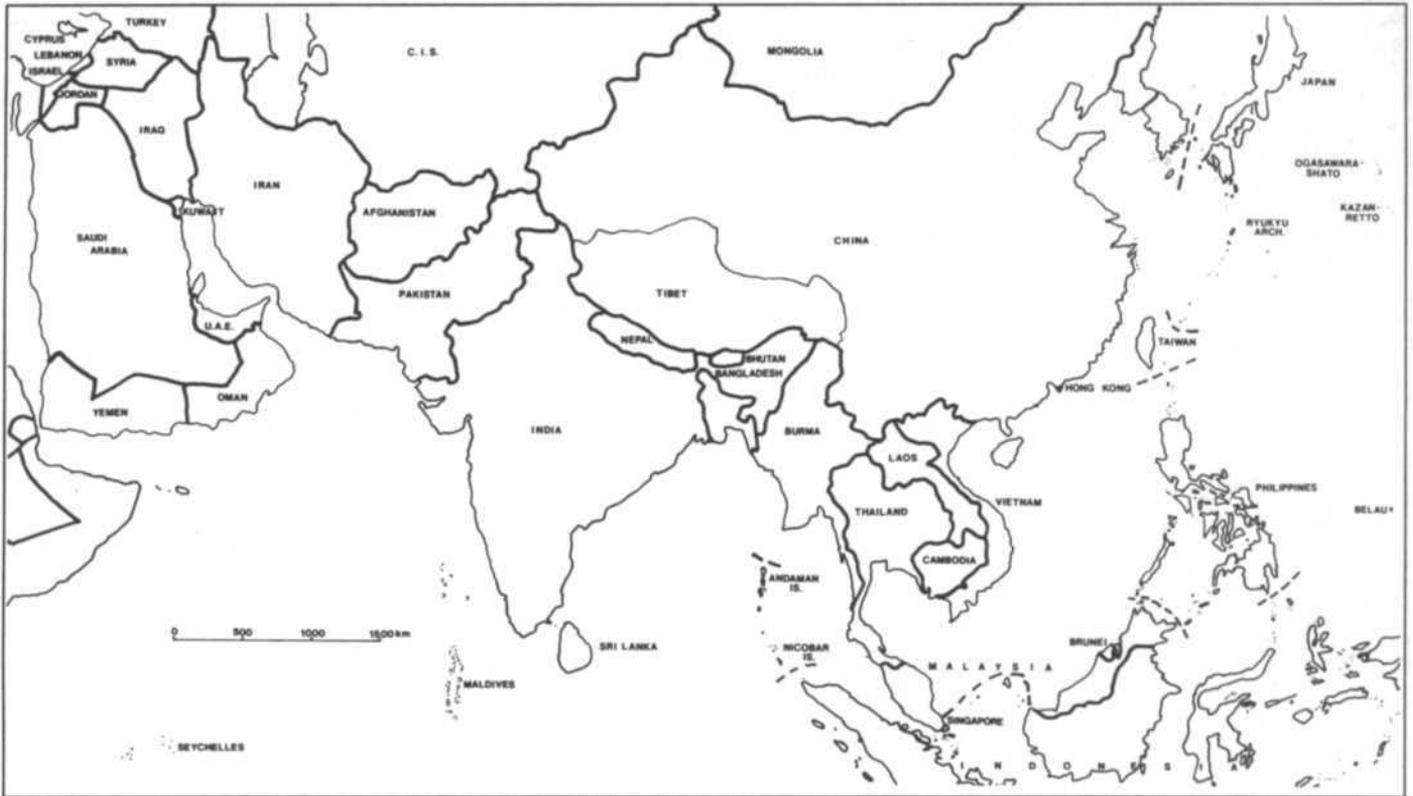


Figure 5. Locality map for the Middle East and Asia. Political boundaries are indicated by heavy solid or dashed lines.



Figure 6. Locality map for South East Asia. Political boundaries are indicated by heavy solid or dashed lines.

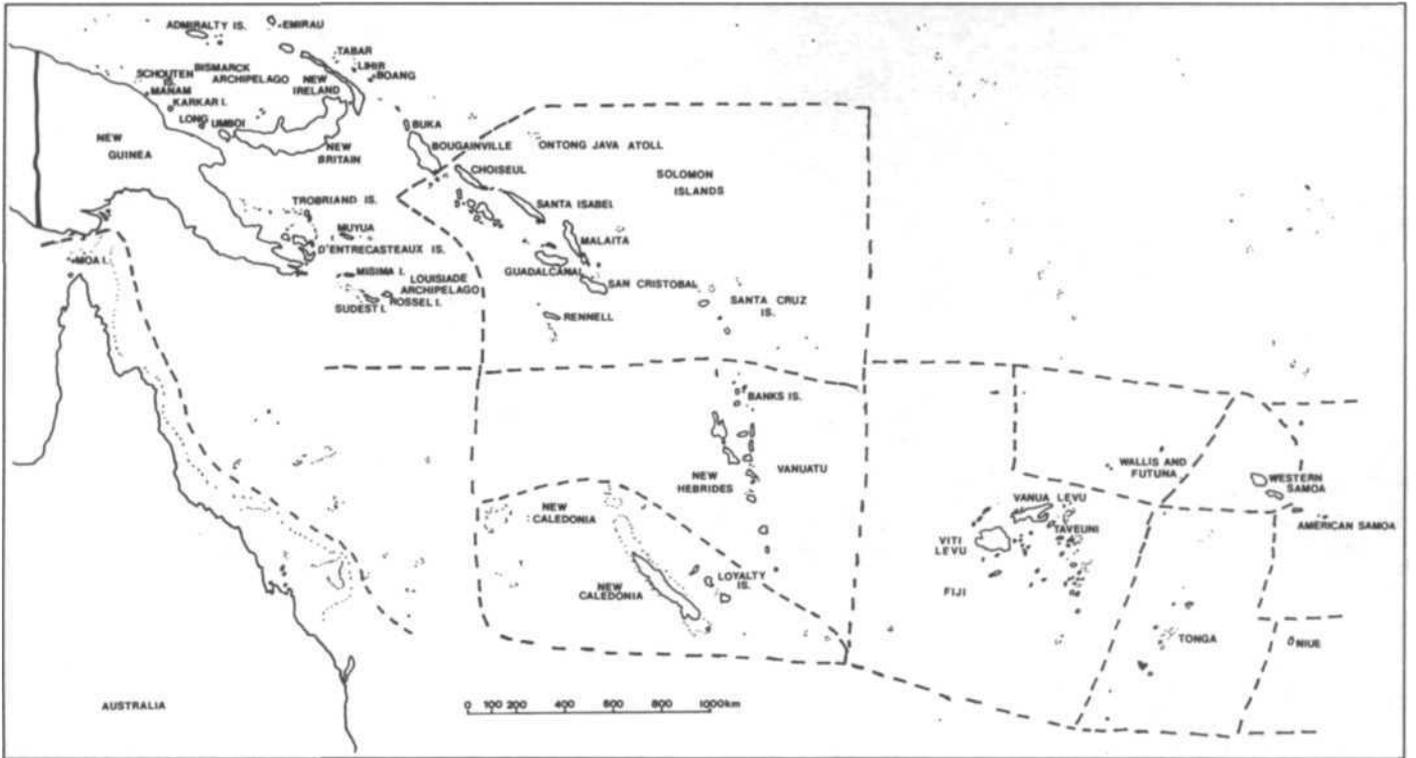


Figure 9. Locality map for the western Pacific Ocean. Political boundaries are indicated by heavy dashed lines.

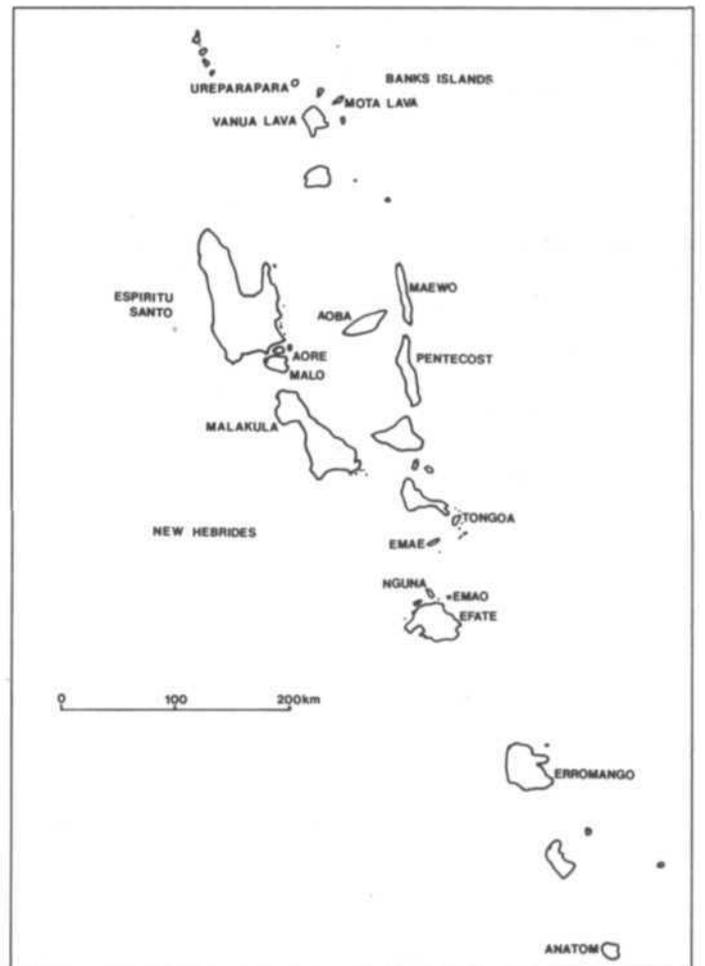


Figure 10. Locality map for Vanuatu.

Species accounts

Acerodon jubatus Golden-capped fruit bat

Genus *Acerodon* (6 species)

All species were placed on Appendix II of CITES in 1989 in view of their similarity in appearance to *Pteropus* species in trade. The genera are distinguishable only by dental characters. *Acerodon* species have already appeared in the Guam trade in shipments from the Philippines.

Acerodon celebensis Sulawesi fruit bat

Priority Grade: 10 (No Data).

Distribution: Salayar; Sangir Islands; Sula Islands (Sula Mangole); Sulawesi.

Status: Netted for food in northern Sulawesi (A. Marshall, pers. comm.).

Population biology: An adult female collected in February carried a large embryo (Bergmans and Rozendaal, 1988). Immature individuals collected in November had forearm lengths similar to those of adults while an immature collected in February was slightly smaller (Bergmans and Rozendaal, 1988).

Occurrence in protected areas:

Sulawesi

Dumoga-Bone National Park.

Summary of threats:

- Lack of information on status.
- Possibly hunting.

Recommended action:

- Survey to assess status, particularly in protected areas.
- Project to assess possible threat from hunting in Sulawesi.

Acerodon humilis Talaud fruit bat

Priority Grade: 8 (No Data: Limited Distribution).

Distribution: Talaud Islands, north-east of Sulawesi.

Summary of threats:

- Lack of information on status.

Recommended action:

- Survey to assess status, particularly in protected areas.

Priority Grade: 2 (Endangered).

Number of subspecies: 2.

A.j. jubatus

Priority Grade: 2 (Endangered).

Distribution: Philippines (Basilan, Biliran, Cebu, Dinagat, Leyte, Luzon, Mindoro, Negros, Panay, Samar, Sulu Archipelago [Bongao, Sanga Sanga, Sibutu, Tawitawi]) (J. Edwards Hill, pers. comm.).

Status: Populations have declined drastically in virtually all areas of the Philippines and this species is probably threatened with imminent extinction. Although widespread within its present distribution, it has vanished from a number of small and medium-sized islands and is also believed to have been completely hunted out or disappeared from larger islands, such as Cebu, which have been completely deforested. On Negros, because of heavy hunting pressure, and the great reduction of forest habitats, the current population is far below that present at the turn of the century. The small upland roosts of about 1000 individuals observed by Heideman and Heaney contrast markedly with the large roosts observed by Steere (quoted in Elliot, 1896) and Worcester (1899) in the late 1800s, by Taylor (1934) from the 1920s, and the roosts of thousands reported by Rabor (1977) in similar habitats in the 1950s and 1960s. There are also reports that in the 1920s joint camps of *Pteropus vampyrus*/*A. jubatus* contained up to 120,000 animals. The largest colonies now are about 5000 individuals, though most of them are only a few hundred - suggesting as much as a 96% decline in 60 years.

Despite these declines, small populations persist in many parts of the Philippines. However, the combination of habitat destruction and both subsistence and commercial hunting has resulted in a threat of extinction of *A. jubatus* on some islands in the next 10-20 years.

As the largest fruit bat in the Philippines and one which roosts in large colonies, this species is very easy to locate and thus exploit. Although it is much less common than *Pteropus vampyrus*, it is the preferred species for hunting (Bräutigam, 1989). It is hunted locally for subsistence purposes using fishing hooks on weighted lines hung from larger lines on trees and is believed to be taken in considerable numbers (Bräutigam, 1989). Many animals that are shot at the roost never fall from the trees, while others may glide out of sight after being shot. As a result, a hunter requiring 10 bats may kill 20-30 individuals. This species is sold in the markets in the Philippines and is commonly eaten, though considered a 'poor man's food' (Bräutigam, 1989).

The Philippines have been an important source of bats for the Guam market, with peak exports of 2471 in 1986 (Bräutigam and Elmquist, 1990; Wiles, 1992). Bats have also been exported

from the Philippines to the CNMI with a total of 2477 exported between 1986-89 (Stinson, *et al.*, 1992). *A. jubatus* has been identified in a shipment confiscated in Guam that ostensibly originated in Saipan (Wiles, 1992).

Forest destruction has increased at a dramatic rate in the Philippines in recent years. As an example, primary forest cover on Negros was reduced from about 60% in 1945 to about 6% in 1987 (Heaney and Heideman, 1987). This has particularly serious implications for *A. jubatus* because of its reliance on primary forest.

Ecology: Taken from or near sea level to primary montane forest at 1100 m (Taylor, 1934 and authors' data). It is present only in or near areas with substantial tracts of forest, and is probably dependent on primary or old secondary forest. It has never been recorded foraging outside primary forest on Negros.

In the Balinsasayao region of Negros, *A. jubatus* feeds mainly on figs (**Musaceae:** including *Ficus benjamina*, *F. chrysolepis*, *F. crassiramea* and *F. variegata*; Utzurrum (1984) and authors' data). It is certainly possible that this species may occasionally feed upon cultivated fruits, but current evidence suggests that the use of cultivated species is uncommon or rare.

Individuals probably fly long distances to feed. On Maripipi, bats were observed commuting at least 12 km to foraging sites on Biliran, and foraging distances could have been as high as 20 or 30 km each way. Those that fed at a submontane forest site on Negros probably travelled at least 5 km to feed.

Observations in the Balinsasayao region of Negros in 1981-84 suggested that average densities were one per 10-20 ha.

Population biology: Females probably produce no more than one young per year. Rabor (1977) reported that populations on Negros gave birth in April or May, and additional data from Negros and elsewhere in the Philippines suggest that young are born in approximately the same period on other islands.

Occurrence in protected areas: Certainly occurs within some designated reserves, but probably all individuals spend at least some time outside protected areas.

Summary of threats:

- Deforestation.
- Hunting.

Recommended action:

- Prevention of habitat destruction and some controls on hunting would slow the decline of this species. It is, however, unlikely that controls on hunting would be enforceable. Because the species is able to fly long distances to forage, it may be tolerant of a moderately large degree of forest fragmentation. The most effective method of protection would be the management of colonies on small islands such as Maripipi, where some habitat and roosts remain, and protection efforts within the relatively small community would have some hope of success.
- Given the decline of the species, it is possible that captive

breeding and reintroduction may eventually be necessary.

- Review of status within protected areas.

A. j. mindcensis

Priority Grade: 2 (Endangered).

Distribution: Philippines (Mindanao).

Status: See *A. j. jubatus*.

Ecology: See *A. j. jubatus*.

Population biology: See *A. j. jubatus*.

Occurrence in protected areas: See *A. j. jubatus*.

Summary of threats:

- Deforestation.
- Hunting.

Recommended action:

- See *A. j. jubatus*.

Principal authors for this species: P. D. Heideman, L. R. Heaney.

Acerodon leucotis

This species has recently been transferred from the genus *Pteropus* (Musser *et al.*, 1982).

Priority Grade: 10 (No Data).

Number of subspecies: 2.

A. l. leucotis

Priority Grade: 10 (No Data).

Distribution: Philippines (Balabac, Calamian Group [Busuanga]).

Status: May be moderately common in good forest (Heaney *et al.*, 1989). Given its restricted range and the current rate of deforestation in the Palawan chain, it seems likely that it is declining in abundance.

Summary of threats:

- Lack of information on status.
- Deforestation.

Recommended action:

- Surveys should be conducted to determine the conservation status of this species and the habitats it uses. Surveys should particularly concentrate on protected areas.

A. l. obscurus

Priority Grade: 10 (No Data).

Distribution: Philippines (Palawan).

Status: See *A. l. leucotis*.

Summary of threats:

- Lack of information on status.
- Deforestation.

Recommended action:

- See *A. l. leucotis*.

Principal authors for this species: P. D. Heideman, L. R. Heaney.

Acerodon lucifer
Panay giant fruit bat

Priority Grade: 1 (Extinct).

Distribution: Philippines (Panay).

Status: Almost certainly extinct as it is known only from a few specimens collected in 1888 and 1892.

A specimen (in the Field Museum of Natural History) from Concepcion, Panay, taken on 16th April 1892 by J. Steere was the last known individual. Steere (quoted in Elliot, 1896) noted that two males had come from a roost in some tall clumps of spiny bamboos (**Gramineae: Bambusa arudinacea**), among the rice fields and almost over some of the native houses. Hundreds of bats were thickly clustered in the tops of the bamboo. There appeared to be at least three species in the roost, although each species used separate trees.

The restricted range makes this species especially vulnerable to hunting and forest destruction. Deforestation has been as severe on Panay as on other islands in the central Philippines. The island retains about 10% of its forest cover, most of it on the highest mountains and ridges. Given the absence of specimens in the last 95 years and the level of deforestation on Panay, it is certain that this species is seriously threatened, if not extinct.

Summary of threats:

- Hunting.
- Deforestation.

Recommended action:

- Surveys of forested areas, particularly protected areas should be conducted to check for this species.
- Captive breeding (with later careful reintroduction) of any individuals found probably would be necessary to preserve this species if it is not already extinct.

Principal authors for this species: P. D. Heideman, L. R. Heaney.

Acerodon macklotii
Sunda fruit bat

Priority Grade: 11 (Not Threatened).

Number of subspecies: 5. With one exception (*A. m. floresii*) all subspecies are confined to single islands within the Lesser Sundas group. Goodwin (1979) noted that all taxa are based on slight differences in colour and/or size and doubted the necessity for recognizing them as subspecies. Sody (1936), in describing *A. m. prajae*, stated that it resembled *floresii* and Goodwin (1979) noted that the measurements given by Sody in his description fall within the range of the series from Timor.

A. m. alorensis

Priority Grade: 8 (No Data: Limited Distribution).

Distribution: Alor.

Summary of threats:

- Lack of information on status.

Recommended action:

- Survey to assess status, particularly in protected areas.

A. m. floresii

Priority Grade: 8 (No Data: Limited Distribution).

Distribution: Flores; Sumbawa.

Summary of threats:

- Lack of information on status.

Recommended action:

- Surveys to assess status, particularly in protected areas.

A. m. gilvus

Priority Grade: 8 (No Data: Limited Distribution).

Distribution: Sumba.

Summary of threats:

- Lack of information on status.

Recommended action:

- Survey to assess status, particularly in protected areas.

A. m. macklotii

Priority Grade: 11 (Not Threatened).

Distribution: Timor.

Status: Common from sea level to an altitude of 450 m (Goodwin, 1979). Goodwin (1979) observed two colonies on Timor each with 300-500 individuals. At both sites the bats were spread out over a large portion of the crowns of large fig trees (**Moraceae:** *Ficus* sp.) on the edge of open forest; the roosting areas were largely defoliated.

Ecology: While no other species of bat roosted with *Acerodon* on Timor, Goodwin (1979) observed them feeding with *Pteropus griseus*, *P. vampyrus* and *Dobsonia peronii*; their staple food in March, April and May consisted of the fruit of at least two species of fig. The bats also fed upon some indeterminate part of the coconut palm (**Palmae:** *Cocos nucifera*). Most of their nutrition was probably obtained from the juice of the fruit. At dusk the bats flew in groups of two to six individuals and were most frequently observed flying into and out of the crowns of coconut palms (Goodwin, 1979).

Population biology: Pregnant females were seen on Timor in March and May (Goodwin, 1979).

Summary of threats:

- Lack of information on status.

Recommended action:

- Survey to assess status, particularly in protected areas.

A. m. prajae

Priority Grade: 8 (No Data: Limited Distribution)

Distribution: Lombok.

Population biology: Kitchener *et al.* (1990) noted that of six females collected on Lombok in October 1987 two were lactating and three others appeared to be lactating. The appearance of a lactating female that was also pregnant demonstrates this subspecies is polyoestrous as a result of a post-partum oestrus.

Summary of threats:

- Lack of information on status.

Recommended action:

- Survey to assess status, particularly in protected areas.

Genus *Aethalops* (1 species)

Aethalops alecto
Pygmy fruit bat

Priority Grade: 9 (Indeterminate).

Number of subspecies: 3. Recently, Kitchener *et al.* (1990) suggested, on the basis of examination of a number of specimens, that the subspecies *A. a. aequalis* should be considered as a separate species.

A. a. aequalis

Priority Grade: 9 (Indeterminate).

Distribution: Borneo (Brunei, Sabah, Sarawak).

Status: Probably fairly common in the hills of Borneo (CM. Francis, pers. comm.). Threatened by deforestation (A. Suyanto and D. Kitchener, pers. comm.).

Ecology: All records are from mountains in the north-west including Gunung Kinabalu (up to 2700 m) and the Crocker Range in Sabah; Gunung Mulu and the Kelabit uplands in Sarawak (Payne *et al.*, 1985). Apparently confined to montane forest above 1000 m (Payne *et al.*, 1985).

Occurrence in protected areas:

Borneo

Brunei

Ulu Temburong National Park (proposed)

Sabah

Crocker Range National Park, Kinabalu Park

Sarawak

Gunung Mulu National Park

Summary of threats:

- Deforestation.

Recommended action:

- Assess impact of deforestation.

A. a. alecto

Priority Grade: 9 (Indeterminate).

Distribution: Lombok; central Peninsular Malaysia; Sumatra.

Status: Lombok Kitchener *et al.* (1990) mist-netted a single adult male in low mossy forest at about 1700 m at Pos Tiga, Mt Rinjani.

Peninsular Malaysia Uncommon (Medway, 1978), known only from the forest above 900 m, on Maxwell's Hill, Gunung Benom and the main range from the Cameron Highlands to Selangor.

Threatened to a small degree by the so far limited disturbance of montane forest, but there are prospects of greater montane forest loss due to road building, expansion of temperate style agriculture, and building of montane holiday homes.

Sumatra The type locality is Indrapura Peak (2225 m), Sumatra.

Ecology: Recorded from montane forest over 900 m. Roosts singly or in small groups of two to three. Main food plants are unknown but presumably are the soft fruits of montane forest trees and climbers.

Population biology: In the Cameron Highlands in Peninsular Malaysia, pregnancies occur between April and June. A single female collected by Kitchener *et al.* (1990) on Lombok in early October 1987, had a large embryo but did not appear to be lactating.

Occurrence in protected areas:

Peninsular Malaysia

Cameron Highlands Wildlife Reserve
Fraser's Hill Wildlife Reserve
Krau Game Reserve (Gunung Benom)

Also along the main ridge of Peninsular Malaysia, some of which is Forest Reserve. It should be noted that Forest Reserves are 'reserved for logging', not totally protected. It might also occur in montane parts of Taman Negara, but little netting has been done there.

Sumatra

Bukit Barisan Selatan National Park
Gunung Leuser National Park

Summary of threats:

- Lack of information on status in Sumatra and Lombok.
- Deforestation.

Recommended action:

- Surveys to assess status in Sumatra and Lombok, particularly in protected areas.

Principal author for this subspecies: G. W. H. Davison.

A. a. ocypete

Priority Grade: 6 (Rare).

Distribution: Jawa.

Status: Rare. Threatened by deforestation (A. Suyanto and D.

Kitchener, pers. comm.)

Summary of threats:

- Deforestation.

Recommended action:

- Assess impact of deforestation.

Genus *Alionycteris* (1 species)

Alionycteris paucidentata

Priority Grade: 5 (Rare: Limited Distribution).

Distribution: Philippines (Mindanao).

Status: Given its restricted range and the current extent of deforestation on Mindanao, it seems likely that it is declining in abundance and possibly threatened.

Ecology: Probably a primary forest species.

Summary of threats:

- Lack of information on status.
- Deforestation.
- Limited distribution.

Recommended action:

- Surveys to assess the status and the habitats used, particularly in protected areas.

Principal authors for this species: P. D. Heideman, L. R. Heaney.

Genus *Aproteles* (1 species)

Aproteles bulmerae **Bulmer's fruit bat**

Priority Grade: 1 (Endangered: Limited Distribution).

Distribution: New Guinea (Western Province, Papua New Guinea).

Status: Rare. First described from 12,000-year-old fossils excavated from a rock shelter near Mount Elimbari, Chimbu Province (Menzies, 1977). It appears to have become extinct there about 9000 years ago. In 1975, it was discovered living in the Hindenberg Wall area of Western Province, Papua New Guinea where it inhabited a cave known as Luplupwintem, 2300 m above sea level. The cave is close to the edge of the Hindenberg Wall and difficult to reach, although it is close to the main track linking Tabubil and the Ok Tedi mine to Telefomin. The species was abundant in 1975, but on a return

visit in 1977 only two bats were seen circling near the roost (Hyndman and Menzies, 1980). It is thought that increasing human population density in the Central Highlands may have led to the decline of the species there, and that it has survived in the remote western part of New Guinea where the human population density is low.

During a visit to the Ok Tedi mining area in April 1987, Flannery (1990) questioned informants who were familiar with this species in the 1970s, including one man who had accompanied Hyndman when he obtained animals in 1975. Informants made no distinction between this species and *Dobsonia moluccense*, except for noting a difference in size. They described how large numbers of *Aproteles* were obtained from Luplupwintem in the 1970s by use of a shotgun. From their accounts, it seems probable that disturbance to the Luplupwintem colony from shotgun hunting led to its decline. When the cave was checked on 11 and 12 April 1987, no bats were seen.

In 1991, a skull and skin of *A. butmerae* were discovered at the Australian Museum. This animal had been collected in 1984 at Afektaman near Telefomin and confirmed that *A. bulmerae* had survived in this area until then. Funding is being sought for a project to search for and, if appropriate, undertake a study of this colony. In 1992, a colony of about 130 bats was discovered in Luplupwintem Cave (L. Seri, pers. corom.).

Summary of threats:

- Lack of information on status.
- Hunting.

Recommended action:

- Survey to assess status, particularly in protected areas.
- Implementation of measures to control hunting, including education programmes.
- A captive breeding programme should be considered for any individuals located.
- Protection of remaining colonies.

Principal author for this species: T. Flannery.

Genus *Balionycteris* (1 species)

Balionycteris maculata Spotted-winged fruit bat

Priority Grade: 11 (Not Threatened).

Number of subspecies: 2.

B. m. maculata

Priority Grade: 11 (Not Threatened).

Distribution: Borneo (Brunei, West Kalimantan, Sabah, Sarawak).

Status: There are scattered records throughout the north and west including Kota Kinabalu, Sepilok, Madai and Tawau in Sabah; the upper Sungai Temburung and Tasek Merimbun in Brunei; Mulu, Niah, Gunung Dulit, and Kuching in Sarawak; Gunung Kenepai in West Kalimantan (Payne *et al.*, 1985). Probably not threatened.

Ecology: Frequently netted in lowland dipterocarp forest.

Occurrence in protected areas:

Borneo

Probably found in all protected areas containing primary and lightly logged forest including:

Brunei

Ulu Temburong National Park (proposed)

Sabah

Danum Valley and Sepilok Reserve

Kinabalu Park



Balionycteris maculata (Photo by K-G. Heller)

Sarawak
Gunung Mulu National Park

Summary of threats:

- Unknown.

Recommended action:

- Work to obtain information on status, feeding habits and population biology, concentrating particularly on protected areas.

B. m. seimundi

Priority Grade: 9 (Indeterminate).

Distribution: Peninsular Malaysia; Riau Archipelago (Durian, Galang); Thailand.

Status: Peninsular Malaysia Widespread and locally common in forest at all elevations including Gunung Brinchang and Pahang (Medway, 1978). Probably commoner in lowland than montane forest.

Riau Archipelago No information, but a number of these islands are now heavily developed (e.g., Batam and Bintang).

Thailand Uncommon, known only from Khao Phu Pah in Trang Province (Lekagun and McNeely, 1977).

Large population reductions would result from forest loss. Currently, forest cover in Peninsular Malaysia is about 40%, with the greatest losses occurring in the lowlands.

Ecology: In Peninsular Malaysia, has been found roosting in small groups in crowns of palms and clumps of epiphytic ferns, rarely in caves (Payne *et al.*, 1985).

Feeds on the fruits of understorey plants and small trees below the main canopy, does not congregate at large food sources as do some other species (e.g., *Cynopterus*).

Population biology: In Peninsular Malaysia, females produce a single young. Pregnancies or carried young have been recorded in nearly every month, even though Medway (1983) suggests a local breeding season at Cameron Highlands.

Occurrence in protected areas:

Peninsular Malaysia

Apparently all protected areas containing primary or lightly logged forest contain this species, including:

Cameron Highlands Wildlife Reserve

Endau-Rompin Park (proposed)

Fraser's Hill Wildlife Reserve

Krau Game Reserve

Sungkai Game Reserve

Taman Negara

Also many reserves under the jurisdiction of the Forest Department, Peninsular Malaysia.

Summary of threats:

- Deforestation.

Recommended action:

- A survey in the Riau Archipelago to assess status, particularly in protected areas.
- Speedy declaration of the Endau-Rompin Park, which remains to be gazetted.
- Pressure for political commitment to retain more substantial Permanent Forest Estate in Peninsular Malaysia.

Principal author for this subspecies: G. W. H. Davison.

Genus *Casinycteris* (1 species)

Casinycteris argynnis
Short-palate fruit bat

Priority Grade: 8 (No Data: Limited Distribution).

Distribution: Southern Cameroun to eastern and central southern Zaire. A distribution map is given in Meirte (1984a).



Casinycteris argynnis (Photo K-G. Heller)

Status: Threatened by forest destruction.

Ecology: Occurs in lowland forest.

Summary of threats:

- Lack of information on status.
- Deforestation.

Recommended action:

- Surveys to assess status, particularly in protected areas, and food plants.
- Further action should be taken if necessary.

Principal authors for this species: W. Bergmans, S. Sowler.

Genus *Chironax* (1 species)

Chironax melanocephalus
Black-capped fruit bat

Priority Grade: 11 (Not Threatened).

Number of subspecies: 2.

C. m. melanocephalus

Priority Grade: 11 (Not Threatened).

Distribution: Borneo (Brunei, Sabah); Jawa; Nias; central Peninsular Malaysia; Sumatra; Thailand.

Status: **Borneo** Recorded from only two localities, Sepilok in Sabah and the upper Sungai Temburong in Brunei.

Jawa Rare (A. Suyanto and D. Kitchener, pers. comm.).

Peninsular Malaysia Locally common in the hills and foothills from the Cameron Highlands south to Selangor, mainly at elevations above 457 m (Medway, 1978). There is a potential for increased tourist and agricultural development of hilly and montane areas, causing loss of previously secure montane forest.

Thailand Recorded from the following provinces: Ranong; Surat Thani, Nakhon Si Thammarat and Yala (Yenbutra and Felten, 1986).

Ecology: In Borneo, several Sabah specimens were netted in the understorey of dipterocarp forest (Francis, 1989).

In Peninsular Malaysia, found roosting in small groups in tree ferns and in a shallow cave (Payne *et al.*, 1985).

Information on food plants is scanty but presumably feeds on the fruits of understorey hill and montane forest trees. Known to feed on *Ficus* (**Moraceae**) (A. Marshall, pers. comm.).

Population biology: At the Cameron Highlands in Peninsular Malaysia, pregnancies in February and April may imply a local breeding season.

Occurrence in protected areas:

Borneo

Sabah

Sepilok Forest Reserve

Peninsular Malaysia

Cameron Highlands Wildlife Reserve

Fraser's Hill Wildlife Reserve

Krau Game Reserve (Gunung Benom)

Taman Negara (montane forest)

Summary of threats:

- Lack of information on status.
- Deforestation.

Recommended action:

- Surveys of Borneo, Nias, Sumatra and Thailand, to assess status, particularly in protected areas.

Principal author for this subspecies: G. W. H. Davison.

C. m. tumulus

Priority Grade: 8 (No Data: Limited Distribution).

Distribution: North and east-central Sulawesi.

Status: The type locality is the Dumoga-Bone National Park, north Sulawesi, where it is believed to be fairly common (W. Bergmans, pers. comm.).

Ecology: Apparently restricted to lowland forest (Bergmans and Rozendaal, 1988). Specimens have been taken in primary forest at altitudes of up to 960 m, in a number of cases near or over small streams.

Feeds on *Ficus* (**Moraceae**) (A. Marshall, pers. comm.).

Population biology: Pregnant females have been collected in March and April (Bergmans and Rozendaal, 1988).

Occurrence in protected areas:

Sulawesi

Dumoga-Bone National Park.

Summary of threats:

- Lack of information on status.

Recommended action:

- Survey to assess status, particularly in protected areas.

Genus *Cynopterus* (4 species)

Cynopterus brachyotis

Priority Grade: 11 (Not Threatened).

Number of subspecies: 9. *C. b. brachyotis* includes the species *C. archipelagus*, which was described from a single immature specimen, now thought to be a variant of *C. b. brachyotis* (P. D. Heideman and L. R. Heaney, pers. comm.) and *C. minor* which was described from a single immature specimen (K. F. Koopman, pers. comm.).

C. b. altitudinis

Priority Grade: 10 (No Data).

Distribution: Highlands of Peninsular Malaysia, on the Main Ridge. Recorded from the Cameron Highlands south to Gunung Bunga Buah (Medway, 1978), but presumably also occurs on mountains north of the Cameron Highlands. Not found on isolated peaks away from the main ridge (e.g., Gunung Benom, Gunung Tahan).

Status: No information, but there is a proposed montane road from Cameron Highlands via Fraser's Hill south to the Genting Highlands. This would make large areas of montane forest susceptible to development and forest clearance.

Occurrence in protected areas:

Peninsular Malaysia

Cameron Highlands Wildlife Reserve
Fraser's Hill Wildlife Reserve

Summary of threats:

- Lack of information on status.
- Development and clearance of montane forest.

Recommended action:

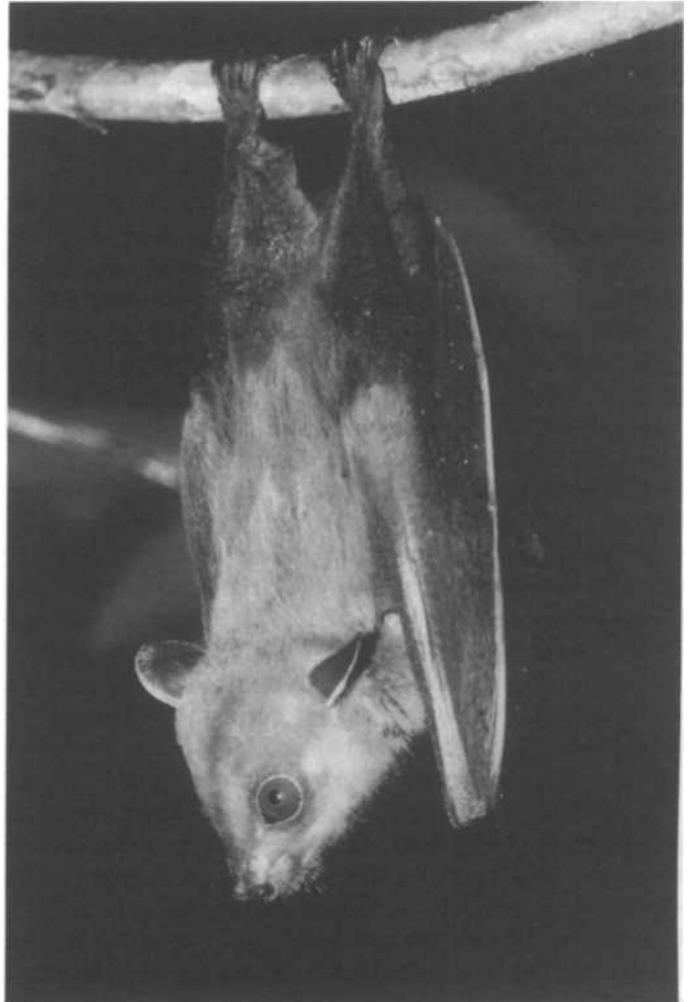
- Survey of status, particularly in protected areas.
- Lobby against proposed montane road.

Principal author for this subspecies: G. W. H. Davison.

C. b. brachyotis

Priority Grade: 11 (Not Threatened).

Distribution: Bangka; Belitung; Borneo (Brunei, Central, East, South and West Kalimantan, Sabah, Sarawak); Lombok; Nicobar Islands; Peninsular Malaysia (including islands of Babi, Great Redang, Langkawi, Pangkor, Penang, Pisang [off Johore], Sri Buat, Tinggi, Tioman and Tulai); Philippines (Balabac, Calamian Group [Busuanga], Culion, Luzon, Maripipi, Negros, Palawan, Polillo); Riau Archipelago;



Cynopterus brachyotis (Photo by K-G. HeDer)

Singapore; Sulawesi; Sumatra; Talaud Islands and adjacent small islands; Thailand.

Status: Borneo Probably one of the commonest mammals of lowlands and hills. Recorded from all parts of the island including Gunung Penriven, the Kelabit Uplands and Gunung Kinabalu up to 1676 m. Also found on islands of: Ereban, Kalimantan; Satang, Sarawak; and Balambangan, Sabah (Medway, 1978; Payne *et al.*, 1985). Occurs in most habitats including lower montane forest, dipterocarp forest, gardens, and mangrove and strand vegetation.

Lombok Kitchener *et al.* (1990) mist-netted this bat in a wide range of habitats, both disturbed and 'natural'. It was most common, however, near Desa Kuta where 20 were collected along a dry watercourse fringed with banana plantations (Musaceae: *Musa* spp.) and village gardens. It appeared equally abundant from sea level to about 200 m, but only one animal was collected at Batu Koq (at 400 m).

Peninsular Malaysia Common everywhere in the lowlands and in montane forest on peaks away from the Main Ridge. Mainly in disturbed forest and cultivation, and only occasionally in primary forest.

Philippines Ranges from sea level to at least 1500 m, although rarely found above 1000 m. Common in vegetated urban areas and in agricultural areas, especially in gardens and orchards, where 7% to 44% of all captures were made (Guerrero and Alcala, 1973; Heaney *et al.*, 1989). Rare in primary forest, but more abundant in clearings and patches of secondary growth forest (6-20% of captures; Heaney *et al.*, 1989; Heideman and Heaney, 1989). In general, therefore most common in agricultural and disturbed habitats and uncommon in undisturbed primary forest. An exception is Maripipi, where it is most abundant in primary forest; this may be related to the absence of *Haplonycteris fischeri* and *Ptenochinus major* which are similar in size and potential competitors (E. A. Rickart, pers. comm.).

In lowland orchards, capture rates (and probably density) were high (44% of total captures; Guerrero and Alcala, 1973; 9% of captures and an average of 1 individual per net-night; Heaney *et al.*, 1989 and unpublished data). In upland primary forest on Negros, capture rates were only 1 per 10 net-nights, and these were almost exclusively in clearings (Heideman and Heaney, 1989), and still lower on Leyte (3 to 5 per 100 net-nights; Heaney *et al.*, 1989).

Because of its preference for disturbed habitats and success in agricultural habitats, it is not currently at risk in the Philippines. Its small size and choice of inconspicuous roost sites reduces its vulnerability to hunters.

Sulawesi Has been collected in primary forest, disturbed primary forest, partly disturbed mangrove forest, overbrackish water less than 100 m from the sea, coastal alang-alang secondary forest mosaic, plantations/secondary forest mosaic, in a solitary fig tree (**Moraceae**: *Ficus* sp.) in a deforested village area, in a grass plain with scattered trees, in a limestone area and among fruit trees in a garden. Altitudes vary from sea level to about 1100 m (Bergmans and Rozendaal, 1988).

Thailand Recorded from Chiang Mai south to Pattani and east to Udon Thani and Chanthaburi (Lekagul and McNeely, 1977).

Ecology: Normally roosts in pairs or small groups in trees, especially under dead palm leaves and among stems and leaves of palms (Taylor, 1934; Lawrence, 1939; Lim, 1966; Lekagul and McNeely, 1977; Payne *et al.*, 1985). It is suggested that it modifies leaves to form a tent (Phillips, 1924; Lekagul and McNeely, 1977), but this is disputed by Rickart *et al.* (1989). Also roosts in the threshold zone of caves.

Feeds primarily upon fruits, but also takes nectar and pollen (Gould, 1978). Diet includes the following plants (Lim, 1966; Guerrero and Alcala, 1973; Gould, 1978, Medway, 1978 and author's data): **Anacardiaceae**: *Mangifera indica* (FR); **Bombacaceae**: *Durio zibethinus* (FL); **Melastomataceae**: *Melastoma malabathricum* (FR); **Moraceae**: *Ficus* spp. (FR); **Musaceae**: *Musa* spp. (FL,FR); **Myrtaceae**: *Psidium guajava* (FR); **Palmae**: *Cocosnucifera* (FL); **Piperaceae**: *Piper aduncum* (FR); **Sapotaceae**: *Chrysophyllum cainito* (FR), *Palaquium* sp. (FR), *Pouteria sapota* (FR); **Sonneratiaceae**: *Sonneratia* spp. (FL).

Marshall (1985) listed 27 plant genera fed upon by members of

the genus *Cynopterus*. Faecal analysis suggests that *Ficus* accounts for a large part of the diet.

At one site on Negros, nine animals moved an average of 650 m between their first and second capture (Heideman and Heaney, 1989). Apparently does not forage in flocks, and it is rare to capture more than one or two at any time.

Animals captured in primary forest at Sepilok, Sabah, were significantly smaller than those in secondary forest, but it is not known whether this reflects dietary differences or taxonomic differentiation (Francis, 1989).

Population biology: In the Philippines, most populations probably produce two young per year (Heideman, 1987). Pregnant females may be found in all or almost all months, although births are restricted to two three-month periods. Females may only produce a single young annually in some populations.

On Negros, most females become pregnant at about 6-8 months of age, while males become sexually mature at approximately 1 year (Heideman, 1987; pers. obs.). Gestation is approximately 3.5-4 months; lactation about 6-8 weeks (Heideman, 1987; pers. obs.). On Lombok, in September and October 1987, Kitchener *et al.* (1990) noted that of 17 females examined, 13 were pregnant, each with a single embryo, and one was lactating. Three of the pregnant females were also lactating, suggesting that it may at least be seasonally polyoestrus. In May 1988, of three adult females collected, one was lactating and two appeared to have been pregnant recently. In Sulawesi, five females collected in January and March had one embryo each. Immature individuals have been collected in January, February and March and in October and November (Bergmans and Rozendaal, 1988). The greatest documented longevity in the wild is 4.5 years (Heideman and Heaney, 1989). Annual survivorship of yearlings/adults in the Balinsasayao region on Negros was estimated to be 70%, implying that about 5% of yearlings may live to 6 years of age (Heideman and Heaney, 1989).

Occurrence in protected areas:

Borneo

Brunei

Temburong National Park (proposed)

Peninsular Malaysia

Taman Negara

Sulawesi

Dumoga-Bone National Park

Summary of threats:

- No major threats.

Recommended action:

- Surveys of Bangka, Belitung, the Nicobar Islands, the Riau

Archipelago, Sumatra, the Talaud Islands and Sulawesi to assess status, particularly in protected areas.

Principal authors for this subspecies: P. D. Heideman, L. R. Heaney.

C. b. brachysoma

Priority Grade: 8 (No Data: Limited Distribution).

Distribution: Andaman Islands.

Summary of threats:

- Lack of information on status.

Recommended action:

- Survey to assess status, particularly in protected areas.

C. b. ceylonensis

Priority Grade: 10 (No Data).

Distribution: Sri Lanka.

Summary of threats:

- Lack of information on status.

Recommended action:

- Survey to assess status, particularly in protected areas.

C. b. concolor

Priority Grade: 8 (No Data: Limited Distribution).

Distribution: Enggano.

Summary of threats:

- Lack of information on status.

Recommended action:

- Survey to assess status, particularly in protected areas.

C. b. hoffeti

Priority Grade: 11 (Not Threatened).

Distribution: Vietnam.

Status: Appears to be widespread. Recorded from 15 localities in 11 provinces throughout southern Vietnam (Van Peenen, 1969).

Summary of threats:

- Unknown.

Recommended action:

- Work needs to be done to provide more information on the population biology, feeding ecology and possible threats as well as status in protected areas.

C. b. insularum

Priority Grade: 8 (No Data: Limited Distribution).

Distribution: Kangean Islands; Laut Kecil Islands.

Summary of threats:

- Lack of information on status.

Recommended action:

- Surveys to assess status, particularly in protected areas.

C. b. javanicus

Priority Grade: 10 (No Data).

Distribution: Bali; Jawa; Madura; Penida.

Status: Jawa Collected in a garden in Jakarta and in the Botanical Garden in Bogor in 1981, where it was common (W. Bergmans, pers. comm.).

Summary of threats:

- Lack of information on status.

Recommended action:

- Surveys to assess status, particularly in protected areas.

C. b. minutus

Priority Grade: 8 (No Data: Limited Distribution).

Distribution: Nias.

Summary of threats:

- Lack of information on status.

Recommended action:

- Survey to assess status, particularly in protected areas.

Cynopterus horsfieldii
Horsfield's fruit bat

Priority Grade: 11 (Not Threatened).

Number of subspecies: 4.

C. h. harpax

Priority Grade: 11 (Not Threatened).

Distribution: Peninsular Malaysia (Penang); Sumatra; Thailand.

Status: Peninsular Malaysia Widespread throughout the mainland and also occurs on the island of Penang (Medway, 1978).

Thailand Rare, with specimens from Trang Tala and Tak (Lekagul and McNeely, 1977).

Ecology: Occurs in the lowlands in Peninsular Malaysia, but its upper altitudinal limit is not known. It is more common in disturbed habitats, such as gardens, orchards, rubber estates and wasteland, than in forest. However, nearly everywhere it is less abundant than *C. brachyotis* and generally its distribution is patchier.

Congregates at large food sources such as mango trees (**Anacardiaceae:** *Mangifera indica*). Pakarnseree (1986) lists the following as food plants of *Cynopterus* (species unidentified) in Thailand: **Bignoniaceae:** *Dolichandrone* spp., *Markhamia* spp., *Oroxylum indicum*; **Bombacaceae:** *Bombax* spp.; **Compositae:** genus unidentified; **Leguminosae:** genus unidentified; **Musaceae:** *Musa* spp.; **Myrtaceae:** *Eugenia* spp.; **Sapotaceae:** *Palaquium* spp.; **Sonneratiaceae:** *Sonneratia caseolaris*; **Ulmaceae:** *Trema* spp.

Summary of threats:

- Unknown.

Recommended action:

- Surveys to assess status in Sumatra and on Penang Island, particularly in protected areas.

Principal author for this subspecies: G. W. H. Davison.

C. h. horsfieldii

Priority Grade: 11 (Not Threatened).

Distribution: Jawa; Lombok.

Status: Lombok Kitchener *et al.* (1990) mist-netted it in most habitats, particularly disturbed situations, but it was most common at Pelangan and Batu Koq.

Population biology: Kitchener *et al.* (1990) noted that all 13 females examined from Lombok in October 1987 showed some reproductive activity. Six were pregnant and three of these were also lactating, suggesting polyoestry. All of the remaining females showed evidence of recent parturition or early pregnancy, four of these were also lactating. A single female caught on Lombok in May 1988 was recently pregnant.

Summary of threats:

- Lack of information on status.

Recommended action:

- Survey to assess status on Jawa, particularly in protected areas.

C. h. persimilis

Priority Grade: 9 (Indeterminate).

Distribution: Borneo (Brunei, Central, South and West Kalimantan, Sabah, Sarawak).

Status: Reported from scattered localities in all districts except East Kalimantan, with cave roosts known from Gunung Kinabalu and Gomantong in Sabah, and near Kuching in Sarawak.

Ecology: Often roosts in rock shelters or caves, usually near the entrance. Occasionally found in trees or palms (Palmae) (Payne *et al.*, 1985).

Summary of threats:

- Unknown.

Recommended action:

- More information is required on occurrence in protected areas as well as general information on its feeding habits and its population biology.

C. h. princeps

Priority Grade: 8 (No Data: Limited Distribution).

Distribution: Nias.

Summary of threats:

- Lack of information on status.

Recommended action:

- Survey to assess status, particularly in any protected areas.

Cynopterus sphinx
Short-nosed fruit bat

Priority Grade: 11 (Not Threatened).

Number of subspecies: 7.

C. s. angulatus

Priority Grade: 11 (Not Threatened).

Distribution: Borneo (Central Kalimantan); south China; Peninsular Malaysia; Sumatra; Thailand.

Status: Borneo Only record is from Central Kalimantan (Payne *et al.*, 1985).

Peninsular Malaysia Known from Selangor northwards (Medway, 1978). Appears to be commoner in the northern

states (Kedah, Perlis, Kelantan) and declines in abundance southwards. Occurrence is patchy but it is common where it is found (G. W. H. Davison, pers. comm.).

Thailand Recorded from Chiangmai, Bangkok, Siracha, Trang, and the area of the Malay peninsula (Lekagul and McNeely, 1977).

Ecology: The information provided by Pakarnseree (1986) (see *C. h. harpax*) for specimens from Thailand applies equally to this subspecies, though G. W. H. Davison (pers. comm.) mentions it also feeds on figs (**Moraceae:** *Ficus* spp.).

Summary of threats:

- Lack of information on status.

Recommended action:

- Surveys to assess status in Borneo, China and Sumatra, particularly in protected areas.

C. s. babi

Priority Grade: 8 (No Data: Limited Distribution).

Distribution: Babi Island, near Simalue Island, west Sumatra.

Summary of threats:

- Lack of information on status.

Recommended action:

- Survey to assess status, particularly in protected areas.

C. s. gangeticus

Priority Grade: 11 (Not Threatened).

Distribution: Central Provinces and Palampur, north-west India.

Status: Prater (1971) described it as common, although he did not distinguish between the subspecies that occur in India.

Ecology: Roosts singly or in small groups among palm leaves, aerial roots of banyan (**Moraceae:** *Ficus benghalensis*), tree hollows, and similar situations, rarely being found in ruins or caves (Prater, 1971).

Leaves roost early in the evening to forage. Feeds on fruit and nectar. Often flies off with ripe fruit, which is eaten elsewhere (Prater, 1971).

Population biology: Pregnant females have been obtained in February and young probably born in March and September have been collected, suggesting two birth peaks (Prater, 1971). Young carried by the mother have been seen in September and it is thought that the gestation is 115-125 days (Prater, 1971).

Summary of threats:

- Unknown.

Recommended action:

- Survey to assess status, particularly in protected areas.

C. s. pagensis

Priority Grade: 8 (No Data: Limited Distribution).

Distribution: Mentawai Islands (Pagai Islands [North Pagai], Siberut and Sipura).

Summary of threats:

- Lack of information on status.

Recommended action:

- Survey to assess status, particularly in protected areas.

C. s. scherzeri

Priority Grade: 8 (No Data: Limited Distribution).

Distribution: Nicobar Islands (CarNicobar and ?Great Nicobar).

Summary of threats:

- Lack of information on status.

Recommended action:

- Survey to assess status, particularly in protected areas.

C. s. serasani

Priority Grade: 8 (No Data: Limited Distribution).

Distribution: Natuna Islands (Serasan).

Summary of threats:

- Lack of information on status.

Recommended action:

- Survey to assess status, particularly in protected areas.

C. s. sphinx

Priority Grade: 11 (Not Threatened).

Distribution: Bangladesh; Burma (Shan States); India (Assam, Bengal, Bhutan Duars, Bombay, Calcutta, Chin Hills, Kumaon, Madras, Sikkim); Sri Lanka; north Thailand.

Status: Bangladesh Seems to be common and widespread. Often found in Dhaka city being mobbed by crows (Khan, 1985).

India See *C. s. gangeticus*.

Sri Lanka Locally common, throughout almost the whole of the cultivated areas in the lowlands and also throughout the higher hills of the central massif up to 1828 m. Generally more abundant in the dry zones than in the wet (Phillips, 1980).

Ecology: In Sri Lanka, roosts in colonies of 6-12 inside seed clusters in kitul palms (**Palmae:** *Caryota urens*) and in talipot palms (*Corypha umbraculifera*). Sometimes roosts in hollow trees (Phillips, 1980). In Bangladesh, lives singly or in small numbers among dead palm leaves and in tree hollows (Khan, 1985). Younger males roost with females, while older males usually roost alone (Phillips, 1980). Adult males can be wanderers, spending their day many miles from the main colony (Phillips, 1980).

In Sri Lanka, feeds on fruits of soursop (**Annonaceae:** *Annona muricata*), guava (**Myrtaceae:** *Psidium guajava*) and mango (**Anacardiaceae:** *Mangifera indica*) and the flowers and fruits of palms and plantains (**Musaceae:** *Musa* spp.) (Phillips, 1980).

Population biology: In Sri Lanka, females with young are found in most months, thus breeding is probably intermittent throughout the year. Females have one young per year (Phillips, 1980).

Summary of threats:

- Lack of information on status.

Recommended action:

- Surveys to assess status in Burma, India and Thailand, particularly in protected areas.

Cynopterus titthaecheilus

Priority Grade: 11 (Not Threatened).

Number of subspecies: 3.

C. t. major

Priority Grade: 8 (No Data: Limited Distribution).

Distribution: Nias.

Summary of threats:

- Lack of information on status.

Recommended action:

- Survey to assess status, particularly in protected areas.

C. t. terminus

Priority Grade: 8 (No Data: Limited Distribution).

Distribution: Timor.

Status: Common in 1968 (Goodwin, 1979), but no recent information on status.

Ecology: At low elevations, roosts in palms and modifies the leaves to make tents. At high elevations, roosts in hollow trees (Goodwin, 1979).

Summary of threats:

- Lack of information on status.

Recommended action:

- Survey to assess status, particularly in protected areas.

C. t. titthaecheilus

Priority Grade: 11 (Not Threatened).

Distribution: Bali; Jawa; Krakatau Islands; Lombok; Sebesi; Sumatra.

Status: Jawa Very common in disturbed situations from low altitudes (Bogor Botanical Gardens) to 1600 m (Cibodas Botanical Gardens) (Kitchener *et al.*, 1990).

Krakatau Islands One of the most common bats in the Krakatau Islands (Tidemann *et al.*, in press).

Lombok Kitchener *et al.* (1990) mist-netted these bats in October 1987 on Lombok, finding them from sea level to 400 m in all habitats, particularly disturbed situations, but most commonly at low altitudes, particularly Pelangan and Kuta. Also collected by A. Suyanto and NAMRU II (Navy Army Medical Research Unit) at Sewela and Kelayan, Lombok Timur, respectively.

Ecology: On Anak Krakatau probably roosts in trees because there are no caves. Circumstantial evidence from the Krakatau Islands suggests that this bat moves between islands (Kitchener *et al.*, 1990).

Population biology: Kitchener *et al.* (1990) suggested possible asynchrony in the reproductive cycle in different areas on Lombok. Of 12 females from Kuta, two had not bred, five were apparently primiparous, four were pregnant but not lactating and one was pregnant and lactating. At Pelangan, Suranadi and Batu Koq all but two females were lactating. These observations were taken to indicate that in the moister areas (which have streams with running water or pooled water) females had generally bred once and were pregnant again, while in the very dry areas of Des Kuta on the central south coast (no potable water) several females had not bred and most were only recently pregnant.

Summary of threats:

- Unknown.

Recommended action:

- Surveys to assess status in Sumatra, Sebesi and Bali, particularly in protected areas.

Genus *Dobsonia* (11 species)

Dobsonia beauforti

Priority Grade: 8 (No Data: Limited Distribution).

Distribution: Biak; Owii; and Waigeo off north-west New Guinea.

Status: Waigeo Known from one cave (Nja-njef).

Population biology: The holotype was lactating at time of capture, on 25 December 1909. All other six females collected at this time contained embryos. There might be a single breeding season with births taking place by the end of December and in January (Bergmans, 1975b).

Summary of threats:

- Lack of information on status.

Recommended action:

- Surveys to assess status, particularly in protected areas, and to obtain baseline information.

Dobsonia chapmani Philippine bare-backed fruit bat

Priority Grade: 1 (Extinct?).

Distribution: Philippines (Cebu, Negros).

Status: Presumed to have been extinct since about 1970 (Heaney and Heideman, 1987). All known specimens, except one from Cebu, were taken from Negros between 1949 and 1964. No specimens have been taken since, despite extensive efforts in its former habitats and collection sites.

Two series are in museums. The first was taken in 1949 at 200 m elevation in Mambaho Cave on Negros, which at the time was surrounded by large tracts of primary dipterocarp forest (Rabor, 1952). The cave was apparently the largest of a series in a ridge of soft limestone that parallels the Bagtik River, a tributary of the Ilog. Rabor estimated about 300 bats in groups of 4-12, with one group of 30, in a poorly lit portion of the cave. All bats taken were subadult males, indicating that this was a bachelor colony. The second series was taken at Lobogon Barrio, near Basay, Negros, in 1964. The series contained adult males and females and was probably from a breeding colony.

In 1945, about 60% of Negros was forested, but a boom in logging and an expansion of sugar plantations reduced this to 12% by 1975 (Alcala, 1976). Almost no forest remained below 800 m, the recorded upper elevational limit of this species. Between 1981 and 1987, Heaney and Heideman (1987) surveyed 10 large caves and numerous smaller caves on southern Negros (including several near the type locality). They found only a single fragment of an apparently old mandible of this species in guano deposits on the floor of one cave. Extensive netting in the

area where Rabor collected his series also failed to produce any specimens. It seems likely that destruction of forests, disturbance of cave roosts by guano mining, and hunting of bats for meat probably all played a role in the demise of this species (Heaney and Heideman, 1987).

Ecology: All specimens from Negros were taken at elevations of between sea level and 800 m. Most appear to have been taken within or on the edge of primary forest.

A female shot in a coconut tree (**Palmae:** *Cocos nucifera*) in 1948 had been feeding on betel nut (*Areca catechu*) fruits, an introduced palm.

Population biology: Births occur in May or June and young fly by August and September. A subadult collected in December 1964 was probably weaned.

Summary of threats:

- Deforestation.
- Disturbance at roosts.
- Hunting.

Recommended action:

- Efforts to determine whether remnant populations of this species persist are still worthwhile, particularly on northern Negros and, possibly, the neighbouring island of Panay, which was connected to Cebu and Negros until about 10,000 years ago (Heaney, 1986).
- Given the loss of almost all of their habitat on Negros and Cebu, captive breeding probably would be the best option for an attempt to preserve any individuals discovered.

Principal authors for this species: P. D. Heideman, L. R. Heaney.

Dobsonia emersa

Priority Grade: 8 (No Data: Limited Distribution).

Distribution: Biak; ?Numfoor; and Owii off north-west New Guinea.

Summary of threats:

- Lack of information on status.

Recommended action:

- Surveys to assess status, particularly in protected areas.

Dobsonia exoleta Sulawesi naked-backed bat

Priority Grade: 10 (No Data).

Distribution: Sulawesi.

Status: Hunted for food in northern Sulawesi (Bergmans and Rozendaal, 1988)

Occurrence in protected areas:

Sulawesi

Dumoga-Bone National Park

Summary of threats:

- Lack of information on status.

Recommended action:

- Survey to assess status, particularly in protected areas.
- Assess possible threat from hunting.

Dobsonia inermis
Solomons naked-backed bat

Priority Grade: 11 (Not Threatened).

Number of subspecies: 2.

D. i. inermis

Priority Grade: 10 (No Data).

Distribution: Bougainville; New Guinea; Solomon Islands (Alu, Fauro, Guadalcanal, Malaita, New Georgia, Ngela Sule, San Cristobal, Shortland, Uki Ni Masi, Vella Lavella).

Summary of threats:

- Lack of information on status.

Recommended action:

- Surveys to assess status, particularly in protected areas.

D. i. minimus

Priority Grade: 8 (No Data: Limited Distribution).

Distribution: Solomon Islands (Choiseul, Santa Isabel).

Summary of threats:

- Lack of information on status.

Recommended action:

- Surveys to assess status, particularly in protected areas.

Dobsonia minor
Lesser naked-backed bat

Priority Grade: 6 (Rare).

Distribution: Bagabag; north and west New Guinea; Sulawesi; Yapen.

Status: Uncommon (Flannery, 1990).

Ecology: Encountered in both primary and secondary rain forest (Flannery, 1990), and two were obtained hanging by day from the branch of a broad-leaved shrub (McKean, 1972). No records of roosting in caves, which contrasts greatly with the habits of the larger *Dobsonia moluccense*. Mist-netted in open areas 1 m from the ground (Greig-Smith, 1975) but is usually caught in nets set over small, overgrown streams or paths (Flannery, 1990). Flannery (1990) never encountered this species at altitudes in excess of 250 m, although Ziegler (1982) suggests the altitudinal limit may be as high as 600 m.

Population biology: A female collected on 18 January and two females caught in late May and early June had single embryos (McKean, 1972). In addition, four females captured in the Yapsiei area in January 1984 were all pregnant (Flannery, 1990).

Summary of threats:

- Lack of information on status.

Recommended action:

- Surveys to assess status, particularly in protected areas.

Principal author for this species: T. Flannery.

Dobsonia moluccense
Greater naked-backed fruit bat

Priority Grade: 11 (Not Threatened).

Number of subspecies: 2. The species *D. magna* is now considered to be a subspecies of *D. moluccense*.

D. m. magna

Priority Grade: 11 (Not Threatened).

Distribution: Australia (New South Wales, Queensland); New Guinea and islands off west coast (Batanta, Misool, Waigeo).

Status: Australia Rare (Strahan, 1983).

New Guinea Common (Flannery, 1990). Abundant in most habitats up to 2700 m in altitude, but may be uncommon or absent in areas of the savannah woodland in the south, as Waithman (1979) reports that it was only captured along the coastal strip during his survey of the Morehead region (Flannery, 1990).

Ecology: Usually roosts in the twilight zone of caves and sometimes forms immense colonies; a cave in the Nong River Valley near Telefomin, New Guinea, is home to a colony of many thousands. Australian groups are much smaller. Colonies of 100 or so have been seen scattered in dark areas under piles of large boulders. Roosts have also been found in old mines,

abandoned houses, and dense vegetation; usually in near-darkness. It is the only Australian megachiropteran to roost in caves (Strahan, 1983). Sometimes roosts singly and Flannery (1990) records seeing solitary bats roosting in small or easily accessible caves, or even under shallow overhangs in the Telefomin area. Vocalization occurs almost continuously in colonies, but the bats forage alone and are silent at night (Dwyer, 1975). Occasionally, individuals also roost in tree hollows and even in the crowns of trees. (Hyde *et al.*, 1984). Brass (1964) even records a group of adults and young taken from a hollow nursery tree in the Markham Valley, New Guinea, in November 1959.

Is a strong flier and Dwyer (1975) reports seeing bats fold their wings and plummet 300 m almost vertically to reach the entrance of their roost cave. Wilson (1985) and Richards (1986b) report that *D. m. magna* manoeuvres well and can fly slowly; it is even capable of flying backwards. This allows it to forage below the forest canopy and reach roosts and food unavailable to *Pteropus* species. Specimens are occasionally caught in deadfall traps set for bandicoots on Mount Karimui, which suggests that it may land on the ground to forage (Hyde *et al.*, 1984). Food taken includes cultivated bananas (**Musaceae**: *Musa* spp.), papaya (Caricaceae: *Carica papaya*), and wild *Ficus* (**Moraceae**) (Hyde *et al.*, 1984). In Australia, the bloodwood (**Myrtaceae**: *Eucalyptus* sp.) is one of its favourite food trees (Strahan, 1983).

Population biology: Breeding appears to be seasonal, with most births occurring September-October. The young do not become sexually mature until they are 2 years old, and are presumably nursed for 5-6 months. The overall pattern of reproduction in the Mount Elimbari area (Chimbu Province, New Guinea) seems to be: copulation at the close of the wet season (April-June); birth at the close of the dry season (August-November); weaning at the height of the wet season (February-April). It is not known whether this reproductive pattern is seen in areas of New Guinea with a less seasonal climate than Chimbu Province, but evidence from the Yapsiei area of west Sepik Province, where seasons are not clearly demarcated, suggests that it is the case (Flannery, 1990). In Australia, males mature at about 2 years of age and copulation occurs at the end of the wet season in May and June. Between September and November, each female gives birth to a single young, which is carried for about 1 month and nursed for a further 4-5 months (Strahan, 1983).

Summary of threats:

- No known threats.

Recommended action:

- Surveys to assess status in protected areas.

D. m. moluccense

Priority Grade: 10 (No Data).

Distribution: Ambon; Aru Islands; Buru; Halmahera; Kai Islands; Seram.

Occurrence in protected areas:

Seram

Manusela National Park

Summary of threats:

- Lack of information on status.

Recommended action:

- Surveys to assess status, particularly in any protected areas.

Dobsonia pannietensis

Priority Grade: 10 (No Data).

Number of subspecies: 3. The subspecies *D. p. anderseni* and *D. p. pannietensis* were formerly included as subspecies of *D. moluccense*.

D. p. anderseni

Priority Grade: 10 (No Data).

Distribution: Bismarck Archipelago (Admiralty Islands [Manus], Boang, Duke of York, Emirau, Lihir, New Britain, Tabar); Umboi.

Summary of threats:

- Lack of information on status.

Recommended action:

- Surveys to assess status, particularly in protected areas.

D. p. pannietensis

Priority Grade: 10 (No Data).

Distribution: D'Entrecasteaux Islands (Fergusson Island, Goodenough Island, Normanby Island); Louisiade Archipelago (Misima Island, Panaeati Island, Rossel Island, Sudest Island);Muyua.

Summary of threats:

- Lack of information on status.

Recommended action:

- Surveys to assess status, particularly in protected areas.

D. p. remota

Priority Grade: 8 (No Data: Limited Distribution).

Distribution: Trobriand Islands (Kiriwina).

Summary of threats:

- Lack of information on status.

Recommended action:

- Survey to assess status, particularly in protected areas.

Dobsonia peronii
Western naked-backed bat

Priority Grade: 9 (Indeterminate).

Number of subspecies: 4.

D. p. grandis

Priority Grade: 9 (Indeterminate).

Distribution: Komodo; Lombok; Penida; Sumbawa.

Status: Bergmans (1978c) notes that from their scarcity in collections one might infer that in the Lesser Sundas, *Dobsonia* is either not very common or mostly restricted to less accessible habitats. As it has been found in caves and hollow trees, near the coast and inland, and from sea level up to an altitude of considerably more than 880 m (on Timor), a relatively low density seems rather more likely than inaccessible habitats. The vertical range for lowland animals from the Lesser Sundas is 0-1000 m, and locally even 0-1200 m (Rensch, 1936). A plausible explanation for a low density could be an equally low occurrence of suitable habitats, since man has destroyed more than 50% of the forest on these islands (Rensch, 1936) and this must have seriously affected bat populations.

Lombok Kitchener *et al.* (1990) collected two adult males and two adult females in 1987 at Pelangan. These were netted using oval fishing nets by village people among coconuts (**Palmae:** *Cocosnucifera*) in the early evening. Another specimen was collected by NAMRU II (Navy Army Medical Research Unit) in a garden at Bilekedit, west Lombok on 24 March 1979.

Ecology: A large series was collected from a hollow tree on Sumbawa (Mertens, 1936). Another specimen, from Komodo, was taken from a colony of about 25 animals hanging in an open cave (Bergmans, 1978c).

Population biology: The two females collected by Kitchener *et al.* (1990) in October 1987 were lactating.

Summary of threats:

- Deforestation.
- Lack of information on status.

Recommended action:

- Studies of feeding ecology and population biology.

D. p. peronii

Priority Grade: 8 (No Data: Limited Distribution).

Distribution: Timor.

Status: See *D. p. grandis*.

Summary of threats:

- Deforestation
- Lack of information on status.

Recommended action:

- Survey to assess status, particularly in any protected areas.

D. p. sumbana

Priority Grade: 8 (No Data: Limited Distribution).

Distribution: Sumba.

Status: See *D. p. grandis*.

Summary of threats:

- Deforestation.
- Lack of information on status.

Recommended action:

- Survey to assess status, particularly in protected areas.

D. p. ssp. incertae sedis

Priority Grade: 8 (No Data: Limited Distribution).

Distribution: Alor; Babar; Flores; Wetar.

Summary of threats:

- Deforestation.
- Lack of information on status.

Recommended action:

- Research to establish taxonomic status.
- Surveys to assess status, particularly in protected areas.

Dobsonia praedatrix
New Britain naked-backed bat

Priority Grade: 10 (No Data).

Distribution: Bismarck Archipelago (Duke of York, New Britain, New Ireland).

Summary of threats:

- Lack of information on status.

Recommended action:

- Surveys to assess status, particularly in any protected areas.

Dobsonia viridis
Greenish naked-backed bat

Priority Grade: 11 (Not Threatened).

Number of subspecies: 2.

D. v. crenulata

Priority Grade: 10 (No Data).

Distribution: Bacan; Banggai Islands; Halmahera; Morotai; Rau; Sulawesi; Ternate; Togian Islands; Waigeo.

Ecology: Two bats were caught by Bergmans and Rozendaal (1988) over brackish water in partially disturbed, tall mangrove forest, within 100 m of the sea on the Banggai Islands.

Population biology: One of the males caught by Bergmans and Rozendaal (1988) on the Banggai Islands in November 1981 was sexually mature.

Summary of threats:

- Lack of information on status.

Recommended action:

- Surveys to assess status, particularly in protected areas.

D. v. viridis

Priority Grade: 10 (No Data).

Distribution: Ambon; Banda Islands; Buru; Kai Islands; Misool; Sangir Islands; Seram.

Summary of threats:

- Lack of information on status.

Recommended action:

- Surveys to assess status, particularly in protected areas.

Genus *Dyacopterus* (1 species)

Dyacopterus spadiceus
Dyak fruit bat

Priority Grade: 6 (Rare).

Number of subspecies: 2. Specimens from the Philippines have not been identified subspecifically.

D. s. brooksi

Priority Grade: 10 (No Data).

Distribution: Sumatra.

Summary of threats:

- Lack of information on status.

Recommended action:

- Survey to assess status, particularly in protected areas.

D. s. spadiceus

Priority Grade: 6 (Rare).

Distribution: Borneo (Brunei, Sabah, Sarawak); central Peninsular Malaysia.

Status: Borneo Recorded from Sepilok and Baturong Caves in Sabah; Baram district, Niah, and near Sibu in Sarawak (Payne *et al.*, 1985), and from Brunei.

Peninsular Malaysia Rare, recorded only in Selangor and Negri Sembilan (Medway, 1978).

Presumably threatened with forest loss; known from both lowland and montane forest and has also been recorded in open country. It is rarely netted, and the reasons for its apparent rarity are unknown.

Ecology: In Borneo, it has been caught near caves, but its roosting sites are unknown. In Peninsular Malaysia it has been found roosting in a tree trunk (Payne *et al.*, 1985) and has recently been netted in forest canopy in the Krau Game Reserve (C. M. Francis, pers. comm.).

One flock was seen feeding in a fig tree (**Moraceae:** *Ficus* sp.) with Horsfield's fruit bat (*Cynopterus horsfieldii*) (Payne *et al.*, 1985).

Occurrence in protected areas:

Borneo

Brunei

Ulu Temburong National Park (proposed)

Sabah

Sepilok Forest Reserve

Not known but likely to occur in large forest areas such as Kinabalu Park.

Peninsular Malaysia

Krau Game Reserve

Not known but likely to occur in large forest areas such as Taman Negara.

Summary of threats:

- Deforestation.

Recommended action:

- Investigation of roosting habits, feeding ecology and population biology of this apparently rare subspecies.

Principal author for this subspecies: G. W. H. Davison.

D. spadiceus (subspecies unknown)

Priority Grade: 10 (No Data).

Distribution: Philippines (Luzon, Mindanao).

Ecology: Probably a primary forest species.

Summary of threats:

- Lack of information on status.

Recommended action:

- Surveys to assess status, particularly in protected areas. Unfortunately, this species seems to have been rare everywhere it has been captured, suggesting this type of information will be difficult to obtain.
- Work to establish taxonomic status.

Principal authors for this species: P. D. Heideman, L. R. Heaney.

Genus *Eidolon* (2 species)*Eidolon dupreanum*

Priority Grade: 11 (Not Threatened). This species was formerly considered a subspecies of *E. helvum* but has recently been elevated to a full species (Bergmans, 1990).

Distribution: Madagascar and offshore islets.

Status: Rather widespread and at least locally common (M. Nicoll, pers. com.).

It is hunted for food, at least locally (Wilson, 1987). As it depends on trees for food, the deforestation in Madagascar threatens its continued existence in many places. All fruit bat colonies at Ankarana Special Reserve are in inaccessible places because local people use the bats as food (J. Wilson, pers. comm.).

Ecology: Wilson (1987) reports on a colony at Ankarana Special Reserve subsisting apparently almost entirely on the fruit of ebony (**Ebenaceae:** *Diospyros* sp.).

Occurrence in protected areas:**Madagascar**

Ankarana Special Reserve (but protection apparently not implemented).

Summary of threats:

- Hunting.
- Deforestation.

Recommended action:

- Occurrence in protected areas should be assessed. If the species does not occur in such areas, the gazetting of new protected areas should take this taxon into account, including its possible migratory habits.

Principal authors for this species: W. Bergmans, S. Sowler.

*Eidolon helvum***Straw-coloured fruit bat or Yellow fruit bat**

A full review of this species is given by DeFrees and Wilson (1988).

Priority Grade: 11 (Not Threatened).

Number of subspecies: 2.

E. h. helvum

Priority Grade: 11 (Not Threatened).

Distribution: Angola; Benin; Burkina Faso; Burundi; Cameroun; Central African Republic; Chad; Congo; Equatorial Guinea (Bioko, Mbini, Pagalu); Ethiopia; Gabon; Gambia; Ghana; Guinea; Guinea-Bissau; Ivory Coast; Kenya; Liberia; Malawi; Mali; Mozambique; Namibia; Niger; Nigeria; Rwanda; São Tomé and Príncipe (Príncipe, São Tomé); Senegal; Sierra Leone; ?Somalia; South Africa; Sudan; Tanzania (Mainland, Mafia, Pemba, Zanzibar); Togo; Uganda; Zaire; Zambia; Zimbabwe.

Moves from its prime habitat, the tropical forests of central Africa, where a variety of fruits is available throughout most of the year, to areas both north and south of this optimal territory. The availability of food determines occurrence elsewhere. Areas where it may be considered a year-round resident include parts of north-eastern Zambia, Malawi, and possibly north-eastern Mozambique and north-eastern Natal (Skinner and Smithers, 1990). Records are infrequent from Namibia, in Zimbabwe as far west as the Matopo Hills, and in Mozambique south of the Zambezi River in the central and southern parts of the country. In the south-west province of Transvaal these bats are considered 'wanderers'. In addition, has been taken in the Orange Free State and in the eastern Cape Province as far west as the Bredasdorp district (Skinner and Smithers, 1990).

Rosevear (1965) reported it had been taken at sea 250 km from the nearest land. Has been recorded from several islands off Cameroun (Ambas and Bimbina) and Sierra Leone, and on islands in the Congo River and in Lake Kivu (Zaire).

Status: In general common throughout its range. Rosevear (1965) noted that in West Africa it was exceedingly common and very widespread. Sometimes occurs in enormous colonies of 100,000-1,000,000 individuals of both sexes. However, it is locally threatened.

M. D. Turtle (pers. comm.) believes hunting in West Africa is sufficient to seriously threaten populations. Is eaten in all communities in south-western Nigeria; hunters are often hired to shoot bats for hotels and restaurants. Most people eat whole bats including the bones (Funmilayo, 1978). Although the subspecies as a whole is not threatened, with the human population in Africa rapidly increasing, and with progressive forest destruction, this situation may change sooner than expected, because the large aggregations in high trees are easy prey for hunters. On the other hand, it is quite adaptable. Colonies are known from the centres of large, busy cities (Lagos, Libreville, Kampala) and from the campus of the University of Ife, Nigeria, where it was hunted both for food and for dissection by zoology students on a sustainable basis (Halstead and Segun, 1975). In other parts, tradition ensures the protection of colonies and consequently, unmolested colonies may exist in the centres of villages and towns. Occasionally the skulls and smoke-dried bodies of this bat are found in ju-ju stalls because it is believed that they improve fertility in women (Shoga, 1974).

Could become a pest in fruit orchards and plantations, eating mango (**Anacardiaceae:** *Mangifera indica*), guava (**Myrtaceae:** *Psidium guajava*), papaya (**Caricaceae:** *Carica papaya*) and avocado pear (**Lauraceae:** *Persea americana*) (Funmilayo, 1976). These bats are certainly fond of bananas and plantains (**Musaceae:** *Musa* spp.) and can become a nuisance in these plantations. In Nigeria, it is killed for meat and because it is regarded locally as a pest because of mechanical damage to tree crops and competition with man for fruit (Funmilayo, 1979). Happold (1987) believes that there is little evidence that these bats damage commercial fruit. In the Ivory Coast it is a threat to non-native pine plantations because it gnaws the bark, wood and leaves killing the trees (Malagnoux and Gautun, 1976). May also eat and destroy dates (**Palmae:** *Phoenix dactylifera*) to such a degree that protective measures are required (Nowak, 1991). Guano creates problems in some villages and possibly poses a threat to the health of villagers (Funmilayo, 1979). For example, leaves used in cooking are often contaminated by faeces (Funmilayo, 1976). However, present control methods are wasteful and need regulation (Funmilayo, 1978).

Has also been shown to be a vector of Lagos bat rabies virus (Boulger and Porterfield, 1958) and as such may be in danger from attempts at extermination. Its large roost size and habit of roosting in areas of high human population, make it particularly susceptible.

Ecology: Inhabits forest and savannah, and is found up to an elevation of 2000 m in the Ruwenzori Mountains (Kingdon, 1974).

Is gregarious and prefers to roost in tall trees by day, but has also been found in lofts and in caves in rocks (Nowak, 1991). In Nigeria, selects trees of particular species for roosting (Okon, 1974) and some tree species, even though common, are not used. Common trees for roosts include *Eucalyptus saligna* (**Myrtaceae**), *Cocos nucifera* (**Palmae**), *Elaeis guineensis* (**Palmae**), and three species of *Ficus* (**Moraceae**) (Jones, 1972). Prefers dead trees that have bare branches; if living trees are used, the leaves are soon broken and the branches become bare. Trees used as day roosts are large with spreading branches, commonly found in dense groves with thick undercover. At night, roosts are chosen according to food availability. Trees are of various heights and sizes, some in groups, others widespread (Okon, 1974). Colonies can number up to 1,000,000; sleeping groups about 100 (Kulzer, 1969; Nowak, 1991). Roosting clusters are located 6-20 m above ground on sturdy branches (Jones, 1972). During periods of migration, colonies disperse into small groups and form temporary roosts from which they eventually form 'regular' roosts (Mutere, 1980). Baranga and Kiregyera (1982) reported a colony of 70,388 bats in Uganda. The average number of bats per tree was 310; the average number of clusters per branch 4; and the average cluster size 8. Most colonies use the same roosts for many years, but because of local fluctuations in food, some colonies make regular seasonal migrations returning after a few months to their former roosting sites (Happold, 1987). For example, in the Ivory Coast, has been observed to migrate, from the tropical forest zone where it stays between June and December, to the Niger basin in the interior where it appears in January and stays until May (Huggel-Wolf and Huggel-Wolf, 1965).

Feeds on the following fruits (both wild and cultivated) and on some flowers (Allen, 1939; Booth, 1959; Harris and Baker, 1959; Osmaston, 1965; Rosevear, 1965; Mutere, 1966, 1967; Jones, 1972; Ayensu, 1974; Kingdon, 1974; Funmilayo, 1979; Thomas, 1982; Dobat and Piekert-Holle, 1985; Fujita and Tuttle, 1991): **Anacardiaceae:** *Anacardium occidentale* (FR,FL), *Mangifera indica* (FR), *Pseudospondias* sp. (FR), *Spondias mombin* (FR); **Annonaceae:** *Annona* sp. (FR); **Bignoniaceae:** *Kigelia aethiopica* (FL), *K. pinnata* (FL); **Bombacaceae:** *Adansonia digitata* (FL), *Bombax buonopozense* (FL), *Ceiba pentandra* (FL), *Ochroma pyramidale* (FL); **Caricaceae:** *Carica papaya* (FR); **Cecropiaceae:** *Musanga cecropioides* (FR); **Chrysobalanaceae:** *Parinari excelsa* (FR); **Combretaceae:** *Terminalia* sp. (FR); **Convolvulaceae:** *Ipomoea albivenia* (FL); **Cunoniaceae:** *Codia* sp.; **Euphorbiaceae:** *Bridelia ferruginum* (FR), *Sapium ellipticum* (FR); **Lauraceae:** *Persea americana* (FR); **Leguminosae:** *Albizia* sp. (L), *Erythrina* sp. (L), *Parkia clappertoniana* (FL), *P. filicoidea* (FL), *P. roxburghii* (FL); **Loganiaceae:** *Anthocleista* spp.; **Meliaceae:** *Azadirachta indica* (FR,FL); **Moraceae:** *Antiaris africana* (FR), *Artocarpus* sp. (FR), *Chlorophora* sp. (L), *C. excelsa* (FR), *Ficus exasperata* (FR), *F. lepieuri* (FR), *F. mucosa* (FR), *F. natalensis* (FR), *F. thonningii* (FR), *F. umbellata* (FR), *F.*

vogelii (FR); **Morinaceae:** *Morina lucinda* (FR); **Musaceae:** *Musa sapientum* (FR), *M. s. paradisiaca* (FR); **Myristicaceae:** *Pycnathus angolensis* (FR); **Myrtaceae:** *Eucalyptus* sp. (FL); *Psidium guajava* (FR), *Syzygium* sp. ; **Palmae:** *Borassus aethiopum* (FR), *Elaeis* sp., *Phoenix dactylifera* (FR); **Passifloraceae:** *Adenia cissampeloides* (FR), *Passiflora* sp.; **Rhamnaceae:** *Maesopsis* sp.; **Rosaceae:** *Eriobotrya* sp.; **Sapotaceae:** *Vitellaria paradoxum* (FR,FL); **Solanaceae:** *Solarium anomalum* (FR); **Sterculiaceae:** *Colasp.*, *Theobroma cacao* (L); **Ulmaceae:** *Celtis* sp.; **Verbenaceae:** *Vitex* sp. (FR).

In Nigeria, feeds almost exclusively at night, visiting only trees that have food resources, whereas trees visited during the day are only for roosting (Okon, 1974). At night, small groups of bats fly to foraging areas in straight lines. On many occasions, near Ibadan, 1000 bats per minute have been counted flying along a fairly narrow flight path. The foraging area is not known, but the powerful flight suggests that these bats utilize food sources many kilometres from their roosts (Happold, 1987). Nowak (1991) suggested that foraging range may be at least 30 km for some of the larger colonies. They may assist in the pollination of the flowers of some trees (Baker and Harris, 1959) but probably not to the same extent as some of the smaller fruit bats (Happold, 1987). Vast quantities of fruits must be required to sustain large colonies; the daily foraging flights, and local seasonal migrations, are clearly related to the availability and abundance of food, the fruiting times of different tree species, and the size of the colony. Colonies do not appear to break up into smaller sub-colonies in times of food shortage, although individuals scatter and forage in smaller groups each night. The gregarious habits of these bats probably evolved in conjunction with their ability to forage on many types of food resource; obviously a species that feeds on only one or two food items could not be sustained in large numbers in one place for more than a short time (Happold, 1987).

Although predation is infrequent and seemingly poses little threat to populations, several animals eat this species; spotted eagle owl (*Bubo africanus*), crows, steppe buzzards, black kite (*Milvus migrans*; Kingdon, 1974), snakes, palm civets, genets and hawks (Funmilayo, 1979), pottos (*Perodicticus potto*; Jones, 1972), Ayer's hawk eagle (*Hieraetus dubius*; Wolf, 1984), and African hawk eagle (*Hieraetus spilogaster*; Louette, 1975). Kingdon (1974) recorded *E. h. helvum* attacking a pied crow.

Population biology: Essentially monoestrus, giving birth to one young annually. Two reproductive strategies are reported; one involving a gestation of four months with conceptions in the autumn and births in the spring (Andersen, 1912), the other involving an extended gestation of at least nine months, incorporating a period of delayed implantation which results in births timed to coincide with the onset of the rainy season (Mutere, 1967; Fayenuwo and Halstead, 1974; Funmilayo, 1979). Anciaux de Faveaux (1978) recorded two colonies of *E. helvum* both breeding at 2° of latitude S, as having different conception times. One colony followed a boreal pattern of conceptions in September/October and births four months later,

while the other followed an austral pattern with conceptions in June/July and births four months later. Anciaux de Faveaux (1978) suggested that this might be a direct result of the migratory nature of the species, the colony with the boreal pattern migrating from the north and the other with the austral pattern colony coming from the south. Wolton *et al.* (1982) suggested that breeding takes place in the dry season in West Africa. In Cameroun, Eisentraut (1941) noted that copulation took place at the end of the rainy season (October and November) with births occurring in February and March. No records of females in breeding condition exist in southern Africa suggesting the improbability of breeding there due to low population density of these migratory animals (Mutere, 1967). The only known longevity record for *E. h. helvum* is 21 years 10 months (Nowak, 1991).

Occurrence in protected areas:

Ghana

Mole National Park

Ivory Coast

Tai National Park

Malawi

Kusungu National Park

Nigeria

Borgu Game Reserve
Pandam Wildlife Park

Summary of threats:

- Deforestation.
- Hunting.
- Persecution in fruit orchards.

Recommended action:

- A study of movements and radius of activity. The colony at Ife may provide an ideal study.
- Where there appear to be conflicts with man (e.g. competition for fruit), the extent of damage should be assessed and weighed against the species's function in pollinating trees and dispersing their seeds.
- A research programme should be developed, incorporating the above elements while the species is still locally numerous. A successful programme at Ife may provide a model for other regions with *Eidolon* populations.
- Compilation of a complete annotated bibliography of *Eidolon* literature.

E. h. sabaeum

Priority Grade: 8 (No Data: Limited Distribution).

Distribution: Saudi Arabia (Nader, 1985b); Yemen.

Ecology: In Taizz, Yemen, a specimen was collected from a papaya tree (**Caricaceae:** *Carica papaya*) (it is not known whether it was feeding). In Al Shugayri, Saudi Arabia, individuals were seen feeding in a *Ficus* tree (**Moraceae**)(Nader, 1985b).

In Yemen, Allen (1939) recorded bats eating ripe dates (**Palmae:** *Phoenix dactylifera*) in the middle of August, and the fruits of a *Borassus* palm.

Summary of threats:

- Lack of information on status.

Recommended action:

- Survey to assess status concentrating particularly on protected areas.
- Study of ecology and biology.

Principal authors for this species: W. Bergmans, S. Sowler.

Genus *Eonycteris* (2 species)

Eonycteris major

Priority Grade: 11 (Not Threatened).

Number of subspecies: 2.

E. m. major

Priority Grade: 11 (Not Threatened).

Distribution: Borneo (Brunei, East and South Kalimantan, Sabah, Sarawak)

Status: Scattered records from most areas, except Central and West Kalimantan, including Kota Kinabalu and Ranau in Sabah, Gunung Dulit and Kuching in Sarawak, Kutai in East Kalimantan, and upper Sungai Tengah in South Kalimantan. Cave roosts have been found in Sarawak along the Sungai Tinjar and in the Bintulu district.

Ecology: Roosts in caves and hollow trees (Payne *et al.*, 1985).

Summary of threats:

- Unknown.

Recommended action:

- Investigate ecology and biology, and status in protected areas.

E. m. robusta

Philippine nectar-feeding fruit bat

Priority Grade: 6 (Rare).

Distribution: Philippines (Biliran, Leyte, Lubang, Luzon,

Maripipi, Mindanao, Negros, Siargao).

Status: Rare wherever it occurs (e.g., only 5 of 2122 bats trapped and less than one capture per 100 net-nights [authors' data]; none in over 300 net-nights in primary forest on Leyte [Heaney *et al.*, 1989]).

This bat is very vulnerable to capture at its roost caves, which it shares with *E. spelaea* and probably *Rousettus (Rousettus) amplexicaudatus*. The latter species are gathered at caves for food throughout the Philippines, with hunters routinely removing 'sacks-full' of individuals. Undoubtedly these sacks sometimes include *E. m. robusta*.

The authors captured no *E. m. robusta* in caves on Negros, despite extensive sampling between 1981 and 1989. Its current rarity in caves and its strong association with primary forest suggests that it has declined sharply in parallel with the deforestation of lowland Negros. May well be threatened throughout its range, but is apparently so rare that the seriousness of the threat is difficult to assess. Even without protection, will probably persist, albeit in very low numbers, as long as undisturbed cave roosts are available in areas near primary, or perhaps secondary, forest.

Ecology: Taken from near sea level to 1100 m. Some Philippine records are from caves (Taylor, 1934; Lawrence, 1939). All records with associated habitat information indicate that the specimens were taken in or near primary forest, and this bat is probably dependent on these forests. Available evidence suggests that this bat roosts primarily in caves, and may be dependent upon them for successful reproduction.

Undoubtedly feeds on nectar and pollen, as do all other macroglossines (Marshall, 1985).

Population biology: An adult female captured on 28 April 1984 on Biliran was carrying a 13 g juvenile (E. A. Rickart, pers. comm.).

Summary of threats:

- Deforestation.

Recommended action:

- Current roosts should be located and protection provided.

Principal authors for this species: P. D. Heideman, L. R. Heaney.

Eonycteris spelaea

Priority Grade: 11 (Not Threatened).

Number of subspecies: 3.

E. s. glandifera

Priority Grade: 4 (Vulnerable).

Distribution: Bali; Borneo (East and South Kalimantan, Sabah, Sarawak); east Jawa; Lombok; Muna off south-east Sulawesi; Philippines (Carabao, Cebu, Marinduque, Mindanao, Negros, Siargao, Siquijor, Sulu Archipelago [Sanga Sanga], Tablas [J. Edwards Hill, pers. comm.]); south-east Sulawesi; Sumba; Timor.

Status: **Borneo** Cave roosts have been found at Gomantong, Sukau, Sungai Segama and Madai in Sabah; Niah, Sungai Tinjar, and near Kuching in Sarawak. Also recorded from the upper Sungai Tengah in South Kalimantan and Kutai in East Kalimantan (Payne *et al.*, 1985).

Lesser Sundas (Bali, Lombok, Muna, Sumba, Timor) Considered endangered because of habitat destruction, cave disturbance and severe hunting pressure, throughout Jawa and the Lesser Sundas (A. Suyanto and D. Kitchener, pers. comm.). It plays an important role in the pollination of durian (**Bombacaceae:** *Durio zibethinus*). Kitchener investigated the relationships between the species, its roosting caves and the durian crop and found serious conservation problems with Indonesian caves being heavily exploited for limestone, guano and bats for food. Fifteen Lombok caves have good bat populations but all are affected by human pressures, particularly fires and removal of bats for food by knocking them down with sticks. This situation will be exacerbated as the human population continues to migrate eastwards along the Lesser Sundas. The human population is increasing and so is its longevity. There is an increasing demand for protein, and bats are a good, often easily accessible food source (A. Suyanto and D. Kitchener, pers. comm.).

Philippines Capture rates of *E. s. spelaea* were 0.2 per net-night in urban orchards (Heaney *et al.*, 1989), and 0.1 per net-night in forest clearings in the Balinsasayao region of Negros, but these bats were very rare within primary forest (Heaney *et al.*, 1981; Heideman and Heaney, 1989). *Eonycteris* made up 2% of total captures in an orchard site on Negros (Heaney *et al.*, 1989), as it did in a similar orchard sampled nearby by Guerrero and Alcalá (1973).

In the Philippines, tolerant of forest clearance, and able to use the nectar and pollen of many trees planted by humans in rural and urban areas. However, because it roosts almost exclusively in caves, usually within 10-20 m of the entrances, it is extremely vulnerable to hunting and disturbance. In the Philippines, many populations have been much reduced by hunters, who capture the bats in their roosts. Some caves with colonies of up to 500 bats in the 1970s and/or early 1980s, held from none to fewer than 50 animals in the late 1980s. At some caves, the only signs of bats were heaps of decomposing skins, sometimes mixed with charred bones.

As long as some roost caves are inaccessible to hunters, viable, if small populations, should remain. It rarely, if ever, attacks fruit, but is an important pollinator of many commercially important species including durian, kapok (**Bombacaceae:** *Ceiba pentandra*), abaca (**Musaceae:** *Musa textilis*), wild banana (*Musa* spp.), mangroves and many commercially valuable forest trees (Start and Marshall, 1976; Gould, 1978).

Ecology: Mist-netted on Lombok from sea-level in all habitats but most commonly in banana plantations, near mango trees (**Anacardiaceae:** *Mangifera indica*) and over watercourses, full or dry. Not recorded in caves (Kitchener *et al.*, 1990).

On Timor recorded from solution caves and cave-like crevices near the coast; in one cave roosted only 5 m above high tide level (Goodwin, 1979).

In the Philippines, ranges from sea-level to at least 1100 m. Most abundant in agricultural habitats, especially orchards, or naturally disturbed forest habitats, particularly those with species of bananas, and is uncommon or rare in submontane primary forest and absent from mossy forest (Heaney *et al.*, 1981, 1989).

Usually roosts in large colonies in caves. In the Philippines, generally found in chambers to which some light penetrates (R. C. B. Utzurrum, pers. comm.). Colonies may be large (e.g., tens of thousands [Start and Marshall, 1976]; thousands [authors' data]) but most Philippine colonies are well under 500. These smaller colonies may be the result of the hunting of bats at roosts or may reflect a greater abundance of suitable cave roosts. There is some segregation by sex and age at roosts, with individual clusters composed of males, females or subadults (Bhat *et al.*, 1980 and authors' data).

A pattern of sexual segregation by elevation suggests that the maternity roost requirements (caves) tie most reproductive females to suitable roosts in the lowlands in the Philippines, where caves tend to be more common than in the volcanic uplands. Start and Marshall (1976) noted that adult males preferentially foraged in mangrove forests and females preferred inland forest, while subadult bats stayed closer to the roost cave than adults.

In the Philippines, commuting distances of at least 10-15 km are likely in many areas; individuals are commonly captured at these distances from known cave sites. Has been reported to forage in flocks, usually of 5-20 but occasionally as many as 50 (Start and Marshall, 1976) and observations in the Philippines provide some evidence for small flocks. Start (1974) found that marked individuals returned to the same site for weeks or months after marking, despite the extensive foraging range he documented (Start, 1974; Start and Marshall, 1976).

Population biology: Observations by Kitchener *et al.* (1990) on Lombok suggest that by October, prior to the onset of the wet season, the period of births had all but finished, or at least was going through a temporary lull, and that most young had assumed a degree of independence. One-third of females of adult size had not bred. There was no indication of asynchronous breeding at Batu Koq, Pelangan, Suranadi and Kuta. At the end of the wet season there were few juveniles captured but all adult females were in active breeding condition. Goodwin (1979) reported a lactating female on Timor in March, but located no nursery roosts during March, April and May, nor were juveniles collected during that period.

In the Philippines, most populations apparently reproduce asynchronously, either entirely aseasonally or with only slight seasonal variation (Heideman, 1987).

Most adult females produce two young per year in the

Philippines (Heideman, 1987). Healthy females could possibly produce three young per year, allowing about 4 months per cycle.

Females appear to become fertile at about 6 months, with males maturing later, possibly as late as 1 year or more.

Occurrence in protected areas:

Borneo

Sabah
Gomantong Caves

Sarawak
Niah Caves

Summary of threats:

- Lack of information on status.
- Deforestation.
- Hunting.
- Roost disturbance.

Recommended action:

- In the Philippines, it is not endangered at present, but protection of these bats at their roosts would offer some direct economic benefits. If cave roosts of other species were protected, this would undoubtedly also benefit *E. s. glandifera* or *vice versa*.
- Surveys to assess status, particularly in protected areas.
- Protection of cave sites and control of hunting in Bali, Borneo, Lombok, Muna, Sumba and Timor.

Principal authors for this subspecies: P. D. Heideman, L. R. Heaney.

E. s. rosenbergii
Sulawesi dawn bat

Priority Grade: 8 (No Data: Limited Distribution).

Distribution: North Sulawesi.

Status: Hunted for food (Bergmans and Rozendaal, 1988).

Occurrence in protected areas:

Sulawesi

Dumoga-Bone National Park

Summary of threats:

- Lack of information on status.

Recommended action:

- Survey to assess status, particularly in protected areas.
- Assess possible threat from hunting

E. s. spelaea
Dawn bat, Cave fruit bat
Common nectar-feeding fruit bat

Priority Grade: 11 (Not Threatened).

Distribution: Andaman Islands; Burma; south China; north-east and north-west India; west Jawa; Peninsular Malaysia (including islands of Langkawi and Tioman); Singapore; Sumatra; Thailand; Vietnam.

Status: Peninsular Malaysia Widespread and locally common on the mainland. Beck and Lim (1973) reported colonies of tens of thousands in large limestone massifs in Peninsular Malaysia.

Thailand Rather common throughout Thailand (Lekagul and McNeely, 1977).

Vietnam Recorded from Quang Tri and Tuyen Doc Provinces (Van Peenen, 1969).

In Jawa, considered endangered; threatened by habitat destruction, cave disturbance and severe hunting pressure (A. Suyanto and D. Kitchener. pers. comm: see *E. s. glandifera*).

In Peninsular Malaysia, threatened by forest clearance in general, and of mangrove in particular. Also threatened by blasting, guano digging and disturbance of caves.

Ecology: In Peninsular Malaysia, is a generalist utilizing both agricultural land and primary forest.

In Peninsular Malaysia, feeds on the following plants (Start and Marshall, 1976 and authors' data): **Bombacaceae:** *Bombax* spp. (FL), *Durio zibethinus* (FL), *Durio* spp. (wild varieties) (FL); **Lecythidaceae:** *Barringtonia* spp. (FL); **Leguminosae:** *Parkia* spp. (FL); **Moraceae:** *Artocarpus* spp. (FL); **Myrtaceae:** *Eugenia malaccensis* (FL); **Sonneratiaceae:** *Duabanga grandiflora* (FL), *Sonneratia* spp. (FL); **Verbenaceae:** *Avicennia* spp. (FL).

In Peninsular Malaysia, may travel up to 38 km to feed (Start and Marshall, 1976).

Population biology: Bhat *et al.* (1980) found that an Indian colony reproduced aseasonally and asynchronously, as did the population studied in Peninsular Malaysia by Start (1974) and, probably, that studied by Beck and Lim (1973) in the same country. In contrast, Lim (1973) reported seasonal reproduction in yet another Peninsular Malaysian population.

Beck and Lim (1973) estimated a gestation of about 6 months, but the accuracy of their estimate was questioned by Start (1974); Bhat *et al.* (1980) estimated a gestation of 3-4 months and a lactation of 5-8 weeks.

In Peninsular Malaysia, a marked animal was at least 5 years old at the time of recapture (Start, 1974).

Occurrence in protected areas:

Peninsular Malaysia

Batu Caves (protected from quarrying since 1980)
Krau Game Reserve, Pahang

Kuala Selangor Nature Park, Selangor (only seen feeding)
Taman Negara National Park

Summary of threats:

- Hunting.
- Disturbance of caves (such as by tourism and quarrying).
- Loss of mangroves.

Recommended action:

- Investigation of status (particularly in protected areas), distribution, ecology and biology in the Andaman Islands, Burma, China, India, Jawa, Peninsular Malaysia, Thailand and Vietnam.
- Efforts should be made to protect roosts in Jawa and Peninsular Malaysia.

Principal author for this subspecies: G. W. H. Davison.

Genus *Epomophorus* (6 species)

Epomophorus angolensis
Angolan epauletted fruit bat

Priority Grade: 6 (Rare).

Distribution: Angola; Namibia.

Status: Restricted distribution, occurring only in woodland areas in western Angola and the extreme north of Namibia, but is locally common (Bergmans, 1988; Crawford-Cabral, 1989) Must, however, be susceptible to habitat destruction.

Feiler (1988) described a trip to the National Park of Kangandala in 1982, and gave data on the massive decline of large mammals because of the civil war. Feiler's conclusion was that only peace, together with well-organized habitat and species protection supported by international help, could save the large mammals from extinction. It is not likely that small mammals such as *Epomophorus* have suffered, but habitat protection is necessary for all species.

Ecology: As a fruit-eating species, probably confined to areas of riverine and other types of evergreen forest where there are fruit-bearing trees (Smithers, 1986).

Shortridge (1934) recorded that in Ovamboland bats hung singly from the bare branches of large *Acacia* (Leguminosae) trees near the Cunene River.

Eats cultivated tree fruits (Monard, 1935).

Population biology: Shortridge (1934) recorded newly-born young clinging to their mothers in September and October in Ovamboland.

Occurrence in protected areas:

Angola

Parc Nacional da Mupa
Parc Nacional do Bikuar

Summary of threats:

- Deforestation.
- Political instability in Angola and possible consequent neglect of protected areas.

Recommended action:

- Investigate the status of protected areas in Angola and what plans exist for their reinstatement.
- Address the question of how international help should be organised to support habitat protection in Angola.

Principal authors for this species: W. Bergmans, S. Sowler.

Epomophorus gambianus

Priority Grade: 11 (Not Threatened).

Number of subspecies: 3.



Epomophorus gambianus (Photo by A. M. Hutson)

E. g. crypturus
Peter's epauletted fruit bat

Priority Grade: 11 (Not Threatened).

Distribution: Angola; Botswana; Malawi; Mozambique; Namibia; South Africa; Tanzania; south-east Zaire; Zambia; Zimbabwe.

Status: Probably not threatened.

Ecology: Predominantly associated with evergreen forests in the higher rainfall areas but occurs in evergreen riverine forests in otherwise dry and unsuitable terrain (Smithers, 1986). Requirements are exemplified in northern Botswana, where it is common throughout the Okavango delta, with its riverine vegetation. It is not found in the drier associations of mopane, (**Leguminosae:** *Colophospermum mopane*), *Acacia* spp. (**Leguminosae**) or *Terminalia* spp. (**Combretaceae**) that surround it and offer insufficient cover and food. It has, however been recorded from mopane woodland in Zimbabwe (A. M. Hutson, pers. obs.). Where there are isolated areas of slightly higher rainfall within otherwise drier country, such as in the Fort Victoria or Matopos Hills areas in Zimbabwe, with pockets of evergreen vegetation supported by run-off from granite bosses, it settles in the moister woodlands and moves into the dry surrounding country to feeding sites. In some areas, man has provided additional suitable conditions in orchard developments, where fruits such as guavas (**Myrtaceae:** *Psidium guajava*), plums (**Rosaceae:** *Prunus domestica*), mangoes (**Anacardiaceae:** *Mangifera indica*) and other soft fleshy fruits provide it with food and where surrounding exotic trees such as *Cyperus* sp (**Cyperaceae**), provide the dense foliage shelter required for roosting (Smithers, 1986).

Occurs in colonies up to hundreds of individuals. In Zimbabwe, commonly uses trees such as the wild fig (**Moraceae:** *Ficus* spp.) or the sausage tree (**Bignoniaceae:** *Kigelia pinnata*), but will use any evergreen tree provided it has dense foliage and twigs thin enough to allow the bats to cling on to them (Smithers, 1986). In Botswana, used the outer finer twigs of a clump of high growing bamboo in a garden fringing the Okavango River, strung out on these in such numbers that the stems were weighed down to within 3 m of the ground (Smithers, 1986).

Feeds on the following plants (Smithers and Wilson, 1979; Pienaar *et al.*, 1980; Smithers, 1986): **Anacardiaceae:** *Mangifera indica* (FR), *Sclerocarya birrea caffra* (FR); **Apocynaceae:** *Rauvolfia caffra* (FR); **Bignoniaceae:** *Kigelia pinnata* (FL); **Bombacaceae:** *Adansonia digitata* (FL); **Caricaceae:** *Caricapapaya* (FR); **Chrysobalanaceae:** *Parinari curatellifolia* (FR); **Ebenaceae:** *Diospyros mespiliformis* (FR), *D. senensis* (FR); **Euphorbiaceae:** *Uapaca kirkiana* (FR); **Leguminosae:** *Xanthoceras zambesiaca*; **Moraceae:** *Ficus* spp. (FR); **Myrtaceae:** *Psidium guajava* (FR); **Rhamnaceae:** *Berchemia discolor* (FR); **Rosaceae:** *Cydonia* sp. (FR), *Eriobotrya japonica* (FR), *Prunus* spp. (FR); **Sapindaceae:**

Litchi chinensis (FR); **Sapotaceae:** *Mimusops zeyheri* (FR).

Was observed feeding with *Epomops dobsonii* and foraging on the same *Diospyros senensis* shrubs as *Rousettus* (*Rousettus aegyptiacus* (Ansell, 1960; Thomas and Fenton, 1978).

Smithers (1986) noted that it eats orchard and garden fruits such as guava, apricots (*Prunus armeniaca*), peaches (*Prunus persica*) and loquats (*Eriobotrya japonica*) and if papaya (*Carica papaya*) are left to ripen on the tree, damages these by biting into them and scratching them as they cling. Apples (**Rosaceae:** *Malus* spp.), pears (**Rosaceae:** *Pyrus* spp.) and other hard fruits remain untouched.

Population biology: Females normally bear a single young annually between September and February (Smithers and Wilson, 1979; Pienaar *et al.*, 1980; Rautenbach, 1982). Twins are known (Smithers, 1986).

Occurrence in protected areas:

Angola

Parc Nacional de Cameia

Botswana

Moremi Wildlife Reserve (Okavango)

South Africa

Kruger National Park

Zaire

Parc National de l'Upemba

Zambia

Luangwa Valley

Nyika National Park

Zimbabwe

Charara Safari Area

Chizarira National Park

Gonarezhou National Park

Hwange National Park

Inyanga National Park

Matopos National Park

Selukwe Reserve

Zambezi National Park

Summary of threats:

- Probably no major threats.

Recommended action:

- None.

E. g. gambianus
Gambian epauletted fruit bat

Priority Grade: 11 (Not Threatened).

Distribution: Benin; BurkinaFaso; Cameroun; Central African Republic, Chad; Ethiopia; Gambia; Ghana; Guinea; Guinea-Bissau; Ivory Coast; ?Liberia; Mali; Niger; Nigeria; Senegal; Sierra Leone; Sudan; Togo.

Status: Considered 'widespread and common' in West Africa (Rosevear, 1965). Happold (1987) considered it to be the commonest of the non-colonial species of fruit bats in Nigeria. Probably not threatened.

Hunted and eaten locally but this is probably not a serious threat yet.

Burkina Faso partially protects this species under wildlife regulations.

Ecology: Common throughout savannahs and woodlands of western Africa. The Sahel Acacia-wooded grassland and deciduous bushland forms the northern limit. Is a woodland species that is found along the forest edge (Bergmans, 1988). Specimens have been collected in the closed rain forest southwest of Kumasi, Ghana (Rosevear, 1965).

Roosts in large hollow trees, dense foliage, accumulated roots along stream banks, and below the thatch of open sheds. Often roosts where there is considerable light, and sometimes groups of about six hang from the midribs of palm fronds (Palmae) in plain sight (Nowak, 1991). Roosts in a variety of trees, including *Khaya senegalensis* (**Meliaceae**), *Kigelia pinnata* (**Bignoniaceae**), *Azadirachta indica* (**Meliaceae**), *Cola* sp. (**Sterculiaceae**), *Mangifera* sp. (**Anacardiaceae**), *Trichilia emetica* (**Meliaceae**), and *Ficus* sp. (**Moraceae**) (Baker and Harris, 1957; Rosevear, 1965; Ayensu, 1974; Poche, 1975; Thomas and Fenton, 1978; Marshall and McWilliam, 1982). Bats roosting in a neem tree (**Meliaceae**: *Azadirachta indica*), did not feed on its fruit (Ayensu, 1974). The African Mammal Project of the National Museum of Natural History, Washington DC, observed roosting with *Micropteropus pusillus* in a neem tree in Ghana.

Feeds on the following plants (Baker and Harris, 1957; Booth, 1959; Harris and Baker, 1959; Rosevear, 1965; Ayensu, 1974; Dobat and Peikert-Holle, 1985; Fujita and Turtle, 1991 and authors' data): **Anacardiaceae**: *Anacardium occidentale* (FR), *Mangifera indica* (FR); **Bignoniaceae**: *Kigelia pinnata* (FL); **Bombacaceae**: *Adansonia digitata* (FL), *Bombax* spp. (FL), *Ceibapentandra* (FL); **Caricaceae**: *Caricapapaya* (FR); **Chrysobalanaceae**: *Maranthes polyandra* (FL); **Ebenaceae**: *Diospyrosmespiliformis* (FR), *D. senensis* (FR); **Leguminosae**: *Parkia clappertoniana* (FL), *P. filicoidea* (FL); **Meliaceae**: *Azadirachta indica* (FL), *Trichilia roka* (FR); **Moraceae**: *Ficus umbellata* (FR); **Musaceae**: *Musa* spp. (FL); **Myrtaceae**: *Psidium guajava* (FR); **Sapotaceae**: *Vitellaria parkii* (FR).

Rather nomadic depending on the location of suitable food. At Ibadan in Nigeria, for example, it was particularly common when mango (*Mangifera indica*) and *Parkia* trees were in flower, and when mangoes were fruiting, but at other times was seen less frequently (Happold and Happold, 1978) Many individuals congregated to feed at a fruiting tree, while at other

times bats probably fed singly or in small groups (Happold, 1987).

Probably pollinates some trees, especially *Parkia clappertoniana* and the silk cotton tree (*Ceiba pentandra*) (Baker and Harris, 1957; Harris and Baker, 1959). These trees have large spherical inflorescences, which hang downwards and are supported on thick stems. When the bats come to feed on the nectar, they land on the inflorescences and push their noses into the cluster of flowers, flapping their wings to maintain balance. Pollen adheres to the pelage of the neck and ventral surface, and is later transferred to other inflorescences on the same or different trees. They usually arrive at the flowering trees at dusk, feeding for only 20-30 minutes and leave due to the arrival of the smaller, but dominant, Veldkamp's dwarf fruit bats (*Nanonycteris veldkampii*). Thus both species utilize the same food resource, but at different times (Happold, 1987). *E. gambianus* generally feeds singly (Poche, 1975; Thomas and Fenton, 1978), but was observed feeding on *Adansonia digitata* in mixed-species flocks with *Micropteropus pusillus* and *N. veldkampii*. In these observations, none of the bat flocks stayed more than 45 minutes; arrival and departure of the flocks was not synchronized. This species may be a dispersal agent for guava (*Psidium guajava*), cashew (*Anacardium occidentale*) and neem. It has been observed leaving neem trees carrying the fruits. However, the relationship between this species and mango trees is a one-sided interaction; the bats were observed destroying as much as one-third of the fruit while foraging, but did not seem to pollinate the flowers or disperse the fruit (Ayensu, 1974).

There are a few records of predation. Pied crows (*Corvus albus*) have been observed to prey upon roosting bats during the day but only when the crows were raising young (Smalley, 1984). A specimen in the British Museum is recorded as having been killed by a crow (Rosevear, 1965).

Population biology: Females collected in western Niger during the peak of the dry season (February-May) were either pregnant or lactating. Pregnant females were collected in February, March and May. Lactating females were taken in February. Weaning probably occurs when abundant food resources are available during the period of maximum vegetative growth in the summer (June-August) rainy season (Poche, 1975). This limited information, probably also applicable to northern Nigeria, suggests that breeding occurs during the dry season (Happold, 1987).

In Burkina Faso, pregnant females were captured in March, May, and September (Koopman *et al.*, 1978).

Marshall and McWilliam (1982), working in Ghana, concluded that this species gave birth at the beginning of the rainy season (April), but that it may be polyoestrus. Thomas and Marshall (1984), classed it as bimodally polyoestrus in the Ivory Coast.

This species may thus be classified as bimodally polyoestrus with two parturition periods, followed by post-partum oestrus, during the rainy season. The timing of the breeding seasons may be determined by the lactating female's need for food rather

than the needs of the young after weaning. The first period of birth occurred in April, coinciding with the onset of the rainy season, and the second in October, the last rainy month. The first lactation occurred during peak fruiting; the second followed 5-6 months later, the length of gestation, regardless of available resources (Thomas and Marshall, 1984).

Occurrence in protected areas:

Burkina Faso

Po National Park

Central African Republic

Bamingwi-Bangoran National Park

Ghana

Mole Game Reserve

Shai Hills Game Reserve

Niger

Park W

Nigeria

Borgu Game Reserve

Darazo Forest Reserve

Kainiji Lake National Park

Nagaruta Forest Reserve

Pandam Wildlife Park

Upper Ogun Game Reserve

Yankari Game Reserve

Summary of threats:

- No major threats.

Recommended action:

- None.

E. g. pousarguesi

De Pousargue's epauletted fruit bat

Priority Grade: 6 (Rare).

Distribution: Central African Republic.

Status: Known only from the type locality (between Mokorou and Yabanda) and from Bangui, both in the Central African Republic (Bergmans, 1978a). Probably not threatened.

Summary of threats:

- Probably no major threats.

Recommended action:

- Assessment of status (particularly in protected areas), distribution, and of possibly aberrant ecological requirements.

Principal authors for this species: W. Bergmans, S. Sowler.

Epomophorus grandis
Lesser Angolan epauletted fruit bat

Priority Grade: 5 (Rare: Limited Distribution)

Distribution: Angola; Congo.

Status: Known only from the type locality (Dundo) in Angola and Pointe Noire in Congo.

Population biology: A male caught by W. Bergmans in December 1972 at Pointe Noire was a very young adult. The female holotype collected in September 1948 was carrying a juvenile male with milk dentition.

Summary of threats:

- Lack of information on status.

Recommended action:

- Assess status and distribution.
- Prepare a proposal for a protected area, which should include other possibly rare or vulnerable species (not necessarily fruit bats), such as *Micropteropus intermedius*.

Principal authors for this species: W. Bergmans, S. Sowler.

Epomophorus labiatus
Ethiopian epauletted fruit bat

Priority Grade: 11 (Not Threatened)

Distribution: Burundi; Chad; Congo; Ethiopia; Kenya; Malawi; Nigeria; Rwanda; Sudan; Tanzania; Uganda; north-east Zaire.

Status: Probably not threatened.

Ecology: Occurs in bushlands and woodlands.

Feeds on the following plants (Verschuren, 1957; Verschuren, 1965; Okia, 1974a; Dobat and Peikert-Holle, 1985; Fujita and Tuttle, 1991):

Anacardiaceae: *Mangifera indica* (FR); **Bignoniaceae:** *Kigelia aethiopica* (FL), *K. pinnata* (FL); **Moraceae:** *Ficus natalensis* (FR), *F. vallis-choudae* (FR); **Simaroubaceae:** *Irvingia smithii* (FR).

Population biology: Seasonally polyoestrus with a bimodal pattern, conceptions occurring twice a year in late March/early April and late September/early October, with births in September and March after a 5-6 month gestation.

Occurrence in protected areas:

Malawi

Kasungu National Park

Rwanda

Parc National de Kagera

Sudan

Nimule National Park

Uganda

Murchison Falls National Park
Queen Elizabeth National Park

Zaire

Parc National de Virunga
Parc National de la Garamba

Summary of threats:

- Probably no major threats.

Recommended action:

- Ascertain whether there are viable breeding colonies in one or more of the protected areas listed above.

Principal authors for this species: W. Bergmans, S. Sowler.

Epomophorus minor
East African epauletted fruit bat

Priority Grade: 11 (Not Threatened)

Distribution: Ethiopia; Kenya; Malawi; Rwanda; Somalia; Sudan; Tanzania (mainland, Zanzibar); Uganda; south-east Zaire; Zambia.

Status: Probably not threatened.

Ecology: Found in woodlands, savannah areas with forest patches, bushlands, and even drier vegetation types.

Feeds on the following plants: **Combretaceae:** ?*Terminalia catappa* (FR); **Moraceae:** *Ficus* (FR); **Salvadoraceae:** *Salvadora persica* (FR).

Population biology: Very little information available on population biology specifically for *E. minor* because in the past it has been regarded as, or confused with, *E. labiatus*. The data available suggests that the breeding cycle may be similar to *E. labiatus*, with births in March followed immediately by a second pregnancy.

Occurrence in protected areas:**Kenya**

Meru Game Reserve; species not identified

Malawi

Kasungu National Park

Tanzania

Lake Manyara National Park

Zambia

Luangwa Valley; species not identified
Lukusuzi National Park

Summary of threats:

- Probably no major threats.

Recommended action:

- Ascertain occurrence of viable populations in protected areas.
- Establish ecological relationship between *E. minor* and *E. labiatus* and then assess ecological requirements.

Principal authors for this species: W. Bergmans, S. Sowler.

Epomophorus wahlbergi
Wahlberg's epauletted fruit bat

Priority Grade: 11 (Not Threatened).

On the basis of differences in dimensions many authors, e.g. Hayman and Hill (1971), have long recognized two subspecies, *wahlbergi andhaldemani*, but Bergmans (1988) has shown that this is not tenable.

Distribution: Angola; Burundi; Cameroun; Congo; Equatorial Guinea (Mbini); ?Ethiopia; Gabon; Kenya; Malawi; Mozambique; Namibia; Somalia; South Africa; Swaziland; Tanzania (mainland, Pemba, Zanzibar); Uganda; south-east and south-west Zaire; Zambia; Zimbabwe.

Status: Not threatened.

Readily visible and easily shot. Known to cause damage to litchi orchards (Sapindaceae: *Litchi chinensis*) in South Africa, although *Rousettus (Rousettus) aegyptiacus* is more important in this respect.

In 1980, rabies serotype 2 (Lagos Bat Virus) was isolated from specimens captured in and around Durban, South Africa. The infected bats were known, in at least one case, to have flown at (attacked?) a human. Lagos Bat Virus, however, is not known to affect humans. This incident, nevertheless, precipitated local bat extermination programmes and if the problem arose again, could seriously threaten insectivorous bat populations as well as fruit bats.

The male bats, with their repetitive bell-like call, are known to keep people awake all night. This, coupled with the problem of faeces splashed over white walls, causes roosts to be sought out and the bats shot.

Dried bodies of this species are used to a limited extent by Zulu witchdoctors as 'muti', but probably not enough to constitute a threat.

Ecology: Occurs in tropical forest and evergreen riverine forests where there are fruit-bearing trees. While its occurrence lies largely within areas with a mean annual rainfall in excess of 700 mm, it penetrates up river valleys carrying evergreen forest into otherwise much drier country with a minimum annual rainfall as low as 250 mm (Limpopo Valley) (Smithers, 1986).

Roosts in the canopies of dense evergreen trees, sometimes in colonies numbering dozens of individuals and often in association with *E. gambianus crypturus*, which is always in much greater numbers (Smithers, 1986). In coastal cities in Mozambique it roosts in evergreen trees in city parks, and even in trees along busy streets (Smithers, 1986).

Feeds on the following plants (Kingdon, 1974; Wickler and Seibt, 1976; Sowler, 1984; Dobat and Peikert-Holle, 1985; Smithers, 1986; Fujita and Tuttle, 1991). **Anacardiaceae:** *Anacardium occidentale* (FR), *Mangifera indica* (FR); **Bombacaceae:** *Adansonia digitata* (FR); **Caricaceae:** *Carica papaya* (FR); **Chrysobalanaceae:** *Parinari curatellifolia* (FR); **Combretaceae:** *Terminalia catappa* (FR); **Ebenaceae:** *Diospyros squarossa* (FR); **Euphorbiaceae:** *Uapaca kirkiana* (FR), *U. sansibarica* (FR); **Moraceae:** *Ficus sycamorus* (FR), *F. natalensis* (FR), *F. polita* (FR), *F. vogelii* (FR); **Musaceae:** *Musa* spp. (FR); **Myrtaceae:** *Psidium guajava* (FR), *Syzygium cordatum* (FR); **Rosaceae:** *Prunus armeniaca* (FR), *P. domestica* (FR); **Sapindaceae:** *Litchi chinensis* (FR); **Zygophyllaceae:** *Balanites wilsoniana* (L).

Moves considerable distances in its search for food. At preferred feeding sites it may settle in the cover of evergreen trees during the day and then quite suddenly, when the supply is exhausted, move off elsewhere (Smithers, 1986).

Population biology: Conceptions occur from May to December, the peak months being May, June and July. Births occur from October to June with the peak birth season in November and December. The majority of females undergo one pregnancy per year terminating in November/December with a small percentage terminating in April (Sowler, 1984). In Kenya, Wickler and Seibt (1976) noted births occurring in January, while O'Shea and Vaughan (1980) found volant young, pregnant and lactating females continuously from November to May. In Zaire, Anciaux de Faveaux (1972) described a biannual cycle with births in March and in October and November, but did not exclude the possibility of continuous polyoestrus reproduction. Reproductive information extracted from specimens collected in Congo, Zaire, Kenya, Tanzania and Zambia support Anciaux de Faveaux's (1972) suggestion.

Occurrence in protected areas:

Angola

Reserva do Luando

Kenya

Amboseli Game Reserve
Masai Mara Reserve

Serengeti National Park
Tsavo National Park

Mozambique

Parque Nacional de Gorongosa

South Africa

Addo Elephant Park
Empisini Nature Reserve (Umkomaas)
Enseleni Nature Reserve
Hans Merensky Nature Reserve
Harold Johnson Nature Reserve
Hluhluwe Game Reserve
Inanda Game Reserve
Itala Nature Reserve
Kenneth Stainbank Reserve
Keurbooms Reserve
Kosi Bay Nature Reserve
Krugers National Park (and adjacent private game reserves on western boundary)
Loskop Dam Nature Reserve
Mkuzi Game Reserve
Ndumu Game Reserve
Ngoye Forest Reserve
Oribi Gorge Nature Reserve
St Lucia Lakes Game Reserve
Sodwana Nature Reserve
Umfolozi Game Reserve
Umgeni Valley Nature Reserve
Umlalazi Nature Reserve
Umtamvuna Nature Reserve
Vernon Crookes Nature Reserve
Wolkberg Wilderness Area

Swaziland

Hlane Game Reserve
Malolotja Nature Reserve
Mlilwane Wildlife Sanctuary

Tanzania

Manyara National Park
Mikumi National Park
Selous Game Reserve
Serengeti National Park

Zaire

Parc National de Virunga

Zimbabwe

Chizarira National Park
Gonarezhou Game Reserve
Inyanga National Park

Summary of threats:

- No major threats.

Recommended action:

- Education programmes, particularly in South Africa, where misinformation in the form of sensationalism has been spread by the press.
- Appoint Bat Public Relations Officers in South Africa, possibly within the Parks Boards, to reduce the risk of further bat eradication campaigns.
- Provide protected status in South Africa, where legislation could be enforced by the National, Transvaal and Natal Parks Boards.

Principal authors for this species: W. Bergmans, S. Sowler.

Genus *Epomops* (3 species)

Epomops buettikoferi
Buettikofer's epauletted bat

Priority Grade: 4 (Vulnerable)

Distribution: Ghana; Guinea; Ivory Coast; Liberia; Nigeria; Sierra Leone.

Status: As a forest species, will suffer from the severe forest destruction in West Africa and should be considered vulnerable, or possibly endangered.

Ecology: An inhabitant of the wetter and drier types of the Guineo-Congolese rain forests of the western Upper Guinea forest block and the adjoining mosaic of lowland rain forest and secondary grassland, with some possibly isolated occurrences in the eastern Upper Guinea region (the Nigerian localities). In Liberia is reported as favouring areas of secondary bush or cultivated land in preference to primary rain forests (Wolton *et al.*, 1982).

Feeds on the following plants (Rosevear, 1965; Wolton *et al.*, 1982; Dobat and Peikert-Holle, 1985; Fujita and Tuttle, 1991)
Bignoniaceae: *Spathodea campanulata* (FL); **Bombacaceae:** *Ceiba pentandra* (FL); **Combretaceae:** ?*Terminalia catappa* (FR); **Ebenaceae:** *Diospyros mespiliformis* (FR); **Leguminosae:** *Parkia roxburghii* (FL); **Moraceae:** *Chlorophora excelsa* (FR), *Ficus vallis-choudae* (FR); **Musaceae:** *Musa* spp. (FL?); **Myrtaceae:** *Psidium guajava* (FR); **Passifloraceae:** *Adenia cissampeloides* (FR), *Smeathmannia pubescens* (FR); **Solanaceae:** *Solanum erianthum* (FR), *S. torvum* (FR).

Population biology: Bergmans (1975a) suggested two breeding cycles per year for Ivory Coast populations. More extensive research showed that in the Ivory Coast there are two parturition periods (March and September) occurring during the two rainy seasons, each followed by apparently immediate embryonic development (Thomas and Marshall, 1978). On this basis it could be classified as bimodally polyoestrus. In Liberia, Wolton *et al.* (1982) also found two breeding peaks per year, births occurring just before the main rainfall peak in July/August and

again at the end of the rains in late November/December. It seems to compress its breeding seasons more closely than *E. franqueti*, resulting in a gestation of 3-4 months.

Occurrence in protected areas:**Ghana**

Bimpang Forest Reserve

Ivory Coast

Tai National Park

Liberia

Mount Nimba

Nigeria

Pandam Wildlife Park

Summary of threats:

- Deforestation.

Recommended action:

- Assess occurrence of viable populations in protected areas.

Principal authors for this species: W. Bergmans, S. Sowler.

Epomops dobsonii

Dobson's fruit bat, Bocage's epauletted fruit bat

Priority Grade: 11 (Not Threatened)

Distribution: Angola; Botswana; Malawi; Rwanda; Tanzania; south-east Zaire; Zambia; Zimbabwe.

Status: Probably not threatened.

Ecology: Largely restricted to woodland vegetation, dominated by *Brachystegia*, *Julbernardia* and *Isoberlinta* (**Leguminosae**). Is restricted by shrubland belts and desert vegetation of the Atlantic coast, by the Lower Guinea rain forest block in the north and by the drier vegetation of the Zambezian deciduous forest and secondary grassland to the south, south-east and east.

Population biology: Females caught at Mount Soque in Angola at the end of August were either pregnant or lactating, which suggests that births occur in August/September. There is no information to suggest bimodality.

Occurrence in protected areas:**Botswana**

Chobe National Park

Malawi

Kasungu National Park

Zaire

Parc National de l'Upemba

Summary of threats:

- Probably no major threats.

Recommended action:

- Investigate ecology, with particular reference to threats, in order to identify possible conservation strategies.

Principal authors for this species: W. Bergmans, S. Sowler.

Epomops franqueti Franquet's epauletted bat, Singing fruit bat

Priority Grade: 11 (Not Threatened).

Two subspecies have been described, *E. f. franqueti* (Tomes) and *E. f. strepitans* Andersen. Bergmans (1989) found these to be poorly differentiated, and synonymized them.

Distribution: Angola; Benin; Cameroun; Central African Republic; Congo; Equatorial Guinea (Mbini); Gabon; Ghana; Ivory Coast; Nigeria; Sudan; Tanzania; Togo; Uganda; Zaire; Zambia.

Status: Unknown, but probably on the whole not threatened. Happold (1987) noted that it did not seem to be as common in the western area of Nigeria as *Epomophorus gambianus*, *Micropteropus pusillus* and *Nanonycteris veldkampii* but was very numerous in some parts of its geographical range such as Gabon (Brosset, 1966b).

Ecology: Essentially a species of the Guineo-Congolian lowland rain forest, occurring in both wetter and drier types. Ranges from eastern Upper Guinea to the whole of Lower Guinea. Within the forest belt it probably does not enter the large area of swamp forest in north-east Congo and adjacent Zaire. On the continental side of the rain forests, occurs in various mosaics of rain forest with woodland and grassland (Bergmans, 1989).

During the day roosts, usually in groups, suspended from small branches, 4-6 m above the ground and often close to water (Brosset, 1966b; Jones, 1972).

Feeds on the following plants (Jones, 1972; Bradbury, 1981; Fujita and Tuttle, 1991): **Anacardiaceae:** *Mangifera* sp. (FR); **Annonaceae:** *Annona* sp. (FR); **Combretaceae:** *Terminalia catappa* (FR); **Lauraceae:** *Persea americana*; **Moraceae:** *Artocarpus* sp. (FR), *Ficus* sp. (FR); **Myrtaceae:** *Psidium guajava* (FR); **Solanaceae:** *Solanum torvum* (FR).

Happold (1987) noted that in Nigeria, it was not known to assist in the pollination of trees. Often congregates to feed on fruiting trees, and, therefore, may be locally common while adequate food is available. Little is known about seasonal movements and flight; tends to fly more frequently at 4-6 m above the ground than at 0-2 m (Jones, 1972), but on occasions will feed on fruit on the ground (Kingdon, 1974).

Rosevear (1965) noted that, along with *Hypsignathus monstrosus*, it is considered a great nocturnal pest of fruit orchards.

Population biology: Working in central Africa, Anciaux de Faveaux (1972) concluded a continuous polyoestrus breeding pattern. Okia (1974b) working in Uganda and Bergmans (1979) in Congo both concluded a bimodally polyoestrus pattern with births timed to occur at the beginning of the two rainy seasons. Okia (1974b) reported a 5-6 month gestation, with copulation in April and early September and births in early September and early February.

Data from museum specimens suggest births in August/September/October in Nigeria, but this may be only a partial picture and the true pattern could be either bimodal or continuous reproduction. Museum data for Cameroun point to bimodality, with births in January/February and in June/July.

Occurrence in protected areas:

Congo

Parc National d'Odzala

Nigeria

Mamu River Forest Reserve
Olokomeji Forest Reserve
Omo Forest Reserve

Uganda

Murchison Falls National Park

Zaire

Parc National de Virunga
Parc National de la Garamba

Summary of threats:

- Possibly deforestation.

Recommended action:

- No necessity for conservation activities at present but its occurrence in protected areas should be assessed along with that of other species of more concern.

Principal authors for this species: W. Bergmans, S. Sowler.

Genus *Haplonycteris* (1 species)

Haplonycteris fischeri Fischer's pygmy fruit bat

Priority Grade: 4 (Vulnerable).

Distribution: Philippines (Dinagat, Leyte, Luzon, Mindanao, Mindoro, Negros). A record from Palawan (Kock, 1969) is probably erroneous.

Status: Rare even in areas of mixed agricultural land, secondary growth, and patches of secondary forest near to continuous primary forest (Heaney *et al.*, 1989 and unpublished data). Even in areas of continuous primary forest, it was about eight times more numerous within forest as within small clearings in forest (Heideman and Heaney, 1989), in contrast to the pattern for some other small fruit bats (e.g., *Cynopterus brachyotis*, *Macroglossus minimus* and *Ptenochirus jagorii*).

The most abundant bat in primary forest on Negros (55% of captures between 800 m and 1000 m and 59% of captures between 1250 m and 1300 m elevation). About 4 individuals were recorded per hectare in the Balinasayao region forest on Negros (Heideman and Heaney, 1989).

No evidence of self-sustaining populations in non-forested areas. Too small and inconspicuous to be threatened by hunting, but is seriously threatened by habitat destruction. The forest habitats of this species have been reduced from about 75% of the land area of the Philippines to perhaps 10 or 20% in the last 100 years, and populations have probably declined similarly. Is threatened by forest destruction throughout its range, but there is some evidence that small populations can persist in secondary forest.

Ecology: Has been taken at elevations from below 100 m to 1550 m. One of the smallest (typically 18-20 g) primary and old secondary forest fruit bats in the Philippines (Heaney *et al.*, 1981, 1989; Heideman and Heaney, 1989).

Feeds on several species of figs (**Moraceae:** *Ficus* spp.), including *Ficus chrysolepis*. Captives readily ate fruits of *Musa* sp. (**Musaceae**), and it is likely that they also feed on fruits of at least one species of *Piper* (**Piperaceae**). Numbers seem to be positively correlated with the abundance of two species of *Piper* vines in the Balinasayao region of Negros, but it is not clear to what extent the species relies on *Piper* fruits or *vice versa*.

Flies and forages largely in the understorey and in the subcanopy, but also feeds in the canopy. Captured in small clearings (< 1 ha) and occasionally along edges of larger clearings, but rarely more than 10 m from the forest edge. Feeding roost sites usually were branches less than 5 m high on a sapling, often out of sight of possible fruit source trees. Individuals in the Balinasayao region of Negros moved, on average, 300 m between net captures (Heideman and Heaney, 1989).

Heideman *et al.* (1987) found teeth from a single *H. fischeri* in one of 23 carnivore scats from the Balinasayao region that contained small mammals. The teeth were far more worn (to the roots) than any other of this species seen by Heideman and Heaney, suggesting that the bat had been very old when eaten. Although mammalian carnivores may take *H. fischeri* opportunistically, the bats' primary predators are probably owls and arboreal snakes.

Population biology: Heideman (1988, 1989) describes in detail the reproductive pattern in the Balinasayao region. Females produced one young per year; births were highly synchronized in late May, June and early July, the earliest part of the wet

season. The duration of lactation was about 3 months, ending in September or early October. The timing of birth periods was different on some other islands (Heideman, 1988). Females reached maturity at about 3-5 months while males were not mature until 10-11 months.

Individuals have been documented to live at least 4 years in the wild; their apparently high annual survivorship rate (about 80%) suggests that about 5-10% of yearlings reach an age of about 10 years (Heideman and Heaney, 1989).

Summary of threats:

- Deforestation.

Recommended action:

- Preserve forest habitats.

Principal authors for this species: P. D. Heideman, L. R. Heaney.

Genus *Harpyionycteris* (1 species)

For a review of the genus, see Tate (1951).

Harpyionycteris whiteheadi
Harpy fruit bat

Priority Grade: 11 (Not Threatened).

Number of subspecies: 3.

H. w. celebensis

Priority Grade: 10 (No Data).

Distribution: Sulawesi.

Status: Hunted for food in north Sulawesi (Bergmans and Rozendaal, 1988).

Population biology: Females collected in January and September carried embryos. A female caught in January 1983 was carrying a young. Immature but rather large specimens were obtained in January, May, June and July while two nearly full-grown females were obtained in June (Bergmans and Rozendaal, 1988).

Occurrence in protected areas:

Sulawesi

Dumoga-Bone National Park

Summary of threats:

- Lack of information on status.

Recommended action:

- Survey to assess status, particularly in protected areas.

H. w. negrosensis

Priority Grade: 4 (Vulnerable).

Distribution: Philippines (Negros).

Status: Typical capture rates in habitats where it was most common were about one animal for every 10 net-nights (Heaney *et al.*, 1989; Heideman and Heaney, 1989). Heideman and Heaney (1989) estimated a density of about one individual for every 1.4 ha in the Balinsasayao submontane forest region.

Uses clearings as flyways, and tolerates low levels of disturbance. However, it seems to be intolerant of complete forest removal, and does not persist in agricultural or urban areas. It is not threatened by hunting, but by habitat destruction.

Ecology: Occurs at maximum density in lower montane forest (Heaney *et al.*, 1989). Is relatively rare or absent from upper mossy forest, and requires primary forest or lightly disturbed forest in good condition to maintain populations (Heaney *et al.*, 1989; Heideman and Heaney, 1989). Will venture short distances across cleared areas to feed, but has never been taken more than a few km from good forest.

Feeds most heavily on the bright red fruits of the vine-forming pandans (**Pandanaceae:** *Freycinetia* spp.) that are present in virtually all primary forest, and are most abundant in montane forest (Heaney *et al.*, 1989). The diet also includes species of *Ficus* (Moraceae).

Probably forages primarily in the canopy and upper portion of the subcanopy. Many of the captures were in open areas on ridgetops or along roads, although some were captured on densely vegetated ridgetops in primary forest. Evidence suggests that it has a moderately large home range (Heideman and Heaney, 1989).

Population biology: There appear to be two synchronous birth periods, one in January and early February (mid-rainy season) and the second in July and early August (early rainy season; Heideman, 1987). Gestation is about 4-5 months and lactation 3-4 months. Most females apparently have two young per year, but at least a few females fail to produce young during the January/February birth period. Some females give birth for the first time at the age of one year (Heideman, 1987).

Summary of threats:

- Deforestation.

Recommended action:

- The protection of montane forests is the most effective way to protect populations of these bats. Some populations will probably persist as long as relatively lightly-disturbed forests remain at middle elevations (i.e., montane and upper lowland

forest, typically at 600 m to 1400 m elevation).

Principal authors for this subspecies: P. D. Heideman, L. R. Heaney.

H. w. whiteheadi

Priority Grade: 10 (No Data).

Distribution: Philippines (Biliran, Camiguin, Leyte, Maripipi, Mindanao, Mindoro).

Status: On Leyte, occurs at maximum density in lower montane forest (Heaney *et al.*, 1989). Is relatively rare or absent from upper mossy forest, and requires primary forest or lightly disturbed forest in good condition to maintain populations (Heaney *et al.*, 1989; Heideman and Heaney, 1989).

For threats see *H. w. negrosensis*.

Ecology: See *H. w. negrosensis*.

Population biology: See *H. w. negrosensis*.

Summary of threats:

- Deforestation.

Recommended action:

- Protection of montane forests (see *H. w. negrosensis*).

Principal authors for this subspecies: P. D. Heideman, L. R. Heaney.

Genus *Hypsignathus* (1 species)*Hypsignathus monstrosus*
Hammer-headed fruit bat

Priority Grade: 11 (Not Threatened).

Distribution: Angola; Burkina Faso; Cameroun; Central African Republic; Congo; Equatorial Guinea (Bioko, Mbini); Gabon; ?Gambia; Ghana; Ivory Coast; Kenya; Liberia; Nigeria; Sierra Leone; Sudan; Togo; Uganda; Zaire.

Status: Unknown, but said to be common and widespread throughout forested Africa (Rosevear, 1965). It will be threatened by deforestation.

Ecology: Is a species of moist forest but has occasionally been found outside the original west and central African rain forest blocks. Occurs in both wetter and drier types of the Guineo-Congolian lowland rain forest, in the mosaic of both, in the swamp forest and in the mosaic of swamp forest with lowland rain forest (Bergmans, 1989).

Feeds on the following plants (Lang and Chapin, 1917;

Rosevear, 1965; Brosset, 1966a; Kingdon, 1974; Bradbury, 1977; Thomas, 1982; Happold, 1987; Fujita and Tuttle, 1991): **Anacardiaceae:** *Mangifera indica* (FR); **Annonaceae:** *Annona* spp. (FR); **Bombacaceae:** *Ceiba* sp.; **Cecropiaceae:** *Musanga cecropioides* (FR); **Loganiaceae:** *Anthocleista* sp. (FR); **Moraceae:** *Chlorophora* sp., *Ficus lyrata* (FR), *F. ovata* (FR), *F. scott-elliotti* (FR); **Musaceae:** *Musa* spp. (FL); **Myrtaceae:** *Psidium guajava* (FR); **Passifloraceae:** *Adenia cissampeloides* (FR); **Solanaceae:** *Solanum* spp. (FR).

Rosevear (1965) noted that this species, along with Franquet's epauletted bat (*Epomops franqueti*), is a considered great nocturnal pest.

Population biology: Most available data (from Zaire, Uganda, Cameroun, Liberia and Gabon) points to a bimodally polyoestrus breeding pattern. The data from Ghana is inconclusive, but suggests births taking place from July to September.

Bradbury (1977), working in Gabon, found two copulation periods, one in July to August, and the other December to February with births occurring in December to February and July to August. Exhibits a classical lek mating system, with traditional arena locations, highly ritualized male displays, extreme skew in mating success among males and the existence of mating centres on lek sites.

In Liberia, Wolton *et al.* (1982), inferred from a small sample size that there are two birth peaks, a pronounced one in August/September (mid-rains) and possibly a second peak at the end of the rains (October/December). This differs from Bradbury's (1977) findings that the two birth peaks were timed to coincide with the two dry seasons in Gabon. Growth of the young is fairly slow, with males reaching adult body size at 12-18 months and females at 6-7 months (Happold, 1987).

Occurrence in protected areas:

Congo

Parc National d'Odzala

Ivory Coast

Tai National Park

Summary of threats:

- Deforestation.

Recommended action:

- Investigate the possibility of designating a forest reserve in an optimum region (possibly Cameroun) where traditional lek arenas exist and there is a viable breeding population. This proposal might also be applied to Gabon where data exist that would facilitate the project (Bradbury, 1977).

Principal authors for this species: W. Bergmans, S. Sowler.

Genus *Latidens* (1 species)

Latidens salimalii

Priority Grade: 5 (Rare: Limited Distribution).

Distribution: India (Madurai District).

Status: Has not been recorded since its description by Thonglongya (1972). The type specimen was collected in 1948, but was incorrectly identified as *Cynopterus sphinx*.

Summary of threats:

- Lack of information on status.

Recommended action:

- Survey to assess status, particularly in protected areas.

Genus *Macroglossus* (2 species)

Macroglossus minimus

Priority Grade: 11 (Not Threatened).

Number of subspecies: 5.

M. m. lagochilus

Dagger-toothed flower bat

Priority Grade: 11 (Not Threatened).

Distribution: Ambon; Banda Islands; Borneo (Brunei, East, South and West Kalimantan, Sabah, Sarawak); Buru; Natuna Islands (?Bunguran Besar, Serasan); Nias; Peleng; Peninsular Malaysia (including islands of Langkawi, Sri Buat and Tioman); Philippines (Cagayan Sulu, Cuyo, Mindanao, Negros, Panay, Samar, Tablas); Sangir Islands (Sangir); Seram; Singapore; Sulawesi; south Thailand; Timor; Vietnam.

Status: **Borneo** Recorded from most areas including Kota Kinabalu, the Wittti Range, Sepilok, Sukau and Tawau in Sabah; near Bandar Seri Begawan in Brunei; the Kelabit Uplands, Niah and Bako in Sarawak; Gunung Kenepai in West Kalimantan; near Kutai in East Kalimantan; upper Sungai Tengah in South Kalimantan (Payne *et al.*, 1985).

Peninsular Malaysia Widespread in the coastal lowlands and mangrove. Also recorded from the islands of Sri Buat (Johore), Tioman and Langkawi (Medway, 1978).

Philippines Most commonly recorded from habitats that have suffered disturbance either through natural causes (e.g., landslides, treefalls, river courses) or human activities (e.g., orchards and gardens). Sometimes the most regularly recorded bat in such sites (Heaney *et al.*, 1981, 1989; Heideman and Heaney, 1989). Uncommon in other habitats. Disturbed sites are colonized by wild banana (**Musaceae:** *Musa sapientum*) and

abaca (*Musa textilis*), which presumably provide abundant food. In disturbed habitats it typically made up 5-20% of total captures (Guererro and Alcalá, 1973; Heaney *et al.*, 1989; Heideman and Heaney, 1989).

Heideman and Heaney (1989) estimated a density of about 2 bats per ha in the Balinsasayao region of Negros. This area had been about 15-30% deforested at the time of the study, and held abundant wild bananas and planted abaca in the small clearings.

Thailand Only recorded from Chantaburi Province in the south-east (Yenbutra and Felten, 1986).

Vietnam Recorded from Con Son and the Provinces of Gia Dinh, Long Kranh and Tuyen Doc (Van Peenen, 1969).

Not threatened by habitat destruction. Although it cannot use areas planted with most field crops, it can utilize small areas that have been planted with trees that produce nectar or pollen on which it can feed. It is too small and inconspicuous to be attractive to hunters.

Ecology: In the Philippines, occurs from sea-level to at least 1500 m. It uses a wider range of habitats than any other fruit bat species in the Philippines, from urban orchards at sea-level to mossy forest (Heaney *et al.*, 1989).

In the Philippines, can very occasionally be found roosting beneath the dead leaves of banana. Usually only a single individual or a mother with a single young are found at the roost site. Start (1974) and Start and Marshall (1976) reported that Peninsular Malaysian animals roosted either alone or in small groups in palms, bananas or other trees in the vicinity of their major food source, such as *Sonneratia* spp. (**Sonneratiaceae**).

Feeds on the flowers of the following plants (Start and Marshall, 1976; Fujita and Tuttle, 1991): **Anacardiaceae:** *Mangifera* sp.; **Bombacaceae:** *Ceiba pentandra*, *Durio zibethinus*; **Flacourtiaceae:** *Muntingia* sp.; **Musaceae:** *Musa* spp.; **Myrtaceae:** *Eugenia malaccensis*, *Syzygium malaccense*; **Palmae:** *Cocos nucifera*; **Rhizophoraceae:** *Rhizophora* spp.; **Sonneratiaceae:** *Sonneratia alba*, *S. caseolaris*, *S. ovata*.

Of these, the most important are cultivated bananas, coconut (*Cocos nucifera*) and two species of mangroves (*Sonneratia alba*, and *S. caseolaris*). In Peninsular Malaysia, is most abundant in mangrove areas, in which it feeds upon all chiropterophilous plants present (Start and Marshall, 1976); in the wider range of habitats used in the Philippines, the diet composition is somewhat broader. In disturbed forest habitats on Negros, it almost certainly feeds heavily on chiropterophilous *Musa* (those with pendulous inflorescences; Start and Marshall, 1976).

Feeds in much the same way as *Eonycteris spelaea*, landing on inflorescences and using its long tongue to pick up nectar and pollen, and to groom pollen from its fur (Start and Marshall, 1976; Gould, 1978). Flies in the subcanopy and readily crosses open areas.

In the Balinsasayao region of Negros, typical movements between captures were about 250 m with a maximum of 750 m (Heideman and Heaney, 1989), although sample sizes were small and re-captures rare. An upland population in mixed

agricultural land and patches of riverine forest in Peninsular Malaysia foraged solitarily and travelled up to 2 km to feed (Start and Marshall, 1976).

Population biology: In the Philippines, apparently reproduces aseasonally (Heideman, 1987). Evidence suggests that females produce a second young very soon after weaning the current one as a result of a post-partum oestrus. Most females probably produce two young per year in the Philippines, very rarely only one, and a few probably manage three births within 12 months in some years.

Start (1974) found that one of the two populations he studied in Malaysia reproduced aseasonally, but data for the second population strongly suggested seasonal reproduction. He estimated a gestation of 120 +/- 10 days, a lactation of 60-70 days, and an interval between successive pregnancies of 140-160 days.

Low long-term recapture rates in the Balinsasayao forests on Negros (Heideman and Heaney, 1989) imply relatively low survivorship (perhaps 40-50% annual survivorship for adults). However, the low recapture rates could be due to the disappearance of bats from the study area due to migration rather than mortality.

Occurrence in protected areas:

Sulawesi

Dumoga-Bone National Park

Summary of threats:

- No major threats.

Recommended action:

- Surveys to assess status, particularly in protected areas, in Ambon, the Banda Islands, Buru, the Natuna Islands, Nias, Peleng, Sangir Islands, Seram, Singapore, Sulawesi, and Timor.

Principal authors for this subspecies: P. D. Heideman, L. R. Heaney.

M. m. microtus

Priority Grade: 10 (No Data).

Distribution: Bougainville; the D'Entrecasteaux Islands (Fergusson Island); Solomon Islands (Choiseul, Fauro, Guadalcanal, Kolombangara, Malaita, Nggela Sule, San Cristobal, Santa Isabel, Vella Lavella).

Ecology: Collected on Bougainville in both primary and secondary rain forest up to an altitude of 1155 m (Strahan, 1983).

Summary of threats:

- Lack of information on status.

Recommended action:

- Surveys to assess status, particularly in protected areas.

M. m. minimus

Common long-tongued fruit bat

Priority Grade: 10 (No Data).

Distribution: Bali; Jawa; Kangean Islands; Lombok; Madura.

Ecology: Kitchener *et al.* (1990) mist-netted 29 individuals on Lombok in October 1987. Roughly equal numbers were found at locations ranging from 50–400 m altitude. Most were captured among banana (**Musaceae:** *Musa* spp.) plantations but three were captured along a track in dense primary rain forest at Suranadi. Others were mist-netted over water courses at Pelangan and Batu Koq, but none was collected at a coastal site at Desa Kuta.

Population biology: Kitchener *et al.* (1990) reported that only three of the 13 females, all apparently adult, collected on Lombok in late September and October, 1987 showed any indication of reproductive activity. The single female collected on Lombok in May 1988 was pregnant but not lactating.

Summary of threats:

- Lack of information on status.

Recommended action:

- Surveys to assess status, particularly in protected areas.

M. m. nanus

Northern blossom bat

Priority Grade: 11 (Not Threatened).

Distribution: Aru Islands; Bismarck Archipelago (Admiralty Islands, New Britain); Kai Islands; Misool; New Guinea.

Status: New Guinea Common (Flannery, 1990). Widespread in lowland New Guinea. At some localities it is more common than *Syconycteris australis*, although it is usually much rarer. With increasing altitude it becomes increasingly rare relative to *S. australis*. The exception to this is in the Munbil area of the Star Mountains, where *M. m. nanus* was not much rarer than *S. australis* at 1000 m.

Ecology: In New Guinea, occurs in a variety of forested areas including rain forest, sago palm swamp (**Palmae:** *Metroxylon* spp.), mangroves and paperbark woodland (**Myrtaceae:** *Melaleuca* spp.) at altitudes ranging from sea-level to 260 m.

Roosts singly or in small groups in the canopy of large-leafed palms and trees and in the roofs of disused buildings (McKean, 1983).

Undoubtedly a nectar feeder; specimens taken from New Guinea lacked fruit in the stomach (McKean, 1983) and captive

individuals refuse to eat fruit. Stomach contents contained pollen grains and occasional (probably accidentally ingested) insect remains (McKean, 1983).

Population biology: In New Guinea it is likely that births may occur at any time of year (Strahan, 1983). Hood and Smith (1989) report uterine storage of sperm in bats on New Guinea.

Summary of threats:

- No major threats.

Recommended action:

- Surveys to assess status, particularly in protected areas, in Misool, the Aru Islands, the Kai Islands and the Bismarck Archipelago.

M. m. pygmaeus

Priority Grade: 11 (Not Threatened).

Distribution: Australia (Northern Territory, Queensland [Murray Island], Western Australia).

Status: Common, although it has a limited distribution (Strahan, 1983). This species is unprotected in Western Australia.

Ecology: In northern Australia has been recorded from lowland rain forest, paperbark swamps, bamboo thickets and monsoon scrub along watercourses, and in banana plantations (**Musaceae:** *Musa* spp.) (Strahan, 1983).

Known roost sites include bamboo thickets and the rolled-up young leaves of banana plants.

Feeds actively upon two introduced plants, the sausage tree (**Bignoniaceae:** *Kigelia pinnata*), and the century plant (**Agavaceae:** *Agave americana*), both of which are pollinated by bats in their countries of origin (Strahan, 1983).

Is an important pollinator of paperbarks, particularly the night-flowering *Melaleuca cajuputi* (**Myrtaceae**) (Strahan, 1983).

Population biology: In Northern Territory, births may occur during the dry season in August and September.

Summary of threats:

- No known threats.

Recommended action:

- Survey to assess status in protected areas.

Macroglossus sobrinus

Priority Grade: 11 (Not Threatened).

Number of subspecies: 2.

M. s. fraternus

Priority Grade: 8 (No Data: Limited Distribution).

Distribution: Mentawai Islands (Siberia, Sipura).

Summary of threats:

- Lack of information on status.

Recommended action:

- Surveys to assess status, particularly in protected areas.

M. s. sobrinus

Priority Grade: 11 (Not Threatened).

Distribution: Burma; Jawa; Krakatau Islands (Krakatau); Nias; Peninsular Malaysia; Sumatra; Thailand.

Status: Jawa Very common in a garden in Jakarta in 1981 (W. Bergmans, pers. comm.).

Peninsular Malaysia Occurs from sea-level up to at least 1800 m. Is rarely recorded in mangroves but is present regularly in lowland and montane forest. Lim (1966) collected most specimens in montane forest, but found it could be locally common in lowlands, old fruit orchards and villages with bamboo.

Thailand Recorded throughout with records from the following provinces: Mae Hong So, Chiang Mai, Chiang Rai, Phetchabun, Nakhon Ratchasima, Uthai Thani, Chanthaburi, Ranong, Surat Thani, Trang, Satun, Songkhla, Pattani and Yala (Lekagul and McNeely, 1977; Yenbutra and Felten, 1986).



Macroglossus sobrinus (Photo by K-G. Heller)

Ecology: In Peninsular Malaysia, roosts singly or in small groups of up to 10 under branches, under roofing near forest, in palm tree crowns, and occasionally in rolled young banana leaves (**Musaceae:** *Musa* spp.) where it competes for sites with *Myotis* spp.

In Peninsular Malaysia, feeds on the pollen and nectar of three species of wild bananas, and some soft fruit. Fujita and Tuttle (pers. comm.) noted that it had also been recorded feeding on the flowers of *Duabanga grandiflora* (**Sonneratiaceae**) in Malaya.

Start (1974) estimated that an adult *M. sobrinus* could survive on the nectar and pollen output of about two or three flowering *Musa* spp., each of which may flower for up to 5 months. This suggested that home ranges could be very small and/or population density very high where *Musa* spp. are dense. At a site in Peninsular Malaysia where *Musa* spp. were scattered in small clusters, Start (1974) found typical movements of about 1-2 km. It appeared that individuals foraged singly or in pairs of a mother and her young (Start and Marshall, 1976). Individuals may be trapline foragers (Gould, 1978), following set routes from plant to plant on successive nights.

Population biology: In Thailand, probably breeds throughout the year (Lekagul and McNeely, 1977).

Occurrence in protected areas:

Peninsular Malaysia

Pasoh Forest Reserve
Taman Negara

Summary of threats:

- Unknown.

Recommended action:

- Surveys to assess status, particularly in protected areas, in Burma, Sumatra, Nias, Krakatau Islands and Jawa.

Principal author for this subspecies: G. W. H. Davison.

Genus *Megaerops* (4 species)

Megaerops ecaudatus
Tail-less fruit bat

Priority Grade: 11 (Not Threatened).

Distribution: Borneo (Brunei, East and West Kalimantan, Sabah, Sarawak); Peninsular Malaysia; west Sumatra; Thailand; Vietnam.

Status: **Borneo** Has been netted mainly in tall forest, and recorded from Gunung Kinabalu (up to 1500 m), Danum, Tawau and Tenom in Sabah; upper Sungai Temburong and Tasik Merimbun in Brunei; the Kelabit Uplands in Sarawak;

Sungai Kapuas in West Kalimantan; and the Kutai district in East Kalimantan (Payne *et al.*, 1985).

Peninsular Malaysia Occurs from sea-level up to the mountain tops at about 1800 m. Found in forest or dense vegetation and open country (Medway, 1978). Generally found singly and is widespread, although the population density is low. Recent studies in Kuala Lumpur suggest this species may be fairly common in the canopy of lowland forest (C.M. Francis, pers. comm.).

Thailand Found throughout Thailand with records from the following provinces: NakhonRatchisima; Ranong; Surat Thani; Satun; Songkhla and Yala (Lekagul and McNeely, 1977; Yenbutra and Felten, 1986).

Vietnam Recorded from the provinces of Khanh Hoa, Kontum, Long Khanh and Ninh Thuan (Van Peenen, 1969).

Ecology: Feeds on figs (**Moraceae:** *Ficus* spp.).

Population biology: There is an extended breeding season in the early months of the year (Medway, 1983), with about 50% of females pregnant in February and other pregnancies recorded in June, at least in the Cameron Highlands in Peninsular Malaysia.

Occurrence in protected areas:

Borneo

Brunei

Temburong National Park

Sabah

Kinabalu Park

Sepilok Forest Reserve

Peninsular Malaysia

Krau Game Reserve

Taman Negara

Summary of threats:

- Unknown.

Recommended action:

- Survey to assess status, particularly in protected areas, in Sumatra.
- More studies on feeding ecology and population biology.

Principal author for this species: G. W. H. Davison.

Megaerops kusnotoi Javan tail-less fruit bat

Priority Grade: 6 (Rare).

Distribution: Jawa.

Status: Rare (A. Suyanto and D. Kitchener, pers. comm.).

Summary of threats:

- Lack of information on status and threats.

Recommended action:

- Survey to assess status, particularly in protected areas - also identify any threats.

Megaerops niphanae

Priority Grade: 10 (No Data).

Distribution: North-east India; Thailand; and Vietnam.

Summary of threats:

- Lack of information on status.

Recommended action:

- Surveys to assess status, particularly in protected areas.

Megaerops wetmorei

Priority Grade: 11 (Not Threatened).

Number of subspecies: 2.

M. w. albicollis

Priority Grade: 9 (Indeterminate).

Distribution: Borneo (Brunei); south Peninsular Malaysia.

Status: Borneo Records are from the extreme lowlands. This habitat is under greatest threat from development.

Peninsular Malaysia The first record was from Pasoh Forest Reserve, an area of primary lowland dipterocarp forest in the extreme lowlands. Several further individuals have been netted in the canopy of lowland forest in the Krau Game Reserve (C. M. Francis, pers. comm.).

Occurrence in protected areas:

Peninsular Malaysia

Krau Game Reserve

Pasoh Forest Reserve

Summary of threats:

- Deforestation in the extreme lowlands.
- Lack of information on status.

Recommended action:

- Measures need to be taken to control the continued development of lowland forest areas, including educational programmes.
- Surveys to assess status, particularly in protected areas.

M. w. wetmorei

Priority Grade: 10 (No Data).

Distribution: Philippines (Mindanao).

Ecology: Probably limited to primary forest (Heaney *et al.*, 1989).

Summary of threats:

- Lack of information on status.

Recommended action:

- Survey to assess status, particularly in protected areas, and habitat usage.

Genus *Megaloglossus* (1 species)

Megaloglossus woermanni

African long-tongued fruit bat, Woermann's bat

Priority Grade: 11 (Not Threatened).

The subspecies *prigoginei* has been proposed (Hayman (1966) in Hayman *et al.*, 1966) to separate specimens from north-east Zaire and 'West Africa', on the basis of size. Bergmans and Van Bree (1972) found indications of a clinal size variation and rejected subspecific divisions. This conclusion had been anticipated by Hayman and Hill (1971).

Distribution: Angola; Cameroun; Central African Republic; Congo; Equatorial Guinea (Bioko, Mbinu); Gabon; Ghana; Guinea; Ivory Coast; Liberia; Nigeria; Togo; Uganda; Zaire.

Status: Not known. Rosevear (1965) believed that it was probably not very common. Threatened by deforestation.

Ecology: Is a lowland forest species. In Nigeria, most of the specimens were taken in the lower strata of the rain forest or in forest clearings (Happold, 1987). In other parts of Africa, recorded from banana plantations, close to cultivated areas, and over water (Brosset, 1966b; Jones, 1971).

Appears to be solitary, but may congregate at suitable flowering trees. In Gabon (Brosset, 1966b) and Ghana (Jeffrey, 1975) groups of males alone have been recorded, and at other times and places, males and females have been found together; this seems to suggest a rather well defined social organization with segregation of the sexes at certain times of year (Happold, 1987).

There is very little direct evidence that this species is predominantly a nectar feeder, as some have thought. It has been suggested that it feeds on the flowers of the following plants (Kock, 1972; Jeffrey, 1975; Dobat and Peikert-Holle, 1985): **Bignoniaceae:** *Crescentia cujete*, *Kigelia* sp.; **Caricaceae:** *Carica papaya*; **Convolvulaceae:** *Ipomoea*

albivenia; **Leguminosae:** *Mucuna flagellipes*, *Parkia bicolor*; **Musaceae:** *Musa* sp.

In Nigeria, is found in the rain forest where flowers are present throughout most of the year; even so, may be nomadic or even make seasonal migrations to find flowering trees (Happold, 1987).

Population biology: From specimens caught in Rio Muni (Equatorial Guinea) and Ghana (Jones, 1971) and in Congo (Adam and Le Pont, 1974; Bergmans, 1979) the reproductive pattern is either seasonally polyoestrus with two breeding seasons a year, or aseasonally polyoestrus. If the former is true, births occur in March/April and September/October. However, the sample size is only seven. In Liberia, Wolton *et al.* (1982), also from a small sample, suggested that the species would appear not to have a well defined breeding season.

Summary of threats:

- Deforestation.

Recommended action:

- Its occurrence in protected areas should be assessed, and its biology studied.

Principal authors for this species: W. Bergmans, S. Sowler.

Genus *Melonycteris* (3 species)

An undescribed and highly endangered *Melonycteris* species occurs on Malaita and San Cristobal in the Solomon Islands (T. Flannery, pers. comm.).

Melonycteris aurantius
Orange fruit bat

T. Flannery (pers. comm.) considers *M. aurantius* to be a subspecies of *M. woodfordi*.

Priority Grade: 8 (No Data: Limited Distribution).

Distribution: Solomon Islands (Choiseul, Nggela Sule).

Status: Probably rare (T. Flannery and L. Seri, pers. comm.).

Summary of threats:

- Lack of information on status.

Recommended action:

- Surveys to assess status, particularly in protected areas.

Melonycteris melanops
Black-bellied fruit bat

Priority Grade: 11 (Not Threatened).

Distribution: Bismarck Archipelago (Duke of York, New Britain, New Ireland); ?New Guinea.

Status: Probably common (T. Flannery and L. Seri, pers. comm.).

Summary of threats:

- Lack of information on status.

Recommended action:

- Surveys to assess status, particularly in protected areas.

Melonycteris woodfordi
Woodford's fruit bat

Priority Grade: 11 (Not Threatened).

Distribution: Bougainville; Solomon Islands (Alu, Choiseul, Fauro, Guadalcanal, Russell Islands [Pavuvu]).

Status: Abundant (T. Flannery and L. Seri, pers. comm.).

Ecology: Kress (1985) recorded feeding at flowers of *Heliconia solomonensis* (**Heliconiaceae**).

Summary of threats:

- No known threats.

Recommended action:

- Surveys to assess status in protected areas.

Genus *Micropteropus* (2 species)

Micropteropus intermedius
Hayman's epauletted fruit bat

Priority Grade: 6 (Rare).

Distribution: Angola; south-west Zaire.

Status: Known from only four specimens; one from Dundo, Angola, one from Luluabourg, Zaire, one from Banana/Netonna, and one from Thysville, Zaire (Bergmans, 1989).

Population biology: The type specimen from Dundo was pregnant at the time of capture (June/July) (Bergmans, 1989).

Occurrence in protected areas: Not known to occur in any protected areas.

Summary of threats:

- Lack of information on status.

Recommended action:

- Surveys to assess status, particularly in protected areas.

Principal authors for this species: W. Bergmans, S. Sowler.

Micropteropus pustilus
Peters' dwarf epauletted fruit bat

Priority Grade: 11 (Not Threatened).

Distribution: Angola; Benin; Burkina Faso; Burundi; Cameroun; Central African Republic; Chad; Congo; Equatorial Guinea (Mbini); Ethiopia; Gabon; Gambia; Ghana; Guinea; Guinea-Bissau; Ivory Coast; Kenya; Liberia; Mali; Nigeria; Senegal; Sierra Leone; Sudan; Tanzania; Togo; Uganda; north-east, south-east and south-west Zaire; Zambia.

Status: General status unknown, but locally common. In Nigeria, common, often occurring in large numbers at fruiting trees (Happold, 1987).

Ecology: In the north remains within the northern limit of the east-west belt of Sudanian and Ethiopian woodlands. In West Africa some localities approach the latitude of 14°N, but in Sudan and Ethiopia it is not known from north of 11°N. The eastern limit of the range appears to be set by the Ethiopian highlands. These are only penetrated by low-lying river valleys on the western side and by the central rift valley in the south, where the only known collecting locality is also the easternmost point of the distribution. In the southern part of the range it remains within the North Zambesian woodland in north-west Angola, central and southern Zaire and on the north-west Zambian border (Bergmans, 1989).

Feeds on the following plants (Harris and Baker, 1959; Green, 1983; Dobat and Peikert-Holle, 1985; Happold, 1987; Fujita and Tuttle, 1991): **Anacardiaceae:** *Anacardium occidentale* (FL); **Annonaceae:** *Annona chrysophila* (FR), *A. senegalensis* (FR); **Bignoniaceae:** *Kigelia pinnata* (FL), *Spathodea campanulata* (FL); **Bombacaceae:** *Adansonia digitata* (FL), *Ceiba pentandra* (FL); **Chrysobalanaceae:** *Maranthes polyandra* (FL), *Parinari polyandra* (FL); **Leguminosae:** *Parkia clappertoniana* (FL), *P. roxburghii* (FL); **Moraceae:** *Ficus capensis* (FR); **Myrtaceae:** *Psidium guajava* (FR); **Sapotaceae:** *Vitellaria parkii* (FR).

In Nigeria, occurs in widely scattered localities, and may be very abundant when it congregates to feed on flowering and fruiting trees (Happold, 1987). Nomadic, and in any particular locality numbers fluctuate depending on the availability of food. Feeds on smaller, and perhaps softer, fruits than do the large fruitbats. In addition, also feeds on nectar, and, like *Epomophorus gambianus*, pollinates the flowers of sausage trees (*Kigelia pinnata*) (Baker and Harris, 1957; Harris and Baker, 1958). Sausage tree flowers hang on thick stalks and have deep, wide

corollas; when a bat alights on the lip of the flower, it pushes its head into the corolla to reach the nectar, and, in doing so, covers the top of its head and shoulders with pollen (Baker and Harris, 1957; Harris and Baker, 1958).

Population biology: Verschuren (1957) working in north-east Zaire, suggested a bimodal pattern of births during November/December and in late February. In Rio Muni (Equatorial Guinea), Jones (1972) suggested breeding occurs throughout the year but mostly in March/April and again in November. Bergmans (1979) reported that in Congo a bimodal pattern occurred with births in September and January/February. In Ghana, births occurred at the beginning and end of the rains in April and the beginning of September (Marshall and McWilliam, 1982). A similar pattern was recorded in the Ivory Coast with births at the beginning and end of the rainy season in April and October (Thomas and Marshall, 1984). It may therefore be concluded that *M. pusillus* is bimodally polyoestrus with a 5-6 month gestation.

Occurrence in protected areas:

Angola

Reserva do Luando

Burkina Faso

Po National Park

Ghana

Mole National Park

Nigeria

Kainji Lake National Park
Olokomeji Forest Reserve
Pandam Wildlife Park

Zaire

Parc National de Virunga
Parc National de la Garamba
Parc National de l'Upemba

Summary of threats:

- No significant threats.

Recommended action:

- Assessment of conservation requirements could be undertaken while working on other, already threatened or endangered species to determine if populations in protected areas are self-sustaining and sufficiently large to survive. Also studies of movements/migration.

Principal authors for this species: W. Bergmans, S. Sowler.

Genus *Myonycteris* (3 species)

***Myonycteris brachycephala*
São Tomé collared fruit bat**

Priority Grade: 3 (Vulnerable: Limited Distribution).

Distribution: São Tomé and Príncipe (São Tomé).

Status: A forest species threatened by habitat destruction. Little forest seems to be left on São Tomé (A. Feiler, pers. comm.). Untouched rain forests remain at high altitudes in the centre and south-west of the island (Imboden, 1987; Anon., 1988a). New specimens have been collected from more than one locality on the island by a Spanish expedition though data from these are not yet published.

Occurrence in protected areas: There are no protected areas on São Tomé.

Summary of threats:

- Deforestation.

Recommended action:

- Virtually nothing is known of the present distribution, biology and ecology of this species. These fundamental data are necessary for an assessment of its chances of survival.

Principal authors for this species: W. Bergmans, S. Sowler.

***Myonycteris relicta*
East African collared fruit bat**

Priority Grade: 3 (Vulnerable: Limited Distribution).

Distribution: Kenya; Tanzania.

Status: Its known range is the coastal Shimba Forest of south-east Kenya and east Tanzania in Pangani, Bagamoya, Kisarawe and Rufiji districts south-westwards to the east slope of the Uzungwa mountains (K. M. Howell and D. Kock, pers. comm.). It may occur in other forested areas in East Africa (Bergmans, 1980; Schlitter and McClaren, 1981). Status is unknown but as the pressure on the remaining forests in East Africa is very high, should probably be regarded as seriously threatened.

Threatened by habitat degradation, even in the protected Shimba Hills National Reserve, and also by habitat destruction, as in large parts of the Usambaras.

Ecology: Essentially a lowland forest inhabitant, known to occur from below 200 m (the type locality) up to about 900 m (Nguru Mountains). Most lowland fruit bats may still be found at 1500 m, and some even higher.

Occurrence in protected areas:

Kenya

Shimba Hills National Reserve

Summary of threats:

- Deforestation.

Recommended action:

- Assessment of occurrence of viable populations in protected areas.
- Gazetting of other protected areas, e.g., in the Usambaras, to protect this and other near-endemics.
- Research to determine its food preferences, habitat requirements and reproductive pattern.

Principal authors for this species: W. Bergmans, S. Sowler.

Myonycteris torquata Little collared fruit bat

Priority Grade: 11 (Not Threatened).

Distribution: Angola; Cameroun; Central African Republic; Congo; Equatorial Guinea (Bioko, Mbini); Gabon; Ghana; Guinea; Ivory Coast; Liberia; Nigeria; Sierra Leone; Togo; Uganda; north-east Zaire; Zambia.

Status: In Nigeria, considered to be the rarest fruit bat, known from only two localities (Happold, 1987). Apparently not uncommon locally, but as a forest species is certainly threatened by habitat destruction and degradation.

Ecology: Recorded from moist forest at low and medium altitudes and surrounding forest-savannah mosaics and woodland-savannah mosaics. In Nigeria, appears to be solitary, living mostly in the rain forest zone or near the forest-savannah boundary (Happold, 1987).

Probably roosts in trees, although one individual in Gabon (Brosset, 1966b) roosted in gaps between the leaves of a banana plant (**Musaceae:** *Musa* sp.) about 5 m above the ground.

Observed eating bananas (Brosset, 1966b). Has been caught near these and near guavas (**Myrtaceae:** *Psidium guajava*) and mangoes (**Anacardiaceae:** *Mangifera indica*). Dobat and Peikert-Holle (1985) report on possible visiting of flowers of *Spathodea campanulata* (**Bignoniaceae**), *Ceiba pentandra* (**Bombacaceae**) and *Parkia roxburghii* (**Leguminosae**).

Population biology: In Liberia, Wolton *et al.* (1982) reported an extended breeding season, beginning in July and continuing well into the dry season (at least until March), with most females giving birth in September at the peak of the rains. Thomas (1983) working in the Ivory Coast, recorded two birth periods: one in February/March and the other in September/October. Brosset (1966b) reported that in Gabon, births occur twice a year, in June and in December/January, in captivity. In the wild,



Myonycteris torquata (Photo by K-G. Heller)

he caught either pregnant or lactating females from November to March, but sexually inactive females in June and July. Anciaux de Faveaux (1972) postulated a reproductive cycle extending from September to May for Cameroun to Congo, with copulations around September, births in December/January and lactation to May.

Occurrence in protected areas:

Ghana

Mole National Park

Congo

Parc National d'Odzala

Zaire

Parc National de la Garamba

Summary of threats:

- Deforestation.

Recommended action:

- Further assessment of occurrence in protected areas, and migratory habits (established by Thomas [1983] in Ivory Coast, but probably less likely in all-forested regions) and of the viability of populations in such areas.

Principal authors for this species: W. Bergmans, S. Sowler.

Genus *Nanonycteris* (1 species)

Nanonycteris veldkampii
Veldkamp's dwarf epauletted bat

Priority Grade: 11 (Not Threatened).

Distribution: Cameroun; Central African Republic; Ghana; Guinea; Ivory Coast; Liberia; Nigeria; Sierra Leone; Togo. Previous records from Zaire or Congo are incorrect (Bergmans, 1989).

Status: Apparently not uncommon locally, but as a predominantly West African forest species is no doubt suffering from large scale deforestation. In Ghana is abundant in the forest zone in the dry season and migrates into the southern Sudan savannah in the rainy season (Thomas, 1983). Even if part of the year is spent outside the forest zone, as in Ghana (Thomas, 1983) and very likely also elsewhere (Bergmans, 1989), this habitat is essential for this species.

Ecology: A forest and savannah species. Feeds on the following plants (Harris and Baker, 1959; Ayensu, 1974; Dobat and Peikert-Holle, 1985; Fedden and Macleod, 1986; Fujita and Tuttle, 1991): **Bignoniaceae:** *Kigelia* sp. (FL); **Bombacaceae:** *Adansonia digitata* (FL), *Ceiba pentandra* (FL); **Caricaceae:** *Carica papaya* (FR); **Chrysobalanaceae:** *Parinari polyandra* (FL); **Leguminosae:** *Eperua falcata*, *Mucuna flagellipes* (FL), *Parkia clappertoniana* (FL), *P. roxburghii* (FL); **Moraceae:** *Ficus umbellata* (FR); **Myrtaceae:** *Psidium guajava* (FR); **Proteaceae:** *Protea ellioti* (FL); **Sapotaceae:** *Vitellaria parkii* (FR).

Population biology: Marshall and McWilliam (1982), working in Ghana, postulated polyoestry, with an extended period of parturition synchronized with the early rains, probably in May and June. Data collected in the Mount Nimba region in Liberia by J. Verschuren and M. J. Coe (*in: Wolton et al.*, 1982) appear to support this, as do data from Cameroun.

Occurrence in protected areas:**Ghana**

Mole National Park

Nigeria

Igangan National Park

Pandam Wildlife Park
Sapoba Forest Reserve

Summary of threats:

- Deforestation.

Recommended action

- Because the species is migratory, at least in part of its range, it is important to survey protected areas in both the forest and savannah zones.

Principal authors for this species: W. Bergmans, S. Sowler.

Genus *Neopteryx* (1 species)

Neopteryx frosti
Small-toothed fruit bat

Priority Grade: 5 (Rare: Limited Distribution).

Distribution: North and west Sulawesi.

Status: Hunted for food in north Sulawesi (Bergmans and Rozendaal, 1988).

Ecology: Specimens were caught simultaneously in three mist-nets set over Sungai Tumpah, which runs through lowland primary rain forest (Bergmans and Rozendaal, 1988).

Population biology: A female caught in March was carrying an embryo (Bergmans and Rozendaal, 1988).

Occurrence in protected areas:**Sulawesi**

Dumoga-Bone National Park

Summary of threats:

- Lack of information on status.

Recommended action:

- Survey to assess status, particularly in protected areas.
- Assess possible threat from hunting.

Genus *Notopteris* (1 species)

Notopteris macdonaldii
Long-tailed fruit bat

Priority Grade: 9 (Indeterminate).

Number of subspecies: 2. There are two recognized subspecies, *N. m. macdonaldii* in Fiji and Vanuatu and the smaller *N. m. neocaledonica* in New Caledonia (Sanborn and Nicholson,

1950). Some specimens bridge the size gap, but populations in different island groups are presumably isolated. Andersen (1912) noted specimens of *N. m. macdonaldii* reported to be from Pohnpei, Federated States of Micronesia, by Jentink, but questions the locality. As noted by Medway and Marshall (1975), given the lack of additional specimens from later work on Pohnpei, and the enormous range extension involved, this record is almost certainly erroneous.

N. m. macdonaldii

Priority Grade: 4 (Vulnerable).

Distribution: Fiji (Viti Levu); Vanuatu.

Status: Medway and Marshall (1975) recorded it from all six islands sampled in the New Hebrides in Vanuatu, from Santo in the north to Anatom in the south. All caves were close to sea-level, but animals were netted at all elevations sampled up to 1100 m. The colonies are referred to as large, but no estimates of numbers are given. Some respondents to a recent questionnaire on fruit bats in Vanuatu mentioned this bat, but it is apparently not exploited (Chambers and Esrom, 1988). Both islands (Pentecost Islands and Vanua Lava in the Banks Islands) for which Chambers and Esrom (1988) obtained local names for *Notopterus* lacked previous literature records. Both Andersen (1912) and Sanborn (1931) report specimens taken over 80 years from what is probably the same locality, Colombo Cave, near Suva, Viti Levu, Fiji. Pernetta and Watling (1978) list this bat as abundant on the large islands of Fiji.

Insufficient recent data are available to assess trends or threats. If experience with New World phyllostomid generalist nectarivores can be used as a guide, the mosaic of regenerating habitats created by periodic storm disturbance or moderate human intervention in rain-forest habitats may favour this bat. However, because it roosts in traditional well-known cave sites, it is highly vulnerable to direct exploitation for food, vandalism, repeated disturbance by guano mining or curious visitors and incidental destruction in the course of quarrying. Evidence of rapid decimation of cave-dwelling pteropodid populations is unfortunately increasingly common (Heaney and Heideman, 1987; D.J. Kitchener, pers. comm.). T. Flannery (pers. comm.) has expressed serious concern about the status of *Notopterus* in Vanuatu and New Caledonia. Recent faunal surveys, which included visits to known cave roosts, yielded no observations of *Notopterus*.

International trade in this species is regulated under wildlife laws.

Ecology: Favours lowland forest and patchy secondary forest in Fiji, rather than montane or swamp forest (Pernetta and Watling, 1978). However, D. Watling (pers. comm.) suggests tentatively that *Notopterus* is more closely associated with intact forest than disturbed habitats. Roosts in caves (see above).

Medway and Marshall (1975) noted that roosts in Vanuatu were dimly illuminated, but from Sanborn's (1931) report on

shooting bats in Colombo Cave on Viti Levu, Fiji, total darkness could be inferred. G. Graham (pers. comm.) reports roosting *Notopterus* from dark portions of a cave on Viti Levu.

Morphology (reduced dentition, elongate brush-tipped tongue) argues strongly for a nectar and pollen specialist, but data are scant. Medway and Marshall (1975) frequently netted *Notopterus* near bananas (**Musaceae:** *Musa* spp.); scratches on the bracts of bananas suggested the flowers are an important food source.

Summary of threats:

- Roost disturbance.
- Hunting.

Recommended action:

- Field surveys of distribution, abundance, utilization and ecology of *Notopterus* (simultaneously with other pteropodids) are needed for status assessment and conservation planning. If as hypothesized above, *Notopterus* will fare reasonably well in a landscape of mixed primary forest, agroforest and plantations, then its prospects for persistence are good if major roost sites can be protected. The extent of dependence on primary forest for feeding and the importance of the species as a pollinator in that community require investigation.

N. m. neocaledonica

Priority Grade: 8 (No Data: Limited Distribution).

Distribution: New Caledonia.

Status: Occurs in caves on New Caledonia. Sanborn and Nicholson (1950) found 200 bats at Hienghene and 300 at Poya. They were told that it occupied only one of several hundred caves at Poya and that it sometimes roosts in hollow trees. There is no recent information on status.

The threats this bat faces would be similar to those discussed under *N. m. macdonaldii*.

The hunting of this species is regulated under wildlife laws.

Ecology: See *N. m. macdonaldii*.

Sanborn and Nicholson (1950) observed that roosting animals on cave walls in New Caledonia were in clusters of 5-25, resembling some Microchiroptera. Males as well as females with young were taken from single clusters, so there is apparently no sexual segregation while the young are prevalent.

Population biology: Sanborn and Nicholson (1950) collected pregnant animals and young in August, suggesting a birth peak slightly earlier than *Pteropus* in New Caledonia. They reported one young per female.

Summary of threats:

- Roost disturbance.
- Hunting.

Recommended action:

- As for *N. m. macdonaldii*.

Principal author for this species: W. E. Rainey.

Genus *Nyctimene* (14 species)

Nyctimene aello
Broad-striped tube-nosed bat

Priority Grade: 6 (Rare).

Distribution: Misool; New Guinea.

Status: New Guinea Uncommon (Flannery, 1990). Widely distributed from Geelvink Bay in the west (Thomas, 1922) to Milne Bay in the east (Thomas, 1900). Also known from the Torricelli Mountains.

Ecology: Of the specimens reported upon by McKean (1972), all were collected in primary rain forest, except one from secondary forest and one from a swamp. The altitude ranged from sea-level to 260 m. The single specimen obtained at 990 m in the Torricelli Mountains was captured by a local hunter.

Has been observed feeding on figs (Moraceae: *Ficus* spp.) (Flannery, 1990).

Population biology: McKean (1972) collected three pregnant females in January and one in February. Greig-Smith (1975) noted that the four specimens collected by him were netted in male-female pairs.

Summary of threats:

- Lack of information on status.

Recommended action:

- Survey to assess status on Misool, particularly in protected areas.
- Studies of feeding ecology and population biology.

Principal author for this species: T. Flannery.

Nyctimene albiventer
Common tube-nosed bat

Priority Grade: 11 (Not Threatened).

Number of subspecies: 2.

N. a. albiventer

Priority Grade: 8 (No Data: Limited Distribution).

Distribution: Halmahera; Morotai; Ternate.

Summary of threats:

- Lack of information on status.

Recommended action:

- Surveys to assess status, particularly in protected areas.

N. a. papuanus

Priority Grade: 11 (Not Threatened).

Distribution: Bismarck Archipelago (Admiralty Islands, New Britain); Kai Islands; New Guinea.

Status: Extremely widespread throughout New Guinea and surrounding islands and is the most commonly caught *Nyctimene* when mist-netting at low altitudes (Flannery, 1990).

Ecology: Commonly caught in both primary and secondary rain forest (Flannery, 1990). A single specimen was taken in *Melaleuca* (Myrtaceae) savannah, and another in monsoon forest in the Morehead region of New Guinea (Waithman, 1979). Seems to have a greater altitudinal range than most other species in New Guinea, being found as high as 1650 m (McKean, 1972). Most stomach contents examined have included pulped vegetable remains, but one contained beetles and ants, and a second had traces of moths (Vestjens and Hall, 1977). Greig-Smith (1975) recorded that it was caught only at dawn, and all individuals were netted at heights of from 0.5-2 m above the ground.

Population biology: Two females caught in January, three in July and one in August were pregnant with a single embryo (McKean, 1972).

Summary of threats:

- No known threats.



Nyctimene albiventer (Photo by B. H. Gaskell)

Recommended action:

- Surveys to assess status in protected areas.

Principal author for this subspecies: T. Flannery.

Nyctimene celaeno

This species was formerly included as a subspecies of *N. aello*.

Priority Grade: 8 (No Data: Limited Distribution).

Distribution: Western New Guinea. A record from Halmahera is based on a juvenile *N. albiventer* in the British Museum (Natural History) (J. Edwards Hill, pers. comm.).

Summary of threats:

- Lack of information on status.

Recommended action:

- Surveys to assess status, particularly in protected areas.

Nyctimene cephalotes
Pallas' tube-nosed bat

Priority Grade: 11 (Not Threatened).

Distribution: Ambon; Australia (Queensland); Buru; Numfoor; New Guinea; Seram; Sulawesi; Tenimber Islands; Timor; Umboi.

Status: **New Guinea** Rare (Flannery, 1990). Has only previously been recorded on the mainland of New Guinea at Mari and Bulla, in the Morehead region of southern Papua New Guinea (Waithman, 1979). However, a previously unreported male specimen is held in the Australian Museum; it was collected during the 1885 Royal Geographical Society Expedition to New Guinea, probably along the lower Strickland River.

Sulawesi Hunted for food in north Sulawesi (Bergmans and Rozendaal, 1988).

Ecology: The only comment on diet is the observation by Muller (1841) that the stomach of a specimen contained only fragments of Coleoptera and Diptera.

Population biology: In Sulawesi, females collected in October and January were pregnant (Bergmans and Rozendaal, 1988).

Occurrence in protected areas:**Seram**

Manusela National Park

Sulawesi

Dumoga-Bone National Park

Summary of threats:

- Lack of information on status.

Recommended action:

- Surveys to assess status, particularly in protected areas, in Ambon, Australia, Buru, Numfoor, Seram, Sulawesi, Tenimber Islands, Timor and Umboi.

Principal author for this species: T. Flannery.

Nyctimene cyclotis
Round-eared tube-nosed bat

Priority Grade: 9 (Indeterminate).

Number of subspecies: 2. The subspecies *certans* may well represent a distinct species (Flannery, 1990).

N. c. certans

Priority Grade: 6 (Rare).

Distribution: Bismarck Archipelago (New Britain); central and eastern New Guinea.

Status: **New Guinea** Rare (Flannery, 1990).

Ecology: A female was netted on the margin of a patch of primary rain forest at 830 m at Lake Katubu, Southern Highlands Province, New Guinea (McKean, 1972). Flannery (1990) obtained a single specimen at Telefomin in March 1986 during 8 days mist-netting at the site. It was caught in a mist-net set in a taro garden at 2300 m in an area that also yielded *Syconycteris hobbit* and *S. australis*. The folk 'taxon' *Brulim*, tentatively identified with this species, is held in awe by the Telefol, who believe it is extremely bad luck to kill one (Flannery, 1990).

Summary of threats:

- Unknown.

Recommended action:

- Survey to assess status, particularly in protected areas, in the Bismarck Archipelago.
- Projects in New Guinea to assess status in protected areas and to learn more about ecology and population biology.

N. c. cyclotis

Priority Grade: 10 (No Data).

Distribution: Western New Guinea.

Status: Recorded only from Vogelkop.

Summary of threats:

- Lack of information on status.

Recommended action:

- Survey to assess status, particularly in protected areas.

Principal author for this species: T. Flannery.

Nyctimene draconilla

Priority Grade: 6 (Rare).

This was formerly included as a subspecies of *N. albiventer*.

Distribution: New Guinea.

Status: Rare (Flannery, 1990). Has been recorded previously only on two occasions; once from the Lorentz River (type locality) and once from the upper Fly River (Koopman, 1982). The record from Rautit Village, West Sepik Province (Greig-Smith, 1975) is erroneous, the specimens now being identified as *Paranyctimene raptor* (Flannery, 1990). Flannery (1990) obtained two specimens in a mist-net at Kiunga, apparently referable to this species.

All of these records are from west of 144°E. Given the difficulty of distinguishing this species from *N. albiventer* it may well be that it is more abundant and widespread than the above data suggest.

Ecology: The Kiunga specimens collected by Flannery (1990) were caught in a mist-net set next to an oxbow of the Fly River, in a small forest clearing.

Summary of threats:

- Lack of information on status.

Recommended action:

- Survey to assess status, particularly in protected areas.

Principal author for this species: T. Flannery.

Nyctimene major
Greater tube-nosed bat

Priority Grade: 11 (Not Threatened).

Number of subspecies: 4.

N. m. geminus

Priority Grade: 8 (No Data: Limited Distribution).

Distribution: D'Entrecasteaux Islands (Fergusson Island, Goodenough Island); Louisiade Archipelago (Logeia Island); Trobriand Islands (Kiriwina).

Summary of threats:

- Lack of information on status.

Recommended action:

- Surveys to assess status, particularly in protected areas.

N. m. lullulae

Priority Grade: 8 (No Data: Limited Distribution).

Distribution: Muyua.

Summary of threats:

- Lack of information on status.

Recommended action:

- Survey to assess status, particularly in protected areas.

N. m. major

Priority Grade: 8 (No Data: Limited Distribution).

Distribution: Bismarck Archipelago (Duke of York, New Britain, New Ireland).

Summary of threats:

- Lack of information on status.

Recommended action:

- Surveys to assess status, particularly in protected areas.

N. m. scitulus

Priority Grade: 8 (No Data: Limited Distribution).

Distribution: Solomon Islands (Choiseul, Guadalcanal, Malaita, New Georgia, Nggela Sule, Shortland).

Summary of threats:

- Lack of information on status.

Recommended action:

- Surveys to assess status, particularly in protected areas.

Nyctimene malaitensis
Malaita tube-nosed bat

Priority Grade: 8 (No Data: Limited Distribution).

Distribution: Solomon Islands (Malaita).

Summary of threats:

- Lack of information on status.

Recommended action:

- Survey to assess status, particularly in protected areas.

Nyctimene masalai

Priority Grade: 8 (No Data: Limited Distribution).

Distribution: Bismarck Archipelago (New Ireland).

Summary of threats:

- Lack of information on status.

Recommended action:

- Survey to assess status, particularly in protected areas.

Nyctimene minutus
Lesser tube-nosed bat

Priority Grade: 11 (Not Threatened).

Number of subspecies: 2.

N. m. minutus

Priority Grade: 10 (No Data).

Distribution: Sulawesi.

Summary of threats:

- Lack of information on status.

Recommended action:

- Survey to assess status, particularly in protected areas.

N. m. varius

Priority Grade: 8 (No Data: Limited Distribution).

Distribution: Buru.

Summary of threats:

- Lack of information on status.

Recommended action:

- Survey to assess status, particularly in protected areas.

Nyctimene rabori
Philippine tube-nosed bat

Priority Grade: 1 (Endangered: Limited Distribution).

Distribution: Philippines (Negros).

Status: Recorded from 200 m to 1300 m, but probably rarely occurs below 600 m. Very rare outside of primary or good secondary forest, and not found in agricultural or urban habitats (Heaney *et al.*, 1989). Does not tolerate disturbance well. Heaney *et al.* (1989) captured only one at a netting site at 600 m in agricultural land and secondary growth 2 km from

continuous primary forest, and suggested that this young animal was dispersing from a narrow strip of forest on a ridge 200 m from the capture point. Made up about 4% of total captures in the Balinsasayao forest region, but was only 1% of total captures at 1280 m, and was not taken at higher elevations. Density at Lake Balinsasayao was about one per 3 ha (Heideman and Heaney, 1989).

Seriously threatened by habitat destruction, but not by hunting. Known breeding populations persist only in a narrow elevational band of forest near the tops of high ridges and on the sides of tall mountains. The upper limit of their distribution is about 1300 m. The current lower limit is about 800-900 m, which is rising rapidly as the forest is cleared. At current rates of deforestation, little habitat for *N. rabori* will remain in 10 years. Might persist in forest patches for some time, but its low density suggests that small forest patches will not support viable populations. As it is known only from southern Negros, its extinction within the next 20 years is probable unless special measures are taken.

Ecology: Often captured near fruiting figs (**Moraceae:** *Ficus* spp.), including *Ficus chrysolepis*.

Three animals moved between 320 m and 1260 m between first and second captures (Heideman and Heaney, 1989). It is unclear whether these are typical movements for the species, or whether individuals may range over somewhat larger areas.

Population biology: Females produce only one young per year, in April or early May, after a gestation of 4.5-5 months. The duration of lactation is about 3-4 months (Heideman, 1987). Young females become pregnant at about 7-8 months of age, and produce their first young at an age of 1 year. Evidence suggests that males reached sexual maturity at about 1 year.

Summary of threats:

- Deforestation.

Recommended action:

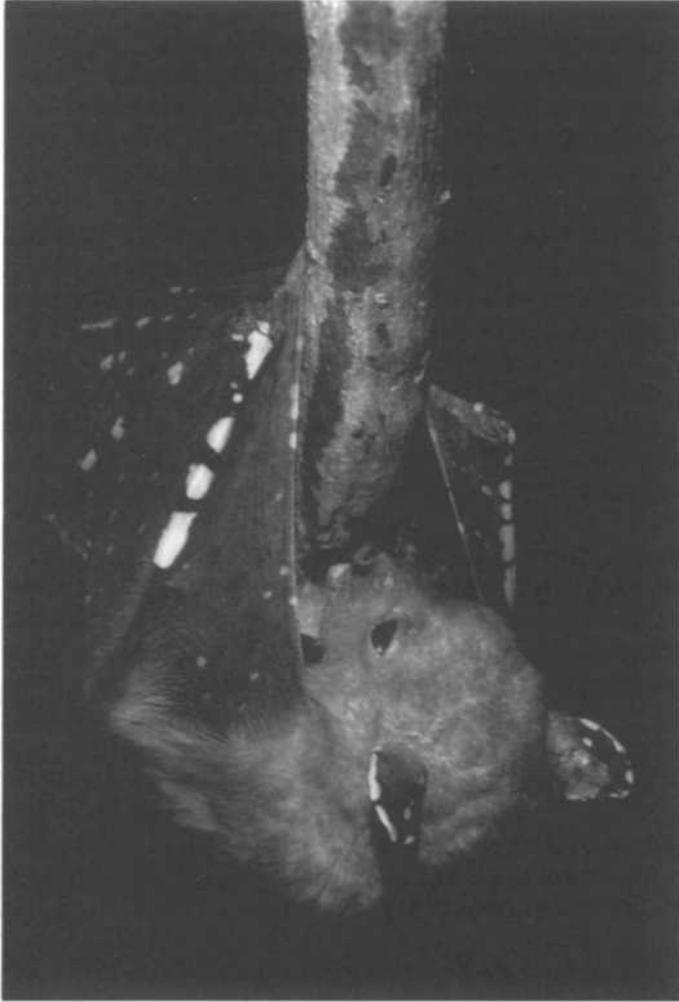
- There is no evidence that this species occurs on any island other than Negros, but the Pleistocene connection of Negros and Panay suggests that it should be sought in the forests of the latter island. Effective protection of forests on Negros, at as low an elevation as possible, would probably ensure the survival of the species. Given the current rate of forest destruction on Negros, captive breeding may be necessary to preserve this species.

Principal authors for this species: P. D. Heideman, L. R. Heaney.

Nyctimene robinsoni
Queensland tube-nosed bat

Priority Grade: 11 (Not Threatened).

Distribution: Tropical and subtropical eastern Australia (New South Wales, Queensland) (Richards, 1983).



Nyctimene robinsoni (Photo by W. E. Rainey)

Status: Common (Strahan, 1983).

Ecology: Permanent roosts *per se* are not utilized, and individuals appear to roost in the vicinity of the tree on which they are feeding at the time (Spencer and Fleming, 1989; C. R. Tidemann, J. R. Nelson and G. C. Richards, pers. comm.).

Based on capture locations and some feeding observations, Richards (1986a) showed that there was a preference for understorey fruits of canopy trees in rain forest. Fruits known to be eaten include: **Moraceae:** *Ficus copiosa* (FR), *F. nodosa* (FR), *Ficus* sp. (?*variegata*) (FR); **Myrtaceae:** *Eugenia erythrocalyx* (FR), *Psidium guajava* (FR), *Syzygium cormiflorum* (FR); **Rubiaceae:** *Randia sessilis* (FR).

Population biology: Females give birth to one young between October and December.

Occurrence in protected areas: Common in national parks with rain forest.

Summary of threats:

- Apparently none.

Recommended action:

- More work on the occurrence of this species in protected areas and also on its ecology and biology.

Principal author for this species: G. C. Richards.

Nyctimene sanctacrucis

Priority Grade: 1 (Extinct).

Distribution: Solomon Islands (Santa Cruz Islands).

Status: Probably extinct (T. Flannery, pers. comm.). Last seen in 1907 on Nendo in the Santa Cruz Islands. A subsequent expedition to find this bat was fruitless. As it is a large and distinctive species it is now presumed extinct. Disturbance has probably caused its disappearance (T. Flannery and L. Seri, pers. comm.).

Summary of threats:

- Disturbance.

Recommended action:

- Surveys for this species should continue, concentrating on protected areas.
- A captive breeding programme should be considered if any individuals are found.

Nyctimene vizcaccia

Priority Grade: 11 (Not Threatened).

Number of subspecies: 2.

The subspecies *N. v. bougainville* was formerly considered a subspecies of *N. aello* and *N. v. vizcaccia* a subspecies of *N. cephalotes*.

N. v. bougainville

Priority Grade: 10 (No Data).

Distribution: Bougainville; Solomon Islands (Choiseul, Fauro, Guadalcanal, Kolombangara, Santa Isabel).

Summary of threats:

- Lack of information on status.

Recommended action:

- Surveys to assess status, particularly in protected areas.

N. v. vizcaccia

Priority Grade: 10 (No Data).

Distribution: Australia (Queensland [Moa Island, Torres

Strait]); Bismarck Archipelago (Admiralty Islands); ?north-east New Guinea; Umboi.

Summary of threats:

- Lack of information on status.

Recommended action:

- Surveys to assess status, particularly in protected areas.

Genus *Otopteropus* (1 species)

Otopteropus cartilagonodus

Priority Grade: 9 (Indeterminate).

Distribution: Philippines (Luzon).

Status: Moderately common at middle elevations in primary lowland forest on southern Luzon, and present but uncommon in montane and mossy forest. Given the restricted range and the extent of deforestation on Luzon, it may be threatened.

Ecology: Taken from 200 m to 1750 m at localities scattered throughout the mountains of Luzon. Never been recorded outside of primary or good secondary forest (unpublished data and specimens at University of the Philippines at Los Banos and Philippine National Museum).

Fig (**Moraceae:** *Ficus* sp.) seeds were found in the faeces of many individuals.

Population biology: May produce either one or, possibly, two young per year on southern Luzon. Pregnancy may include a period of post-implantation developmental delay. Births occur synchronously within the population.

Summary of threats:

- Deforestation.

Recommended action:

- More detailed information on the habitat choices and abundance of this species should be obtained. Undoubtedly this species has declined in abundance as rain forest has been cleared.

Principal authors for this species: P. D. Heideman, L. R. Heaney.

Genus *Paranyctimene* (1 species)

Paranyctimene raptor

Lesser tube-nosed bat, Unstriped tube-nosed bat

Priority Grade: 6 (Rare).

Distribution: New Guinea.

Status: Uncommon (Flannery, 1990). Recorded as far east as Morwuna, Milne Bay Province (Koopman, 1982), and as far west as the upper Fly River (type locality) and the northern foothills of the Star Mountains. Probably widespread in New Guinea, with the lack of records in Irian Jaya almost certainly due to a lack of collecting there (Flannery, 1990).

Ecology: Specimens from Raut Village (originally referred to *Nyctimene draconilla*; see Hill, 1983) were taken at 525 m above sea-level on one night in a single mist-net, and seemed to form a group that consisted of three males and one female (Greig-Smith, 1975).

The dentition is most unusual. The canines are extremely fine and the cheekteeth are also long and pointed. While this suggests an unusual diet, there are as yet no studies to indicate what this may be (Flannery, 1990).

Population biology: Females pregnant with a single embryo have been collected in January, February and May (McKean, 1972). Flannery (1990) netted two lactating females in May 1986 near Yapsiei, West Sepik Province. A female collected by Greig-Smith (1975) in July-August had a single young.

Summary of threats:

- Unknown.

Recommended action:

- Projects to assess status in protected areas, and study ecology and population biology.

Principal author for this species: T. Flannery.

Genus *Penthetor* (1 species)

Penthetor lucasi
Lucas' short-nosed fruit bat

Priority Grade: 11 (Not Threatened).

Distribution: Borneo (Central, East, South and West Kalimantan, Sabah, Sarawak); Peninsular Malaysia; Riau Archipelago; Singapore; Sumatra.

Status: Borneo Apparently widespread. There are specimens from: the foot of Gunong Kenepai, Sungai Kapuas, Puruk Tjahu, Barito and Perbuwa in Kalimantan; Sebuyau and Gunong at 610 m in Sarawak; and Tenom, Sabah. It is also found from cave roosts at Sikadar cave and Bidi near Bau, I Division, Lobang Pedang Salai, Sungei Baram, and Gua Lobang Sungei Tinjar, all in Sarawak (Medway, 1977).

Peninsular Malaysia Irregularly distributed mainly in the lowlands but up to 1828 m at the Cameron Highlands (Medway, 1978; Medway, 1983).

Threatened generally by forest destruction.

Ecology: Roosts in limestone caves in quite light conditions near the entrances, in rock clefts and between big river boulders. Medway (1983) suggests that this may limit distribution. May also roost in small clusters or singly in hollow trees.

Eats a wide variety of hard fruits and seeds of forest trees, both of the canopy and understorey layer.

Population biology: Medway (1983) reported that in Selangor there were many pregnancies in September, few in June, none in January, February, March or July. Gives birth to one young each.

Occurrence in protected areas:

Borneo

Occurs patchily in lowland forest and at low densities in most forest reserves and other protected areas, such as:

Brunei

Ulu Temburong National Park (proposed)

Sabah

Kinabalu National Park

Sarawak

Gunung Mulu National Park

Niah Caves

Peninsular Malaysia

Cameron Highlands Wildlife Refuge

Endau-Rompin Park

Fraser's Hill

Krau Game Reserve

Taman Negara

Sumatra

Gunung Leuser National Park (W. Bergmans, pers. comm.)

Summary of threats:

- Deforestation.

Recommended action:

- Surveys to assess status, particularly in protected areas, in the Riau Archipelago and Sumatra.

Principal author for this species: G. W. H. Davison.

Genus *Plerotes* (1 species)

Plerotes anchietae

d'Anchieta's fruit bat, Broad faced fruit-bat

Priority Grade: 6 (Rare).

Distribution: Western central Angola (on the Angola plateau;

Crawford-Cabral, 1989); south-east Zaire; north Zambia (Bergmans, 1989).

Status: Unknown. Threatened by loss of woodland habitat. Appears to be highly specialized and as such will be very vulnerable to destruction of food plants.

Ecology: All localities are within the wetter Zambezian miombo woodland, with the possible exception of Kasama in Zambia, which is in the mosaic of Zambezian dry evergreen forest and wetter miombo woodland. All collecting localities are at altitudes of at least 1000 m.

Nothing is known of feeding habits. From its weak jaws and dentition, a diet of pollen and nectar may be expected (Allen, 1939).

Occurrence in protected areas:

Zaire

Parc National de l'Upemba

Summary of threats:

- Deforestation.

Recommended action:

- In general, a further assessment of the distribution and a study of the species's ecology and biology, and, if necessary, conservation action.

Principal authors for this species: W. Bergmans, S. Sowler.

Genus *Ptenochirus* (2 species)

Ptenochirus jagorii

Jagor's dog-faced fruit bat

Priority Grade: 11 (Not Threatened).

Distribution: Philippines (Biliran, Bohol, Camiguin, Carabao, Dinagat, Leyte, Luzon, Maripipi, Mindanao, Mindoro, Negros, Siargao, Sulu Archipelago [Sanga Sanga], Tablas).

Status: Second most abundant species in the submontane forest in the Balinsasayao region (830-1000 m) on Negros but was extremely rare at 1300 m, and not present at higher elevations (Heaney *et al.*, 1989). Comprised about 30% of all captures. Density estimates on Negros ranged from 1.1 to 3.1 individuals per ha. (Heideman and Heaney, 1989).

Occasionally occurs outside primary or good secondary forest (Guerrero and Alcalá, 1973 and authors' data), but does not persist outside forest. Forages in urban or agricultural areas near forests, and it is possible that it is limited by roost sites rather than by an inability to use urban/agricultural habitats. Although the evidence suggests that most individuals roost in tree hollows, it has been observed in the entrances of caves in

agricultural areas near secondary forests on Leyte and Bohol, but always in locations that make it very vulnerable to hunters. Thus, the combination of habitat destruction and hunting may be acting synergistically to prevent its persistence outside forest.

Suitable habitat (primary or good secondary forest) has declined in the Philippines from about 80% to less than 10% of total land area; population levels probably have declined commensurately. Not seriously threatened at present, as it is probably able to survive at reduced density in secondary forest.

Ecology: Taken from sea level to 1300 m in appropriate habitat. Most abundant in primary forest or good secondary forest at lower or middle elevations (Heaney *et al.*, 1981; Heaney *et al.*, 1989).

Apparently roosts singly and in groups of up to 10 or more. In forest, roosts are probably usually in tree hollows, and perhaps in foliage, but individuals may be found roosting in cave entrances in localities where caves are abundant (E. A. Rickart, pers. comm.). An apparent maternity roost was in a standing hollow dead tree with an opening 12 m above ground in primary forest. Rabor (1977) noted that it can be found '...singly or in small numbers, suspended on the walls of shallow cliffcaves formed by overhanging rocks...' and reported capturing a single male in an earthen bank. Lawrence (1939) reported collecting a single male from the underside of a coconut frond on Mindoro.

On Negros, feeds heavily on figs (**Moraceae:** *Ficus* spp.) including *Ficus chrysolepis*, fruits of at least one unidentified plant (**Lauraceae**), and cultivated or wild bananas (**Musaceae:** *Musa* spp.). Figs appear to comprise the major part of its diet. Many were captured beneath a pair of fruiting coffee trees (**Rubiaceae:** *Coffea arabica*), a dozen coconut palms (**Palmae:** *Cocos nucifera*) and several dozen abaca plants (*Musa textilis*) in the middle of a clearing about 50 m from the forest edge. The bats were apparently feeding on the sweet coffee fruits; they may also have been feeding on abaca flowers or fruit or coconut flowers. Sanborn (1952) reported Rabor's capture (Rabor, 1977) of two individuals apparently feeding on young fruits or flowers of kapok (**Bombacaceae:** *Ceiba pentandra*).

Average movements for adult males were 320 m at an upland site on Negros; this was significantly less than the mean (690 m) for adult females and young of either sex (Heideman and Heaney, 1989). This may indicate fidelity to a resource that males defend (for example, a roost) and that males may remain near a roost site to increase their contact with females (Heithaus and Fleming, 1978), or that males may move shorter distances because they use temporary roosts near food sources while females prefer scarce tree cavities (Morrison, 1978).

P. jagorii flying near and feeding in a 14-m canopy *Ficus chrysolepis* tree flew along the edge of the crown, only occasionally landing in the tree, and then apparently only briefly, to remove a fruit. The bats flew elsewhere with the fig fruits. Ejecta were uncommon under the crown, but there were clusters of 5-50 ejecta at three localities, presumably feeding roosts, 10-50 m from the tree. Feeding roosts have been found

with 100 or more ejecta, indicating the consumption of perhaps 10 or more figs. These limited observations suggest that bats may return to a given feeding roost at least several times (or, perhaps, feed in small groups), but they sometimes use a given feeding roost only once.

Population biology; In the central Philippines, probably undergoes two synchronized birth periods each year, separated by 4 months, with some variation in timing from island to island (Heideman, 1987). Unusual in occasionally producing twins (less than 1% of pregnancies). The duration of gestation is about 4 months and that of lactation about 3 months (Heideman, 1987). On Negros, females undergoing their first pregnancy give birth midway between the two birth peaks of parous females (Heideman, 1987).

Longevities of 5 years documented in the wild; individuals of between 4-5 years of age were healthy and still reproducing (Heideman and Heaney, 1989). The teeth of these animals were appreciably worn, however, and other signs of age were apparent. Estimated annual survivorship was approximately 70% for marked animals, suggesting that about 5 out of 100 yearlings would reach an age of 8 years.

Summary of threats:

- Hunting.
- Deforestation.

Recommended action:

- Beyond attempts to preserve forest habitats, no action is necessary to protect this species at present.

Principal authors for this species: P. D. Heideman, L. R. Heaney.

Ptenochirus minor

Priority Grade: 11 (Not Threatened).

Distribution: Philippines (Biliran, Dinagat, Leyte, Mindanao). A record from Palawan is probably erroneous.

Status: Abundant within primary lowland forest, common in montane and mossy forest (up to 1250 m), uncommon in secondary forest, and absent outside of forest (Heaney *et al.*, 1989; E. A. Rickart, pers. comm.). On Leyte, most frequently netted in primary forest (Heaney *et al.*, 1989).

Currently, large populations are present in forest. The principal habitat of this bat is threatened by deforestation, but it would probably persist in good secondary forest.

Ecology: A single male was observed roosting among the leaves of a two metre high understory shrub in primary forest on Leyte.

Fig seeds (**Moraceae:** *Ficus* spp.) were often present in the faeces.

Population biology: Females on Leyte and Biliran produce one young synchronously in July/August; they may or may not give birth again between November and January, but data are lacking for these months.

Summary of threats:

- Deforestation.

Recommended action:

- Protection of primary forest areas large enough to protect larger species of bats should also provide excellent protection for populations of this species.

Principal authors for this species: P. D. Heideman, L. R. Heaney.

Genus *Pteralopex* (3 species)

T. Flannery (pers. comm.) notes that a very distinctive, as yet undescribed, new *Pteralopex* species has recently been found on Guadalcanal in the Solomon Islands.

Pteralopex acrodonta

Priority Grade: 1 (Endangered: Limited Distribution).

Distribution: Fiji (Taveuni). Only two specimens are known, captured in montane forest on Taveuni (Hill and Beckon, 1978).

Status: Endangered or extinct. Not found on most recent expedition (T. Flannery and L. Seri, pers. comm.).

Ecology: There is no direct information on feeding ecology, but the highly cusped teeth and well-developed jaw musculature of the genus suggests a diet of fruits and other plant material that is tougher than typical for *Pteropus*.

Population Biology: There is no direct information on population biology, but the lack of observations by local residents and visiting scientists suggests that this species lives solitarily or in small groups in the montane forest.

Summary of threats:

- Lack of information on status.
- Proposals for development involving forest clearance in the uplands of Taveuni.

Recommended action:

- Survey to assess status, particularly in protected areas.
- Captive breeding should be considered for any individuals found.

Principal author for this species: W. E. Rainey.

Pteralopex anceps

Priority Grade: 1 (Endangered: Limited Distribution).

Distribution: Bougainville; Solomon Islands (Choiseul).

Status: Endangered or extinct. Six months of recent fieldwork failed to locate a single specimen (T. Flannery and L. Seri, pers. comm.). Probable reason for decline is disturbance from increasing human population. The islands in the north-west Solomons are the most heavily populated and have the greatest disturbance factors (T. Flannery and L. Seri, pers. comm.).

Summary of threats:

- Lack of information on status.

Recommended action:

- Surveys to assess status, particularly in protected area
- Captive breeding should be considered for any individuals found.

Pteralopex atrata
Cusp-toothed fruit bat

Priority Grade: 1 (Endangered: Limited Distribution).

Distribution: Solomon Islands (Guadalcanal, Santa Isabel).

Status: Endangered or extinct (T. Flannery and L. Seri, pers. comm.). See also *P. anceps*.

Summary of threats:

- Lack of information on status.

Recommended action:

- Surveys to assess status, particularly in protected areas.

Genus *Pteropus* (57 species)

Pteropus admiralityatum
Admiralty fruit bat

Priority Grade: 11 (Not Threatened).

Number of subspecies: 4.

P. a. admiralityatum

Priority Grade: 10 (No Data).

Distribution: Bismarck Archipelago (Admiralty Islands, Emirau, New Britain, Tabar).

Summary of threats:

- Lack of information on status.

Recommended action:

- Surveys to assess status, particularly in protected areas.

P. a. colonus

Priority Grade: 10 (No Data).

Distribution: Solomon Islands (Choiseul, Mono, Shortland).

Summary of threats:

- Lack of information on status.

Recommended action:

- Surveys to assess status, particularly in protected areas.

P. a. goweri

Priority Grade: 8 (No Data: Limited Distribution).

Distribution: Solomon Islands (N'Dai).

Summary of threats:

- Lack of information on status.

Recommended action:

- Survey to assess status, particularly in protected areas.

P. a. solomonis

Priority Grade: 10 (No Data).

Distribution: Solomon Islands (Guadalcanal, Ghizo, Kolombangara, Malaita, Ranonggo, Russell Islands [Mbanika], Simbo, Vella Lavella).

Summary of threats:

- Lack of information on status.

Recommended action:

- Surveys to assess status, particularly in protected areas.

Pteropus alecto

Priority Grade: 11 (Not Threatened).

Number of subspecies: 4.

P. a. alecto

Priority Grade: 10 (No Data).

Distribution: Lombok; Salayar; Sulawesi.

Status: Sulawesi Hunted for food in north Sulawesi. In January 1982 about 100 live *P. alecto* were offered for sale in Unjung Padang market. They were virtually undamaged and evidently had been mistnetted (Bergmans and Rozendaal, 1988).

Population biology: A pregnant female was caught in Sulawesi in January (Bergmans and Rozendaal, 1988).

Summary of threats:

- Lack of information on status.
- Possibly hunting in Sulawesi.

Recommended action:

- Surveys to assess status, particularly in protected areas.
- Assess possible threat from hunting in Sulawesi.

P. a. aterrimus

Priority Grade: 8 (No Data: Limited Distribution).

Distribution: Bawean; Kangean Islands.

Summary of threats:

- Lack of information on status.

Recommended action:

- Surveys to assess status, particularly in protected areas.

P. a. gouldi

Gould's fruit bat, black or blackish fruit bat

Priority Grade: 11 (Not Threatened).

Distribution: South New Guinea and the north and east coast of Australia (New South Wales, Northern Territory, Queensland, Western Australia).

Status: Australia Common (Strahan, 1983). Occurs from Shark Bay in the west to northern New South Wales in the east. Mangrove islands in the estuaries of most northern rivers usually contain camps, often consisting of hundreds or thousands of individuals. Smaller camps of several hundred to several thousand may be found in mangroves, paperbark swamps (**Myrtaceae: Melaleuca** spp.) or occasionally in patches of rain forest (Strahan, 1983).

This species is unprotected in Queensland and Western Australia and listed as 'noxious' in Northern Territory.

New Guinea Rare (Flannery, 1990). Previously reported from mainland New Guinea on only two occasions, once at Bugi, Western Province in 1937 (Tate, 1942), and more recently by Waithman (1979), also in Western Province. Waithman (1979) found the species widespread, although scattered, in the Morehead area in June and September 1973. The Australian Museum holds a large series collected in the 19th century on Yule Island, Central Province (Flannery, 1990).

Ecology: In New Guinea occurs from sea level to 60 m (Waithman, 1979).

Is a high-roosting species and seeks dense leaf-cover. The perimeter of the camp is guarded by old males, which observe intruders and, if they come too close, fly into the camp to raise an alarm. Also roosts on sheltered vertical rock faces in arid areas of Queensland, Australia (A. M. Hutson, pers. comm.).

In Australia, preferred food includes the blossoms of eucalypts (**Myrtaceae:** *Eucalyptus* spp.), paperbarks and turpentines. Groups are known to travel as far as 50 km from their camps to feed. Other native and introduced blossoms and fruits, particularly mangoes (**Anacardiaceae:** *Mangifera indica*), are also eaten (Strahan, 1983).

Fujita and Tuttle (1991) summarized information on food plants collected by Australian researchers as follows: **Anacardiaceae:** *Mangifera indica* (FR); **Leguminosae:** *Castanospermum australe* (FL); **Loranthaceae:** *Loranthus* sp. (FL); **Moraceae:** *Ficus macrophylla* (FR); **Myrtaceae:** *Angophora costata* (FL), *A. lanceolata* (FL), *A. subvelutina* (FL), *Eucalyptus acmenoides* (FL), *E. alba* (FL), *E. baileyana* (FL), *E. camaldulensis* (FL), *E. citroidea* (FL), *E. cloeziana* (FL), *E. corymbosa* (FL), *E. crebra* (FL), *E. grandis* (FL), *E. gummifera* (FL), *E. hemiploia* (FL), *E. intermedia* (FL), *E. longifolia* (FL), *E. maculata* (FL), *E. miniata* (FL), *E. paniculata* (FL), *E. pilularis* (FL), *E. polycarpa* (FL), *E. propinqua* (FL), *E. ptychocarpa* (FL), *E. saligna* (FL), *E. tereticornis* (FL), *E. tessellaris* (FL), *E. tetradonta* (FL), *E. torelliana* (FL), *E. umbra* (FL), *Lophostemon suaveolus* (FL), *L. confert* (FL), *Melaleuca dealbata* (FL), *M. leucadendron* (FL), *M. quinquenervia* (FL), *M. viridiflora* (FL), *Syncarpia laurifolia* (FL); **Proteaceae:** *Banksia aemula* (FL), *B. integrifolia* (FL), *B. robur* (FL), *B. serrata* (FL), *Grevillea robusta* (FL); **Rubiaceae:** *Nauclea orientalis* (FL); **Rutaceae:** *Citrus* sp. (FR).

Population biology: Copulations reported from March to April. Single young born from August to the end of November with peak in October. Young do not leave the camp until they are about 3 months old.

Summary of threats:

- No significant threats.

Recommended action:

- Surveys to assess status in protected areas.

Principal author for this subspecies: T. Flannery.

P. a. mono

Priority Grade: 8 (No Data: Limited Distribution).

Distribution: Savu; Sumba.

Summary of threats:

- Lack of information on status.

Recommended action:

- Surveys to assess status, particularly in protected areas.

Pteropus anetianus
White flying-fox

Priority Grade: 9 (Indeterminate).

Number of subspecies: 7.

Endemic to Vanuatu. Felten and Kock (1972) recognized seven subspecies. As noted by Medway and Marshall (1975), the significant morphological divergence among adjacent islands and the apparent absence of the species from Tanna Island, suggests very limited dispersal. Chambers and Esrom (1988) list local names for *P. anetianus* on islands from which it has not previously been reported, emphasizing that its distribution and systematics are incompletely known.

Not protected by law in Vanuatu.

P. a. anetianus

Priority Grade: 3 (Vulnerable: Limited Distribution).

Distribution: Vanuatu (Anatom, Erromango).

Status: Unknown.

An important food item for humans on Vanuatu. Chambers and Esrom (1988) reported that most people hunted bats for their own consumption, but some sold them in the market and bats were on menus at some tourist hotels. They also noted that, although local customs restricted the take of fruit bats in only a few areas of the country, there was no evidence that current hunting levels were causing declines in populations. The only threat to bat populations they identified was the greatly increased killing of fruit bats by villagers immediately following typhoons.

From the evidence available, it seems that neither direct exploitation nor habitat destruction through logging or agricultural conversion have yet seriously affected populations, offering time to establish a long-term management policy.

Ecology: Neither Baker and Baker (1936) nor Medway and Marshall (1975) observed conspicuous diurnal aggregations in trees comparable with those of *Pteropus tonganus geddiei*. Chambers and Esrom (1988) noted that colonies were much smaller and quieter than those of *P. t. geddiei*.

Observed feeding with *P. t. geddiei* on fruits of *Ficus* (**Moraceae**) on Erromango (Medway and Marshall, 1975), although it was reported to be more frequently a blossom feeder than *P. t. geddiei*. Sanborn and Nicholson (1950) noted that both species fed in coconut groves, but *P. anetianus* arrived earlier in the day.

Based on the abundance of bat remains in peregrine falcon (*Falco peregrinus*) eyries in Fiji (White *et al.*, 1988), it seems

likely that this bird, which is widely distributed in Vanuatu (Medway and Marshall, 1975), is an important natural predator.

Summary of threats:

- Typhoons.
- Hunting for food poses a potential threat.

Recommended action:

- Like many pteropodids, *P. anetianus* is poorly known, but there is no evidence that its survival is threatened. Field surveys to provide information on the distribution, abundance, systematics and natural history of *P. anetianus* are necessary prerequisites to developing effective long-term conservation policies. Land-use policies aimed at the conservation of natural resources (e.g., establishment of forest reserves) will probably benefit pteropodids and other wildlife. It is important to gain enough natural history information on species such as *P. anetianus* to identify seasonal patterns of resource and habitat use so that critical components of the annual cycle are not inadvertently overlooked. Selected information on the ecology of this species (e.g., pollination or seed dispersal for economically or culturally significant plants) may provide one basis for its inclusion in the resource planning process.

P. a. aorensis

Priority Grade: 3 (Vulnerable: Limited Distribution).

Distribution: Vanuatu (Aore, Espiritu Santo).

Status: Baker and Baker (1936) reported that it was far less common than *P. t. geddiei* near Hog Harbour, Espiritu Santo. Sanborn and Nicholson (1950) reported it as numerous on Espiritu Santo, but less common than *P. t. geddiei*.

A summary of the threats is given under *P. a. anetianus*.

Ecology: See *P. a. anetianus*.

Population biology: Males become most active sexually between October and January. Females probably have a birth peak in August to September, concurrent with *P. t. geddiei* (Baker and Baker, 1936).

Summary of threats:

- Typhoons.

Recommended action:

- See *P. a. anetianus*.

P. a. bakeri

Priority Grade: 3 (Vulnerable: Limited Distribution).

Distribution: Vanuatu (Efate, Emao, Nguna).

Status: Unknown except for general comments under *P. a.*

anetianus which includes information on threats.

Ecology: Medway and Marshall (1975) observed it feeding with *P. t. geddiei* on fruits of *Syzygium* (Myrtaceae). See also general comments under *P. a. anetianus*.

Summary of threats:

- Typhoons.

Recommended action:

- See *P. a. anetianus*.

P. a. banksiana

Priority Grade: 3 (Vulnerable: Limited Distribution).

Distribution: Vanuatu (Banks Islands [Ureparapara, Vanua Lava]).

Status: Unknown except for general comments under *P. a. anetianus*, which includes information on threats.

Ecology: See *P. a. anetianus*.

Summary of threats:

- Typhoons.

Recommended action:

- See *P. a. anetianus*.

P. a. eotinus

Priority Grade: 3 (Vulnerable: Limited Distribution).

Distribution: Vanuatu (Aoba, Maewo, Malakula, Malo, Pentecost).

Status: Unknown except for general comments under *P. a. anetianus*, which also includes information on threats.

Ecology: See *P. a. anetianus*.

Summary of threats:

- Typhoons.

Recommended action:

- See *P. a. anetianus*.

P. a. motalavae

Priority Grade: 3 (Vulnerable: Limited Distribution).

Distribution: Vanuatu (Banks Islands [Mota Lava]).

Status: Unknown except for general comments under *P. a. anetianus*, which also includes information on threats.

Ecology: See *P. a. anetianus*.

Summary of threats:

- Typhoons.

Recommended action:

- See *P. a. anetianus*.

P. a. pastoris

Priority Grade: 3 (Vulnerable: Limited Distribution).

Distribution: Vanuatu (Emae, Tongoa).

Status: Unknown except for general comments under *P. a. anetianus*, which also includes information on threats.

Ecology: See *P. a. anetianus*.

Summary of threats:

- Typhoons.

Recommended action:

- See *P. a. anetianus*.

Principal authors for this species: W. E. Rainey, E. D. Pierson.

Pteropus argentatus
Silvery fruit bat

Priority Grade: 8 (No Data: Limited Distribution).

Distribution: Type locality is possibly Ambon, but there is doubt about the origin of this specimen. Specimens from Sulawesi have been transferred to *Acerodon celebensis* (Masser *et al.*, 1982).

Summary of threats:

- Lack of information on status.

Recommended action:

- Survey to assess status, particularly in protected areas.

Pteropus brunneus

Priority Grade: 1 (Extinct?).

Distribution: Percy Island, Queensland, Australia.

Status: Almost certainly 'extinct', although considerable doubt exists as to the validity of this species. (K. Koopman, pers. comm.). Corbet and Hill (1991) thought that the record of this species may refer to a vagrant *Pteropus hypomelanus*.

Summary of threats:

- Lack of information on status.

Recommended action:

- Survey to assess status.
- Review of the taxonomic status of this species.

Pteropus caniceps
Ashy-headed fruit bat

Priority Grade: 11 (Not Threatened).

Number of subspecies: 2.

P. c. caniceps

Priority Grade: 10 (No Data).

Distribution: Bacan; Halmahera; Morotai; Sula Islands (Sulabesi); Ternate.

Summary of threats:

- Lack of information on status.

Recommended action:

- Surveys to assess status, particularly in protected areas.

P. c. dobsoni

Priority Grade: 10 (No Data).

Distribution: Sulawesi.

Summary of threats:

- Lack of information on status.

Recommended action:

- Surveys to assess status, particularly in protected areas.

Pteropus chrysoproctus
Ambon flying-fox

Priority Grade: 10 (No Data).

Distribution: Ambon; Asilulu;Buru; Gorong Islands (Panjang); Keffing; Seram; Watubela Islands.

Summary of threats:

- Lack of information on status.

Recommended action:

- Surveys to assess status, particularly in protected areas.

Pteropus conspicillatus
Spectacled flying-fox

Priority Grade: 11 (Not Threatened).

Number of subspecies: 2.

P. c. chrysauchen

Priority Grade: 11 (Not Threatened).

Distribution: Bacan; Gebe; Misool; Morotai; north-west New Guinea; Obi; Salawati; Schouten Islands; Ternate.

Status: New Guinea Uncommon (Flannery, 1990). Records from mainland New Guinea are few, it being restricted to the north-west.

Summary of threats:

- Lack of information on status.

Recommended action:

- Surveys to assess status, particularly in protected areas, in Bacan, Gebe, Misool, Morotai, Obi, Salawati, Schouten Islands, and Ternate.

P. c. conspicillatus

Priority Grade: 11 (Not Threatened).

Distribution: Alcester Island; Australia (north-east Queensland [Fitzroy Island]); D'Entrecasteaux Islands; Louisiade Archipelago; Muyua; south-east New Guinea; Trobriand Islands (Kiriwina).

Status: Australia Common in its limited range (Strahan, 1983), although new information indicates a decline in the Cairns-Atherton-Innisfail region. Currently has unprotected status in Queensland.

New Guinea Uncommon. Records from mainland New Guinea are few and this species is confined to the south-east.

Ecology: In Australia, camps may be located in patches of mangroves but are more frequently in tall trees in swamps and rain forest (Strahan, 1983). Usually located in the vicinity of rain forest (Richards 1987; Richards, 1990a).

In Australia, favourite foods are fruit, particularly light-coloured rain-forest fruit that has a high visibility at night, and the ratio of fruit:flowers is approximately 4:1 (Richards, 1990b). G. C. Richards showed that feeding territoriality contributed to dispersal of seeds over long distances. When individuals raided a tree in which others had established territories, they were typically evicted but did not leave without carrying a fruit away. The author lists the following food plants: **Anacardiaceae:** *Anacardium occidentale* (FR), *Mangifera indica* (FR); **Annonaceae:** *Annona muricata* (FR), *A. squamosa* (FR), *Polyalthiamicheali* (FR), *Rollinia deliciosa* (FR); **Burseraceae:** *Canarium muelleri* (FR); **Caricaceae:** *Carica papaya* (FR); **Chrysobalanaceae:** *Parinari nonda*; **Combretaceae:** *Terminalia arenicola* (FR), *T. catappa* (FR), *T. sericocarpa* (FR); **Elaeocarpaceae:** *Elaeocarpus angustifolius* (FR), *E. bancroftii* (FR); **Lauraceae:** *Neolitsea dealbata* (FL); **Leguminosae:** *Albizia procera* (L), *Castanospermum australe*

(FL), *Tamarindus indica* (FR); **Meliaceae:** *Melia azedarach* var. *australasica* (FR); **Moraceae:** *Ficus crassipes* (FR), *F. fraseri* (FR); *F. pleurocarpa* (FR), *F. triradiata* (FR), *F. virens* var. *sublanceolata* (FR); **Musaceae:** *Musa* sp. (FR); **Myrtaceae:** *Decaspermum humile* (FR), *Eucalyptus citriodora* (FL), *E. cloeziana* (FL), *E. intermedia* (FL), *E. polycarpa* (FL), *E. tereticornis* (FL), *Psidium guajava* (FR), *Syncarpia* sp. (?*glomulifera*) (FL), *Syzygium dictyophlebium* (FR), *S. forte* (FR,FL), *S. kuranda* (FR), *S. wesa* (FR); **Palmae:** *Archontophoenix alexandrae* (FR), *Arecastrum romanzoffianum* (FR); **Proteaceae:** *Grevillea robusta* (FL); **Rubiaceae:** *Nauclea orientalis* (FR); **Rutaceae:** *Acronychia acidula* (FR), *Citrus sinensis* (FR), *C. reticulata* (FR); **Sapindaceae:** *Litchi chinensis* (FR); **Sapotaceae:** *Manilkara kauki* (FR); **Verbenaceae:** *Faradaya splendida* (FR).

Fujita and Tuttle (1991) additionally listed the following food plants: **Myrtaceae:** *Eucalyptus torelliana* (FL), *Melaleuca leucadendron* (FL).

Can drink sea-water and crocodiles have been known to catch them as they do so (Flannery, 1990).

Population biology: In Australia, copulation occurs from March to May and one young is born between October and early December (Strahan, 1983).

Occurrence in protected areas: In Australia, most colony sites are not protected but during seasonal movements some sites in national parks are occupied.

Summary of threats:

- Unprotected status in Australia.

Recommended action:

- Monitoring of north Queensland populations to document possible declines and their causes.
- Reinstate protected status in Queensland.
- Surveys to assess status, particularly in protected areas, New Guinea, the Trobriand Islands, Muyua, Alcester Island, D'Entrecasteaux Islands, and the Louisiade Archipelago.

Principal author for this subspecies : G. C. Richards.

Pteropus dasymallus
Ryukyu flying-fox

Priority Grade: 1 (Endangered: Limited Distribution).

Number of subspecies: 5.

P. d. daitoensis
Daito fruit bat

Priority Grade: 1 (Endangered: Limited Distribution).

Distribution: Ryukyu Archipelago (Kita-daitojima, Minami-daitojima). Originally assumed to be confined to Minami-

daitojima (Kuroda, 1921; Kuroda, 1933; Kuroda, 1940) but recently confirmed also to occur on Kita-daitojima (Ikehara, 1973).

Status: Ikehara (1973) counted two and nine animals simultaneously on Kita and Minami-daitojima, respectively, in October 1972. Takara (1976) estimated the population size to be at least 50 on each island.

Probable that destruction of natural environments caused by human exploitation and by introduced animals and plants is causing reduction in available food plants and roosting sites. Shimojana (1978) and Maruyama (1982) noted that several inhabitants pointed out the recent reduction in numbers on Minami-daitojima, although there are at present no scientific data to confirm this. It has been reported that several animals were recently electrocuted on power cables (M. Toyama, pers. comm.).

Ecology: Has been recorded as using the following sites as roosts: in a branch of *Casuarina equisetifolia* (**Casuarinaceae**) in the coastal bush; in a bamboo grove; in the top of *Livistona chinensis* (**Palmae**) about 13 m above ground (Ikehara, 1973); in bushes of *Casuarina equisetifolia* and *Pandanus tectorius* (**Pandanaceae**) near the coast; in a *Casuarina equisetifolia* bush on an islet in an inland lake (Maruyama, 1982).

Feeds on the following plants (Ikehara, 1973; Takara, 1976; Shimojana, 1978; Maruyama, 1982): **Guttiferae:** *Garcinia subelliptica* (FR); **Moraceae:** *Ficus microcarpa* (FR), *F. superba* var. *japonica* (FR), *Morus australis* (FR); **Palmae:** *Cocos nucifera* (FR), *Livistona chinensis* (FL).

Occurrence in protected areas: Although it is protected as a national monument by the Japanese Government, no special areas are designated as sanctuaries.

Summary of threats:

- Deforestation.

Recommended action:

- Survey to assess status, particularly in protected areas.
- Studies of the factor(s) restricting population size.
- Conservation of food plants and roosting sites may be effective for conservation.

P. d. dasymallus
Erabu fruit bat

Priority Grade: 1 (Endangered: Limited Distribution).

Distribution: Ryukyu Archipelago (Oosumi Group: Kuchinoerabujima, Tokara Group: Akusekijima (Yamagata, 1929; Funakoshi, 1990), Nakanoshima (Funakoshi, 1990), Tairajima (Funakoshi, 1990), Takarajima (Nagai, 1929; Funakoshi, 1990)). Funakoshi (1990) also lists records, based on information from inhabitants, for Kuchinoshima and Suwanosejima in the Tokara Group.

Earlier records for Okierabujima (Matsuura, 1920) and south Japan (Uchida, 1963) are considered unreliable because they were based on scant or misleading information. Kuroda (1933) reviews other misleading locality records provided by previous authors (e.g., Siebold, 1824; Temminck, 1825; Dobson, 1878; Andersen, 1912).

Status: Shimojana (1978) observed no individuals on Kuchierabujima in August, 1977. He also reported that the inhabitants talked of recent reduction in populations of this bat. Kunisaki and Kamishikirei (1988) reported that the maximum number of bats observed simultaneously on Kuchierabujima was 9 during the survey in 1986.

Protected as a national monument by the Japanese Government.

Ecology: Funakoshi (1989) listed the following food plants: **Ebenaceae:** *Diospyros* sp. (FR, FL); **Elaeagnaceae:** *Elaeagnus* sp. (FR, L); **Elaeocarpaceae:** *Elaeocarpus decipiens* (FR); **Gingkoaceae:** *Ginkgo* sp. (L); **Moraceae:** *Ficus erecto* (FR), *F. microcarpa* (FR, B, L), *F. pumilo* (FR), *F. superba* (FR, L), *Morus australis* (FR); **Musaceae:** *Musasp.* (FR); **Myrsinaceae:** *Ardisia crenata* (FR); **Palmae:** *Livistona chinensis* (FL); **Rhamnaceae:** *Rhamnus liukiensis* (FR); **Rosaceae:** *Rhaphiolepis indica* (FL); **Theaceae:** *Eurya emarginata* (FR).

Occurrence in protected areas: There are no protected areas within the range of distribution.

Summary of threats:

- Lack of information on status.

Recommended action:

- Urgent need for surveys to assess status and threats.

P. d. formosus
Taiwanese fruit bat

Priority Grade: 1 (Endangered: Limited Distribution).

Distribution: Taiwan (Kashoto [=Lutao] (Kishida, 1924; Chen, 1984), ?Kotosho [=Lanyu] (Kano, 1934; Chen, 1984), ?Main Island: Takoo [=Takao or Kaohsung] (Andersen, 1912; Chen, 1984), Karenko [=Hualien] (Horikawa, 1932; Chen, 1984)). Recent intensive surveys have confirmed its occurrence only on Kashoto.

Status: On Kashoto, where it has been hunted for food, population has been remarkably reduced during the last few decades (information from inhabitants). Handling is currently regulated by the Government of the Republic of China under the law validated in June, 1989.

Occurrence in protected areas: There are no protected areas within the range of distribution.

Summary of threats:

- Hunting.

Recommended action:

- Urgent need for surveys to assess status and threats.
- Strict regulation against hunting is strongly desirable.

P. d. inopinatus
Orii's fruit bat

Priority Grade: 1 (Endangered: Limited Distribution).

Distribution: Ryukyu Archipelago (Okinawajima). Has occasionally been observed on Minnajima, an islet off-shore of the Motobu Peninsula of Okinawajima (Hinoue, pers. comm.). However, because this animal is not observed on the latter island throughout the year, it is highly probable that the above observations indicate a temporary migration from Okinawajima.

Status: Seems to be abundant in the southern and central parts of Okinawajima (Maruyama, 1980; Shiroma *et al.*, 1981). There is no information concerning its status in the Motobu Peninsula or the northern part of the island.

Ecology: Feeds on the following plants (Maruyama, 1980; Ikehara *et al.*, 1981; Shiroma *et al.*, 1981): **Actinidiaceae:** *Actinidia rufa* (FR); **Araliaceae:** *Schefflera actophylla* (T); **Bromeliaceae:** *Ananas comosus* (FR,T); **Elaeocarpaceae:** *Elaeocarpus decipiens* (T), *E. japonicus* (T); **Ericaceae:** *Pieris japonica* (FR); **Euphorbiaceae:** *Bischofia javanica* (FR,T); **Fagaceae:** *Castanopsis sieboldii* (LB); **Guttiferae:** *Garcinia subelliptica* (FR); **Moraceae:** *Ficus microcarpa* (FR,T), *F. stipulata* (FR), *F. septica* (FR), *Morus australis* (T,L); **Musaceae:** *Musa paradislaca* (FR); **Rutaceae:** *Citrus* spp. (FR); **Smilacaceae:** *Smilax* spp. (T); **Theaceae:** *Schima wallichii* (T); **Zingiberaceae:** *Alpinia intermedia* (FR,T).

Population biology: Maruyama (1980) observed a 'possible copulation' on 15 September. Shiroma *et al.* (1981) reported that one juvenile was born on 13 May in captivity.

Occurrence in protected areas: There are no protected areas within the range of distribution.

Summary of threats:

- Unknown.

Recommended action:

- Urgent need for survey to assess status and threats.

P. d. yayeyamae
Yaeyama fruit bat

Priority Grade: 1 (Endangered: Limited Distribution).

Distribution: Ryukyu Archipelago (Miyako Group: Taramajima

(Ikehara and Shimojana, 1975); Yaeyama Group: Haterumajima, Hatomajima, Iriomotejima, Ishigakijima, Kohamajima, Kuroshima, Taketomijima, Yonagunijima [Ikehara *et al.*, 1984]).

Status: Population sizes seem relatively large on Ishigakijima, Iriomotejima and Yonagunijima. However, populations have been remarkably reduced during the last decade on Haterumajima and Kohmajima. In 1981, H. Ota recorded 127 bats on Haterumajima. In 1985, he counted only 33 animals and found that most of the forest they used for daytime roosting had been turned into sugar cane fields. He found no bats on a visit in 1988. It seems likely, therefore, that it is seriously threatened.

Occurrence in protected areas: Exploitation of native vegetation is strictly regulated by the Japanese Government in nearly half the forest on Iriomotejima where this bat seems abundant. However, there is no regulation specific to handling bats.

Summary of threats:

- Deforestation.

Recommended action:

- Urgent need for surveys to assess status and threats.
- Drafting of tighter regulations to protect bat populations.

Principal author for this species: H. Ota.

Pteropus faunulus

Priority Grade: 8 (No Data: Limited Distribution).

Distribution: Nicobar Islands (Car Nicobar).

Summary of threats:

- Lack of information on status.

Recommended action:

- Survey to assess status, particularly in protected areas.

Pteropus fundatus

Priority Grade: 8 (No Data: Limited Distribution).

Distribution: Vanuatu (Banks Islands [Mota Lava]).

Summary of threats:

- Lack of information on status.

Recommended action:

- Survey to assess status, particularly in protected areas.

Pteropus giganteus
Indian flying-fox

Priority Grade: 11 (Not Threatened).

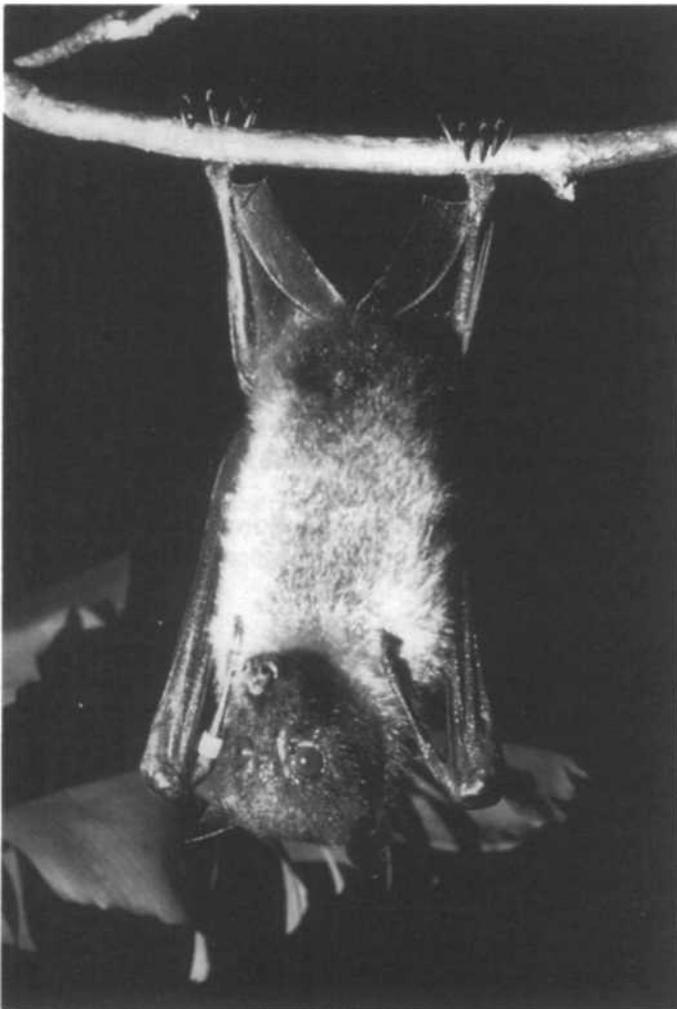
Number of subspecies: 4.

P. g. ariel

Priority Grade: 1 (Endangered: Limited Distribution).

Distribution: Maldives.

Status: Dolbeer *et al.* (1988) reported on methods used to control fruit bats on the Maldives. This action was taken because of supposed damage to fruit crops (almonds (**Rosaceae**: *Prunus dulcis*), guavas (**Myrtaceae** *Psidium guajava* and mangoes (**Anacardiaceae**: *Mangifera indica*). They reported that bats were common, but not overly abundant, on most islands visited in 1986-87. Population densities ranged from 0.6 to 2.1 bats/ha on 5 islands that were censused. Thoddoo Island, with at least 150 bats, had the largest bat population. Populations on other



Pteropus giganteus (Photo by T. H. Kunz)

islands were as follows: Feridhoo (82 bats), Alifushi (79 bats), Kuramathi/Rasdoo (50 bats) and Mualku (40 bats). Banyan trees (**Moraceae**: *Ficus benghalensis*) were by far the most common daytime roosting sites (Dolbeer, 1987). To reduce the size of bat populations, mist-nets were erected, and the bats caught were killed with chloroform-soaked rags. Mist-netting allowed populations to be very significantly reduced, in one case by almost 80%. In this case the cull left only an estimated 16 bats on the island of Alifushi. Estimated reductions of 55% and 67% were achieved on Thoddoo and Feridhoo respectively. Dolbeer *et al.* (1988) estimated that bat populations would increase at a rate of 49% a year, and further hypothesized that a bat population would take at least 3.5 years to recover to its previous level following culling. On this basis, they recommended reducing the population by 75% every 3 to 4 years. They further recommended that culling should take place in March and April, when pregnant females would be present. They stated that bat populations should never be reduced to below 0.25 bats/ha, which translates to 10 to 20 bats for a typical 40 to 80 ha island.

It is clear that under the regime described above, populations must be considered seriously threatened. The suggested culling rates have been put forward using the assumption that the population size is known and that all other mortality factors are taken into account. At best this is a very dangerous suggestion. With the small population sizes involved in the Maldives, there is a real danger of precipitating the extinction of many populations. The importance of bats as potential 'keystone' species in such island situations is not discussed by Dolbeer *et al.* (1988).

Ecology: Dolbeer *et al.* (1988) stated that bats were known to feed on commercial crops of almond, guava, and mango and were considered to be serious pests, although no evidence to support this claim was put forward.

Population biology: Dolbeer *et al.* (1988) obtained information on reproductive status from bats that were killed during culling. Pregnant females were encountered only during April 1987. Litter size was always one and most foetuses were at a similar stage of development indicating that the reproductive period was synchronized within the population and that parturition would take place from mid-April to early May. Immature bats were not collected during April but were collected at other times of the year. In 1987, parturition coincided with the average onset of the rainy season in the Maldives.

Summary of threats:

- Culling because of supposed fruit damage.

Recommended action:

- There is an urgent need to assess the damage caused by bats to commercial fruit crops. Where a need for control of populations is perceived, methods used should be non-destructive and should be based on a sound knowledge of population sizes and mortality factors.

- Education programmes should be instigated stressing the potential role of bats as 'keystone' species.
- Detailed population surveys of major islands in the Maldives need to be undertaken, concentrating on any protected areas.

P. g. chinghaiensis

Priority Grade: 10 (No Data).

Distribution: North-west China (Chin Hai province). This record is well outside the currently known distribution of *P. giganteus* and it is possible that this subspecies is not endemic to this region of China.

Summary of threats:

- Lack of information on status.

Recommended action:

- Survey to assess status, particularly in protected areas.

P. g. giganteus

Priority Grade: 11 (Not Threatened).

Distribution: Andaman Islands; Bangladesh; Burma; India (north to Punjab and eastwards to Sikkim, Bhutan Duars and Pegu); Pakistan; Sri Lanka.

Status: **Bangladesh** Widely distributed (Khan, 1985). The largest colony seen by Khan was at Barisal town in 1978, where he counted over 2500 bats on 11 trees of *Ficus religiosa* (**Moraceae**), *Albizia richardiana* (**Leguminosae**), *Enterolobium saman* (**Leguminosae**) and *Anthocephalus indica* (**Rubiaceae**). By 1981 the size went down to a little over 1000 bats because some of the trees were cut down for use in the construction of buildings (Khan, 1985).

India Thought not to be seriously threatened at present. However, bats are killed for food, because they are thought to be of medicinal value and also because of damage to fruit orchards. Are included under the Wildlife Protection Act as vermin. In a number of areas, they are considered sacred. For instance, a colony of about 500 bats in a banyan tree (*Ficus benghalensis*) complex in a small village east of Madurai in southern India is considered sacred and is treated with special care. It is thought that people who disturb the colony will be punished by the god Muni.

Sri Lanka Plentiful over most of the cultivated and jungle areas of the whole island with the exception of the highlands. Often particularly numerous along the densely populated coastal belt from north of Colombo south to Matarut appears to be absent, during the greater part of the year, from the Hambantota district. In the hills it is resident up to around 915 m, being found in great numbers around Kandy; quite recently, a colony has been established in the Lower Dikoya Valley (1067 m) but it does not appear to be resident at high altitudes. However, many will make nightly raids into the higher hill country, when

certain trees are in flower. Thus, in the Passara District where the nearest colony is said to be over 32 km distant, numbers appear during September in areas above 915 m to feed on flowers of red gum trees (**Myrtaceae:** *Eucalyptus robusta*) (Phillips, 1980).

In Pakistan this species is specifically exempted from protection under wildlife regulations.

Ecology: Roosts are very conspicuous and often in large trees such as banyans or tamarinds, generally close to water. Colonies may number many hundreds (Phillips, 1980). In Bangladesh, live in large colonies ranging from several hundred to a few thousand. The most preferred roosting trees in Bangladesh are *Ficus benghalensis*, *F. religiosa*, *Dendrocalamus strictus* (**Graminae**), *Enterolobium saman*, *Albizia* spp., *Borassus flabellifer* (**Palmae**), *Cocos nucifera* (**Palmae**), *Phoenix sylvestris* (**Palmae**), *Eucalyptus globosus* (**Myrtaceae**), *Mangifera indica* (**Anacardiaceae**), *Tamarindus indica* (**Leguminosae**), *Artocarpus lakoocha* (**Moraceae**) and *Casuarina equisetifolia* (**Casuarinaceae**) (Khan, 1985).

Feeds on the following plants (Phillips, 1980; Fujita and Turtle, 1991; author's data): **Anacardiaceae:** *Anacardium occidentale* (FR), *Mangifera indica* (FL); **Annonaceae:** *Annona muricata* (FR), *Polyalthia longifolia* (FR); **Bombacaceae:** *Ceiba pentandra* (FL); **Caricaceae:** *Carica papaya* (FR); **Combretaceae:** *Terminalia catappa* (FR); **Ebenaceae:** *Diospyros embryopteris* (FR), *D. melanoxylon* (FR); **Euphorbiaceae:** *Hevea brasiliensis* (FL); **Guttiferae:** *Calophyllum inophyllum* (FR); **Leguminosae:** *Albizia falcata* (FL), *Erythrina lithosperma* (FL); **Meliaceae:** *Melia azedarach* (FR); **Moraceae:** *Artocarpus integra* (FR), *Ficus benghalensis* (FR), *F. benjamina* (FR), *F. infectoria* (FR), *F. microcarpa* (FR), *F. mysorensis* (FR), *F. racemosa* (FR), *F. religiosa* (FR); **Musaceae:** *Musa paradisiaca* (FR); **Myrtaceae:** *Eucalyptus robusta* (FL), *Psidium guajava* (FR), *Syzygium cumini* (FR), *S. jambos* (FR); **Palmae:** *Cocos nucifera* (FL); **Proteaceae:** *Grevillea robusta* (FL); **Rhamnaceae:** *Ziziphus* sp. (FR); **Rubiaceae:** *Anthocephalus cadamba* (FR); **Sapotaceae:** *Madhuca indica* (FR).

Can be destructive in orchards and various methods have been tried to eradicate them, although these have met with little success (Prater, 1971).

Population biology: In India, produces a single young that is born in February or March after a gestation of 140-150 days (Neuweiler, 1969; Prater, 1971). Neuweiler (1969) studied a colony of 800-1000 bats in India and discovered a vertical rank order among males, each having a particular roosting area in the tree. Copulation took place from July to October and births took place mostly in March. When the young became independent they separated from the colony and gathered in a neighbouring tree.

In Sri Lanka, copulation was observed during March with the single young born from the end of May to early July (Bhat, 1942). Both sexes shared the same camps.

Summary of threats:

- No significant threats.

Recommended action:

- More work needs to be done to assess the importance of the supposed damage to fruit orchards. Methods of control need also to be investigated.

Principal author for this subspecies: G. Marimuthu.

P. g. leucocephalus

Priority Grade: 10 (No Data).

Distribution: North-east India (Assam, Manipur); Nepal.

Status: In Nepal this species is partially protected under wildlife regulations.

Summary of threats:

- Lack of information on status.

Recommended action:

- Surveys to assess status, particularly in protected areas.

Pteropus gilliardi
Gilliard's flying-fox

Priority Grade: 8 (No Data: Limited Distribution).

Distribution: Bismarck Archipelago (New Britain).

Summary of threats:

- Lack of information on status.

Recommended action:

- Survey to assess status, particularly in protected areas.

Pteropus griseus
Grey flying-fox

Priority Grade: 11 (Not Threatened).

Number of subspecies: 3.

P. g. griseus

Priority Grade: 10 (No Data).

Distribution: Bonerate; Jampea; Semau; Timor.

Summary of threats:

- Lack of information on status.

Recommended action:

- Surveys to assess status, particularly in protected areas.

P. g. mimus

Priority Grade: 10 (No Data).

Distribution: ?Philippines (Luzon); Salayar; Sulawesi.

Summary of threats:

- Lack of information on status.

Recommended action:

- Surveys to assess status, particularly in protected areas.

P. g. pallidus

Priority Grade: 8 (No Data: Limited Distribution).

Distribution: Banda Islands.

Summary of threats:

- Lack of information on status.

Recommended action:

- Survey to assess status, particularly in protected areas.

Pteropus howensis

Priority Grade: 8 (No Data: Limited Distribution).

Distribution: Solomon Islands (Ontong Java Atoll).

Summary of threats:

- Lack of information on status.

Recommended action:

- Survey to assess status, particularly in protected areas.

Pteropus hypomelanus

Priority Grade: 11 (Not Threatened).

Number of subspecies: 16.

P. h. annectens

Priority Grade: 8 (No Data: Limited Distribution).

Distribution: Natuna Islands (Serasan, Subi Besar).

Summary of threats:

- Lack of information on status.

Recommended action:

- Surveys to assess status, particularly in protected areas.

P. h. cagayanus
Island flying-fox

Priority Grade: 11 (Not Threatened).

Distribution: Philippines (Cagayan Sulu, Dinagat, Guimaras, Leyte, Luzon, Maripipi, Mindanao, Negros, Panay).

Status: Taken from sea-level to over 900 m. Rarely netted or observed in primary forest (Heaney *et al.*, 1981, 1989; Heideman and Heaney, 1989). Most common in disturbed habitats, and

frequently observed in coconut (**Palmae**: *Cocos nucifera*) groves and orchards, either at roosts or during foraging at night. Occasional individuals were found entangled in high electrical wires or tower support cables near urban orchards.

Relative abundance is difficult to assess, because individuals normally fly well above the heights at which bat nets are usually set.

Quite tolerant of disturbance, and persists in some agricultural habitats, although nowhere in the Philippines does it seem to be particularly abundant, perhaps because it is often hunted. Roosts in noisy and highly visible colonies of ten to several hundred individuals, and is vulnerable to hunters. It is probable that hunters at times exterminate local populations, especially given its low reproductive rate.

Ecology: Roosts in tall trees or coconut palms in groups of a few to several hundred (Lim, 1966 and authors' data). When very tall emergent trees were available, the bats usually choose one of these.

Some bats have been observed landing on coconut palms, and farmers indicate they feed upon the coconut flowers. Also been observed feeding on mango (**Anacardiaceae**: *Mcmgifera indica*) and chico (**Sapotaceae**: *Pouteria sapota*); undoubtedly also eats fruit and possibly nectar and pollen of some native species (e.g., *Ficus* spp. (**Moraceae**)).

Probably flies fairly long distances to forage at times, but those captured were never more than about 6-8 km from a known roost. A number of individuals may feed simultaneously in the same tree.

Population biology: The very limited data available suggest that females give birth in April and May on Negros and Maripipi (Heideman, 1987). Lactation lasts at least 3 months, and reproductive maturity in both sexes occurs at an age of more than 1 year (Heideman, 1987).

Summary of threats:

- Hunting.

Recommended action:

- Under current conditions, this subspecies persists in disturbed habitats despite being hunted. No action is necessary to protect this subspecies in the Philippines at this time. However, it would be worthwhile to monitor it (e.g., at representative roosts), as heavier hunting pressure could easily reduce population sizes considerably.

Principal authors for this subspecies: P. D. Heideman, L. R. Heaney.

P. h. canus

Priority Grade: 8 (No Data: Limited Distribution).

Distribution: Natuna Islands (Laut, Pandak, Panjang).

Summary of threats:

- Lack of information on status.

Recommended action:

- Surveys to assess status, particularly in protected areas.

P. h. condorensis

Priority Grade: 11 (Not Threatened).

Distribution: Cambodia; Thailand; Vietnam (Con Son).

Status: **Thailand** Lekagul and McNeely (1977) record it as being found off the south-east coast, while Yenbutra and Felten (1986) record it from the Provinces of Rayong and Surat Thani.

Vietnam Van Peenen (1969) recorded only one locality (Con Son) in southern Vietnam.

Summary of threats:

- Unknown.

Recommended action:

- Survey to assess status, particularly in protected areas in Cambodia.

P. h. engcmus

Priority Grade: 8 (No Data: Limited Distribution).

Distribution: Enggano; Mentawai Islands (Siberut, Sipura).

Summary of threats:

- Lack of information on status.

Recommended action:

- Surveys to assess status, particularly in protected areas.

P. h. fretensis

Priority Grade: 8 (No Data: Limited Distribution).

Distribution: Peninsular Malaysia (Jerak, west of the Sembilan Islands); Berhala (west of Jerak in the Straits of Malacca).

Status: No information.

These islands are increasingly visited by holidaymakers so there is an increased risk of shooting and disturbance. This bat is seldom seen as a pest by island residents, but may be shot by mainland villagers when it flies to feed on the adjacent mainland.

In Malaysia this species is partially protected under wildlife regulations.

Ecology: Recorded as eating ripe mango (**Anacardiaceae**: *Mangifera indica*). Apart from this, diet is unknown, but presumably includes forest fruits.

Occurrence in protected areas: Not in a protected area.

Summary of threats:

- Risk of shooting and disturbance.

Recommended action:

- Surveys to assess status.

Principal author for this subspecies: G. W. H. Davison.

P. h. geminorum

Priority Grade: 8 (No Data: Limited Distribution).

Distribution: Burma (Mergui Archipelago [South Twin Island]); Peninsular Malaysia (Paya Island southeast of Langkawi off Kedah); Thailand (coastal islands of Ko Samui and Ko Tao).

As noted above (*P. h. fretensis*) these islands are increasingly being disturbed by holidaymakers. On the islands off Thailand, bats are eaten, usually being killed at the roost site with a long stick or, increasingly, by shooting. The bats are claimed to cure asthma. The roost sites in coconut palms (**Palmae: *Cocos nucifera***) are susceptible: they are rather low and exposed, and easy to find because the bats are noisy.

Occurrence in protected areas: Paya Island is a marine reserve. This protection refers only to the waters, not to the land itself, but a management plan is being prepared by the Fisheries Department, Peninsular Malaysia, to conserve the land resources.

Summary of threats:

- Shooting and disturbance.

Recommended action:

- Surveys to assess status, and inclusion of roosts in designation of any protected areas.

Principal author for this subspecies: G. W. H. Davison.

P. h. hypomelanus

Priority Grade: 10 (No Data).

Distribution: Halmahera; Ternate.

Summary of threats:

- Lack of information on status.

Recommended action:

- Surveys to assess status, particularly in protected areas.

P. h. lepidus

Priority Grade: 10 (No Data).

Distribution: Anamba Islands (Jimaja); Peninsular Malaysia



Pteropus hypomelanus (Photo by T. H. Knnz)

(islands of Aur, Great Redang, Lang Tengah, Pemanggil, Perhentians, Tioman); Tambelan Islands (Saddle Island).

Ecology: In Tioman Island Wildlife Reserve in Peninsular Malaysia, roosts were found in palm trees every few hundred metres along the coast, but not inland.

Occurrence in protected areas:

Peninsular Malaysia

Tioman Island Wildlife Reserve

Shooting occurs in this reserve. Bats were common here in 1981, but less so in 1989 (G. W. H. Davison, pers. comm).

Summary of threats:

- Lack of information on status.

Recommended action:

- Surveys to assess status and threats from shooting, particularly in protected areas.

P. h. luteus

Priority Grade; 11 (Not Threatened).

Distribution: Bismarck Archipelago (New Britain); D'Entrecasteaux Islands; Louisiade Archipelago; New Guinea; Solomon Islands (Russell Islands); Trobriand Islands (Kiriwina).

Status: New Guinea Rare (Flannery, 1990). Only recorded once, at Marienberg, 61 km inland from the mouth of the Sepik River (Sanborn, 1931).

Summary of threats:

- Lack of information on status.

Recommended action:

- Surveys to assess status, particularly in protected areas, in the Bismarck Archipelago, D'Entrecasteaux Islands, the Louisiade Archipelago, the Solomon Islands and the Trobriand Islands.

P. h. macassaricus

Priority Grade: 10 (No Data).

Distribution: Sangir Islands; Sulawesi; Talaud Islands.

Summary of threats:

- Lack of information on status.

Recommended action:

- Surveys to assess status, particularly in protected areas.

P. h. maris

Priority Grade: 1 (Endangered: Limited Distribution).

Distribution: Maldives.

Status: Unknown but probably threatened by culling (see above under *Pteropus giganteus ariel*).

Summary of threats:

- Culling because of supposed fruit damage.

Recommended action:

- This subspecies's role in possible damage to commercial fruit crops needs to be assessed urgently. If control methods are required they should be non-destructive and based on a sound knowledge of population sizes and mortality factors.
- Education programmes emphasizing the potential ecological role of bats should be instigated.
- Population surveys of major islands in the Maldives should be undertaken, concentrating on protected areas.

P. h. robinsoni

Priority Grade: 8 (No Data: Limited Distribution).

Distribution: Peninsular Malaysia (Sembilan Islands [Lallang, Rumbia]).

Status: Unknown. These islands are increasingly visited by holidaymakers and the bats are shot when they feed on the mainland (see *P. h. fretensis*).

Ecology: See *P. h. fretensis*.

Occurrence in protected areas: Does not occur in any protected areas.

Summary of threats:

- Shooting and disturbance.

Recommended action:

- Surveys to assess status.

Principal author for this subspecies: G. W. H. Davison.

P. h. simalurus

Priority Grade: 8 (No Data: Limited Distribution).

Distribution: Simalue Islands (Tapeh Islet).

Summary of threats:

- Lack of information on status.

Recommended action:

- Survey to assess status, particularly in protected areas.

P. h. tomesi

Priority Grade: 10 (No Data).

Distribution: Borneo (Coastal islands: East Kalimantan [Bilang-bilang]; Sabah [Mantanai, Mengalum]); Philippines (Sulu Archipelago [Sibutu]).

Status: Unknown.

Ecology: Roosts in the fronds of coconut palms (**Palmae:** *Cocos nucifera*) or in the branches of small trees (Payne *et al.*, 1985). Sometimes travels to the mainland to feed, but no information on diet (Payne *et al.*, 1985).

Occurrence in protected areas:

Borneo

Sabah

Mantanai Islands Wildlife Reserve

Summary of threats:

- Lack of information on status.

Recommended action:

- Surveys to assess status, particularly in protected areas.

P. h. vulcanius

Priority Grade: 8 (No Data: Limited Distribution).

Distribution: Manam (= Vulcan) off north-east New Guinea.

Summary of threats:

- Lack of information on status.

Recommended action:

- Survey to assess status, particularly in protected areas.

*Pteropus insularis***Carolines fruit bat, Chuuk (Truk) fruit bat**

Priority Grade: 1 (Endangered: Limited Distribution).

Distribution: Federated States of Micronesia (Chuuk).

Status: Does not receive local protection from the Federated States of Micronesia or the Chuuk State Government.

Little information available on abundance. Bruner and Pratt (1979) saw groups of three or four bats flying on Moen in 1976 and 1978 and noted the bats were not wary of humans. In 1983, J. Engbring (pers. comm.) observed colonies estimated to contain about 1000 bats at the summit of Tol and about 100 bats at the top of Dublon. Bats were commonly seen in 1984 on Moen, Dublon, Fefan and Tol (J. Engbring *in* Wiles and Payne, 1986). The population was estimated at 5628 in 1986 (Engbring, 1986). Numbers have almost certainly declined substantially since then, because imports into Guam from Chuuk have increased dramatically since that date. Recently, large numbers of bats were being shipped to Guam from islands within the Chuuk lagoon. There has been a noticeable decline recently in bat numbers on Moen. During a 4-day visit to Chuuk in February 1989, G. Wiles observed moderate numbers near the summit of the mountain on Tol. However, a colony of 200 observed by Engbring in 1984 appears to have disappeared. On Moen, Wiles saw very few bats and was told by residents of the island that numbers had declined significantly during the past few years. Rainey (1990) also reported low numbers during a brief visit to several islands in 1989.

A large commercial trade has existed in Micronesia during the last 20 years, with large numbers of bats captured on a number of islands and exported to the Mariana Islands for use as food (Wiles and Payne, 1986). Records reveal that 5795 *P. insularis* were exported from Chuuk to Guam between 1978 and 1989 (Wiles, 1992), with more than half of this amount, 3723 animals, exported in 1988 and 1989. The residents of Chuuk are not known to hunt this species for local use.

Chuuk's dense human population has destroyed much of the native forest on the islands in the Chuuk Lagoon. Remnants of these forests occur on the mountain tops on Moen, Dublon,

Fefan, Tol and other small islands. Most of the lower slopes of these islands have been converted to coconut (**Palmae:** *Cocos nucifera*) and breadfruit (**Moraceae:** *Artocarpus altilis*) forest, with mangoes (**Anacardiaceae:** *Mangifera indica*), bananas (**Musaceae:** *Musa* spp.) and other food crops also present. This type of habitat change has probably affected fruit bats by altering their food sources and reducing colonial roosting sites.

Ecology: Observed to feed on the flowers of coconut.

Occurrence in protected areas: No protected areas have been established within the geographic range of this species.

Summary of threats:

- Commercial hunting.
- Conversion of native forest to agroforest.

Recommended action:

- Population surveys should be conducted throughout Chuuk. The presence of this species on neighbouring islands should also be investigated. Follow-up surveys should be conducted at regular intervals of 2-5 years to determine the status and trend of each population. Census techniques should be assessed and standardized.
- CITES regulations pertaining to *P. insularis* need to be enforced. A wildlife inspector from the US Fish and Wildlife Service should be permanently stationed on Guam to inspect incoming commercial shipments of bats and assure compliance with CITES regulations.
- Pending the outcome of population surveys, regulations should be written on a local level to give this species adequate legal protection. The laws can take a variety of approaches to prevent overhunting, such as a) giving bats full protection, b) allowing bats to be hunted at subsistence level only, or c) allowing sustainable quotas for commercial harvests if adequate data on reproduction and population structure are available.
- An environmental education programme should be initiated in Chuuk. The programme should emphasise the importance of conserving natural resources, including fruit bats and other wildlife.
- The Chuuk Government should be encouraged to create protected areas. Areas for consideration should include the pockets of native forest that still remain near the summits of several islands, including Tol, Dublon and Moen.
- The biology and ecological role of this species should be studied. Information on reproduction and population structure is particularly needed.

Principal author for this species: G. Wiles.

Pteropus leucopterus

Priority Grade: 4 (Vulnerable).

Distribution: Philippines (Catanduanes, Dinagat, Luzon).

Status: Unknown. Rare and very probably endangered by deforestation on Luzon. Known predominantly from 'politically sensitive' areas, which may preclude the initiation of wide ranging status surveys (R. Wirth and W. L. R. Oliver, pers. comm.). The status on Luzon and Dinagat could be investigated as part of the cloud rat project on these islands (R. Wirth and W. L. R. Oliver, pers. comm.).

Ecology: Has been taken only on ridgetops near primary forests. Very little is known about its habitat. The majority of specimens have been taken from cloud forests and storm forests (the latter heavily damaged by typhoons at irregular intervals), (Heaney *et al.*, 1987; R. Wirth and W. L. R. Oliver, pers. comm.).

Summary of threats:

- Deforestation.

Recommended action:

- Where feasible, surveys should be conducted to determine the conservation status of this species and the habitats it uses. Its status in protected areas should be assessed.
- Consideration should be given to instigating a captive breeding programme using animals collected from 'non-sensitive' areas. Any such project should be based at Silliman University in Dumaguete City, Negros and/or the The University of the Philippines at Los Banos, Luzon, and possibly involve reputable foreign institutions at a later stage (R. Wirth and W. L. R. Oliver, pers. comm.).

Principal authors for this species: P. D. Heideman, L. R. Heaney.

Pteropus livingstonii
Comoro black fruit bat, Livingstone's bat

Priority Grade: 1 (Endangered: Limited Distribution).

Distribution: Comoros (Anjouan, Moheli).

Status: **Anjouan** According to Humboldt (Milne-Edwards and Oustalet, 1888) was abundant in the great forests of Anjouan's peaks in the late 19th Century. However, by 1977 Cheke and Dahl (1981) reported it to be extremely rare and threatened by active and progressive deforestation. Sightings of 'a number' of bats had been reported near Dzilandze in 1977, and over 60 were seen there in 1988. In 1989, the University of East Anglia Comoro Islands Expedition reported this population to be much reduced, with only a handful of sightings. Census work showed the presence of a group of 30-40 in primary forest about 3 km south of Dzilandze. The bats appeared to have moved to this new site due to disturbance from people and as a result of Cyclone Calasanji (January 1989). The forest in this area is rapidly being underplanted and cleared and there is a prospect of a highland road being built. The estimated total population was about 60 individuals. In July 1990, J. B. Carroll (pers. comm.) located a single roost estimated to contain between 60

and 120 bats. A single bat was seen flying at another locality on the island.

Moheli Reports of a few individuals seen in 1975 and 1977. The UEA expedition in 1988 found no evidence of this species, although they did not rule out the possibility of relict populations being present.

Grand Comore The UEA expedition in 1988 found no evidence of this species on Grand Comore. They did not rule out the possibility of relict populations in the Karthala Forest, although these should have been noticed by the many collectors who have visited the site since the mid-1800s. Is now extremely rare and threatened by a number of factors.

Deforestation is a serious problem in the Comoros, but there are difficulties in quantifying and monitoring the destruction. The deforestation is a gradual process of underplanting with fruit, coconuts (**Palmae:** *Cocos nucifera*), manioc (**Euphorbiaceae:** *Manihot esculenta*), maize (**Graminae:** *Zea mays*), peas (**Leguminosae:** *Pisum sativum*) and sweet potatoes (**Convolvulaceae:** *Ipomoea batatas*). This type of agriculture necessitates the removal of scrub and herbaceous layers and some large trees. This, coupled with grazing, severely affects regeneration. It also appears that in this new type of forest, *P. seychellensis comorensis* (the common Comorian fruit bat) outcompetes *P. livingstonii*. Whereas *P. s. comorensis* was formerly confined to areas below 400 m, roosts were recorded at 610 m and 1000 m in 1989 (Thorpe, 1989). *P. livingstonii* is confined to diminishing patches of primary forest. On Anjouan, virtually all of the remaining primary forest is on uncultivable slopes, while on Moheli some is still accessible but is declining rapidly. Grande Comore fares the best but this is due to the large size of the Karthala Forest. The annual loss of forest on Grande Comore is alarming. Other causes of deforestation include losses due to the cultivation of cash crops such as cloves (**Myrtaceae:** *Syzygium aromaticum*), particularly at the farmland-forest interface. Somewood is cut for fuel. Commercial exploitation is low but can be very damaging to non-target species. Anjouan is more densely populated than any African country and pressure for land is intense.

Cyclones are common in the Indian Ocean, although few affect the Comoros. A serious cyclone (winds in excess of 64 knots) appears to hit the Comoros every 10 or so years. It seems likely that the Moheli population was wiped out as a result of two major cyclones: Elinah in January 1983 and Kaimsey in April 1984. Kaimsey, with winds up to 100 knots, destroyed 80% of the food crops on Moheli. The low relief and small area of Moheli makes it more susceptible than the larger Anjouan with its complex topography. The recent incidence of major cyclones is unprecedented in climatic records for the Comoros. This could represent a shift in the storm belt of the western Indian Ocean. Whereas the Comoros were once on the edge of the cyclone belt, they are now within it (I. Thorpe, pers. comm.).

The 1989 UEA Expedition noted that part of the population had moved from Dzilandze to Hasiaka. At Dzilandze local people saw them as guardians of the lake and protected them.

This belief is not well known at Hasiaka and an influx of refugees from Madagascar (who eat bats) has further diluted the belief. Young boys now have no qualms about catapaulting bats for sport or food (Thorpe, 1989).

There is no legal protection of endangered species on the Comoros.

In 1990 the Jersey Wildlife Preservation Trust was planning to take 10 bats into captivity for breeding at Jersey Zoo as a safeguard against extinction (I. Thorpe, pers. comm.). J. B. Carroll (pers. comm.) reports that this expedition was unsuccessful at obtaining any bats for captive breeding, but it is hoped to mount another expedition in the future.

Ecology: Was seen feeding on the fruits of *Ficus lutea* (**Moraceae**) (I. Thorpe, pers. comm.).

Population biology: Voeltzkow (1904) saw numerous adult females with almost fully grown adult young in the second week of October.

Occurrence in protected areas: No protected areas have been established in the Comoros.

Summary of threats:

- Deforestation.
- Cyclones.

Recommended action:

- Assessment and monitoring of populations on Anjouan, and surveys to locate possible relict populations on Moheli and Grande Comore.
- Establishment of forest reserves on Anjouan and on Moheli and possibly Grande Comore if populations exist.
- In non-protected areas protect habitat through protection of canopy trees and maintenance of diversity through controls on logging and underplanting or through re-vegetation.
- More work on the species's feeding ecology and population biology, particularly looking at habitat requirements.
- Educational programmes should be initiated covering the role of fruit bats in forest ecology and the effects of habitat destruction and roost disturbance.
- Establishment of captive breeding colonies.

Principal author for this species: J. B. Carroll.

Pteropus lombocensis

Priority Grade: 11 (Not Threatened).

Number of subspecies: 2.

P. l. lombocensis

Priority Grade: 8 (No Data: Limited Distribution).

Distribution: Flores; Lombok.

Summary of threats:

- Lack of information on status.

Recommended action:

- Surveys to assess status, particularly in protected areas.

P. l. solitarius

Priority Grade: 8 (No Data: Limited Distribution).

Distribution: Alor.

Summary of threats:

- Lack of information on status.

Recommended action:

- Survey to assess status, particularly in protected areas.

Pteropus lylei
Lyle's fruit bat

Priority Grade: 11 (Not Threatened).

Distribution: Cambodia; Thailand; Vietnam.

Status: **Thailand** Lekagul and McNeely (1977) reported it being found along the coastal area of the Gulf of Thailand, south to Phetburi, north to Ayutthaya and east to Cambodia.

Vietnam Recorded only from Saigon (Van Peenen, 1969).

Summary of threats:

- Unknown.

Recommended action:

- Surveys to assess status, particularly in protected areas.

Pteropus macrotis
Big-eared fruit bat

Priority Grade: 11 (Not Threatened).

Number of subspecies: 2.

P. m. epularius

Priority Grade: 11 (Not Threatened)

Distribution: Australia (Queensland: Boigu Islands); New Guinea.

Status: **Australia** Rare. Only recorded from the Boigu Islands, 10km south of New Guinea in the Torres Strait (G. C. Richards, pers. comm.).

New Guinea Common (Flannery, 1990). Has been recorded at various localities in southern New Guinea from the Oriomo Plateau (Western Province) in the west to Milne Bay (Milne Bay

Province) in the east. Koopman (1982) records that it was also found in several localities in northern New Guinea. Thus it is probably widespread throughout the lowlands.

Ecology: Possibly forages in drier areas than other *Pteropus* species (Ziegler, 1982), and McKean (1972) noted that of the four specimens reported by him, one was captured in a mist-net in dryish monsoon forest and that three were shot at night while feeding on the flowers of coconut palms (**Palmae:** *Cocos nucifera*) in the same general environment.

Summary of threats:

- No known threats.

Recommended action:

- Assessment of status in protected areas and projects to learn more about ecology and population biology.

Principal author for this subspecies: T. Flannery.

P. m. macrotis

Priority Grade: 8 (No Data: Limited Distribution).

Distribution: Aru Islands (Wokam).

Summary of threats:

- Lack of information on status .

Recommended action:

- Survey to assess status, particularly in protected areas.

Pteropus mahaganus
Lesser fruit bat

Priority Grade: 3 (Vulnerable: Limited Distribution).

Distribution: Bougainville; Solomon Islands (Santa Isabel).

Status: Rare and possibly endangered (T. Flannery, pers. comm.).

Summary of threats:

- Lack of information on status.

Recommended action:

- Surveys to assess status, particularly in protected areas.

Pteropus mariannus

Priority Grade: 1 (Endangered: Limited Distribution).

Number of subspecies: 7. Yoshiyuki (1989) considered *P. m. loochoensis* to be a full species.

Populations of *P. mariannus* on a number of the Mariana Islands have never been identified to subspecies level. Recently,

Wiles and Glass (1990) questioned the validity of distinguishing two subspecies of *P. mariannus* in the Mariana Islands. This was based on the evidence of movements of *P. mariannus* between islands, which would facilitate gene flow through the chain.

P. m. loochoensis
Greater loochoo fruit bat

Priority Grade: 1 (Endangered: Limited Distribution).

Distribution: Ryukyu Archipelago (Okinawajima).

Status: Imaizumi (1970) reported that only two specimens are known to have been collected. Kuroda (1932) remarked that it 'seemed to be very rare'. Current information on status is unavailable.

May be threatened by typhoons. These are rare but can cause serious problems. Strong typhoons (windspeed in excess of 130 knots) occur once every 10-15 years. They can denude large areas of foliage and fruit and there have been reports from Indian Ocean islands of dead bats being found under trees after storms.

There are problems of habitat destruction in the Ryukyus. In some areas, most of the forest that bats use for daytime roosting has been turned over to sugar cane fields (**Graminae:** *Saccharum officinarum*). It is not known how this may have affected bats.

Legal status in the Ryukyus unknown.

Ecology: No specific information available but there is extensive data available for *P. mariannus* in the Marianas (see below).

Summary of threats:

- Forest destruction.
- Typhoons.

Recommended action:

- Intensive population surveys should be made in Okinawajima, concentrating on known protected areas. Follow-up surveys should be conducted at regular intervals of 2-5 years to determine the status and trend of the population. Census techniques should be assessed and standardized.

Principal authors for this subspecies: H. Ota, G. Wiles.

P. m. mariannus
Marianas fruit bat

Priority Grade: 1 (Endangered: Limited Distribution).

Distribution: Commonwealth of the Northern Mariana Islands (Aguijan, Rota, Saipan, Tinian); Guam.

Status: The Guam population of *P. m. mariannus* is listed as endangered by the US Fish and Wildlife Service and the Government of Guam. It is locally protected on the remaining Mariana Islands by the Commonwealth of the Northern Mariana

Islands. Populations on Saipan, Tinian and Aguijan are listed as Category 1 Endangered Species by the US Fish and Wildlife Service, meaning that the agency supports full endangered species status for these populations but does not have sufficient time or resources to finalize the listing. Populations on Rota are Category 2 Candidate Endangered Species, meaning that the US Fish and Wildlife Service has some evidence of vulnerability but not enough to justify an endangered listing at present.

Aguijan Intensive surveys in 1983 and 1984 (Wiles *et al.*, 1989) indicated that there were fewer than 10 bats on Aguijan. However, approximately 300 bats were seen in 1988 (Wiles and Glass, 1990). The population declined to about 50 bats in 1989 (Stinson *et al.*, 1992).

Guam Full details of the history of the decline of bat populations on Guam is given by Wiles (1986, 1987a, 1992). Crampton (1921) reported bats as 'not an uncommon sight' in 1920. By 1931 (Coultas, 1931) they were considered uncommon on the island, the introduction of firearms had led to their destruction. In 1945, Baker found bats uncommon in the northern half of Guam and confined primarily to the forested cliffines. He failed to locate a single colony in one year's work. In 1958, Woodside (in Wiles, 1987a) reported a maximum population of 3000, a 'greatly reduced' number. Between 1963 and 1968 monthly counts showed the island's population dropping. The last large roost in south Guam was of 150 bats at Orote Point Island in 1971. In 1972, a colony on the USAF base numbered 500-600 and made up the bulk of the island's population (estimated at less than 1000). This colony disappeared soon after and from 1974-5 the island's population was estimated at less than 100 bats. In 1978, a survey by Wheeler and Aguon (1978) estimated the population to be fewer than 50 bats. In 1980, there was a dramatic increase with a new colony at Pati Point numbering several hundred bats. In total, there were 240 bats in early April and 508 bats in mid-May. The sudden increase was probably due to immigration from Rota (Wiles and Glass, 1990). In 1981-82, the colony increased from an estimated 600 at the end of 1981 to 780-850 in 1982. In 1983, there was a decline to an estimated 500-600 bats. There were 50-100 in the forest within 1.5 km of the north cliffline from Bijia Point to Lates Point, with most animals between Achae Point and Tarague point. There were also 25-50 bats in south Guam in Nav May, Talofofu and Malojloj regions. The total island-wide estimates were: for 1981, 650-750; for 1982, 850-100; and for 1983, 600-775. In 1984, between February and April, bats were located at 11 sites, all on USAF-controlled land in northern Guam (Wiles, 1987a). The estimated total was 450-500 bats between Achae and Lafac Point in northern Guam. No bats were recorded from southern Guam or from the north-east and north-west coasts, although up to 50 bats may still inhabit these areas. A roost at Mergagan Point lost up to 40-50 bats to poachers in 1984, giving a new overall estimate of 425-500 bats (Wiles, 1987a). In 1985 the population was estimated at 695-800, although this was reduced to 500-600 by 1987. In 1988 the population increased to 600-650 due to immigration from Rota. There is currently no recruitment of young into the population

due to predation by brown tree snakes (*Boiga irregularis*) (Wiles, 1987b).

Rota Wheeler (1980) believed that only 200-400 bats were left on Rota in 1979, but his estimate was probably far too low. Wiles *et al.* (1989) estimated the population at 1500-2000 bats in 1983 and 800-1000 bats in 1984. The latter figure was also probably an underestimate. More detailed and reliable surveys of the population were conducted between August 1986 and January 1988, with estimates of 2000-2500 bats obtained (Stinson *et al.*, 1992). A severe typhoon struck the island in January 1988. Four surveys conducted between April 1988 and July 1989 indicate that population has declined to an estimated 1000-1400 bats, with the reduction caused by increases in poaching rather than storm-related factors (Stinson *et al.*, 1992).

Saipan Saipan may well have had several thousand bats until as recently as the early 1970s (Wiles *et al.*, 1989). Wheeler (1980) failed to observe any bats on the island. More intensive surveys in 1983 and 1984 (Wiles *et al.*, 1989) indicated that there were fewer than 50 bats on Saipan. Numbers on Saipan increased to about 75-100 animals in 1985 and 1986 (P. O. Glass, pers. comm.).

Tinian Wheeler (1980) estimated that there were 25-100 bats on Tinian. More intensive surveys in 1983 and 1984 (Wiles *et al.*, 1989) indicated that there were fewer than 25 bats on Tinian.

P. m. mariannus faces a number of threats:

Hunting: On Guam bats have never been viewed as agricultural pests and have been taken solely for human consumption. Overhunting has been the most important cause of decline (Wiles, 1987a). *P. m. manannus* was probably greatly reduced in numbers in the early 1900s. The expanding population and the use of firearms has accentuated the decline. Bats were removed from the list of Unprotected Wildlife in 1965 and in 1966 a 10-week hunting season was imposed. In successive years the hunting seasons became shorter and the catches more restrictive, culminating in a hunting ban in 1973 (Wiles, 1987a). In 1981 and 1984 there was additional protection when both species on Guam (*P. mariannus* and *P. tokudae*) were included in the Guam and US Endangered Species Lists respectively. But illegal hunting continues. Between 1981-84 there were 8 reported cases of hunting at colonies and 7 reported cases of hunting along flyways or at feeding sites. Colony hunting is very destructive and 50+ can be caught in one night (Wiles, 1987a). Night hunting is now opportunistic. Between 1981 and 1990 there was only one arrest and conviction, resulting in a \$100 fine.

Micronesian islanders hunt *P. mariannus* as a local food source throughout its range, except on Kosrae. Hunting for this purpose has been most intensive in the Marianas. Numerous observers on Guam, beginning with Coultas (1931), have implicated overhunting in the decline of *P. m. mariannus* on the island. Illegal hunting was responsible for the drastic decline in fruit bats on Rota in 1988 (Stinson *et al.*, 1992), with most of the

bats there killed for local consumption. Hunting for local use is also presumed to have caused severe declines in the bat populations on Saipan, Tinian and Aguijan in the 1960s and 1970s, although some of the harvested bats were exported to Guam (Wiles and Payne, 1986).

A large commercial trade involving at least four subspecies of *P. mariannus* has existed during the last 20 years, with large numbers of bats captured and exported to the Mariana Islands for use as food (Wiles and Payne, 1986; Wiles, 1992). Most of the bats were shipped to Guam but smaller numbers have also entered Saipan, Tinian and Rota. Records indicate that between 1975 and 1989, Guam imported an estimated 16,324 *P. m. mariannus* from neighbouring islands in the south Marianas (Wiles and Payne, 1986; Wiles, 1992).

Forest destruction: Deforestation is not currently a major conservation problem on the Micronesian islands inhabited by *P. mariannus*. Rapid modern development has occurred since 1985 on Guam and Saipan, but the resulting losses of forest have generally not taken place in areas used by bats. In the 1920s and 1930s much of the forest on Saipan, Tinian, Aguijan and Rota was cleared for agriculture by the Japanese. During and after World War II, military invasions and subsequent construction of military bases on Guam, Saipan and Tinian also resulted in some forest loss. However, secondary forests have regrown in many areas, particularly on Guam. Many of these forests are substantially modified, but contain a combination of introduced and native plants used by fruit bats.

Predation by brown tree snakes (*Boiga irregularis*): On Guam, predation on young *P. m. mariannus* by brown tree snakes has become a greater threat to the long-term survival of the island's population than illegal hunting. The snake was introduced to Guam shortly after the end of World War II and became abundant, particularly in southern Guam. Large numbers of snakes did not occur in the north of the island, where most bats remained, until the early 1980s (Wiles, 1987b). Observations of bat colonies from 1984 to 1988 indicated that virtually all juvenile fruit bats did not survive beyond an estimated age of 1-2 months, almost certainly because they were being eaten by snakes (Wiles, 1987b). *B. irregularis* is nocturnal and highly arboreal, and is already responsible for the near total disappearance of the island's forest-dwelling avifauna (Savidge, 1987).

Typhoons: These are a rare but serious threat. Strong typhoons (wind speed in excess of 130 knots) occur about once every 10-15 years. There is no evidence that typhoons have caused major declines of bats on Guam (Wiles, 1987a) but under present conditions, with most animals in a single colony, a typhoon directly striking the roosting area could have disastrous results.

Ecology: All Micronesian subspecies of *P. mariannus* congregate in colonies in native forest, coastal strand, and mangroves (Perez, 1968; Wiles, 1987a, 1987c; Falanruw, 1988a; Wiles *et al.*, 1989, 1991; J. Engbring, pers. comm.). The populations

include a small percentage of animals that roost alone or in small aggregations. Within colonies, bats gather in harems, which contain a male and 2-15 females, and bachelor groups, or roost as individuals on the periphery of these groups (Wiles, 1987b; Wiles *et al.*, 1991)

On Guam and Rota, colonies normally occur at isolated locations along cliffs, where human disturbance is minimal and the surrounding terrain offers some protection from winds.

The known food plants of *P. mariannus* in the Marianas include the following species (data from Wiles, 1987b; P. O. Glass, pers. comm.). **Agavaceae:** *Agave rigida* (FL); **Anacardiaceae:** *Mangifera indica* (FR); **Annonaceae:** *Annona reticulata* (FR); **Apocynaceae:** *Neisosperma oppositifolia* (FR), *Ochrosia mariannensis* (FR); **Bombacaceae:** *Ceibapentandra* (FL); **Caricaceae:** *Carica papaya* (FR); **Casuarinaceae:** *Casuarina equisetifolia* (FL), *C. litorea* (FL); **Combretaceae:** *Terminalia catappa* (FR,FL); **Cycadaceae:** *Cycas circinalis* (FR); **Elaeocarpaceae:** *Elaeocarpus joga* (FR,FL); **Guttiferae:** *Calophyllum inophyllum* (FR), *Mammea odorata* (FR,FL); **Hernandiaceae:** *Hernandia sonora* (FR); **Lauraceae:** *Persea americana* (FL); **Lecythidaceae:** *Barringtonia asiatica* (FL); **Leguminosae:** *Cynometra ramiflora* (L), *Erythrina variegata* (FL), *Mucunagigantea* (FL); **Loganiaceae:** *Fagraeabateriana* (FL); **Meliaceae:** *Aglaia mariannensis* (FR); **Moraceae:** *Artocarpus altilis* (FR,L), *A. mariannensis* (FR,L,T), *Ficus prolixa* (FR), *F. tinctoria* (FR); **Musaceae:** *Musa* sp. (FR); **Myrtaceae:** *Psidium guajava* (FR); **Palmae:** *Cocos nucifera* (FL); **Pandanaceae:** *Freycinetiareineckeii* (FR,FL), *Pandanus fragrans* (FL), *P. tectorius* (FR,FL); **Passifloraceae:** *Passiflora suberosa* (FR); **Rubiaceae:** *Guettarda speciosa* (FL); **Sapindaceae:** *Tristiropsis obtusangula* (FR); **Solanaceae:** *Cestrum diurnum* (FR); **Urticaceae:** *Dendrocnidne latifolia* (FR,FL), *Pipturus argenteus* (FR); **Verbenaceae:** *Premna obtusifolia* (FR).

Movements of *P. mariannus* are poorly known. Bats from Guam's only remaining colony are suspected to forage up to 10-12 km from their roosting site. Wiles and Glass (1990) provide evidence of inter-island movements. On rare occasions, groups of 50-300 bats fly 60-80 km between Rota and the neighbouring islands of Guam and Aguijan. Hunting and other forms of human disturbance are believed to cause most of these flights. Additional movements between other islands by solitary bats and groups of several individuals have also been noted.

Population biology: On Guam, copulation and lactation have been observed throughout the year (Wiles, 1987b). Approximately 7-20% of all harem females possess small to medium-sized young each month with no consistent peak in births noted between years.

Occurrence in protected areas: The Government of Guam has designated four conservation reserves that total approximately 1700 ha, but none contain significant numbers of fruit bats. However, most of the island's bats roost and feed on Andersen Air Force Base (6250 ha), with small numbers also present on the US Naval Facility (134 ha), US Naval Communications

Area Master Station (1196 ha) and US Naval Magazine (3578 ha). Military bases on Guam have functioned as partial refuges for fruit bats and other wildlife in the past 35 years. By limiting access to civilians and clearing few additional tracts of native forest, the military has unintentionally reduced illegal hunting and maintained habitat.

Summary of threats:

- Illegal hunting.
- Predation by snakes.
- Forest destruction.
- Typhoons.

Recommended action:

- Sources of mortality must be minimized to prevent further reductions in population and to allow for expansion. Illegal hunting must be eliminated by a combined effort from conservation officers, military security police and federal wildlife enforcement agents. With the addition of *P. mariannus* to Appendix I of CITES in 1990, a wildlife inspector from the US Fish and Wildlife Service should be permanently stationed on Guam to inspect incoming shipments of bats and ensure compliance with CITES regulations.
- Measures must be taken on Guam to reduce predation by brown tree snakes. Various snake control methods should be tested and implemented. At present, control methods may be possible in small areas, such as around traditional roosting sites, but control over a much larger area is not currently feasible. A large-scale control programme will require substantial outlays of funding, and may not be achievable for years. Efforts to prevent the spread of snakes to other islands are needed so that other bat populations do not become threatened.
- Environmental education programmes should be expanded and new ones started. Programmes should emphasize the importance of conserving natural resources, including fruit bats and other wildlife.
- The US Fish and Wildlife Service has proposed that 'critical' habitat be listed for fruit bats on Guam, under the US Endangered Species Act. The current proposal would list about 100 sq km of forest in northern and southern Guam. If accepted, this action would provide long-term protection for the island's forests.
- Additional research on the biology and ecological role of *P. m. mariannus* is needed, focusing particularly on reproduction and population structure, and on habitat requirements and food habits.
- Essential forest ecosystems need to be managed for the benefit of fruit bats.
- Periodic surveys of distribution and status of fruit bats need to be undertaken to evaluate trends and appraise success of management efforts.
- A co-operative agreement needs to be developed between the Territory of Guam, the Commonwealth of the Northern Mariana Islands, and the US Fish and Wildlife Service for the

management and protection of fruit bats.

- Existing populations of fruit bats on Guam could be augmented by reintroducing them to suitable habitat within their former ranges.
- The process of listing populations of *P. m. mariannus* as endangered on Rota, Aguijan, Tinian and Saipan should be completed by the US Fish and Wildlife Service. Legal status as endangered species for these bats would focus attention on the severity of the situation, extend law enforcement responsibilities to US federal agents, increase the penalties for killing and marketing fruit bats, and potentially open up new sources of funding for research and recovery.
- Although most bats are on the USAF base, there is little direct protection of the bats there. Guam Conservation Officers were prevented from patrolling USAF property between November 1983 and July 1985 because of firearms restrictions. USAF security police are limited in the amount of patrolling they can do for violation of wildlife laws. Thus there needs to be more liaison between conservationists and the military, and rigorous prosecution of illegal take, sale and trespass laws.
- For more details of recommended action see also Wiles (1987b), Wiles *et al.*, (1989) and US Fish and Wildlife Service (in press).

Principal author for this subspecies: G. Wiles

P. m. paganensis
Pagan Island fruit bat

Priority Grade: 1 (Endangered: Limited Distribution).

Distribution: Commonwealth of the Northern Mariana Islands (Alamagan, Pagan).

Status: Locally protected in the CNMI. Populations on islands north of Saipan are Category 2 candidate endangered species, meaning that the US Fish and Wildlife Service has some evidence of vulnerability but not enough to justify an endangered listing at present.

Alamagan Wiles *et al.* (1989) surveyed the island in 1983, though only two counts were made. No bats were seen on either occasion. A recent trip to Alamagan in March 1988 discovered moderate numbers of fruit bats in many of the island's forested ravines (P. O. Glass, pers. comm.). This suggests that numbers have perhaps increased since 1983.

Pagan Wiles *et al.* (1989) surveyed the island in 1983. They noted one colony believed to contain 2000 bats (this was probably the largest colony in the Marianas). They estimated 2500 bats on the island as a whole.

Threatened by hunting and by the effects of typhoons (see *P. m. mariannus*).

Ecology: See *P. m. mariannus*.

Population biology: See *P. m. mariannus*.

Occurrence in protected areas: There are no protected areas within the geographic range.

Summary of threats:

- Illegal hunting.
- Typhoons.

Recommended action:

- Clarify taxonomic relationship between this subspecies and *P. m. mariannus*. Inter-island movements in the Marianas suggest that all fruit bats in the archipelago are the same subspecies (Wiles and Glass, 1990).
- See also *P. m. mariannus*.

Principal author for this subspecies: G. Wiles.

P. m. pelewensis
Belau fruit bat

Priority Grade; 1 (Endangered: Limited Distribution).

Distribution; Belau.

Status: Extensive population surveys have never been made. Owen (1977) described fruit bats as common but declining, yet visitors to Belau from 1983 to 1985 found bats to be common in many areas (Wiles and Payne, 1986). In 1988, Wiles and Conry (1990) estimated 130-170 bats in the Ngerukewid Islands Wildlife Preserve, a somewhat isolated group of islands in south-central Belau. Fruit bat abundance appeared to be much lower on several other islands in central and southern Belau at the same time.

Threatened by hunting and the effects of infrequent typhoons (see *P. m. mariannus*). Guam imported an estimated 112,184 bats from Belau between 1975 and 1989 (Wiles, 1992).

Not protected on Belau. The recently amended CITES regulations do not cover trade between Belau and Guam because this is deemed not to be international.

Ecology: The diet probably contains an even greater variety of foods than that described above for *P. m. mariannus* in the Mariana Islands, reflecting the fact that Belau's forests are the most diverse in Micronesia, but only a few food plants have thus far been reported (Perez, 1968; Wiles and Conry, 1990):

Anacardiaceae: *Mangifera indica* (FR); **Apocynaceae:** *Neisosperma oppositifolia* (FR); **Combretaceae:** *Terminalia catappa* (FR); **Cycadaceae:** *Cycas circinalis* (FR); **Leguminosae:** *Intsia bijuga* (FL); **Moraceae:** *Ficus* spp. (FR); **Myrtaceae:** *Eugenia malaccensis* (FR); **Palmae:** *Gulubia palauensis* (FL); **Pandanaceae:** *Pandanus tectorius* (FR).

Population biology: Females have been observed flying with young in January (Wiles and Conry, 1990), but not in April (Perez, 1968).

Occurrence in protected areas: Occurs in the small Ngerukewid Islands Wildlife Preserve, which is the only nature reserve in the Caroline Islands.

Summary of threats:

- Commercial hunting.
- Typhoons.

Recommended action:

- Intensive population surveys should be made in Belau. Follow-up surveys should be conducted at regular intervals of 2-5 years to determine the trend and status of the population. Census techniques should be assessed and standardized.
- Pending the outcome of fruit bat population surveys, new local regulations should be made to give bats adequate legal protection in Belau. The laws can take a variety of approaches in preventing overhunting, such as 1) giving bats full protection, 2) allowing bats to be hunted at subsistence level only, or 3) allowing sustainable quotas for commercial harvests if appropriate information on reproduction and population structure is available.
- The general comments under *P. m. mariannus* concerning minimizing sources of mortality, environmental education programmes, research needs and the management of forest ecosystems apply equally to *P. m. pelewensis*.

Principal author for this subspecies: G. Wiles.

P. m. ualananus
Ualan fruit bat

Priority Grade: 1 (Endangered: Limited Distribution).

Distribution: Federated States of Micronesia (Kosrae).

Status: Coultas (1931) observed only a few during 5 months of collecting birds on Kosrae for the Whitney South Sea Expedition in 1931. He reported bats to be nearly extinct and attributed their rarity to a disease that reportedly killed 'thousands' of animals in about 1927. In 1983 J. Engbring (pers. comm.) observed several colonies, each with about 100-400 bats, high in the interior of the island. No current population estimates are available. Kosraean government officials believe that the island's population has declined significantly in recent years (G. Jackson, pers. comm.). A brief survey in 1989 revealed that bats were not common (Rainey, 1990).

Has been threatened by hunting for export to the Marianas. Government officials in Kosrae stated in 1989 that significant numbers have been exported to the Marianas in recent years (W. E. Rainey, pers. comm.), although the Guam Department of Agriculture does not have documentation to support this. Recently amended CITES regulations have made this trade illegal.

Also threatened by the effects of infrequent typhoons (see *P. m. mariannus*).

Not locally protected on Kosrae.

Ecology: There is no specific information on this subspecies, although feeding habits are probably similar to those of *P. mariannus* in the Marianas.

Population biology: See *P. m. mariannus*.

Occurrence in protected areas: There are no protected areas on Kosrae.

Summary of threats:

- Commercial hunting.
- Typhoons.

Recommended action:

- See *P. m. pelewensis*.

Principal author for this subspecies: G. Wiles.

P. m. ulthiensis
Ulithi fruit bat

Priority Grade; 1 (Endangered: Limited Distribution).

Distribution: Federated States of Micronesia (Yap [Ulithi Atoll]). Enquiries to islanders on Ulithi resulted in reports of bats occurring on several other atolls where they had previously been unreported. They were reported to occur on Fais and Satawal, single islands located 80 km east and 800 km south-east of Ulithi, respectively, and on Woleai, 500 km south-east of Ulithi. These are presumably *P. mariannus*, possibly *P. m. ulthiensis*, or perhaps *P. insularis*, known from Chuuk (Wiles *et al.*, 1991).

Status: In March 1986, Wiles *et al.* (1991) surveyed 14 islands within Ulithi Atoll. A total of 715 bats were observed during the census and the overall population was estimated at 895-1060 bats at an overall density of 0.43-0.51 bats per ha. Fruit bats were most numerous on Sorlen, Fossarai (including Lolang) and Asor, each with a population of at least 120 animals. The largest number and highest density was on Sorlen, where a colony of 146 bats resided. Most other islands apart from the above three had estimated populations of 40-70 bats. Eight other islands in the atoll had suitable habitat but were not surveyed. If the densities of bats were the same as elsewhere, this would increase the overall estimated population to 1128-1333 bats. The bats do not avoid islands with people, but did avoid villages by day. There was some evidence of deliberate disturbance by Ulithians, with small numbers occasionally shot by hunters. The estimated densities for fruit bats are the highest recorded for *Pteropus*.

Although hunting does take place, it is on a relatively small scale and has probably had little effect on the overall population (Wiles *et al.*, 1991). Fruit bats have been protected from hunting since 1981 (Falanruw, 1988a, 1988b). In November 1988, a month-long hunting season was introduced. Methods of harvest other than air guns and traditional methods were prohibited. The number of animals killed during the season is unknown, but

two shipments totalling 37 bats were exported to Guam (Wiles *et al.*, 1991)

Ulithi was struck by two severe typhoons in December 1986 and January 1987. It is not known what effect the storms had on the bat population.

Ecology: Most day roosting is colonial, with 68% of bats observed during a survey in March 1986 roosting in colonies of > 20 bats (Wiles *et al.*, 1991). Colonies were present on most islands, typically in the upper halves of emergent trees with crowns several metres above the surrounding forest canopy. Colonies were composed mainly of harem groups of one male and several females and usually contained some solitary individuals, mostly males (Wiles *et al.*, 1991).

Feeds on the following plants (Wiles *et al.*, 1991): **Apocynaceae:** *Neisosperma oppositifolia* (FR); **Guttiferae:** *Calophyllum inophyllum* (FR); **Moraceae:** *Artocarpus altilis* (FR,L), *Ficus prolixa* (FR); **Musaceae:** *Musa sp.* (FL); **Myrtaceae:** *Eugenia javanica* (FR); **Palmae:** *Cocos nucifera* (sap); **Pandanaceae:** *Pandanus tectorius* (FR); **Rubiaceae:** *Guettarda speciosa* (FR,L).

In Ulithi, fruit bats undoubtedly play a major role in dispersing fruits of trees that have seeds >1 cm in diameter, such as *Pandanus*, *Guettarda*, *Neisosperma*, *Eugenia*, and *Calophyllum*. Micronesian starlings (*Aplonis opaca*) are the only other frugivorous vertebrates on the atoll, but they feed primarily on smaller fruit and fruit with smaller seeds (Baker, 1951; Jenkins, 1983). Coconut crabs (*Birgus latro*) feed on fallen fruit (Reyne, 1939; Holthuis, 1963) and may rival *Pteropus* as seed dispersal agents for some island tree species, but this aspect of crab biology is poorly understood (Wiles *et al.*, 1991).

Population biology: Four of 19 females in harems were noted with small and medium-sized young in March (Wiles *et al.*, 1991). See also general comments under *P. m. mariannus*.

Occurrence in protected areas: There are no protected areas on Ulithi Atoll.

Summary of threats:

- Commercial and local hunting.
- Typhoons.

Recommended action:

- The recommendations given under *P. m. mariannus* concerning minimizing sources of mortality, education programmes, research needs, the management of forest ecosystems and the need for periodic surveys apply equally to this subspecies.

Principal author for this subspecies: G. Wiles.

P. m. yapensis
Yap fruit bat

Priority Grade: 1 (Endangered: Limited Distribution).

Distribution: Federated States of Micronesia (Yap).

Status: Abundance declined sharply because of overhunting in the late 1970s (Falanruw, 1988a, 1988b). Observations in 1976 and 1978 indicated that fruit bats were less common on Yap than on other islands in the Carolines (Bruner and Pratt, 1979). By 1981, just 1000 animals were believed to be left in the island group (M. V. C. Falanruw *in* Wiles and Payne, 1986) causing the Yap Government to ban all hunting. Surveys in 1984 and 1986 revealed that numbers had increased to an estimated 2500-5000 bats (Engbring, 1985, 1986).

Has been threatened by hunting both for local use and for export. Guam imported an estimated 23,410 bats from Yap between 1975 and 1989 (Wiles, 1992). The recent ban on hunting has lessened this threat for the time being, although some illegal hunting continues (M. V. C. Falanruw, pers. comm.). The recently amended CITES regulations have made the trade in fruit bats to Guam illegal. Also threatened by typhoons (see *P. m. mariannus*).

Locally protected on Yap.

Ecology: Falanruw (1988a) listed the following food plants: **Anacardiaceae:** *Camposperma brevipetiolata* (FR), *Mangifera indica* (FR), *Semecarpus veneosus* (FR); **Annonaceae:** *Annona muricata* (FR); **Bombacaceae:** *Ceiba pentandra* (FR); **Caricaceae:** *Carica papaya* (FR); **Chrysobalanaceae:** *Parinari* spp. (FL); **Combretaceae:** *Lumnitzera littorea* (FL), *Terminalia catappa* (FR); **Euphorbiaceae:** *Glochidion* sp. (FL); **Guttiferae:** *Calophyllum inophyllum* (FR,FL); **Leguminosae:** *Inocarpus fagifer* (FR); **Moraceae:** *Artocarpus altilis* (FR), *A. heterophyllum* (FR), *Ficus prolixa* (FR); **Musaceae:** *Musa* spp. (FR); **Myrtaceae:** *Eugenia* spp. (FR); **Palmae:** *Cocos nucifera* (FR); **Pandanaceae:** *Freycinetia* sp. (FL), *Pandanus tectorius* (FR); **Rutaceae:** *Citrus* spp. (FR); **Sonneratiaceae:** *Sonneratia alba* (FR,FL,L).

Population biology: Reproduces throughout the year, but with more births possibly occurring from February to March and August to October (Falanruw, 1988a). See also *P. m. mariannus*.

Occurrence in protected areas: There are no protected areas on Yap.

Summary of threats:

- Hunting.
- Typhoons.

Recommended action:

- The general recommendations given under *P. m. mariannus* concerning minimizing the sources of mortality, education programmes, research needs, management of forest ecosystems and need for periodic surveys apply equally well to *P. m. yapensis*.

Principal author for this subspecies: G. Wiles

P. mariannus (subspecies unknown)

Priority Grade: 1 (Endangered: Limited Distribution).

Distribution: Commonwealth of the Northern Mariana Islands (CNMI) [Agrihan, Anatahan, Ascuncion, Farallon de Medinilla, Guguan, Maug, Sarigan].

Status: Locally protected in the CNMI, although a limited special hunt was allowed on Anatahan in 1988. Populations on islands north of Saipan are Category 2 candidate endangered species, meaning that the US Fish and Wildlife Service has some evidence of vulnerability but not enough to justify an endangered listing at present.

Agrihan Wiles *et al.* (1989) made counts of two separate colonies in 1983. They estimated Agrihan's bat population to be about 1000 animals. This was considered conservative and as no surveys were made of the island's upper hillsides and crater, which are partly forested, it is likely that several thousand bats could be present on this large island.

Anatahan Wiles *et al.* (1989) report that circumnavigation of the island in 1983 revealed two bat colonies on the lower slopes of the east and north-east coasts. Counts of 628 and 576 bats were obtained. Their survey did not include the central crater. They suspected that similar numbers of animals dispersed along the southern coast and into the island's craters, and estimated that about 2500 bats occurred in these two colonies. T. O. Lemke climbed to the southern rim of the large central crater in 1984, and noted that fruit bats were common inside the crater but did not make counts. The overall estimate for the island was 3000 bats.

Ascuncion Wiles *et al.* (1989) made one count in 1983, sighting 394 bats. In 1984 a high level of bat activity was seen. Adequate forest cover and food are available on the island to support a relatively small but dense population of fruit bats. Wiles *et al.* (1989) estimated 400 fruit bats to be on Ascuncion.

Farallon de Medinilla Modest numbers of bats were reported in 1971. Since then, the US military has used the island as a bombardment range. Wiles *et al.* (1989) report on a visit in 1984 during which no bats were seen.

Farallon de Parajos Wiles *et al.* (1989) made 1-day surveys in 1983 and 1984 but located no fruit bats on the island and found that suitable habitat for bats was absent.

Guguan Although fisherman have observed fruit bat colonies in the past in Guguan's eastern ravines (J. Eads, pers. comm.), none was located by Wiles *et al.* (1989) during a survey in 1983. However, they estimated that southern Guguan supported a dense population of fruit bats: of a total of 400, approximately 150 bats occurred in the centre of the island and 250 on the southern plateau and surrounding cliffs.

Maug Eldredge *et al.* (1977) and visiting fisherman previously noted small numbers of fruit bats on Maug. Wiles *et al.* (1989) reported on a visit in 1984, which located no bats. A typhoon in 1981 destroyed much of the existing forest and may have killed most of the bats. They estimated that Maug supported a small population of fewer than 25 bats.

Sarigan Wiles *et al.* (1989) surveyed the island in 1983 and found no colonies. They estimated the total population to be 125 animals. A second visit in 1983 located a small colony of 30 bats in a *Ficus* (**Moraceae**) tree in an isolated valley not previously visited.

Threatened by hunting and the effects of typhoons (see *P. m. mariannus*).

Ecology: See *P. m. mariannus*.

Population biology: See *P. m. mariannus*.

Occurrence in protected areas: The CNMI has declared the islands of Ascuncion, Farallon de Parajos and Maug as wildlife sanctuaries.

Summary of threats:

- Illegal hunting.
- Typhoons.

Recommended action: See *P. m. mariannus*.

Principal author for these populations: G. Wiles.

Pteropus mearnsi

Priority Grade: 8 (No Data: Limited Distribution).

It has been suggested by K. Koopman (pers. comm.) that *P. mearnsi* may be synonymous with *Pteropus speciosus*.

Distribution: Philippines (Basilan, Mindanao [only on the Zamboanga Peninsula]).

Summary of threats:

- Lack of information on status.

Recommended action:

- Surveys to assess status, particularly in protected areas.

Pteropus melanopogon **Black-bearded fruit bat**

Priority Grade: 11 (Not Threatened).

Number of subspecies: 3.

P. m. aruensis

Priority Grade: 8 (No Data: Limited Distribution).

Distribution: Aru Islands.

Summary of threats:

- Lack of information on status.

Recommended action:

- Survey to assess status, particularly in protected areas.

P. m. keyensis

Priority Grade: 8 (No Data: Limited Distribution).

Distribution: Kai Islands (Little Kai).

Summary of threats:

- Lack of information on status.

Recommended action:

- Survey to assess status, particularly in protected areas.

P. m. melanopogon

Priority Grade: 10 (No Data).

Distribution: Ambon; Banda Islands; Boano Buru; Gorong Islands (Manawoka); Saparua; Seram; Tenimber Islands.

Summary of threats:

- Lack of information on status.

Recommended action:

- Surveys to assess status, particularly in protected areas.

Pteropus melanotus

Priority Grade: 11 (Not Threatened).

Number of subspecies: 6.

P. m. melanotus

Priority Grade: 8 (No Data: Limited Distribution).

Distribution: Nicobar Islands (Car Nicobar).

Summary of threats:

- Lack of information on status.

Recommended action:

- Survey to assess status, particularly in protected areas.

P. m. modiglianii

Priority Grade: 8 (No Data: Limited Distribution).

Distribution: Enggano.

Summary of threats:

- Lack of information on status.

Recommended action:

- Survey to assess status, particularly in protected areas.

P. m. natalis

Priority Grade: 11 (Not Threatened).

Distribution: Christmas Island off the south coast of Jawa.

Status: Christmas Island remained unsettled by humans until 1888, when it was colonized by a small group to exploit phosphate. Andrews (1900, 1909) provided comments on the status of fruit bats at the time of first human settlement of the island and 20 years after settlement in 1908. Unlike several other indigenous mammals on the island, which seemingly had become extinct by 1908, fruit bats were still present in good numbers. Visits in 1932 and 1947 showed that the fruit bats were still present in some abundance (Gibson-Hill, 1947). In 1984, about 3500 bats were estimated to be using six identified camps and perhaps the same number were roosting singly or in small groups dispersed through the forest. Two other camps have since been located (J. Tranter and H. Yorkston, pers. comm.). The maximum size of the population seems unlikely to exceed 10,000. The camps appear to be important as maternity sites, and perhaps as assemblage areas for copulation.

Fruit bats are preyed on by feral cats; *Pteropus* constituted 21% by weight of the gut contents of 95 feral cats and are thus an important source of food for this animal. However, this situation has probably existed since the turn of the century and appears stable (Tidemann, 1989). Introduced house rats (*Rattus rattus*) also form an important part of the diet of feral cats (31% by weight) and probably for this reason, feral cats are commonest in areas of seral vegetation (non-climax vegetation, which occurs on ground that has been mined for phosphate) which sustain large numbers of rats. In seral vegetation, *Pteropus* feed close to the ground on *Muntingia* (**Flacourtiaceae**) fruit and it is likely that most fall prey to cats there.

Until recently, a workforce of about 3000 people was stationed on the island in connection with phosphate mining. A number hunted fruit bats for consumption and quite large catches were made, in some cases 200 at a time. Hunting is a simple matter because these bats to a large extent are diurnal and evince little fear of humans. Information on when most catches were made was difficult to obtain, but it seems likely that most hunting was done at about the same time as the peak of births (Tidemann, 1985, 1987). Phosphate mining ceased in 1987 because it was no longer profitable and the human population of the island has since become much reduced. Hunting does not now seem to be a serious threat to survival. A much reduced mining venture is to be started up soon, but it will be restricted to areas that have already been cleared of natural vegetation.

Probably of far greater concern in the longer term is the fact that in mid-1987 the rat snake (Family Colubridae: *Lycodon aulicus capucinus*) was accidentally introduced to the island from Asia (probably in building materials) and since then about 30 individuals have been found (Smith, 1988; D. Phillips, pers.

comm.). Given the threat posed to *P. mariannus* on Guam by the introduced colubrid snake, *Boiga irregularis*, it seems likely that *Lycodon* could also become a serious problem on Christmas Island.

Ecology: Utilizes most vegetation types present, including seral vegetation, which occurs on ground that has been mined for phosphate.

Camps were located in *Pisonia* (**Nyctaginaceae**), *Barringtonia* (**Lecythidaceae**) and *Ficus* (**Moraceae**) canopy emergents, but dispersed individuals were present in many vegetation associations. An important feature of camp locations seems to be the ease with which departing animals can gain access to wind currents, which they use extensively to commute to feeding locations.

The following food plants were noted either through direct observation or analysis of gut contents. Pollen from many other taxa were also isolated from gut contents, but were unidentifiable due to a lack of reference material. **Anacardiaceae:** *Mangifera indica* (FR); **Caricaceae:** *Caricapapaya* (FR); **Combretaceae:** *Terminalia catappa* (FR,FL); **Euphorbiaceae:** *Macaranga tanarius* (FL); **Flacourtiaceae:** *Muntingia calabura* (FR); **Lecythidaceae:** *Barringtonia asiatica* (FL), *B. racemosa* (FL); **Meliaceae:** *Dysoxylum gaudichaudianum* (FL), *Melia azedarach* (FL); **Moraceae:** *Ficus* spp. (FR,L); **Myrtaceae:** *Eugenia grandis* (FR,FL), *Psidium guajava* (FR); **Palmae:** *Arenga listeri* (FL), *Cocos nucifera* (FL); **Rubiaceae:** *Morinda citrifolia* (FL); **Sapindaceae:** *Tristiropsis acutangula* (FR,FL); **Sapotaceae:** *Plachonella nitida* (FR,FL); **Solanaceae:** *Physalis* sp. (FL); **Ulmaceae:** *Celtis cinnamomea* (FR); **Urticaceae:** *Dendrocnide* sp. (FL), *Pipturus argenteus* (FL).

The fruit of the introduced plant *Muntingia calabura* provides an important food source, particularly in areas that have been cleared for phosphate mining. *Muntingia* is a colonist of disturbed areas and its seeds are dispersed by *P. melanotus*.

A revegetation programme is also about to be initiated by the Australian National Parks and Wildlife Service. This should ensure an expansion of the feeding resources available.

Population biology: There is a single breeding season with a peak period of births in February. One young is produced after a gestation of about 5 months. Females mature rapidly and can become pregnant when they are only 6 months old. By contrast, males take about 18 months to reach maturity. The result of these differences in maturation rates is a highly skewed population structure in which mature females outnumber mature males by about 3:1 which is reflected in the social structure of camps and a consequently polygamous mating system.

Occurrence in protected areas: Christmas Island National Park is under the control of the Australian National Parks and Wildlife Service. The National Park has recently been extended substantially and now covers 63% of the island. This action ensures protection of the major camps and feeding areas.

Summary of threats:

- Probable predation by rat snakes.

Recommended action:

- The most serious potential threat is from the introduced rat snakes. The Australian National Parks and Wildlife Service is initiating an investigation into the status of this animal.

Principal author for this subspecies: C. R. Tidemann.

P. m. niadicus

Priority Grade: 8 (No Data: Limited Distribution).

Distribution: Nias.

Summary of threats:

- Lack of information on status.

Recommended action:

- Survey to assess status, particularly in protected areas.

P. m. satyrus

Priority Grade: 8 (No Data: Limited Distribution).

Distribution: North Andaman Islands.

Summary of threats:

- Lack of information on status.

Recommended action:

- Survey to assess status, particularly in protected areas.

P. m. tyleri

Priority Grade: 8 (No Data: Limited Distribution).

Distribution: South Andaman Islands.

Summary of threats:

- Lack of information on status.

Recommended action:

- Survey to assess status, particularly in protected areas.

Pteropus molossinus
Pohnpei fruit bat

Priority Grade: 1 (Endangered: Limited Distribution).

Distribution: Federated States of Micronesia (?Chuuk [Mortlock Islands], Pohnpei [Ant Atoll, Pakin Atoll]).

Status: Does not receive local protection from the Federated States of Micronesia or the Pohnpei State Government.

Chuuk Reported to occur in the Mortlock Islands (Thomas, 1882), but its status and distribution there is unknown. Because of the small area of these islands, which totals only 12 sq km, the overall population probably does not contain more than several thousand individuals.

W. E. Rainey, based on an examination of the relevant specimens, but without actual fieldwork, believes that this locality record is erroneous and that there are no occurrences outside Pohnpei, Ant and Pakin.

Pohnpei Described as common at all elevations in the 1950s (Jackson, 1962). Bruner and Pratt (1979) observed 'many' bats throughout the island during visits in 1976 and 1978. Locally common in the northern half of Pohnpei in July 1981 (Wiles and Payne, 1986). Evidence gathered in 1989 indicated that significant declines in the populations have occurred recently (Rainey, 1990).

Ant Atoll: Common in 1957 on this atoll which lies 15 km west of Pohnpei (Jackson, 1962).

Pakin Atoll: Reported on this atoll (approximately 30 km west of Pohnpei) by Pohnpeian government staff (W. E. Rainey, pers. comm.).

Has been threatened by the large commercial trade that has developed in the past 20 years. Records show that 15,223 bats were exported from Pohnpei to Guam between 1979 and 1989 (Wiles, 1992). Shipments to Guam increased significantly in 1989, with 6478 animals exported (Wiles, 1992). Fruit bats from the Mortlock Islands have also been shipped to Guam in the past few years, but the volume of this trade and the species composition is unknown. Hunting for local use is virtually non-existent because bats are viewed as unacceptable food by Pohnpeians. The recently amended CITES regulations have made this trade to Guam illegal.

Many areas of native forest at lower elevations on Pohnpei have been converted to agroforest, which contains breadfruit (Moraceae: *Artocarpus altilis*), coconut trees (**Palmae:** *Cocos nucifera*), mangoes (**Anacardiaceae:** *Mangifera indica*), bananas (**Musaceae:** *Musa* spp.), and other food crops, or secondary forest. This activity probably affects fruit bats by altering food sources and reducing colonial roosting sites.

Ecology: Jackson (1962) and Bruner and Pratt (1979) saw many individuals and pairs of bats around the island, an indication that a large proportion may roost outside colonies. G. Wiles observed a colony of about 200-300 individuals in forest on top of Sokeh's Rock in 1981.

Has been observed to eat the fruits of *Clinostigma* (**Palmae**) and the flowers of *Ceiba pentandra* (**Bombacaceae**) and *Cocos nucifera* (Jackson, 1962; author's data).

Population biology: Jackson (1962) collected unweaned young on Pohnpei in February, September and November.

Occurrence in protected areas: No protected areas have been established within the range of *P. molossinus*.

Summary of threats:

- Commercial hunting.
- Deforestation.

Recommended action:

- Population surveys should be conducted throughout the range of *P. molossinus*. In the Mortlock Islands, where at least one other species of *Pteropus* occurs, participants in surveys must be able to distinguish *P. molossinus* from *P. phaeocephalus* and perhaps *P. insularis*. Follow-up surveys should be conducted on all islands at regular intervals of 2-5 years to determine the status and trend of each population. Census techniques should be assessed and standardized. The methods used by Wiles *et al.* (1991) to census *P. mariannus ulthiensis* on Ulithi Atoll may be applicable on the atolls within this species's range.
- CITES regulations pertaining to *P. molossinus* need to be enforced. A wildlife inspector from the US Fish and Wildlife Service should be permanently stationed on Guam to inspect incoming shipments of bats and ensure compliance with CITES regulations.
- Pending the outcome of population surveys, regulations should be written on a local level to give this species adequate protection. The laws can take a variety of approaches to prevent overhunting, such as a). giving bats full protection, b). allowing bats to be hunted at subsistence level only, or c). allowing sustainable quotas for commercial harvests if suitable information on reproduction and population biology is available.
- An environmental education programme should be initiated on Pohnpei and the Mortlock Islands. This should emphasize the importance of conserving natural resources, including fruit bats and other wildlife.
- The Pohnpei and Chuuk governments should be assisted in creating new protected areas. One important area for consideration is the heavily forested ridge of tall mountains in central Pohnpei.
- The biology and ecological role of *P. molossinus* should be studied. Information on reproduction and population structure is particularly needed.

Principal author for this species: G. Wiles.

Pteropus neohibernicus
Bismarck fruit bat

Priority Grade: 11 (Not Threatened).

Number of subspecies: 2

P. n. hilli

Priority Grade: 8 (No Data: Limited Distribution).

Distribution: Bismarck Archipelago (Admiralty Islands).

Summary of threats:

- Lack of information on status.

Recommended action:

- Survey to assess status, particularly in protected areas.

P. n. neohibernicus

Priority Grade: 11 (Not Threatened).

Distribution: Bismarck Archipelago (Duke of York, Mioko [near Duke of York], New Britain, New Ireland); Gebe; Karkar Island; Misool; New Guinea; Sakar; Umboi.

Status: **New Guinea** Common (Flannery, 1990). Seems to be widespread on the mainland, being recorded from the Morehead region of the trans-Fly (Waithman, 1979), Mount Dayman (Brass, 1956), the Torricelli Mountains and Andei (=Manokwari) and Mansinam, Vogelkop Peninsula (Andersen, 1912). Indeed, it is probably present throughout most of the country below 1000 m. Can clearly survive on small islands, as demonstrated by its presence on Karkar and Sakar. Why it has not spread to other larger islands in the region, such as the Louisiade Archipelago and the D'Entrecasteaux Islands, remains mysterious.

Ecology: In New Guinea, forms massive camps in swamp forest in areas such as the upper Sepik, from which it flies into foothill forest and surrounding floodplain forest each night to feed on fruiting trees. The purple fruits of a sapotaceous tree are reported to be particularly attractive (Brass, 1964). One colony at Madang is composed of thousands of individuals. The clatter of noise of this colony can be heard for 0.5 km or so. A sweet odour characterizes the roosting site (Smith and Hood, 1981). On one night at about 21.30 h in January, Flannery (1990) observed hundreds of animals in the Yapsiei area, flying at considerable altitude, in an easterly direction from swamps along the Sepik into foothill forest. The wingbeats of this bat are extremely loud when they are circling overhead looking for food or about to alight in a tree. Smith and Hood (1981) report that on New Ireland this species stripped a *Ficus* tree (Moraceae) of fruit within 3 nights, and that bat activity around the tree dwindled to nothing after 5 nights. This species has a distinctive smell that it is difficult to describe, but it is nevertheless avidly sought as a food item in most of New Guinea.

Dillon (1960) reports on a very curious occurrence involving large pteropodids, probably *P. neohibernicus*, on the north coast of Irian Jaya at dawn. The bats were attempting to pluck floating fruit out of the sea and occasionally dipped into the water too far and splashed in. When this happened, they came to rest quietly on the surface with the wings well spread and gradually rode in on the waves of the rising tide. On reaching the beach they tumbled out of the light surf, and dragged themselves up the beach to the dunes above the high-water mark. From here they climbed the trunks of saplings to 2.4 or 3 m, and launched themselves into the air.

Population biology: Two out of four females taken in the Yapsiei area in January 1984 were pregnant. Smith and Hood (1981) reported finding individuals in breeding condition in June-August 1979 on New Ireland, and many females carrying half-grown young were observed. Hyde *et al.* (1984) believed that populations may separate into male and female camps at certain times of year but could not confirm this.

Summary of threats:

- No known threats.

Recommended action:

- Surveys to assess status, particularly in protected areas, on islands in the Bismarck Archipelago.

Principal author for this subspecies: T. Flannery.

Pteropus niger

Greater Mascarene fruit bat, Mauritian fruit bat

Priority Grade: 3 (Vulnerable: Limited Distribution).

Distribution: Réunion (now extinct); Mauritius.

Status: Mauritius Locally common (Cheke and Dahl, 1981). There were some camps of a few hundred but most bats were in groups of 1-15. At night they ranged 16-24 km from the roost. All the camps were in hilly wooded country. Camps were found from Montagne Fayence in the east, south through the Bamboa Mountains, the southern foothills of the central Plateau, Black River gorges and west to Montagne du Rempart. They were absent from the Moka Range and Nicoliere in the north-west.

The population was estimated at 10,000 in 1974 but recent evidence suggests it may be higher (Cheke and Dahl, 1981).

Reunion It was originally described from here by Brisson (Andersen, 1912), but has long since been extinct.

Rodrigues A specimen of *P. rodricensis* found by J. Anderson in 1881 was re-identified as *P. niger* by Andersen (1912). If this species were ever established on Rodrigues, it colonized from Mauritius.

It is shot for food and sport. In 1974, the annual bag was 1000 individuals, although recent evidence suggests it may be higher. Large numbers of bats are shot at but few are killed, so many are probably wounded. Hunting is traditional and therefore difficult to ban, but it should be possible to reduce the wastage. Legislation is before parliament to omit bats from the list of game species permissible to hunt without giving them special status.

Cyclones can be a serious problem. Cyclone Carol in 1960 was very severe. 'Gervaise' in 1975 was the most severe since 'Carol' and 'Claudette' in 1979 also caused havoc. The effects of cyclones are that all the fruit is stripped off the trees, bats are swept from their roosts and there is a small amount of food available for the survivors

On Reunion this species is fully protected under wildlife regulations.

Ecology: Known to feed on mango (**Anacardiaceae:** *Mangifera indica*), litchi (**Sapindaceae:** *Litchi chinensis*), longan (**Sapindaceae:** *Dimocarpus longan*), jackfruit (**Moraceae:** *Artocarpus heterophyllus*), fruits of badamier (**Combretaceae:** *Terminalia catappa*), flowers of traveller's palm (**Strelitziaceae:** *Ravenala* spp.), kapok (**Bombacaceae:** *Ceiba pentandra*), Mauritius hemp (**Agavaceae:** *Furcraea gigantea*) and fruit of native trees in the indigenous forest (Cheke and Dahl, 1981).

Population biology: Cheke and Dahl (1981) reported that females with large, almost fully independent young were seen in December. Copulation was observed in April. Copulating pairs separated from the flock to copulate elsewhere.

Summary of threats:

- Hunting.
- Cyclones.

Recommended action:

- A survey needs to be undertaken to assess the current status of the population, concentrating particularly on protected areas.
- The effects of hunting need to be monitored.

Pteropus nitendiensis

Priority Grade: 8 (No Data: Limited Distribution).

Distribution: Solomon Islands (Santa Cruz Islands [Nendo]).

Summary of threats:

- Lack of information on status.

Recommended action:

- Survey to assess status, particularly in protected areas.

Pteropus ocularis
Seram fruit bat

Priority Grade: 10 (No Data).

Distribution: Buru; Seram.

Summary of threats:

- Lack of information on status.

Recommended action:

- Surveys to assess status, particularly in protected areas.

Pteropus ornatus

Priority Grade: 9 (Indeterminate).

Number of subspecies: 2.

P. o. auratus

Priority Grade: 8 (No Data: Limited Distribution).

Distribution: New Caledonia (Loyalty Islands [Lifou, Mare]).

Status: See *P. o. ornatus*.

Ecology: See *P. o. ornatus*

Population biology: see *P. o. ornatus*.

Summary of threats:

- Lack of information on status.

Recommended action:

- Survey to assess status, particularly in protected areas.

P. o. ornatus

Priority Grade: 8 (No Data: Limited Distribution).

Distribution: New Caledonia (New Caledonia).

Status: Sanborn and Nicholson (1950) reported that '*P.ornatus* makes up the bulk of the fruit bat population in New Caledonia' and that they were less numerous than in the New Hebrides or Solomon Islands. They observed only two large fruit bat camps, of 4000 and 1500, with all other aggregations averaging around 300 animals per site.

Current camp sizes or recent population estimates are unavailable, although recent commercial imports to New Caledonia of *P. tonganus geddiei* from Vanuatu (E. Baneï, pers. comm.) suggest reduced local availability or restrictions on commercial harvest in New Caledonia. Hunting of fruit bats is controlled by local wildlife laws and commercial sale is prohibited.

Insufficient recent data are available to assess status or identify threats. Fruit bats remain a favoured food item in New Caledonia and are available in restaurants by arrangement (A. M. Bauer, pers. comm.).

Ecology: Sanborn and Nicholson (1950) noted that bats rested during the day in aggregations covering several acres which were typically located at the upper end of dense rain forest on mountain slopes. *Aleurites moluccana* (**Euphorbiaceae**). the tallest tree in these patches, was favoured for roosting. Both obvious damage to roost trees from prolonged site use and reluctance to abandon a site in response to shooting or other disturbance indicate substantial site fidelity. However, they also noted that site occupancy varied seasonally in response to a north-south gradient in fruiting and flowering of fruit trees. Few bats were observed roosting alone. When *P. o. ornatus* and *P. tonganus* were found in the same camp, they typically did not roost in the same tree.

Sanborn and Nicholson (1950) suggested that *P. o. ornatus*

ranged from sea level to at least 1066 m, but they failed to observe fruit bats in 'the dense forest commonly found on the tops of mountains...' above that elevation.

Sanborn and Nicholson (1950) observed that this species foraged predominantly nocturnally, leaving the roost an hour before sunset. However, small numbers of animals were observed foraging after 14.00 h. Feeds on the following plants (Sanborn and Nicholson, 1950): **Anacardiaceae:** *Mangifera indica* (FR); **Caricaceae:** *Carica papaya* (FR); **Elaeocarpaceae:** *Elaeocarpus percisifolius* (FR); **Juglandaceae:** *Carya* spp. (FL); **Musaceae:** *Musa* spp. (FR); **Myrtaceae:** *Melaleuca viridiflora* (FL), *Psidium guajava* (FR), *Syzygium* spp. (FR); **Palmae:** *Cocos nucifera* (FL); **Passifloraceae:** *Passiflora* spp. (FR).

Population biology: Data suggest that there is a six month gestation and a birth peak from late August to October (Sanborn and Nicholson, 1950). Sanborn and Nicholson (1950) concluded animals did not breed until their second year and observed no instances of more than one embryo or young per female.

Summary of threats:

- Unknown.

Recommended action:

- Recent field surveys of distribution, abundance, and utilization of *P. ornatus* and other New Caledonian fruit bats are needed for status assessment. Valuable data may emerge from ongoing fieldwork by the Australian Museum. Any land-use planning to preserve habitat that will support fruit bats and other remarkable elements of New Caledonia's endemic fauna and flora, should take account of the recorded movements of animals in response to fruiting and flowering.

Principal author for this species: W. E. Rainey.

Pteropus personatus
Masked fruit bat

Priority Grade: 10 (No Data).

Distribution: Bacan; Halmahera; Morotai; ?Sulawesi; Ternate.

Occurrence in protected areas:

Sulawesi

Dumoga-Bone National Park

Summary of threats:

- Lack of information on status.

Recommended action:

- Surveys to assess status, particularly in protected areas.

Pteropus phaeocephalus
Mortlock Islands fruit bat

Priority Grade: 1 (Endangered: Limited Distribution).

Distribution: Federated States of Micronesia (Chuuk [Mortlock Islands]).

Status: Does not receive local protection from the Federated States of Micronesia or the Chuuk State Government.

Mortlock Islands The Mortlock Islands are considered to include all of the islands south-east of the Chuuk Lagoon, from Nama Island to Satawan atoll. These islands are sometimes distinguished as the Upper Mortlocks (Nama Island and Losap atoll) and Lower Mortlocks (Namoluk atoll to Satawan atoll). Status and exact distribution are unknown. Thomas (1882) reported two species of small *Pteropus*, *P. phaeocephalus* and *P. molossinus*, to be present in the Mortlocks but did not provide specific island locations for his specimens. Because older references often list the Mortlocks as including only the atolls of Etal, Lukonor and Satawan, it is possible that Thomas's (1882) specimens originated from one of these three atolls.

Girschner (1912) and Marshall (1975) recorded *Pteropus* on all islets in Namoluk atoll, but did not identify which species was present or comment on general abundance.

Government officials in Chuuk report that fruit bats also occur on Losap atoll. Because the atoll is located about 80 km south-east of the Chuuk Lagoon, where *P. insularis* occurs, it is possible that this is the species present rather than *P. phaeocephalus* or *P. molossinus*.

No information is available on population size or trends. However, because of the small land area in the Mortlock Islands, which totals only about 12 sq km, the overall population probably does not contain more than several thousand animals.

Girschner (1912) reported that fruit bats are eaten by the residents of Namoluk atoll. Recent information from the Mortlocks suggested that bats were being harvested for commercial export to the Mariana Islands. In February 1989 G. Wiles learned from government officials in Chuuk that several people from the atolls of Losap, Etal and Satawan were sending regular shipments of bats to Moen, Chuuk, for export to the Marianas. Regular overnight boat traffic between the Mortlocks and Moen made the shipment of bats possible without spoilage. The amendment of the CITES regulations in 1989 has made this trade illegal.

Summary of threats:

- Commercial hunting, in combination with periodic habitat destruction and population reduction by typhoons.

Recommended action:

- Population surveys of fruit bats should be conducted throughout the Mortlock Islands. Participants in surveys must be able to distinguish between *P. phaeocephalus*, *P. molossinus* and *P. insularis*. Follow-up surveys should be conducted at regular intervals of 2-5 years to determine the

status and trend of each population. Census techniques should be assessed and standardized. The methods used by Wiles *et al.* (1991) to census *P. mariannus ulthiensis* on Uliithi Atoll may be applicable on the atolls within this species's range.

- CITES regulations pertaining to *P. phaeocephalus* need to be enforced. The wildlife inspector from the US Fish and Wildlife Service stationed on Guam should inspect incoming shipments of bats and other foodstuffs from the Federated States of Micronesia and ensure compliance with CITES regulations. Special attention should be given to establishing CITES imports from the FSM to the Commonwealth of the Northern Mariana Islands.
- Pending the outcome of population surveys, regulations should be written on a local level to give this species adequate protection. The laws can take a variety of approaches to prevent overhunting, such as a) giving bats full protection, b) allowing bats to be hunted at subsistence level only, or c) allowing sustainable quotas for commercial harvests if suitable information on reproduction and population structure is available.
- An environmental education programme should be initiated in the Mortlock Islands. This should emphasize the importance of conserving natural resources, including fruit bats and other wildlife.
- The taxonomic relationships between *P. phaeocephalus* and other species should be clarified. K. Koopman (pers. comm.) has suggested that *P. phaeocephalus* may be a subspecies of *P. insularis*, which occurs on the main islands of the Chuuk Lagoon.

Principal author for this species: G. Wiles.

Pteropus pilosus
Belau fruit bat

Priority Grade: 1 (Extinct).

Distribution: Belau.

Status: The government of Belau does not give this species any legal protection.

Presumed to be extinct. Known only from two specimens (both in the British Museum [Natural History]), which were collected prior to 1874 (K. Koopman, pers. comm.). Coultas (1931) spent 3 months in Belau in 1931 as part of the Whitney South Sea Expedition, but did not find *P. pilosus*. There have also been no observations of this bat in more recent studies (Perez, 1968; Owen, 1977; Wiles and Conry, 1990). In addition, none has been seen amongst shipments of *P. mariannus pelewensis*, which were confiscated and examined on Guam between 1984 and 1989 (Wiles, 1992).

Causes for the probable extinction are unknown. The bat's disappearance was perhaps related to the subsistence hunting of fruit bats by Belauans. *P. pilosus* is considerably larger than *P. m. pelewensis* and may have been selected for by hunters. It is

possible that any animals that may have survived into the 1960s or 1970s were commercially harvested along with large numbers of *P. m. pelewensis* for export to the Marianas.

Summary of threats:

- Hunting.

Recommended action:

- Intensive population surveys are needed in Belau for *P. m. pelewensis*. Researchers should be familiar with the appearance of *P. pilosus* (based on museum specimens) and watch for this species when performing the surveys. A slight chance remains that a relict population could still occur in a remote area of the archipelago where commercial hunting has been limited.
- Wherever possible, customs and wildlife officials in Guam and the Commonwealth of the Northern Mariana Islands should continue to examine shipments of fruit bats from Belau for *P. pilosus*.

Principal author for this species: G. Wiles.

Pteropus pohlei
Geelvink Bay fruit bat

Priority Grade: 8 (No Data: Limited Distribution).

Distribution: Yapen off north New Guinea.

Status: Last seen in 1932, but there has been no recent expedition to investigate (T. Flannery and L. Seri, pers. comm.).

Summary of threats:

- Lack of information on status.

Recommended action:

- Survey to assess status, particularly in protected areas.

Pteropus poliocephalus
Grey-headed fruit bat

Priority Grade: 11 (Not Threatened).

Distribution: Eastern Australia (New South Wales, Queensland, Victoria).

One of the few species in the genus that is confined to a continental land mass. It extends to higher latitudes than any other pteropodid. The most southerly breeding camp is near Ulladulla at a latitude of 35° 16' S. Endemic to the south-eastern forested areas of Australia, principally east of the Great Dividing Range. In the north its range overlaps with *P. alecto* and over most except the southern part it is seasonally sympatric with *P. scapulatus* (Hall, 1987). Camps containing all three species may be seen in the vicinity of the New South Wales/Queensland border. The distribution may be extending southwards (Strahan, 1983; Menkhorst and Dixon, 1985; Aston, 1987). Camps are



Pteropus poliocephalus (Photo by T. H. Kunz)

scattered at more or less regular intervals down the latitudinal range, but tend to be occupied on a seasonal basis.

Status: There seems little doubt that numbers have declined substantially since the 1930s when the first estimate of abundance was carried out (Ratcliffe, 1931, 1932), and although an overall assessment of the population has yet to be carried out, it appears to be still relatively common. The major cause of the reduction in numbers appears to be the clearing of native vegetation for agriculture. Eucalypt forest has been extensively cleared over much of its range, and rain forest over the same area is now reduced to remnants, many of which support fruit bat camps. Forays from these and camps in other vegetation types to surrounding fruit crops cause significant economic damage (Fleming and Robinson, 1987; Jamieson, 1988). Shooting of fruit bats on crops is widely carried out as a control method, although the total number killed is likely to be insignificant at population level. Of much greater concern is the shooting of animals in camps, as is still practised in Queensland, which causes considerable disruption, often when pregnant or lactating females are present. The only completely effective method of crop protection available to fruit-growers at present is exclusion

netting, which is costly to erect and maintain and is impracticable to use in some situations.

This species is protected in Victoria, but is currently unprotected in Queensland. It is protected in New South Wales, but permits may be obtained to destroy animals on crops.

Ecology: Numbers of animals in camps are linked to the reproductive cycle as well as food availability. Pregnant females congregate in the maternity camps some time before giving birth and numbers of males do not peak until later during lactation. Copulation occurs in these camps. Camps are usually in rain forests and less frequently in mangroves. In some cases they may be in very small isolates of rain forest, less than 2 ha, which are very prone to edge effects. In the south of its range camps are usually in gullies supporting small patches of forest within eucalypt forest.

The social behaviour associated with camping and breeding follows a fixed pattern. Females in advanced pregnancy segregate from the males and each bears a single young. Females carry their young for about 4-5 weeks. During the nursing period, males rejoin the females. Competition between males and courtship of females lead to pair-formation and the establishment of territories. The camp then divides into family units, groups of unattached adults, and juvenile packs, with guard groups of unattached old males on the periphery (Strahan, 1983).

Long distance movements between camps, both north and south, have been demonstrated through tracking of radio-tagged individuals (Eby, in press) and banded animals. There seems little doubt that the population is continuous with unrestricted gene flow.

In some years the rate of successful pregnancies is low and this is often coincident with high mortality rates of unweaned young. Significant adult mortality sometimes occurs over wide areas, probably through ingestion of plants containing toxic substances (L. S. Hall, pers. comm.). These events appear to coincide with poor flowering of various food plants.

Utilizes a wide range of flowers and fruits of both native and introduced plants, but main food source is the blossoms of various species of *Eucalyptus* and other species in the family Myrtaceae. Seasonal and spatial changes in the availability of this resource are the probable cause of long-distance movements (Ratcliffe, 1931, 1932; Nelson, 1965a, 1965b; Eby, in press). Animals present at one site over an extended period also show seasonal changes in diet reflecting locally changing food availability (Parry-Jones and Augee, in press). Individuals may forage up to 50 km away from a camp (Eby, in press). It is regarded as a pest of cultivated fruit over much of its range (Hall, 1987).

The following is a list of known food plants. Most cultivated fruits that are eaten have not been included; for a detailed discussion of these see Jamieson (1988). Sources are Ratcliffe (1931, 1932), Nelson (1965a, 1965b), Hall and Richards (1979), McWilliam (1985-86), Parry-Jones and Augee (in press).
Apocynaceae: *Melodinus australis* (FR); **Cunoniaceae:** *Schizomeria ovata* (FR); **Ebenaceae:** *Diospyros* sp. (FR); **Leguminosae:** *Bauhinia hookeri* F. Mueller (FL);

Castanospermum australe Cunn. (FL); **Loranthaceae:** *Amyema* spp. (FL); **Moraceae:** *Ficus* sp. (FR), *Cudrania cochinchinensis* (FR), *Morus* sp. (FR); **Musaceae:** *Musa* sp. (FR); **Myrtaceae:** *Angophora costata* (FL), *A. floribunda* (FL), *A. subvelutina* (FL), *Callistemon* spp. (FL), *Eucalyptus acmenioides* (FL), *E. alba* (FL), *E. beyeri* (FL), *E. citriodora* (FL), *E. cloeziana* (FL), *E. crebra* (FL), *E. fibrosa* (FL), *E. grandis* (FL), *E. gummifera* (FL), *E. haemastoma* (FL), *E. intermedia* (FL), *E. longifolia* (FL), *E. maculata* (FL), *E. microcorys* (FL), *E. moluccana* (FL), *E. paniculata* (FL), *E. pilularis* (FL), *E. punctata* (FL), *E. racemosa* (FL), *E. resinifera* (FL), *E. robusta* (FL), *E. siderophloia* (FL), *E. tereticornis* (FL), *E. tessellaris* (FL), *E. tindaliae* (FL), *Leptospermum* spp. (FL), *Melaleuca quinquenervia* (FL), *Melaleuca* sp. (FL), *Psidium guajava* (FR), *Syncarpia glomulifera* (FL), *S. hillii* (FL); **Palmae:** *Archontophoenix cunninghamiana* (FR) *Livistona australis* (R. Br.) Mart. (FL), *Phoenix canariensis* (FR); **Pittosporaceae:** *Pittosporum undulatum* (FR); **Proteaceae:** *Banksia aemula* (*B. serratifolia*) (FL), *B. integrifolia* (FL), *B. serrata* (FL), *Grevillea robusta* (FL); **Rubiaceae:** *Morinda jasminoides* (FR); **Salicaceae:** *Populus* sp. (L); **Solanaceae:** *Solanum mauritianum* (FR); **Verbenaceae:** *Avicennia marina* (L); **Vitaceae:** *Cissus* sp. (FR); **Xanthorrhoeaceae:** *Xanthorrhoea* spp. (FL).

Fujita and Tuttle (1991) also list the following food plants: **Moraceae:** *Ficus macrophylla* (FR); **Myrtaceae:** *Angophora lanceolata* (FL), *Eucalyptus baileyana* (FL), *E. corymbosa* (FL), *E. fastigata* (FL), *E. globoidea* (FL), *E. hemiploia* (FL), *E. intermedia* (FL), *E. obliqua* (FL), *E. planchoniana* (FL), *E. propinqua* (FL), *E. radiata* (FL), *E. reanans* (FL), *E. saligna* (FL), *E. sieberi* (FL), *E. umbra* (FL), *E. viminalis* (FL), *Lophostemon confert* (FL), *Melaleuca leucadendron* (FL), *Syncarpia laurifolia* (FL); **Proteaceae:** *Banksia robur* (FL); **Sapindaceae:** *Diploglottis cunninghamii* (FL).

Population biology: Reproductive biology has been summarized in Martin *et al.* (1987). Copulation peaks in March-April and most births occur in September-October. Both sexes appear to require 18 months or so to reach sexual maturity (Nelson, 1965b). Lactation may last for 5-6 months (Martin *et al.*, 1987), although the young can fly when about 8-10 weeks old (Strahan, 1983).

Occurrence in protected areas: Colonies occur in many national parks and other protected areas, which contain large patches of eucalypt and some rain forest, which provide food. Because of the wide-ranging movements, and the incomplete nature of information about these and overall resource requirements, the degree of protection afforded is somewhat uncertain.

Summary of threats:

- Lack of legal protection in Queensland.
- Forest clearance.

Recommended action:

- Transfer to protected fauna list in Queensland.

- Development of effective methods of discouraging animals from eating fruit crops.
- Replanting of agriculturally unproductive areas with native tree species to provide alternative food sources.

Principal author for this species : C. R. Tidemann.

Pteropus pselaphon
Bonin fruit bat

Priority Grade: 3 (Vulnerable: Limited Distribution).

Distribution: Japan (Kazan-retto [Kita-iwojima, Iwojima, Minami-iwojima], Ogasawara-shato [Chichijima, Hahajima]).

Status: Kuroda (1930) noted that this species was abundant in Kazan-retto, but had been considerably reduced in the Ogasawara-shato. Ogasawara-shato and Kazan-retto were removed from Japan and assigned to the US Government from 1945 to 1967. During that period, Hahajima in Ogasawara-shato remained uninhabited, and several hundred bats were seen there just after the island was re-assigned to Japan in 1968, although a large number of animals seemed to have been regularly captured each year (Hasuo, 1969, 1970a; Nakane *et al.*, 1970). The number of bats seems to have fallen rapidly since 1968, and Matsumoto (1978) reported that only three animals were simultaneously observed in the summer of 1978 when he and his colleagues surveyed the island. He also noted that this species had already been extirpated on Chichijima (Matsumoto, 1978, 1980).

An intensive survey was conducted on Minami-iwojima, an uninhabited island in Kazan-retto, in the middle of June 1982 recording a maximum of 79 animals observed simultaneously (Ishii, 1983). On the basis of these results, Ishii (1983) estimated a population size of 'a hundred to several hundreds'. There is no information available for other islands.

Matsumoto (1978, 1980) assumed the reduction of available food plants to be the primary factor causing the rapid decline on Hahajima.

Designated as a natural monument by the Japanese Government in 1968, thus regulating its handling.

Ecology: Feeds on the following plants (Layard, 1829; Hasuo, 1969, 1970b; Imaizumi, 1970; Matsumoto, 1978, 1980): **Agavaceae:** *Agave americana* (FL); **Caricaceae:** *Carica papaya* (FR); **Lauraceae:** *Persea kobu* (FR); **Moraceae:** *Moms* spp. (FR); **Musaceae:** *Musa paradisiaca* (FR); **Pandanaceae:** *Freycinetia boninensis* (FR,FL), *Pandanus boninensis* (FR); **Sapotaceae:** *Pouteria obovata* (FR).

Population biology: Ishii (1983) reported that two females captured on Minami-iwojima in the middle of June were pregnant, each with one embryo.

Occurrence in protected areas: Most of the range of distribution is within protected areas.

Summary of threats:

- Deforestation.
- Hunting.

Recommended action:

- Surveys to assess status, particularly in protected areas.
- Conservation of natural vegetation and food plants of this species where possible.
- Measures to control hunting.

Principal author for this species: H. Ota.

Pteropus pumilus
Little golden-mantled fruit bat

Priority Grade: 4 (Vulnerable).

Distribution: Miangas (formerly in the Philippines, now in Indonesia); Philippines (Balut, Camiguin, Leyte, Maripipi, Mindoro, Negros, Sarangani Islands, Sulu Archipelago [Bongao, Sanga Sanga, Tawitawi], Tablas).

Status: **Philippines** Rare at all elevations on most larger islands (Negros and Leyte; Heaney *et al.*, 1989; Luzon; unpubl. data). Common on the very small island of Maripipi, but none was captured on adjacent Biliran (E. A. Rickart, pers. comm.). Many of the areas where it occurs are 'politically sensitive'.

None of 27 bats marked and released in primary forest at Lake Balinsasayao on Negros was recaptured (Heideman and Heaney, 1989). It made up less than 0.5 to 3% of captures in forest and forest clearings, respectively, on Negros (Heaney *et al.*, 1981; Heideman and Heaney, 1989). As it tends to forage and fly in the canopy, and hence is not commonly netted except on ridgetops, it may be more abundant than capture rates imply. However, it is possible that individuals range over large areas, and average population densities may be quite low.

Tolerates only a small amount of disturbance. Has been seen foraging in clearings within and near forest. It may fly at least 2 km from forest, but has never been taken at greater distances. Records prior to 1970 document presence at lowland sites on Negros where it was absent in sampling between 1981 and 1989. Not hunted systematically, as its roosts are apparently not conspicuous and its body size is relatively small for the genus. Threatened mainly by habitat destruction, and extirpation is likely on some islands within the next 20 years if forest clearance continues at the current rate.

Ecology: A bat of primary and good secondary forest at elevations from 200 m to at least 1000 m; probably occurs down to sea-level in suitable forest habitat. Absent from purely agricultural habitats (Heaney *et al.*, 1989), but has been taken in mixed secondary growth, young secondary forest, and agricultural land within 2 km of forest (Heaney *et al.*, 1989).

Apparently, a roosting bat has been observed only once. This was a single individual roosting from a frond of a 5 m canopy tree fern (**Cyatheaceae:** *Cyathea*) in secondary forest at 600 m

elevation on Maripipi (E. A. Rickart pers. comm.) Probably roosts either in small groups or alone in inconspicuous sites in forest vegetation.

Lawrence (1939) reported capturing individuals feeding on a partially ripened fruit in a kapok tree (**Bombacaceae**: *Ceiba pentandra*) and another in an 'alemandras tree'. Also feed on figs (**Moraceae**: *Ficus* spp.).

Aggregates in small numbers at fruiting trees, but is usually silent while feeding. In a fruiting tree in a clearing on Maripipi 15-20 individuals made occasional relatively quiet calls (E. A. Rickart, pers. comm.). They remained within the fruiting tree to feed; it is not clear how often they use feeding roosts away from fruiting trees. Six to twelve *Acerodon jubatus* and about the same number of smaller bats (probably *Cynopterus brachyotis* and/or *Ptenochirus jagorii*) fed simultaneously in the same tree.

Population biology: The few data available (Heideman, 1987) do not provide a clear indication of the timing of reproduction. On some islands there is a suggestion of asynchrony, while on others females appear to be fairly tightly synchronized. The occasional capture of females simultaneously lactating and in early pregnancy suggests that a post-partum oestrus occurs and that some or most females give birth twice a year.

Summary of threats:

- Deforestation.

Recommended action:

- Preservation of forest habitat, especially on small islands where they are most abundant (e.g., Maripipi), would be the best way to preserve this species. As population densities on large islands appear to be low, this species may be vulnerable to habitat fragmentation.
- The initiation of a captive-breeding programme for this species should be considered. This could be initiated with animals from certain known areas such as a privately owned site near Dumaguete City, Negros, which has been extensively studied by researchers from or affiliated with Silliman University. Programmes could be based at Silliman University or the University of the Philippines at Los Banos, Luzon, with the possible later involvement of reputable foreign institutions (R. Wirth and W. L. R. Oliver, pers. comm.).

Principal authors for this species: P. D. Heideman, L. R. Heaney.

Pteropus rayneri
Solomon Islands fruit bat

Priority Grade: 11 (Not Threatened).

Number of subspecies: 7.

P. r. cognatus

Priority Grade: 8 (No Data: Limited Distribution).

Distribution: Solomon Islands (San Cristobal, Uki Ni Masi).

Summary of threats:

- Lack of information on status.

Recommended action:

- Surveys to assess status, particularly in protected areas.

P. r. grandis

Priority Grade: 8 (No Data: Limited Distribution).

Distribution: Bougainville; Buka; Solomon Islands (Alu, Choiseul, Santa Isabel, Shortland).

Summary of threats:

- Lack of information on status.

Recommended action:

- Surveys to assess status, particularly in protected areas.

P. r. lavellanus

Priority Grade: 8 (No Data: Limited Distribution).

Distribution: Solomon Islands (Ghizo, Ranonggo, Vella Lavella).

Summary of threats:

- Lack of information on status.

Recommended action:

- Surveys to assess status, particularly in protected areas.

P. r. monoensis

Priority Grade: 8 (No Data: Limited Distribution).

Distribution: Solomon Islands (Mono).

Summary of threats:

- Lack of information on status.

Recommended action:

- Survey to assess status, particularly in protected areas.

P. r. rayneri

Priority Grade: 8 (No Data: Limited Distribution).

Distribution: Solomon Islands (Guadalcanal, Malaita).

Summary of threats:

- Lack of information on status.

Recommended action:

- Surveys to assess status, particularly in protected areas.

P. r. rennelli

Priority Grade: 8 (No Data: Limited Distribution).

Distribution: Solomon Islands (Rennell).

Summary of threats:

- Lack of information on status.

Recommended action:

- Survey to assess status, particularly in protected areas.

P. r. rubianus

Priority Grade: 8 (No Data: Limited Distribution).

Distribution: Solomon Islands (Kolombangara, New Georgia, Simbo).

Summary of threats:

- Lack of information on status.

Recommended action:

- Surveys to assess status, particularly in protected areas.

Pteropus rodricensis
Rodrigues fruit bat

Priority Grade: 1 (Endangered: Limited Distribution).

Distribution: Mauritius (extinct), Rodrigues.

Status: Mauritius A skull found on Round Island off Mauritius (Mason, 1907) was *P. rodricensis*. It would have been expected to have been found in dry woodland characteristic of north-west Mauritius. The last relict of this habitat type remained on Round Island long after it was destroyed on the mainland.

Rodrigues Cheke and Dahl (1981) documented the decline on Rodrigues. In the 18th and 19th centuries and until 1916 it was reported as abundant. In 1955, large numbers (about 500) roosted in tamarinds (**Leguminosae:** *Tamarindus indica*) on the east flank of Baie aux Huitres valley below Jardin Mamzelle. There were 100 or so at Cascade Pigeon, and 'plenty' in Anse Mourouk and elsewhere. In total there were about 1000 individuals. In 1965, there were fewer bats but they were still common. There were 200 at Cascade Pigeon and good numbers at Jardin Mamzelle. Between 1967 and 1971 Elysee noted a marked decline in numbers. In 1971-72 Ales noted no more than 10 bats at Jardin Mamzelle. In 1974 very low numbers were reported (a maximum of 69+ in July). In 1975, Gardner noted 70+ at Cascade Pigeon. In 1976, Durrell counted up to 130 individuals. He caught 25, 18 for captive breeding. Eight (3 males and 5 females) went to Mauritius and 10 (3 males and 7

females) went to Jersey Zoo. In September 1978, Hartley and Cheke counted 151. In 1979, Cyclone Celine II reduced the population to about 70. By 1981, numbers had risen to at least 200 and more probably 250 (Carroll and Mace, 1988). In 1988, a single count of bats leaving the roost gave a figure of 412 (Carroll and Mace, 1988). At the end of February 1990 the population was estimated to be greater than 1000, based on an actual count of 650. A cyclone hit the island in February 1991 and a count immediately after the cyclone suggested little change in the population size. However, in the summer of 1991, an expedition from the University of Dublin counted a maximum of 350 bats (J. B. Carroll, pers. comm.).

Deforestation has been a serious threat. Between 1955 and 1968, there was clear felling of a large stand (100++) of old mature tamarinds at a place still known as Tamarins, on the west slope of the Baie aux Huitres valley. Ripe tamarind pods are a favourite food source. There have also been losses of other food and shelter trees at other sites.

Cyclones destroy remnant forest, and with it feeding areas. Both 'Monique' in 1968 and 'Fabienne' in 1972 probably killed many bats. This bat is known to be a poor flier in moderate wind.

Administrators and other Mauritians on duty on the island, in the habit of hunting fruit bats in Mauritius, have also done so on Rodrigues, being no doubt unaware the species was in danger. After a quiet period from 1972 to 1977, Mauritian visitors have again been shooting bats.

At the end of 1991 a total of 9 zoos held colonies of captive-bred *P. rodricensis*: Mauritius Black River Zoo; Jersey Zoo; Paignton Zoo; Chester Zoo; London Zoo; Bronx Zoo, New York; Brookfield Zoo, Chicago; Folsome Childrens Zoo, Nebraska; and the Lube Foundation, Florida. The total captive population was greater than 250 animals (J. B. Carroll, pers. comm.).

Because of the success of the captive-breeding programme plans are being formulated to introduce the species to an Indian Ocean island outside the cyclone belt.

In Mauritius this species is fully protected under wildlife regulations.

Ecology: Tamarinds are very important food plants. Also feeds on the rose apple (Myrtaceae: *Eugenia jambos*), mango (**Anacardiaceae:** *Mangifera indica*), native *Pandanus* spp. (**Pandanaceae**), palms (**Palmae:** *Hyophorbe verschafeltii* and possibly *Latania verschafeltii*), *Pyrostria trilocularis* (**Rubiaceae**) (said to be abundant by Balfour, (1879), but now common only in Cascade Pigeon and Cascade St Louis), *Terminalia catappa* (Combretaceae)(formerly more common) and figs (**Moraceae:** *Ficus* spp.)(now very rare).

Population biology: There is an annual reproductive cycle. Dependent young are present from late August through to early February. Births in captivity are from October to April. Young are normally weaned at 10-11 weeks but occasionally suckle at 6 months and associate with their mother for 1 year.

Summary of threats:

- Deforestation.
- Cyclones.
- Hunting.

Recommended action:

- Continued monitoring of the wild population needs to be undertaken to assess long-term trends.
- Research into feeding biology.
- Ban on further deforestation.
- Ban on hunting.

Pteropus rufus
Madagascar fruit bat

Priority Grade: 11 (Not Threatened).

Andersen (1908) proposed to separate populations from southern Madagascar as *P. rufus princeps* (type locality: Fort Dauphin). This was based on a difference in size and on the implicit assumption that the southern populations would be somehow geographically isolated from the typical northern and central ones. Later collecting and observations have shown the species's distribution to be continuous, and subspecific divisions can probably not be maintained.

Distribution: Madagascar.

Status: Mostly confined to coastal areas, offshore islands and low-lying plains towards the interior. Is entirely absent from the central high plateau, where *Eidolon* is the only fruit bat. Most common on the west and east coasts and less common on the arid south coast. Most roosts occur within 100 km of the coast, the only exception is one 80 km south of Ihosy in the central south.

Widely hunted for food, but there is no indication that the population is in decline. The effects of habitat destruction are unknown, but the bats will roost in primary forest, secondary forest and domestic fruit trees.

This species is listed as 'noxious' under wildlife regulations.

Ecology: Reported to visit flowers of *Ceiba* sp. (Bombacaceae) (Dobat and Peikert-Holle, 1985). B. Stequert reported to the Zoological Museum in Amsterdam that the species was observed to fly from the island Nosy Tany Kely to Nosy Be to feed on papaya (**Caricaceae:** *Carica papaya*), guava (**Myrtaceae:** *Psidium guajava*) and mango (**Anacardiaceae:** *Mangifera indica*) every evening (July, 1975).

Occurrence in protected areas: Roosts occur in the following protected areas:

Berenty private reserve
Mananara MAB Biosphere Reserve
RNI 9 Bemahara
RNI 12 Marojejy

The following protected areas are at least visited by *Pteropus*:

Analabe private reserve, Morondava
Andranonema special reserve
Montagne d'Ambre National Park
RNI 7 Ankarafantsika
Swiss cooperation forest, Morondava

Summary of threats:

- Deforestation.

Recommended action:

- Assessment of viability of populations in protected areas. Efforts should be made to provide better, active protection of such areas.

Principal authors for this species: W. Bergmans, M. Nicoll, S. Sowler.

Pteropus samoensis
Samoa fruit bat

Priority Grade: 4 (Vulnerable).

Number of subspecies: 2. The subspecies *P. s. nawaiensis* was considered by Andersen (1912) to be a distinct species, but was considered a subspecies of *P. samoensis* by Wodzicki and Felten (1975).

Is a Category 2 Candidate Endangered Species under the US Endangered Species Act (US Fish and Wildlife Service, 1988) meaning that the US Fish and Wildlife Service has some evidence of vulnerability but not enough to justify an endangered listing at present.

P. s. nawaiensis

Priority Grade: 9 (Indeterminate).

Distribution: Fiji (Nayau, Ovalau, Taveuni, Vanua Levu, Viti Levu).

Status: Noted as 'abundant' on Viti Levu and Vanua Levu by Pernetta and Watling (1978). A 1-week survey by the US Fish and Wildlife Service and Bat Conservation International in the vicinity of Suva, Viti Levu, in July 1989, located some individuals (G. Graham, pers. comm.), but current status, distribution, and population trends elsewhere in Fiji are unknown.

On Fiji, pteropodids are an important food item for peregrine falcons (*Falco peregrinus*). In rain-forest habitat, 56% of all prey-remains collected in eyries contained bats (White *et al.*, 1988). There are four pteropodid species on Fiji, and it is not known what proportion of the bats taken are *P. s. nawaiensis*.

Fiji also lies within the typhoon belt. The effects of typhoons on populations in Samoa have been well documented (see *P. s. samoensis*).

Ecology: Does not form large colonies, and is most often found roosting alone (Pernetta and Watling, 1978).

According to Pernetta and Watling (1978) feeds in open areas on Fiji. D. Wilson (pers. comm.) observed one feeding on nectar or leafbuds of a *Pandanus* sp. (**Panadanaceae**) on Fiji.

Observations in 1989 on Viti Levu, Fiji, suggest *P. s. nawaiensis* is less diurnal than *P. s. samoensis*. *P. s. nawaiensis* was never observed foraging before 16.00h, did not exhibit soaring behaviour, and was seen flying only below the forest canopy (G. Graham, pers. comm.).

Summary of threats:

- Predation.
- Typhoons.

Recommended action:

- A survey should be conducted to determine distribution and assess status, particularly in protected areas.
- In-depth studies on ecology are needed to ensure that land-use and wildlife management policies are consistent with the persistence of viable populations.

P. s. samoensis

Priority Grade: 1 (Endangered: Limited Distribution).

Distribution: American Samoa (Tutuila); Western Samoa.

Status: In 1986 American Samoa passed legislation restricting local hunting, and prohibiting export of fruit bats. Similar regulations were instituted in Western Samoa in 1989.

Cox (1983, 1984b) observed indications of drastic declines on 'Upolu, Western Samoa, in the 1980s due to commercial hunting and forest clearance. Subsequent work by the authors suggest generally low densities in Samoa, with probably no more than 500 animals left on Tutuila, the largest island on American Samoa, and populations seriously depleted on 'Upolu. In 1984, Cox petitioned the US Fish and Wildlife Service (USFWS) to list *P. s. samoensis* as endangered under the US Endangered Species Act (US Fish and Wildlife Service, 1985). In 1988, based on a 1986 USFWS survey, the Service issued a finding of 'not warranted' but retained the species as a candidate, category 2 (US Fish and Wildlife Service, 1988). A 1989 USFWS survey concluded the species to be in 'no immediate danger of extinction' (Wilson, 1990), although reporting a 27% decline in total number of observations, and a 70% decline in number of animals observed on the large island of 'Upolu between 1986 and 1989. The 1989 survey noted 176 animals at 49 survey sites. Anecdotal data after an intense typhoon in February 1990 indicate significant mortality, particularly from the increased post-storm hunting.

The primary cause of population declines in Samoa in recent years has been the commercial exportation of fruit bats for a luxury food market in Guam. From 1982-1986, Western Samoa was the primary supplier (Wiles and Payne, 1986; Wiles, 1992), shipping between 2700 and 8350 animals per year. Since export

documents did not distinguish between the two Samoan species (*P. s. samoensis* and *P. tonganus tonganus*), it is impossible to assess what proportion of these shipments consisted of the endemic *P. s. samoensis*. Based on relative abundance, the expectation would be that most animals in any shipment would be *P. t. tonganus*. Chiefs on Savai'i, however, report instances of buyers on Guam seeking exclusively *P. s. samoensis*. There is also evidence that *P. s. samoensis* is behaviourally more vulnerable to hunting than *P. t. tonganus*, because it is a relatively slow, with poor manoeuvring ability, is primarily diurnal, and shows little inclination to escape when approached at a roost or shot at on the wing (authors' pers. obs.; L. Manuele, pers. comm.). The amendment of the CITES regulations in 1989 has made the international trade in bats illegal.

Although commercial hunting poses the greatest threat, chiefs in Western Samoa report that bat populations began to show a decline with the introduction of firearms (La Mosetele, pers. comm.). Harvesting of bats for local consumption may pose a threat to populations, especially those that have already been placed under stress by commercial harvest and deforestation. There are several examples of non-commercial hunting causing or contributing to pteropodid extinctions (e.g. *P. tokudae* on Guam [Wiles, 1987a]; *Dobsonia chapmani* in the Philippines [Heideman and Heaney, 1988]).

Loss of habitat, due to logging and agricultural conversion, poses the second most significant threat to populations in Samoa. In Western Samoa, commercial logging is an important source of revenue (Engbring, 1989), and in 1985 only 38% of land on 'Upolu, and 59% on Savai'i was classified as rain forest (Iakopo, 1985). Knowles (1988) estimated that 1-2% of rain-forest habitat is being lost annually in American Samoa, mainly for agricultural purposes. The extremely steep (>30%) slope of much American Samoan land provides some limit on development (Engbring, 1989), but extensive loss of lowland forest can reduce wildlife populations relying on altitudinal variation in seasonal fruiting patterns (Cox *et al.*, 1992).

The range of *P. samoensis* is within the typhoon belt. Samoa experienced at least 39 typhoons between 1831 and 1926, and there have been three very severe storms in the past 24 years, in 1966, 1987 and 1990 (Amerson *et al.*, 1982; Knowles, 1988; authors' pers. obs.). Typhoon Tusi devastated the Manua Islands of American Samoa in January, 1987, and the more severe Typhoon Ofa hit all the islands of both Western and American Samoa in February, 1990, but damaged Savai'i most extensively. Post-storm surveys of the Manua Islands in 1987 suggested severe depletion of bat populations (Cox, 1987; Knowles, 1988), but considerable recovery of the forest and the bats by 1988 (Knowles, 1988). Reports from American and Western Samoa (Daschbach, 1990; B. Landin, pers. comm.) in February, 1990 indicated intense post-storm hunting pressure on surviving bat populations in the weeks following Typhoon Ofa.

Ecology: Does not form large colonies, and is most often found either alone, or in small family groups (adult male, adult female and a single young) in emergent canopy trees near the tops of

ridges (Cox, 1983; authors' pers. obs.). Occasionally, aggregations of between 9 and 40 have been observed (I. Gurr, pers. comm; Wilson, 1990; authors' pers. obs.). On rare occasions, individuals have been found roosting in association with a *P. tonganus tonganus* colony (I. Gurr, pers. comm.). The male and female of individual pairs often roost in separate trees, but will usually fly out together, and return to the roost at approximately the same time (authors' pers. obs.).

Feeds primarily on the fruits and flowers of forest trees (Cox, 1983, 1984a), and is found in agroforest and villages much less frequently than *P. t. tonganus*. Although it has been observed feeding in coconut (**Palmae**: *Cocos nucifera*) plantations, in breadfruit (**Moraceae**: *Artocarpus altilis*) trees, and along the forest edge (Knowles, 1988; Engbring, 1989; authors' pers. obs.), it appears to prefer primary forest.

Serves as a major pollinator for the nectarless, dioecious liana, *Freycinetia reinecki* (**Pandanaceae**), by feeding on its fleshy bracts (Cox, 1984a). Also feeds on the following plants (Cox, 1983, 1984a; Engbring, 1989; Cox *et al.*, 1992; D. Wilson, pers. comm.): Anacardiaceae: *Mangifera indica* (FR); *Rhus taitensis* (FL); **Annonaceae**: *Cananga odorata* (FL); **Bombacaceae**: *Ceiba pentandra* (FL); **Caricaceae**: *Carica papaya* (FR); **Lecythidaceae**: *Barringtonia asiatica* (FL); **Leguminosae**: *Erythrina* sp. (FL); **Liliaceae**: *Collospermum samoense* (FR); **Loganiaceae**: *Fagraea beretiana* (FR); **Meliaceae**: *Dysoxylum samoense* (FR), *D. moata* (FR); **Moraceae**: *Artocarpus altilis* (FR), *Ficus graeffi* (FR); **Pandanaceae**: *Freycinetia reinecki* (FL); **Sapindaceae**: *Cupaniopsis samoensis* (FR); **Sapotaceae**: *Planchonella torricellensis* (FR)

Primarily diurnal, and can be seen soaring on thermals (Cox, 1983), often spiralling upwards in pairs. Although its activity patterns differ seasonally, it most frequently feeds in the early morning and late afternoon (authors' pers. obs.). Observations at roosts and feeding trees, using night vision equipment, strongly suggest that animals return to a home roost close to dark, and do not leave the roost until shortly before dawn (authors' pers. obs.).

Individual animals, recognizable by colour patterns, are found at the same roosts day to day, and possibly even year to year. Antagonistic vocalizations have been heard near the apparent boundary between two roosting pairs, suggesting territorial defence of roosts. As many as five animals have been observed simultaneously in a single feeding tree, and although no hostile interactions were observed, each animal maintained a distance of at least 3 m from its nearest neighbour (authors' pers. obs.).

Population biology: The reproductive cycle is not known with certainty, but females have been observed carrying young in July and August (Engbring, 1989; J. Engbring, pers. comm.); a captive animal which was still pre-volant when acquired in July, was probably born in May or June. Since most *Pteropus* species have a well defined, synchronous breeding season, with one young per female per year (Baker and Baker, 1936; Falanruw,

1988a; Pierson and Rainey, 1992), it is probable that the majority of births occur between June and August.

Occurrence in protected areas: In 1988, the US Congress voted to establish a national park in American Samoa, which is planned to include about 3240 ha of forest habitat, containing both Samoan fruit bat species. In Western Samoa, during 1989 and 1990, two reserves (one of 12,150 ha and the other of 10,120 ha) were established on Savai'i as refugia for Samoan wildlife, particularly fruit bats. They incorporate the two largest tracts of unlogged lowland forest in Samoa. A long term research programme by the authors is monitoring fruit bat populations in both these areas. There is also O le Pupu-Pu'e National Park on the island of 'Upolu, which contains suitable bat habitat.

Summary of threats:

- Commercial hunting.
- Deforestation.
- Typhoons.

Recommended action:

- An urgent re-assessment of population status is required.
- The most important short-term measure for ensuring viable populations is to limit hunting. The ban on commercial export should be maintained, along with regulation of local take. Every area in the Pacific that has been subjected to commercial harvest has experienced serious depletion of its fruit bat populations (Wheeler, 1980; Glass *et al.*, 1987; Wiles, 1987a, 1987b; Bräutigam, 1988; Wiles *et al.*, 1989; Rainey, 1990). There is also considerable evidence that the use of firearms for local harvest can put severe pressure on fruit bat populations (Wodzicki and Felten, 1975, 1980).
- Existing laws in American and Western Samoa need to be more strictly enforced, and periodically reviewed for their effectiveness in providing adequate protection.
- In-depth studies on the ecology are needed to ensure that land use and wildlife management policies are consistent with the persistence of viable populations.
- Public awareness programmes (i.e., TV and radio spots, school programmes, newspaper articles) on wildlife and rain-forest conservation have already been initiated by the local conservation organization, Le Vao Matua, in Samoa, but these need to be expanded regionally.

Principal authors for this species: E. D. Pierson, W. E. Rainey, P. Cox, T. Elmqvist.

Pteropus sanctacrucis

Priority Grade: 8 (No Data: Limited Distribution).

Distribution: Solomon Islands (Santa Cruz Islands).

Summary of threats:

- Lack of information on status.

Recommended action:

- Survey to assess status, particularly in any protected areas.

Pteropus scapulatus
Little red fruit bat, Collared fruit bat

Priority Grade: 11 (Not Threatened).

Distribution: North-western, northern and eastern Australia (New South Wales, Northern Territory, Queensland, Victoria, Western Australia); southern New Guinea.

Status: Australia Apparently common throughout its geographic range (Strahan, 1983). Has the broadest range of any megachiropteran bat in Australia and overlaps with all other species. However, it is highly nomadic and most of the range covers underpopulated and remote regions of the continent where no information has been gathered and thus the sizes and movements of population have not been adequately assessed.

Not considered to be a serious pest to fruit-growers, although raids orchards and severely damages crops when native plants fail to flower. Since fruit bats appear to lead each other to ripening fruit, some fruit growers take advantage of this behaviour by poisoning fruit at the edge of an orchard, killing the scouts before they are able to return to the camp and communicate their discovery.

This species is unprotected in New South Wales, Queensland and Western Australia and listed as 'noxious' in Northern Territory.

New Guinea Rare (Flannery, 1990). Recorded from New Guinea on only one occasion, along the coastal strip between the Wassa Kussi and Morehead Rivers, in April-June 1973 (Waithman, 1979). Five skulls were collected by local hunters.

Ecology: Groups of individuals usually form camps in tall vegetation near water, although limestone cavities (Prociv, 1983) and sclerophyll forests (Hall and Richards, 1979) away from open water are also used. Camps more often in coastal mangroves, forest-lined banks of rivers and estuaries, and on islands in streams, Between 5000 and 1,000,000 may occupy one of these camps for periods ranging from a few days to 2 months.

Eucalyptus flowers (**Myrtaceae:** *Eucalyptus* spp.) form the greatest proportion of the diet. Fruits are of less importance. Leaves, growing shoots, bark and sap are also eaten. Feeding records are summarized below (data from Ratcliffe, 1931, 1932; Nelson, 1965a; Calaby, 1966; Armstrong, 1979; Friend and Braithwaite, 1986; McWilliam, 1985-86; author's data).

Apocynaceae: *Alstonia actinophylla* (FL); **Casuarinaceae:** *Casuarina cristata* (C); **Chrysobalanaceae:** *Maranthes corymbosa* (FL); **Cupressaceae:** *Callitris columellaris* (S); **Guttiferae:** *Calophyllum sil* (FL); **Lecythidaceae:** *Planchonia careya* (FL); **Leguminosae:** *Albiza umbellatum* (FL), *Bauhinia* spp. (FL,S), *Castanospermum australe* (FL), *Erythrophleum chlorostachys* (FL) ; **Moraceae:** *Ficus opposita* (FR), *F. racemosa* (FR), *F. scobina* (FR), *F. virens* (FR); **Myrtaceae:**

Angophora costata (syn: *A. lanceolata costata*) (FL), *A. floribunda* (syn: *A. intermedia*) (FL), *A. woodsiana* (FL), *Eucalyptus bigalerita* (FL), *E. bleeseri* (FL), *E. camaldulensis* (FL), *E. citriodora* (FL), *E. clavigera* (FL), *E. confertiflora* (FL), *E. ferruginea* (FL), *E. fibrosa* (syn: *E. siderophloia*) (FL), *E. foelscheana* (FL), *E. grandifolia* (FL), *E. gummifera* (FL), *E. intermedia* (FL), *E. latifolia* (FL), *E. longifolia* (FL), *E. maculata* (FL), *E. microtheca* (FL), *E. miniata* (FL), *E. paniculata* (FL), *E. papuana* (FL), *E. pilularis* (FL), *E. polycarpa* (FL), *E. populnea* (FL), *E. porrecta* (FL), *E. ptychocarpa* (FL,L), *E. setosa* (FL), *E. tectfica* (FL), *E. tereticornis* (FL), *E. tessellaris* (FL), *E. tetradonta* (FL), *E. trachyphloia* (FL), *Lophostemon grandiflorus* (FL), *L. lactifluus* (FL), *Melaleuca argentea* (FL), *M. cajuputi* (FL), *M. dealbata* (FL), *M. leucadendron* (FL), *M. nervosa* (FL), *M. quinquenervia* (FL), *M. symphyocarpa* (FL,B), *M. viridiflora* (FL), *Melaleuca* sp. (FL), *Syncarpia hillii* (FL), *Syzygium armstrongii* (FR,FL), *S. eucalyptoides bleeseri* (FL), *S. e. eucalyptoides* (FR,FL), *S. forte* (FR,FL), *S. suborbiculare* (FL); **Palmae:** *Carpentaria acuminata* (FL); **Proteaceae:** *Banksia integrifolia* (FL), *Grevillea pteridifolia* (FL), *G. robusta* (FL); **Rosaceae:** *Malus sylvestris* (FR), *Prunus persica*, *Pyrus communis* **Rubiaceae:** *Aidiaracemosa* (syn: *A. cochinchinensis*) (FR,FL), *Nauclea orientalis* (FR,FL); **Rutaceae:** *Citrus* spp. (FR), *Citrus reticulata* **Salicaceae:** *Populus* spp. (FL,S,L); **Tamaricaceae:** *Tamarix articulata* (FL,S,L); **Verbenaceae:** *Vitex glabrata* (FR).

Fujita and Tuttle (1991) also listed the following food plants: **Loranthaceae:** *Loranthus* sp. (FL); **Myrtaceae:** *Angophora subvelutina* (FL), *Eucalyptus acmenoides* (FL), *E. alba* (FL), *E. cloeziana* (FL), *E. hemiploia* (FL), *E. planchoniana* (FL), *E. umbra* (FL), *Syncarpia glomulifera* (FL), *S. laurifolia* (FL); **Proteaceae:** *Banksia aemula* (FL).

Important pollinators of native forests. Their diet of flowering species is extremely broad, including the dominant plant species of native forests. Therefore, the health of large tracts of native forests is maintained by the foraging behaviour of these animals (McCoy, 1990).

Nomadic and probably move into areas in response to the local availability of food, which fluctuates considerably from year to year. Most of the information about their movements comes from settled areas in the eastern part of their range during the summer months, between December and March, when camps form along the coastal strip. There is almost no information about their movements over most of their range for the rest of the year.

Population biology: The seasonal pattern of breeding and associated behaviour is similar to, but out of phase with, those of other Australian fruit bats. It has been suggested by McWilliam (1985-86) that the autumn parturition of this species compared to births in the spring for other Australian *Pteropus* species is linked to their need to be mobile in spring and summer when the majority of their food plants flower over vast areas. Camps are formed in November or December and territories are established within these roosts after the bats pair. After copulation, females leave to form their own groups and may establish new camps or

even join the camps of other species of fruit bat. Young are born in April or May, when the population is dispersed, and are raised without the protection of huge numbers of cohorts. Young are occasionally seen in January and February, suggesting that there is a weak bimodal breeding cycle (Hall and Richards, 1979). Young are dependent on the adults for at least 3 months after birth until they learn to fly. Juveniles are frequently suckled and groomed by their mothers at the roost for a further 3-6 months after they fly. By the following November, when camps are again formed, the juveniles congregate in groups separate from the adults. They become sexually mature at 18 months of age.

Occurrence in protected areas: Makes use of suitable forests in national parks and reserves, although none of these has been established specifically for the protection of the species. In the northern part of their range, maternity camp sites in dense pockets of monsoon forest in national parks are used each year while the young are unable to fly.

Summary of threats:

- No significant threats.

Recommended action:

- There is no measure of the population size or understanding of population movements. A detailed study should be made.
- Information on unlicensed shooting of animals in camps is required so that protective legislation can be developed for the whole geographic range.
- More information is required on the damage caused at fruit orchards and about the methods of control used by fruit-growers.

Principal author for this species : M. McCoy.

Pteropus seychellensis

Priority Grade: 11 (Not Threatened).

Number of subspecies: 3. The subspecies *P. s. aldabrensis* and *P. s. comorensis* were formerly considered to be separate species. Recently, Bergmans (1990) has suggested that *P. s. aldabrensis* should again be considered as a separate species.

P. s. aldabrensis
Aldabra fruit bat

Priority Grade: 3 (Vulnerable: Limited Distribution).

Distribution: Aldabra Atoll.

Status: First collected by Abbot in 1893. There is a limited but healthy population (Cheke and Dahl, 1981). Carroll (1985) noted that although the population is only several hundred, it is apparently stable. Hutson (1991) also believed the population to

be stable but limited by the size of the island (about 150 sq km) and food resources.

There are no known threats. However, the small size of the population and the limited land area available makes the bats vulnerable to the activities of man as well as to the effects of natural events such as cyclones.

Ecology: Feeds on the following plants (Fryer, 1911; Cheke and Dahl, 1981; Dobat and Peikert-Holle, 1985): **Agavaceae:** *Agave* sp. (FL); **Celastraceae:** *Cassine* sp. (FL); **Combretaceae:** *Terminalia catappa* (FR); **Moraceae:** *Ficus avi-avi* (FR); **Palmae:** *Cocos nucifera* (FL); **Verbenaceae:** *Avicennia* sp. (L).

Roberts and Seabrook (1989) reported bats feeding on coccids gleaned from the leaves of *Ficus* trees on Aldabra.

Population Biology: Females carrying young have been observed only in December and January, while copulation has been reported in October, November, March and June; this suggests a similar seasonality to that prevailing on the granitic islands (Cheke and Dahl, 1981).

Occurrence in protected areas: Aldabra Atoll was declared a Strict Nature Reserve on 17 February 1976, shortly before the return of Aldabra to the colony of the Seychelles on 23 June 1976. On 28 June 1976, the colony became independent as the New Republic of Seychelles and the status of Aldabra as a Strict Nature Reserve lapsed. But the government of Seychelles agreed to continue the policy of nature conservation on the atoll. On 9 September 1981 it was designated as a Special Reserve under the Seychelles National Parks and Nature Conservancy Act. In December 1982, The UNESCO World Heritage Committee agreed to its inclusion in the World Heritage List (Stoddart and Ferrari, 1983). The atoll is inhabited by only a small number of scientific personnel and their staff and so the usual pressures on the bat population do not exist (Carroll, 1985).

Summary of threats:

- No known threats.

Recommended action:

- Continue the atoll's status and its active management as such. For the understanding of the population dynamics of a subspecies consisting naturally of a supposed few hundred specimens, it should be included in a future research programme on the atoll.

P. s. comorensis
Comoros lesser fruit bat

Priority Grade: 11 (Not Threatened).

Distribution: Comoros (Anjouan, Grand Comore, Mafia, Mayotte, Moheli); Tanzania (Mafia).

Status: The presence of 'huge batts' was first reported from Moheli in 1626 (Herbet, 1638). It was not until the 1860s that 2 species were known to be involved. There was little serious change in status over the first half of the 20th century.

Grand Comore Mountfort (1974) reported that in 1971, 1000 individuals were seen in the crater of the 'Lac Salle' in the north-eastern tip of Grand Comore. No bats were seen here in July 1975 or March 1977 (Cheke and Dahl, 1981). However, about 1500 individuals formed camps in the craters near Leoni and N'Bachile villages south of the capital (Moroni). Large numbers were seen around the crater lake of Dziani Boundouni in the east but no large camps were located. In 1975 and 1977, it was common in the west-central portion of Grand Comore up to 400 m. Bats were seen at a number of localities in the south and east but never in the northern third of the island. In 1988 The University of East Anglia Comoro Islands Expedition (Thorpe, 1988) reported bats as particularly common around Moroni with several large (50+ individuals) roosts in kapok trees (**Bombacaceae:** *Ceibapentandra*) distributed around the town. Two roosts in tamarind trees (**Leguminosae:** *Tamarindus indica*) were seen at Lac Sal in late July, each containing approximately 15 individuals. A large roost of 150-200 individuals was present in a plantation of *Casuarina equisetifolia* (**Casuarinaceae**) at 610 m near the village of Maueni below the forest at La Grille. Another roost of 30 individuals was seen at 1000 m in the La Grille forest near Oussoudjou. No camps were seen close to Mitsamiouli on the north-east coast of the island, but bats were seen flying along the coast at dusk. A few individuals were seen flying at M'Vouni at 400 m on the east side of Mount Karthala, and some were seen along the road close to Fomboni on the south-east coast.

Anjouan Cheke and Dahl (1981) reported bats as numerous throughout the western slopes of the N'Tingui Massif. Several large (2000+) and smaller (<50) day camps were observed. Individuals were seen feeding on Kapok trees. In 1988 the UEA Expedition (Thorpe, 1988) noted that a large roost was probably present around the upper reaches of Mutsamudu. It was not located, although many bats could be seen flying at dusk. Three individuals were seen at dusk near Sima in the west of the island, and a few individuals were recorded at the lakes Dzilandze (900 m) and Dzialoutsounga (1000 m). Approximately 15 were seen feeding on the nectar of a clump of *Erythrina fusca* (**Leguminosae**) along the road between Moya and Sima and 25 individuals were seen in a roost close to the airport at Ouani.

Mayotte Cheke and Dahl (1981) reported one large feeding group near Coconi in the centre of the island. This island was not visited by the UEA Expedition.

Moheli Cheke and Dahl (1981) reported that sightings were less frequent than on the other islands but were made throughout the western half of the island between 0 and 300-400 m. Large numbers were seen around the crater lake of Dziani Boundouni in the east, but no large camps were found. In 1988 the UEA Expedition (Thorpe, 1988) reported that bats were seen feeding in the coconut palms (**Palmae:** *Cocos nucifera*) close to Fomboni, but no roosts were located. A few individuals were seen between 300-400 m but were not at all common. A roost of perhaps 20

individuals was seen in a ravine along the coastal road halfway between Fomboni and Miringoni.

Mafia N. Payne (pers. comm.) reported seeing two camps on Mafia in October 1990.

The UEA Expedition (Thorpe, 1988) noted that there are very specific requirements for roost sites; bats take advantage of topographical features to protect them from high winds, to maximize their thermoregulatory abilities, and to gain updrafts on the way to the feeding grounds. These requirements indicate that roost sites may be a limiting factor to the population size. Social interactions at the roost probably limit the density of individuals in a particular tree, and so if roosts are destroyed, disturbed, or have the local microclimate affected by deforestation, then populations may suffer. Deville (1977) noted that 44% of primary and secondary forest on the Comoros had been put under cultivation between 1968 and 1974. Current populations are patchily distributed compared to even 20 years ago (Cheke and Dahl, 1981).

There is little hunting on the islands because the majority of the population are Muslims who consider bats unclean. Away from the towns, there was evidence that bats were taken for food (Thorpe, 1988). The main methods of hunting were with catapults or sling-shots. It was unclear whether this practice was on the increase (Thorpe, 1988).

Cheke and Dahl (1981) considered that electricity wires were an important cause of mortality. The bats are electrocuted when both wires are touched simultaneously during take-off or landing. Verschuren (1985) considered it an important cause of mortality in the Seychelles. However, the UEA Expedition (Thorpe, 1988) observed few cases, and these were clustered around Moroni where both bats and electricity wires were common.

Cyclones affect *Pteropus* (Jones, 1980). Cheke and Dahl (1981) attributed the low numbers of bats seen on the west of Grand Comore in 1977 compared with 1975 to the cyclone, which caused high winds and heavy rain in early 1977. In 1950 a cyclone devastated Anjouan and Moheli and probably killed many bats (Cheke and Dahl, 1981).

Cheke and Dahl (1981) also noted that volcanic eruptions could be a threat to bat populations. A day after an eruption on Grand Comore, many bats were seen being sucked into the updrafts caused by the spout and burnt within it.

Ecology: The UEA Expedition observed bats feeding on the fruits of kapok (*Ceibapentandra*), papaya (**Caricaceae:** *Carica papaya*) and the nectar from the flowers of *Erythrina fusca*. J. F. Dahl (pers. comm.) reports bats eating figs (**Moraceae:** *Ficus* sp.) and the fruits of badamier (**Combretaceae:** *Terminalia catappa*), and also the nectar from kapok and possibly also baobabs (**Bombacaceae:** *Adansonia madagascariensis*). This species is an important cross-pollinator for many fruit species (J. F. Dahl, pers. comm.).

Although occasional individuals could be seen flying during the day, most activity began just before sunset, when the large roosts would begin to disperse and start to forage. The bats usually return to the roosts before sunrise (Thorpe, 1988). Cheke and Dahl (1981) often recorded 5-6 km journeys, and

suggested that much longer journeys were probably common.

An interesting behaviour is sea-dipping. At dusk, individuals were seen flying a short way out to sea, and following an incoming wave would dip their ventral surface or feet into the water before flying inland. This function appeared to be to collect sea-water only (Cheke and Dahl, 1981). Andersen (1912) suggested that it was to collect salts lacking in the fruit diet, which were ingested when the bat later preened itself, although an alternative suggestion was to rid the bats of ectoparasites (Bergmans, 1978b).

Cheke and Dahl (1981) suggested that strong flight (Dahl, 1979b) and the "time staggered" daily activity patterns (Dahl, 1979a) enabled this bat to exploit spatially and temporally separated food sources.

Population biology: Appears to be one annual breeding season extending over 2-3 months (Cheke and Dahl, 1981). This breeding season corresponds with the transition between the wet and dry seasons between April and June. The number of juvenile bats seen in June support this conclusion if a gestation of 150 days is assumed. Further confirmation is provided by Peters (1869) who shot pregnant females on Anjouan in October 1844.

Occurrence in protected areas: No protected areas have been established in the Comoros. The same seems to hold for Mafia (Stuart and Adams, 1989).

Summary of threats:

- Deforestation.
- Cyclones.
- Volcanic eruptions.

Recommended action:

- A further assessment of populations should be made in the Comoros. The gazetting of areas to receive protection should take this species into account (as well, of course, as *Rousettus (Rousettus) obliviosus* and other vulnerable taxa). An assessment of the situation on Mafia and of the possibilities for the species's protection there is highly desirable.

P. s. seychellensis
Seychelles fruit bat

Priority Grade: 11 (Not Threatened).

Distribution: Seychelles (Cousin, Curieuse, La Digue, Felicite, Mahe, Marianne, Praslin, Silhouette).

Status: Although first reported in 1742 by Picault, it was not described until 1877 (Milne-Edwards, 1877). It is considered to be common, with roosts reported on Mahe, Praslin, Silhouette and La Digue. Has also been seen flying over Felicite, Curieuse, Aride, Cousin, North and other islands to feed. There are sometimes temporary camps on these islands and there have been reports of flights from Praslin to Mahe (36 km).

Traditional roosts have been known for 30 years. The bats roost in tall trees, such as *Casuarina (Casuarinaceae)* and *Albizia (Leguminosae)*. The roosts are mostly on north and west facing slopes during the south-east trade winds, which blow from May to October, the bats shifting to other sheltered sites during the north-west monsoon from November to April. This species has difficulty flying in moderate wind.

Racey (1979) reports a census of bats on the Praslin group of islands. Counts in July and August 1977 yielded figures of 1443 bats on Praslin (3 roosts) and 439 on La Digue (1 roost). The estimate of numbers on Praslin and surrounding islands was 2500. Nicoll and Racey (1981) report a further census on Felicite in 1978 when 170 bats (1 roost) were located. In September 1979, 2500 bats (10 roosts) were counted on Mahé. This figure may however be a substantial under-estimate and there may be as many as 10,000 on the island (Cheke and Dahl, 1981).

Man is the only predator (Nicoll and Racey, 1981). Bats are hunted for home consumption, but on Mahé and Praslin they are also sold to restaurants. Racey (*in: Cheke and Dahl, 1981*) reported that one restaurant on Mahé processed up to five bats a day, or 1500 or more per year. Nicoll and Racey (1981) judged that on Praslin there was little immediate cause for concern, but that the efforts to catch bats were much greater on Mahé because of the demands of tourist restaurants.

Nicoll and Racey (1981) found that, although the bats' diet included many cultivated fruits, the Seychellois generally did not consider it as a serious pest 'and few kill it in order to protect fruit'. Until the government banned the carrying of firearms in 1977, the bats were shot while feeding. Since that time, netting and catapulting have been the principal methods of collecting bats. The banning of firearms has reduced the exploitation of the bats, but interest in increased development of commercial fruit growing poses another potential problem, in that bats might then be regarded as pests on fruit farms (Carroll, 1985).

Other human activities may adversely affect these bats (Nicoll and Racey, 1981). Accidental fires have occurred from time to time, killing food trees and destroying traditional roosts, forcing bats to seek alternative sites of poorer quality. Felling of roost trees is also a problem and was observed in one unoccupied roost on Praslin. A large *Albizia* tree was also felled within a large roost containing 2000-3000 bats inside the Morne Seychellois National Park on Mahe (Nicoll and Racey, 1981).

Verschuren (1985) noted that many bats in the Seychelles were killed by electricity wires (see under *P. s. comorensis*).

Ecology: Racey and Nicoll (1984) noted that there are several types of social group within roosts, although the first two comprise the majority of bats: 1) Family group always comprising one adult male and one adult female with a dependent juvenile; 2) Adult group comprising one adult male accompanied by one or two adult females with no juveniles present; 3) Juvenile aggregation; 4) Female groups; 5); Male groups; 6) Females and juveniles.

Following births in late November and December, most adults are organized into family groups. Each group occupies

and defends a spherical territory about 2 m in diameter against other bats, most of the defence being carried out by the male. By April, when the bats move to the roosts they occupy during the south-east trade winds, the young form large aggregations in the centre of the roost and family groups are uncommon. The remaining bats form adult groups, which occupy similar territories to family groups, and are established and maintained by males. Adult groups account for the majority of bats throughout the south-east trade winds, but by the time females give birth, groups with more than one female lose one member to become family groups.

Individual bats occasionally hang on their own, often at the edge of the roost, at any time throughout the year. They can be of either sex, are occasionally joined by another bat, and are not territorial. They may have been unsuccessful in establishing a territory, or temporarily displaced from a territory following a disturbance in a roost. Juvenile aggregations are maintained throughout the south-east trade winds until the young bats are about 1 year old. There is no discernible territorial behaviour within these aggregations, where individuals frequently roost in association with neighbours. All male and all female groups are usually found on the edges of roosts, or as satellites of the main roosts.

Besides main seasonal roosts, groups of bats may be encountered occupying trees for from several hours to more than a month. These transient groups may comprise bats that have flown to alternative sites following disturbance within a roost. The numbers of bats involved are generally small but may occasionally reach several hundreds. Bats frequently fly between islands to feed and may be absent from their home roost for several days or weeks. These bats are normally well spaced, hang quietly among the foliage and are difficult to detect. Some roost sites are used only when the bats are in transit from one seasonal roost to another.

Racey and Nicoll (1984) listed the following food plants, although they considered this list to be incomplete: **Anacardiaceae:** *Anacardium occidentale* (FR), *Mangifera indica* (FR), *Spondias dulcis* (FR); **Apocynaceae:** *Neisosperma oppositifolia* (FR); **Bombacaceae:** *Ceiba pentandra* (FL); **Caricaceae:** *Carica papaya* (FR?, taken only in captivity); **Combretaceae:** *Terminalia catappa* (FR); **Flacourtiaceae:** *Aphloia* sp. (FR?, not confirmed); **Guttiferae:** *Calophyllum inophyllum* (FR), *Pentadesma butyracea* (FL); **Meliaceae:** *Sandoricum indicum* (FR); **Moraceae:** *Artocarpus altilis* (FR), *A. heterophyllum* (FR), *Ficus avi-avi* (FR), *F. benghalensis* (FR), *F. natutarum* (FR), *F. reflexa* (FR); **Musaceae:** *Musa* spp. (FR?, only taken in captivity); **Myrtaceae:** *Eugenia jambos* (FR?), *E. javanica* (FR), *E. malaccensis* (FR,FL), *Psidium guajava* (FR), *P. littorale* (FR); **Palmae:** *Cocos nucifera* (FL); **Sapotaceae:** *Mimusops sechellarum* (FR), *Northea hornei* (FR); **Sonneratiaceae:** *Sonneratia caseolaris* (FR?, not confirmed).

Some fruits may be carried away from the source tree and eaten elsewhere. For example, the fruits of the capucin, *Northea hornei*, were found under roost trees, although there were no capucin trees in the vicinity. It is also common to see flying bats

carrying the fruits of the cashew (*Anacardium occidentale*). On Cousin the fruits of the bois chauve-souris, *Neisosperma oppositifolia*, could be found some distance from the trees after the bats had visited the island during the night and have even been found under bat roosts on Praslin, an island where *Neisosperma* has not been found. It is possible that these fruits are among several that are regularly dispersed by fruit bats. As well as a possible seed disperser, the bat may act as a pollinator of species such as *Pentadesma butyracea*, whose pale flowers with their copious nectar supply are borne on long, straight branches, and smell of rancid butter. Drops of nectar are present all over the petals, and to reach these, the fruit bat must brush against the anthers. Another very popular tree when in flower is kapok, *Ceiba pentandra*, which is known to be pollinated by fruit bats elsewhere in its range (Baker and Harris, 1959).

Population biology: Copulation occurs most commonly in June and July, although males may attempt to copulate at any time, and most young are born in November and December, suggesting a gestation similar to that recorded in other pteropodids (Racey, 1973). Births have also been recorded in September and October with a single occurrence in March. There is no evidence to suggest the litter size exceeds one.

Occurrence in protected areas: Nicoll and Racey (1981) mentioned a roost of 2000-3000 bats in the Morne Seychellois National Park on Mahe.

Summary of threats:

- No significant threats.

Recommended action:

- Assessment of the present situation, followed by either - as Nicoll and Racey (1981) suggested - regular censusing to provide a basis for a regularly reviewed conservation policy that would provide adequate protection for roosts while controlling the level of culling, or, in case the situation has grown worse, promoting active protection by the government.
- Assess impact of bats on commercial fruit crops and review control methods.
- Information sheets for tourists.

Pteropus speciosus

Doubts exist as to the systematic status of this species: it may be synonymous with *Pteropus griseus*, which is relatively widely distributed (R. Wirth and W. L. R. Oliver, pers. comm.).

Priority Grade: 6 (Rare).

Distribution: Laut Kecil Islands and Masalembu Besar in the Java Sea; Philippines (Basilan, Malanipa, Mindanao, Sulu Archipelago). Records from Cebu and Negros in the Philippines are erroneous.

Status: Uncertain. It is rare in collections. Bräutigam (1989) noted that there is no good information on distribution or population numbers. It is dependent on forest trees for roosting and is assumed to be colonial (Bräutigam, 1989), making it particularly vulnerable to deforestation and hunting. It is subject to sport hunting and occurs in an area where forest is being cleared and hunting pressure is heavy (Bräutigam, 1989). Available evidence suggests that it is already experiencing population declines due to local hunting pressure and loss of suitable habitat (Bräutigam, 1989). Bräutigam (1989) believed local use to be limited because bats are forbidden food among the growing Muslim community within the species range.

Is known predominantly from 'politically sensitive' areas, which may preclude the initiation of any wide ranging surveys of status and management needs (R. Wirth and W. L. R. Oliver, pers. comm.).

Summary of threats:

- Deforestation.
- Hunting.

Recommended action:

- Where possible, surveys should be conducted to determine the conservation status, particularly in protected areas, and the habitats it uses.

Principal authors for this species: P. D. Heideman, L. R. Heaney.

Pteropus subniger

Priority Grade: 1 (Extinct).

Distribution: Mauritius; Reunion.

Status: **Mauritius** Cheke and Dahl (1981) concluded that it was extinct. First recorded on Mauritius by Desjardin in 1829/30, the last authentic record was in 1859. It is believed to have died out between 1864 and 1873. It roosted in trees and deforestation would have led to fewer roosts, and these would have been more accessible to hunters.

Reunion First described from Reunion by Brisson in 1756. La Nux (1772) noted that it had been common in 1722 but was by then rare. No new records appeared after 1862 when it was described as very rare. It seems probable, therefore, that it became extinct in the 1860s. The reasons for extinction may have been a combination of receding forest, a low birth rate and hunting. In the 1730s it had been common enough to consider using bat oil for trade. In 1772 both this species and *P. niger* were becoming rarer. It possible that it was able to exploit the higher altitude forest and thus survive longer than *P. niger*.

Summary of threats:

- Deforestation.
- Hunting.

Recommended action:

- It seems probable that this species has been extinct for over 100 years. The chance of finding specimens now is very slight but this possibility should not be overlooked.

Pteropus temmincki
Temminck's fruit bat

Priority Grade: 10 (No Data).

Number of subspecies: 3.

P. t. capistratus

Priority Grade: 10 (No Data).

Distribution: Bismarck Archipelago (Duke of York, New Britain, New Ireland).

Summary of threats:

- Lack of information on status.

Recommended action:

- Surveys to assess status, particularly in protected areas.

P. t. Hops

Priority Grade: 8 (No Data: Limited Distribution).

Distribution: Buru.

Summary of threats:

- Lack of information on status.

Recommended action:

- Survey to assess status, particularly in protected areas.

P. t. temmincki

Priority Grade: 8 (No Data: Limited Distribution).

Distribution: Ambon; Seram.

Occurrence in protected areas:

Seram

Manusela National Park

Summary of threats:

- Lack of information on status.

Recommended action:

- Surveys to assess status, particularly in protected areas.

Pteropus tokudae
**Guam fruit bat, Little Marianas fruit bat
Tokuda's fruit bat**

Priority Grade: 1 (Extinct?).

Distribution: Guam.

Status: Classified as endangered by the US Fish and Wildlife Service and the Government of Guam.

Guam Considered to be extinct on Guam (Wiles, 1987a). It had always been considered rare by hunters, elderly residents and scientific collectors (Baker, 1948; Perez, 1972). Only three specimens have ever been collected: two individuals were obtained in 1930 (Tate, 1934) and hunters shot a female in 1968 (Perez, 1972). The latter animal was the only one present among more than 100 *P. mariannus* killed and examined during legal hunting seasons in the 1960s. Aside from a possible sighting by M. Wheeler (pers. comm.) at Ritidian Point in June 1979, no observations have been made since 1968, despite intensive field work on the island's fruit bats since 1978 (Wiles, 1987a).

Other islands in the Marianas Several hunters have reported the presence of a small fruit bat, possibly *P. tokudae*, on Anatahan and several other islands in the northern Marianas. There are also conflicting reports about the historical presence of a small fruit bat on Rota, although recent interviews with elderly residents indicate that this was probably not true (J. Riechel, pers. comm.). Japanese collectors visited some of the islands in the 1920s and 1930s, but there have been few other biological investigations of the islands north of Saipan. The survey of Wiles *et al.* (1989) and a number of recent field trips to each of the islands by the staff of the Commonwealth of the Northern Mariana Island Division of Fish and Wildlife have not discovered any fruit bats other than *P. mariannus*.

There were a number of possible causes of the decline. Residents of Guam have long hunted *Pteropus* as a food source. The island's population of *P. mariannus* declined greatly as a result (Coulter, 1931; Baker, 1948; Perez, 1972; Wiles, 1987a), and hunting may have had a similar impact on *P. tokudae*. It may have been more vulnerable than *P. mariannus* to hunting with long-handled hoop nets, a technique widely used in the past.

The species was already rare by the time the brown tree snake (*Boiga irregularis*) was introduced to Guam after World War II. Snakes have become abundant and are a serious predator on young *P. mariannus* and other wildlife (Savidge, 1987; Wiles, 1987b). Snakes were found mainly in southern Guam for the first one or two decades after their arrival and did not reach the northern end of the island in large numbers until the early 1980s. Thus, snakes could have preyed on any *P. tokudae* remaining in the south, but it is doubtful that they ever did so in northern Guam.

Although some loss of forest occurred on Guam prior to World War II, large amounts of suitable habitat remain throughout the island. It seems unlikely that habitat destruction

limited the small population of this species that remained in the 1930s and thereafter.

Population biology: The female killed in 1968 was carrying a juvenile that was large enough to fly away and escape capture (Perez, 1972, unpubl. data).

Summary of threats:

- Hunting.

Recommended action:

- Conservation measures for *P. tokudae* are briefly discussed in a recovery plan written mainly for *P. mariannus* on Guam (US Fish and Wildlife Service, in press). At present, the future of *P. tokudae* appears to depend on the remote chance that it can be found in the northern Marianas. Repeated intensive population surveys of *P. mariannus* are needed for these islands; a component of the surveys should be to search for *P. tokudae*.

Principal author for this species: G. Wiles.

Pteropus tonganus
Insular fruit bat

Priority Grade: 11 (Not Threatened).

Number of subspecies: 3.

One of the most widely distributed of all *Pteropus* species, and in the eastern portions of its range (i.e., Niue, Cook Islands and Tonga) it is the only bat species. It is described by Koopman (1979) as a 'supertramp' species, referring to its absence from the largest, species-rich islands, and its occurrence on small, species-poor ones. There is a decrease in size across the range of *P. t. geddiei* and *P. t. tonganus*, with the Cook Islands population being the smallest (Wodzicki and Felten, 1980).

P. t. basiliscus

Priority Grade: 8 (No Data: Limited Distribution).

Distribution: Karkar Island off the north-east coast of New Guinea (Koopman, 1979), but also apparently occurs on Koil Island, Schouten Islands, about 200 km to the west (specimen in the British Museum [Natural History]).

Status: Current status is unknown.

The exact nature of threats are not known, but it is likely that they are similar to those facing other subspecies of *P. tonganus*. It is likely that it is a popular food item and as such may be threatened by commercial and non-commercial harvesting.

Deforestation poses a significant threat to fruit bat populations on many Pacific Islands and may similarly affect this bat.

Typhoons are also a recurring problem in the Pacific and can be devastating to local bat populations (e.g., *P. samoensis* in

Samoa, hit by a storm in February 1990).

Epidemics and the effects of predators may also pose a threat (see *P. t. tonganus*).

Occurrence in protected areas: There are not thought to be any protected areas within the range of *P. t. basiliscus*.

Summary of threats:

- ?Commercial hunting.
- ?Deforestation.
- Typhoons.
- Epidemics.

Recommended action:

- Surveys to assess status.
- The effect on populations of local harvesting should be carefully monitored.
- The enforcement of CITES regulations must be continued.
- More work is needed on ecology, particularly on foraging and roosting requirements.
- Consideration should be given to the establishment of reserves.
- A public awareness programme is needed emphasizing the importance of fruit bats in forest ecosystems. A model for this can be found in Samoa and Guam.

P. t. geddiei

Priority Grade: 11 (Not Threatened).

Distribution: New Caledonia (Loyalty Islands); Solomon Islands (Malaita, Rennell, Santa Cruz Islands); Vanuatu.

Status: **New Caledonia** Less common than the endemic *P. ornatus* in New Caledonia (Revilliod, 1914; Sanborn and Nicholson, 1950). It was described as 'relatively abundant' in New Caledonia in 1950, but limited, at least part of the year, to the central portion of the island (Sanborn and Nicholson, 1950). Recent reports on importation of *P. tonganus* for food from Vanuatu to New Caledonia (E. Banei, pers. comm.) raise serious questions about the current status of bat populations on New Caledonia.

The hunting of this species is regulated under local wildlife laws.

Solomon Islands Recent survey work by T. Flannery (pers. comm.) indicates that it is not common, but widespread, throughout the Solomon Islands.

Vanuatu Reportedly the most common bat on Vanuatu (Baker and Baker, 1936; Chambers and Esrom, 1988). In a recent questionnaire survey in Vanuatu, the majority (14) of respondents said bat densities had not changed; seven said they had increased, and five perceived a decrease. There was no evidence that local hunting pressure is causing population declines (Chambers and Esrom, 1988).

Fruit bats are a popular food item throughout most of the range. In Vanuatu, they occasionally appear in Port Vila market, and are served at local tourist hotels (Chambers and

Esrom, 1988). In a survey questionnaire, 85% of the respondents said fruit bats were an important food item, and that people in the villages killed them using traditional methods (bow and arrow, sticks, stones, catapult, stick or string with hooks) as well as guns. Although taboos existed in some areas, there were generally few traditional controls on harvest (Chambers and Esrom, 1988). Bats are also widely eaten on New Caledonia (A. Brauer, pers. comm.).

The threat of non-commercial harvest should not be underestimated, because overhunting is thought to have been the primary cause of extinction for at least two pteropodid species in recent years (*P. tokudae* on Guam [Wiles, 1987b]; *Dobsonia chapmani* in the Philippines [Heaney and Heideman, 1988]), and currently places others at high risk, including the Niue and Cook Islands populations of *P. tonganus*, and *P. voeltzkowi* on Pemba off Tanzania (Seehausen, 1990).

Although commercial harvest for a luxury food market in Guam has caused serious depletions in some *P. t. tonganus* populations (see below), its impact on *P. t. geddiei* has probably been limited. A single bat was exported from the Solomon Islands to Guam in 1979. Also, 12 bats had been exported from Vanuatu to Guam up to the end of 1989 (Wiles, 1992). In addition, Vanuatu exported 365 *P. tonganus* to Noumea, New Caledonia in 1989 and early 1990 (E. Banei, pers. comm.).

Loss of native forest poses a significant threat to fruit bat populations on many Pacific and Indian Ocean islands, and has probably already affected *P. t. geddiei* on the Solomon Islands (Flannery, 1989).

Severe tropical storms are a recurrent threat. Evidence from the Marianas (P. O. Glass, pers. comm.), Vanuatu (Chambers and Esrom, 1988) and Samoa (N. Daschbach and B. Landin, pers. comm.) suggests, however, that the primary cause of storm-related mortality for fruit bats is intensive post-storm hunting. Following typhoons, food is in short supply for both bats and people. The animals are often forced to forage for fallen fruit on the ground, and roost without the concealment of canopy shelter, thus making themselves vulnerable to hunting.

On Fiji, pteropodids are an important food item for peregrine falcons (*Falco peregrinus*). In the range of *P. t. geddiei*, peregrine falcons are found in the Loyalty Islands, New Caledonia, the Solomon Islands and Vanuatu. Although no information is available, it is reasonable to expect that peregrines act as predators in these areas as well.

In the Solomon Islands, fruit bat teeth are used to make bracelets and necklaces, and on Vanuatu unspecified bat parts are used to make arrows (Chambers and Esrom, 1988).

Ecology: *P. tonganus* appears to be strongly colonial throughout most of its range (Baker and Baker, 1936; Degener, 1949; Medway and Marshall, 1975; Wodzicki and Felten, 1975; Pernetta and Watling, 1978; Wodzicki and Felten, 1980; Chambers and Esrom, 1988). Colonies are most often found in large, canopy trees, in mangrove or terrestrial forest, often near the edge of cliffs (Medway and Marshall, 1975; Wodzicki and Felten, 1980; authors' pers. obs.). Colony size and composition may vary seasonally. *P. t. geddiei* has been found roosting singly

in the Cook Islands (Wodzicki and Felten, 1980) and singly, in pairs or small groups on Niue (Wodzicki and Felten, 1975), but such roosting behaviour may be attributable to depleted population levels.

In Vanuatu, Baker and Baker (1936) found that both sexes congregated together in camps from September to January, often in large *Casuarina* (**Casuarinaceae**) trees near the shore. When females became pregnant, in about February, they left the camps and became difficult to find, while the males stayed together. In June, in late pregnancy, females were found in inland camps, which at this time contained few males. At this time males lived separately, and were difficult to find. In New Caledonia as well, camp size fluctuated, and the animals moved seasonally (Sanborn and Nicholson, 1950). There *P. t. geddiei* was sometimes associated with the endemic *P. ornatus*, but the two species were almost always in separate trees (Sanborn and Nicholson, 1950).

P. tonganus feeds on the fruits and flowers of a wide range of native and introduced forest trees, plus a variety of agriculturally important plants, including banana (*Musaceae*: *Musa* spp.), coconut (**Palmae**: *Cocos nucifera*), papaya (**Caricaceae**: *Carica papaya*), mango (**Anacardiaceae**: *Mangifera indica*) and breadfruit (**Moraceae**: *Artocarpus altilis*). This species seems more willing to venture into agroforest and plantations than local endemics such as *P. samoensis* in Samoa, or *P. anetianus* in Vanuatu. Reported to feed on the fruits of *Syzygium* (**Myrtaceae**) and *Ficus* (**Moraceae**) and flowers of *Eugenia malaccensis* (**Myrtaceae**) in Vanuatu (Medway and Marshall, 1975). Chambers and Esrom (1988) noted that it was less frequently a blossom feeder than *P. anetianus*. Ridley (1930) reported that it fed on the following species: **Leguminosae**: *Inocarpus fagifer* (FR); **Moraceae**: *Artocarpus incisor* (FR); **Sapotaceae**: *Sideroxylon sundaicum* (FR).

Population biology: Baker and Baker (1936) noted that there was a general tendency for fruit bats to have a fixed, and synchronized breeding season, with young being born, after a six month gestation, in March-April north of latitude 4°N, and about September south of latitude 3°N. This pattern seems to hold for *P. t. geddiei* in Vanuatu (Baker and Baker, 1936) and New Caledonia (Sanborn and Nicholson, 1950).

Animals probably do not breed until they are 2 years old (Baker and Baker, 1936; Sanborn and Nicholson, 1950).

Occurrence in protected areas: No information is available on the status in reserves, but the following reserve areas may contain fruit bat populations:

New Caledonia

Parc Territorial de le Riviere Bleue

Solomon Islands

Queen Elizabeth Park (ca 6080 ha) (Singh, 1986)

Summary of threats:

- Hunting.

- Deforestation.
- Typhoons.

Recommended action:

- Surveys to determine current status are urgently needed, particularly in the Solomon Islands, where distribution is poorly understood and specifically in the Santa Cruz Islands, where there is no information on status. Surveys are also required in New Caledonia, where it is reportedly less common than the endemic *P. ornatus*, and these should particularly look at the Loyalty Islands, where again there is no information on status.
- The effect on populations of local hunting should be carefully monitored.
- Enforcement of CITES regulations.
- Further examination of ecology is needed, with a particular focus on identifying foraging and roosting requirements.
- Given the critical role fruit bats play in Pacific island ecosystems (Cox *et al.*, 1991), consideration should be given to the establishment of reserves that specifically address the habitat requirements of this subspecies.
- A public awareness programme on the importance of fruit bats is needed throughout much of the Pacific. This should involve media exposure, and educational programmes in schools. Models for such a programme can be found in the work of the regional conservation organization La Vao Mania, on Samoa and the Division of Aquatic and Wildlife Resources in Guam.

P. t. tonganus

Priority Grade: 9 (Indeterminate).

Distribution: American Samoa; Cook Islands (Mangaia, Rarotonga); Fiji; Niue; Tonga; Wallis and Futuna; Western Samoa.

The distribution includes the easternmost limit for the Pteropodidae.

Status: Protected by local hunting restrictions in American and Western Samoa, and Tonga (where the King's colony is protected), and excluded from commercial exploitation in Western and American Samoa.

American Samoa Amerson *et al.* (1982) estimated a population of 140,000 fruit bats in American Samoa in 1975-76, but this is subject to question because the authors did not clearly specify their census techniques, and failed to distinguish between the two Samoan species (*P. samoensis* and *P. tonganus*). Knowles (1988) identified 11-14 roosts for *P. tonganus* on Tutuila, the largest island of American Samoa, with two large colonies (ca 3000 individuals in each), and other colonies in the low hundreds, yielding a total estimate of 10,000-13,000 animals on Tutuila. One of the large colonies contained no more than 1000 animals in July 1988. Populations appear to have been seriously depleted following Typhoon Ofa in February 1990.

Cook Islands Hunting for local consumption appears to be

placing substantial pressure on populations in the Cook Islands. Wodzicki and Felten (1980) noted serious population declines in recent years, and D. Steadman (pers. comm.), who spent several months in the Cook Islands in 1989, reports that the population may number fewer than 1000 on Mangaia, and is considerably lower on Rarotonga. There are no local laws protecting fruit bats.

Fiji Widespread throughout the islands of Fiji (Pernetta and Watling, 1978), but current population trends are unknown. Degener (1949) described a roost of 'thousands' in the dense forest at Naruka. A brief survey by the US Fish and Wildlife Service and Bat Conservation International in 1989 located one colony near Suva with an estimated 5000 animals (D. Wilson, pers. comm.). Although Pernetta and Watling (1978) referred to it as abundant in 1978, Watling has recently expressed concerns about declines based on the disappearance of some colonies from traditional roosting sites (D. Bruning, pers. comm.).

International trade in this species is regulated under local wildlife laws.

Niue Apparently common at the turn of the century, when large flocks could be seen flying overhead, and still abundant in the 1920s. Reduction of native forest and the introduction of firearms, however, has led to drastic population reductions. On two extended visits in 1968 and 1969 Wodzicki and Felten (1975) did not observe any bats flying. A wildlife ordinance was passed in 1972 prohibiting the shooting of fruit bats, but was no longer in effect in 1980 (Wodzicki and Felten, 1980). Remaining animals were apparently restricted to the Tapu Forest Sanctuary and surrounding Huvalu Forest. Typhoon Ofa, which caused extensive damage to Niue in February 1990, probably provided additional threats to any remaining bat populations.

Tonga A brief faunal survey of Tonga in 1986 (Gill, 1987) noted large colonies at Tofoa and Kolovai on Tongatapu, and scattered individuals on 'Eua. The Kolovai colony has been designated a fruit bat reserve, and is protected by the royal family. The status of populations on other islands, where the hunting ban does not apply, is unknown.

Wallis and Futuna A few specimens, now housed at the Paris Museum, were collected from Wallis and Futuna in the 1970s, but nothing is known of the current status of populations there.

Western Samoa Data are limited. Observations at flyways indicate that there is a small colony on the Falealupo Peninsula, and a colony near the Tafua Peninsula. There are also reports of a colony of about 100 near Fagafau on Savai'i.

Extensive hunting of fruit bats for local consumption has led to serious population declines on Niue (Wodzicki and Felten, 1975) and the Cook Islands (Wodzicki and Felten, 1980). Fruit bats are also a traditional food in Samoa, and eaten most commonly in the less westernized sections of Western Samoa. Here local chiefs report that bat populations began to decline with the introduction of firearms, but cultural recognition of the ecological importance of fruit bats provides a basis for instituting village controls against overharvest, as has been done now in two areas of Savai'i (Falealupo and Tafua).

A significant threat in recent years, particularly in Samoa, has been commercial exploitation for a luxury food market in Guam. As early as the late 1960s, following depletion of their own fruit bat resources, residents in Guam began importing bats from a number of islands in the Pacific (Wiles and Payne, 1986). American Samoa was a major supplier from 1980-86, and Western Samoa was the primary supplier from 1982-86. By the close of financial year 1989, at least 37,496 Samoan fruit bats (not distinguished by species) had been shipped to Guam. Over 5000 had come from Tonga and six from Fiji (Wiles, 1992). The amendment of the CITES regulations in 1989 made this international trade illegal.

Loss of native forest threatens *P. t. tonganus* on Niue (Wodzicki and Felten, 1975), the Cook Islands (Wodzicki and Felten, 1980) and Samoa (Cox, 1983, 1984b; Knowles, 1988). Substantial forest clearing in Wallis and Futuna has probably affected bat populations there. Even though *P. tonganus* is ecologically fairly adaptable, and is known to feed in agroforest, it shows a preference for native fruits in limited captive feeding trials, and roosts in emergent canopy trees at least part of the year. Deforestation and road construction also can pose an indirect threat by providing easier access to roost areas for hunters.

Severe tropical storms are a recurring problem. Evidence from Samoa (Daschbach, 1990; B. Landin, pers. comm.) suggests, however, that the primary source of storm-related mortality is intensive post-storm hunting (see under *P. t. geddiei*). Typhoon Ofa in February 1990 had a particularly severe impact on Samoa and Niue.

There are reports in the literature of epidemics decimating fruit bat populations on a number of islands, such as *Pteropus neohibernicus hilli* on Manus in the Admiralty Islands in 1985, *P. rayneri grandis* in Bougainville and Buka in the Solomon Islands in 1987 (Flannery, 1989) and *P. mariannus ualanus* in Kosrae in the 1930s (Coultas, 1931). Such an epidemic severely impacted *P. t. tonganus* populations near Savu Savu in Fiji sometime prior to 1949 (Degener, 1949).

On Fiji, pteropodids are an important food item for peregrine falcons (*Falco peregrinus*). In rain-forest habitat, 56% of all prey remains collected in eyries contained bat parts (White *et al.*, 1988).

Ecology: On Rarotonga, in the Cook Islands, this species roosts in hilly, deeply forested areas, in open trees, like *Cananga odorata* (**Annonaceae**), *Cerbera manghas* (**Apocynaceae**), *Guettarda speciosa* (**Rubiaceae**) and *Homalium acuminatum* (**Flacourtiaceae**). In Niue, it roosts primarily in *Planchonella torricellensis* (**Sapotaceae**), *Ficus prolixa* (**Moraceae**) and *Syzygium richii* (**Myrtaceae**) (Wodzicki and Felten, 1975). In Tonga, a large camp is located in *Casuarina* (**Casuarinaceae**) trees in the Kolovai fruit bat Sanctuary.

Combined data from the Cook Islands, Niue, Fiji and Samoa (Jaegar, 1954; Wodzicki and Felten, 1975, 1980; Cox, 1983; Ash, 1987; Cox *et al.*, 1992) provided the following list of food plants: **Anacardiaceae:** *Mangifera indica* (FR), *Rhus taitensis* (FL); **Annonaceae:** *Cananga odorata* (FR,FL); **Apocynaceae:**

Cerbera manghas (FR), *Ochrosia oppositifolia* (FR); **Bombacaceae:** *Ceiba pentandra*; **Caricaceae:** *Carica papaya* (FR); **Combretaceae:** *Terminalia catappa* (FR); **Ebenaceae:** *Diospyros samoensis* (FR); **Elaeocarpaceae:** *Elaeocarpus rarotongensis* (FL); **Guttiferae:** *Calophyllum inophyllum* (FR); **Lauraceae:** *Persea americana* (FR); **Leguminosae:** *Inocarpus fagifer* (FR); **Loganiaceae:** *Fagraea beretiana* (FR); **Moraceae:** *Artocarpus altilis* (FR), *A. heterophyllum* (FR), *Ficus prolixa* (FR); **Musaceae:** *Musa paradisiaca* (FR), *M. nana* (FR); **Myrtaceae:** *Metrosideros villosa* (FL), *Psidium guajava* (FL), *Syzygium clusifolium* (FR,FL), *S. cumini* (FR), *S. inophylloides* (FR,FL), *S. jambos* (FR,FL), *S. malaccense* (FR,FL), *S. richii* (FR,FL); **Palmae:** *Cocos nucifera* (FR,FL); **Pandanaceae:** *Pandanus tectorius* (FR); **Rutaceae:** *Citrus sinensis* (FR); **Sapindaceae:** *Pometiapiinata* (FR); **Sapotaceae:** *Planchonella torricellensis* (FR,FL); **Solanaceae:** *Solarium lycopersicum* (FR).

Observations of *P. tonganus* feeding at *Ceiba pentandra* trees indicate that animals stake out territories in the trees, and then fight with other animals to maintain their feeding post.

Population biology: The synchronized breeding season observed by Baker and Baker (1936) for *P. t. geddiei* (see above) seems to hold for *P. t. tonganus* populations in the Cook Islands (Wodzicki and Felten, 1980) but not for those in Niue or Samoa, where the limited data suggest an asynchronous breeding season as is found in *P. mariannus* on Yap and Guam (Falanruw, 1988a; Wiles, 1987a).

Wodzicki and Felten (1975) estimated that young were born on Niue from March to June, based on the weights of immature captured animals. A re-evaluation of their data, using the growth curve of a captive *P. samoensis* (a species of comparable size), however, suggested their specimens had been born in June, July and October. D. Wilson (pers. comm.) saw no young in Fiji in July but P. Cox and E. D. Pierson observed a roost in American Samoa in July 1987, which contained pregnant females and females carrying very small young. There are also observations of females carrying young in August, October and January (S. Gurr, pers. comm.). The estimated birth times for two immature animals that were netted in Samoa are October and April.

Occurrence in protected areas: Occurs within two recently established rain-forest reserves in Western Samoa (12,150 and 10,125 ha), and the 3250-ha area set aside in 1988 to become a United States National Park in American Samoa. There is a fruit bat sanctuary at Kolovai, on Tonga, where the animals are protected by the royal family. In 1975, occurred in the Tuvalu Forest sanctuary on Niue (Wodzicki and Felten, 1975), but no information is available on its current status there.

Summary of threats:

- Hunting.
- Deforestation.
- Typhoons.
- Predation.

- Epidemics.

Recommended action:

- Surveys to determine current status are urgently required, particularly in Niue and the Cook Islands, where there were strong indications of population declines 10-15 years ago.
- The effect of local harvest on populations should be assessed, especially since Wodzicki and Felten (1975, 1980) found that local hunting was seriously reducing populations on Niue and the Cook Islands. Local regulations such as those in effect in American and Western Samoa should probably be considered in other areas. Better enforcement is needed in Samoa.
- A major threat to *P. tonganus* throughout its range is a commercial, luxury food market in Guam. Although the combination of local restrictions plus the listing of this species on Appendix I of CITES in 1989 has made trade into Guam illegal, there needs to be continuing enforcement of CITES regulations in Guam, and co-operation by all potential exporting jurisdictions in controlling exports.
- Further examination of ecology is needed, with a particular focus on identifying foraging and roosting requirements.
- Given the critical role fruit bats play in Pacific island ecosystems (Cox *et al.*, 1991), consideration should be given to the establishment of reserves that specifically address the habitat requirements of fruit bats.
- A public awareness campaign on the importance of fruit bats is needed throughout much of the Pacific. This should involve media exposure, and educational programmes in schools. Models for such a programme can be found in the work of the regional conservation organization La Vao Matua, on Samoa and the Division of Aquatic and Wildlife Resources in Guam.

Principal authors for this species: E. D. Pierson, W. E. Rainey, P. Cox, T. Elmqvist.

Pteropus tuberculatus

Priority Grade: 8 (No Data: Limited Distribution).

Distribution: Solomon Islands (Santa Cruz Islands [Vanikoro]).

Summary of threats:

- Lack of information on status.

Recommended action:

- Survey to assess status, particularly in protected areas.

Pteropus vampyrus
Large fruit bat

Priority Grade: 11 (Not Threatened).

Number of subspecies: 7.



Pteropus vampyrus (Photo by T. H. Kunz)

P. v. edulis

Priority Grade: 8 (No Data: Limited Distribution).

Distribution: Savu; Timor.

Status: **Timor** Goodwin (1979) observed a spectacular colony of 2000 adults of both sexes near Metinar, Timor, in a dense mangrove forest which extended for about 8 km along the coast.

Ecology: The colony mentioned above on Timor fed on fruits of *Ficus* (**Moraceae**) in association with *Pteropus griseus*, *Acerodon macklotii* and *Dobsonia peronii*.

Summary of threats:

- Lack of information on status.

Recommended action:

- Surveys to assess status, particularly in protected areas.

P. v. intermedius

Priority Grade: 10 (No Data).

Distribution: Extreme south of Burma and adjacent areas of Thailand.

Summary of threats:

- Lack of information on status.

Recommended action:

- Surveys to assess status, particularly in protected areas.

P. v. lanensis

Priority Grade: 4 (Vulnerable).

Distribution: Philippines (Bohol, Canon, Catanduanes, Cebu, Dinagat, Leyte, Luzon, Mindanao, Mindoro, Negros, Palawan, Samar).

Status: Heavily hunted, both at its conspicuous roosts and in orchards. Individuals are sometimes captured by entanglement in weighted, fish hook-strung lines suspended from ropes stretched between tall trees in coconut groves (**Palmae:** *Cocos nucifera*). The declines in mixed *Pteropus/Acerodon* roosts from the reported 100,000 per camp in the 1920s to the 500-1000 reported currently indicate drastic falls in population numbers. It is possible that it could be extinct within the Philippines in the next 20 years, although it is more likely that small populations would persist in isolated areas. Although it may be able to persist in agricultural habitats, heavy hunting pressure is causing a serious decline on many Philippine islands. Most captures are for local consumption, but, in recent years, the large demand for fruit bats on Guam has resulted in heavy trade in large fruit bats, and a small number of these have been *P. v. lanensis*.

Ecology: Recorded from sea-level to at least 1300 m Found in a variety of habitats, including primary forest, orchards and coconut groves. An important difference between this bat and *Acerodon jubatus*, which often uses the same roosts, is that *P. v. lanensis* can be found in orchards and coconut groves in agricultural areas.

Roosts in large colonies in canopy and emergent trees, often sharing roost sites with *Acerodon jubatus*. J. B. Steere (cited in Elliot, 1896) visited Negros in 1888, and wrote that 'the fruit bats of the Philippines prefer small islands for their roosts, but will take up isolated localities. I found one roost on Negros occupying one immense hardwood tree standing by itself far from the forest on the plains of the western side of the island. Where they were not hunted for food by natives, they sometimes roost near native houses or villages for protection'. Taylor (1934) described a mixed colony of *A. jubatus* and *P. v. lanensis* on Mindanao made up of about 150,000 individuals, about one-third of which were the latter subspecies. Mudar and Allen

(1986) reported specimens of both *A. jubatus* and *P. v. lanensis* from a roost of 800-1000 bats in north-eastern Luzon. There were similar mixed roosts in the Philippines that contained 500-1000 individuals.

Has been reported feeding on coconut pollen, nectar, and/or flowers and durian nectar and flowers (**Bombacaceae**: *Durio zibethinus*) (Gould, 1977) and '...flowering shoots and a wide variety of fruit, including rambutan (**Sapindaceae**: *Nephelium lappaceum*), langsung (**Meliaceae**: *Lansium domesticum*) and other cultivated fruit' (Medway, 1978). Also feeds on fig fruits (**Moraceae**: *Ficus* spp.) (authors' pers. obs. and Goodwin, 1979), and probably eats a wide variety of other wild fruits.

Lawrence (1939) reported watching bats from a big colony '...in a tree in a large swamp near Zamboanga..' (Mindanao) in April, when they flew about 27 km nightly to Basilan to feed. Rabor (1977) described commuting flights of these bats elsewhere in the Philippines, from camps to foraging grounds that must be at least 10-20 km distant, and this is consistent with reports for other large species in the genus (see review in Heideman and Heaney, 1989). Like *A. jubatus*, often feeds noisily in groups of a few to 20 or more in large fruiting trees.

Population biology: In the Philippines, females appear to give birth once a year, in April or May. Timing of births is apparently similar throughout the Philippines (Rabor, 1977; Mudar and Allen, 1986; Heideman, 1987; authors' data), but more data are necessary.

Summary of threats:

- Hunting.

Recommended action:

- Controls on hunting, particularly at roosts, would slow the decline. It is worth noting, however, that under current conditions any controls on hunting are probably unenforceable. The subspecies is able to forage in agricultural areas, and hence is probably less at risk from habitat destruction than *A. jubatus*, but more at risk from hunting. The most effective method of protection probably would be management of colonies on small islands, where some habitat and roosts remain and protection efforts within the relatively small human community would have some hope of success. Captive breeding might also be attempted.

Principal authors for this subspecies: P. D. Heideman, L. R. Heaney.

P. v. malaccensis

Priority Grade: 11 (Not Threatened).

Distribution: Anamba Islands; Bangka; Lingga Islands; Mentawai Islands (Pagai Islands, Sipura); Peninsular Malaysia; Riau Archipelago; Singapore; Sumatra; Thailand; Vietnam.

Status: Peninsular Malaysia Widespread but declining in forest areas.

Sumatra Found quite commonly in the Padang Highlands up to 914 m.

Thailand Recorded from the coastal area of the peninsula and the south-east coast as far north as Korat, with records from the provinces of Chon Buri, Krabi and Hakhon Si Thammarat (Lekagul and McNeely, 1977; Yenbutra and Felten, 1986).

Vietnam Van Peenen (1969) noted that it had been recorded from only two localities in southern Vietnam. These were Phu Quoc Island and Hue in Thua Thien Province.

Threatened by the rapid loss and degradation of mangroves for coastal reclamation, aquaculture, and to logging and loss of lowland forest to commercial logging and land clearance for oil palm/rubber estates. It is also threatened by hunting (with or without licences). Is eaten throughout its range (in Malaysia more by Chinese, not Malays; elsewhere by almost everyone). It is also shot as a pest of fruit orchards despite its value as a pollinator.

Ecology: In Sumatra, roosts in kapok trees (**Bombacaceae**: *Ceibapentandra*) in cultivation, and in remnant forest patches.

Feeds on cultivated durian (**Bombacaceae**: *Durio zibethinus*), rambutan (**Sapindaceae**: *Nephelium lappaceum*), mango (**Anacardiaceae**: *Mangifera indica*), banana (**Musaceae**: *Musa* spp.), langsung (**Meliaceae**: *Lansium domesticum*), and other orchard fruits. It also feeds on a wide variety of wild forest tree fruits as well as flowers and nectar.

Population biology: In Peninsular Malaysia, apparently pregnancies peak from November to January but can occur in other months. In Thailand, pregnancies occur in about the same period or later, with births in March-April. Females have one young each.

Occurrence in protected areas: In Peninsular Malaysia, occurs in the Taman Negara National Park, occasionally in the Krau Game Reserve, Pahang, and during 1987-88 a roost occurred in Templer's Park, Selangor. Widespread but declining in forest areas, most of which are forest reserves (i.e. forest under the jurisdiction of the Forest Department and used for logging). Also present in the area of the proposed Endau-Rompin Park, Johore/Pahang.

Colonies sometimes move, especially because of disturbance, and long-distance movements may carry them in and out of protected areas. Everywhere are more dependent on lowland forest over level ground than on hill forest, and become commoner towards the coast and mangrove areas.

Summary of threats:

- Habitat destruction.
- Hunting.

Recommended action:

- Surveys to assess status in Sumatra and adjacent small islands, concentrating on protected areas.

- More information is needed about the general ecology and biology and about the threats to survival.

Principal author for this subspecies: G. W. H. Davison.

P. v. natunae

Priority Grade: 11 (Not Threatened).

Distribution: Borneo (Brunei, Central, East, South and West Kalimantan, Sabah [Balembangan, Banggi], Sarawak); Natuna Islands (Bunguran Besar).

Status: Payne *et al.* (1985) recorded that it was found throughout lowland coastal areas, occasionally invading the interior during the fruiting season. C. M. Francis (pers. comm.) reports that flock sizes in Sabah appear to have become smaller over the past 10 years, possibly indicating a decline.

Ecology: Eats both nectar and fruit including some orchard species such as rambutan (**Sapindaceae:** *Nephelium lappaceum*) and mangoes (Anacardiaceae: *Mangifera indica*). It pollinates the flowers of many forest trees such as durians (Bombacaceae: *Durio zibethinus*). It sometimes flies long distances to feed in flowering or fruiting trees (Payne *et al.*, 1985).

Summary of threats:

- Unknown.

Recommended action:

- More work is needed to investigate ecology and biology and any threats.

P. v. pluton

Priority Grade: 8 (No Data: Limited Distribution).

Distribution: Bali; Lombok; Sumbawa.

Summary of threats:

- Lack of information on status.

Recommended action:

- Surveys to assess status, particularly in protected areas.

P. v. vampyrus

Priority Grade: 11 (Not Threatened).

Distribution: Jawa; Krakatau Islands (Sebesi, Sebuku, Sertung).

Status: Tidemann *et al.* (in press) recorded it from islands in the Krakatau group off west Jawa. Bats were seen to move between the islands. A single specimen was seen roosting in a *Casuarina* (**Casuarinaceae**) tree and a colony of 250 roosted in *Terminalia* (**Combretaceae**) trees on Sertung in 1985 but was not seen in

1986. In the same region, Dammerman (1948) observed large numbers of *Pteropus* moving between Sebesi and Sebuku. At Bogor Gardens, west Java, it roosted in a variety of trees, including dead ones, in groups of hundreds of individuals (Kitchener *et al.*, 1990).

Summary of threats:

- Unknown.

Recommended action:

- Surveys to assess status, particularly in protected areas.

Pteropus vetulus

Priority Grade: 5 (Rare: Limited Distribution).

Distribution: New Caledonia (Loyalty Islands, New Caledonia).

Status: Sanborn and Nicholson (1950) regarded it as scarce on New Caledonia. There were indications of a wide distribution as regards both elevation and area. There is no information available regarding status in the Loyalty Islands.

The hunting of this species is regulated under local wildlife laws.

Summary of threats:

- Lack of information on status.

Recommended action:

- Surveys to assess status, particularly in protected areas.

Pteropus voeltzkowi
Pemba fruit bat

Priority Grade: 1 (Endangered: Limited Distribution).

Distribution: Tanzania (Pemba).

Status: Andersen (1912) wrote that 'only one colony of *Pteropus voeltzkowi* is said to exist in Pemba, at Fufuni, at the middle of the south coast'. Kingdon (1974) recorded it as occurring along the road between Mantangatuani and Mgogoni. Carroll (1985) quoted information supplied by R. H. W. Pakenham that there were several roosts in southern Pemba, and also on the islands off the south and north-west coasts. The bats on the islands off the south coast flew to forage on south Pemba. This is supported by specimens from various localities on Pemba in the British Museum (Natural History). From the available evidence, Carroll (1985) considered it to be 'apparently abundant'. It is important to remember that *Eidolon helvum* also occurs on Pemba, and on at least one of the associated islands (Fundo). Thus, there could be confusion between species.

However, more recent evidence suggests it may have undergone a serious decline in numbers in the past few years. Seehausen (1990) reported on a visit made to Pemba in late October and early November 1989. Despite extensive searching,

he could only locate one group of three bats on the central-west coast at Kisiwani; in addition on four occasions he saw a single bat in flight at dusk. At Mgogoni, it was reported that there was a small colony of about 50 bats in a section of natural forest on one of the steep, inaccessible hills. Seehausen (1990) could not confirm the presence of this colony. More recently, H. Bentjee (pers. comm.) reported seeing 150-200 *Pteropus* roosting in large trees in NW Ngezi Forest in December, 1989. He did not see any *Pteropus* in any other forest patches on Pemba (Msitu Mkuu and Ras Kiuyu).

Seehausen (1990) listed possible threats as predators, hunting and deforestation. Information on natural predators is limited, but there do not appear to be any that would constitute a serious threat. Hunting, on the other hand, may be a serious problem. In the past, traditional hunting methods, such as the use of long sticks, were used. But more recently, firearms have been a preferred method. The extent of hunting is unknown. Carroll (1985) thought that there was 'some hunting'. It may be that, as in the Comoros, the Muslim population of Pemba consider bats unclean. Deforestation may also have played an important role in the decline. The western half of Pemba was formerly covered with tropical rain forest, whereas the eastern half was dominated by baobab (**Bombacaceae**: *Adansonia digitata*) and *Borassus* (**Palmae**) palm savannahs and coastal bush. Bats were endemic to the rain forest and formerly occurred throughout the west of the island but not in the east. Much of the original rain forest was cleared in the 18th Century, but bats continued to survive in remnant patches of forest on hill slopes. However, these remnants are now threatened and coupled with hunting this has reduced the population to a critical level (Seehausen, 1990).

Ecology: Is very social and it has been found in large colonies until very recently. It does not appear near human settlements unless large trees are fruiting. It is primarily a forest species and is now restricted to small remnants of forest in the north-west of the island.

Seehausen (in press) recorded the following food plants; **Anacardiaceae**: *Mangifera indica* (FR); **Annonaceae**: *Cananga odorata* (FL), *Uvaria leptocladon* (FR); **Bombacaceae**: *Ceiba pentandra* (FL); **Caricaceae**: *Carica papaya* (L); **Moraceae**: *Artocarpus altilis* (FR), ?*A. heterophyllus* (FR), *Ficus capensis* (FR), *Ficus* sp. (FR); **Myrtaceae**: *Eugenia malaccensis* (FR), *Syzygium malaccense* (FL), *S. jambolanum* (FR); **Pandanaceae**: ?*Pandanus* spp. (FR).

Depending on the supply of fruit, colonies move from one site to another.

Population biology: Seehausen (1990) recorded births between June and August, between the rains. Assuming a gestation of 4-6 months, copulation probably takes place between January and April.

Occurrence in protected areas: Is said to occur in Ngezi Forest, which has the status of a forest reserve, but there is no legislation restricting hunting in that area. The forest is estimated at 5-12 sq km, probably nearer the former (Pakenham, 1984).

Summary of threats:

- Hunting.
- Deforestation.

Recommended action:

- Surveys to locate remaining colonies.
- Research to obtain ecological data as a basis for better conservation planning. Questions of particular importance: interdependency of vegetation and the fruit bat as a pollinator and seed disperser; niche separation between *P. voeltzkowi* and other frugivorous faunal elements; food demands of *P. voeltzkowi*.
- To reduce pressure on the forest remnants and hunting pressure on *P. voeltzkowi*. However, this must not be done in a restrictive manner, but must be discussed with the people concerned. People know about the importance of forest but feel forced by circumstances to expand arable ground or to cut trees for fuel and construction wood. The reason for hunting is demand for protein. Alternatives have to be developed by and with the people with financial and logistic help from the conservation community.
- Public discussion and educational activities must be promoted. As a first step, an educational poster has been printed, which will be distributed to schools in Pemba.
- A captive breeding programme should be built up as a support, rather than a substitute for conservation efforts on Pemba.

Principal authors for this species: R. H. W. Pakenham, O. Seehausen.

Pteropus woodfordi
Least fruit bat

Priority Grade: 10 (No Data).

Distribution: Solomon Islands (Fauro, Guadalcanal, Kolombangara, New Georgia, Nggela Sule, Russell Islands [Mbanika, Pavuvu]).

Summary of threats:

- Lack of information on status.

Recommended action:

- Surveys to assess status, particularly in protected areas.

Genus *Rousettus* (3 subgenera)

Subgenus *Boneia* (1 species)

Rousettus (Boneia) bidens

Priority Grade: 8 (No Data: Limited Distribution).

The genus *Boneia* was recently synonymized with *Rousettus* by

Bergmans and Rozendaal (1988). K. Koopman (pers. comm.) believes it should be included as a subgenus of *Rousettus*, while Hill and Corbet (1991) consider *Boneia* to be a separate genus.

Distribution: Gorontalo to Menado in north Sulawesi.

Status: Hunted for food in north Sulawesi (Bergmans and Rozendaal, 1988).

Ecology: Tambun, from where some specimens are said to have originated, is located in an area with a primary forest/farm bush mosaic. *Boneia* is a cave-dweller. Tambun area lies at an altitude of 200-500 m; the type specimen of *Boneia menadensis* was collected at an elevation of about 1000 m. From this information it may be expected to be a lowland forest bat, possibly restricted in its distribution by the presence of suitable caves (or substitutes), and foraging in partly cultivated areas as well (Bergmans and Rozendaal, 1988).

Population biology: Two females collected in June and July were pregnant (Bergmans and Rozendaal, 1988).

Occurrence in protected areas:

Sulawesi

Dumoga-Bone National Park

Summary of threats:

- Lack of information on status.
- Possibly hunting.

Recommended action:

- Survey to assess status and investigate biology and ecology.
- Assess possible threat from hunting.

Subgenus *Lissonycteris* (1 species)

Rousettus (Lissonycteris) angolensis

Priority Grade: 11 (Not Threatened).

Number of subspecies: 3.

R. (L.) a. angolensis Angolan soft-furred fruit bat

Priority Grade: 11 (Not Threatened).

Distribution: North-west Angola; central and southern Cameroun; Central African Republic; central Congo; Equatorial Guinea (Bioko, Mbini); Gabon; eastern Nigeria; north-west and south-west Zaire.

Status: Unknown. Possibly quite common, but not known from many localities. In Nigeria, very localized in rocky habitats in the rain forest zone and relict forests in savannah (Happold,

1987). Happold (1987) thought it was probably uncommon. Threatened by deforestation. Locally, hunting may threaten populations (as in Congo; Bergmans, 1979).

Ecology: Occurs in forest habitats.

In Nigeria, habitually roosts in caves. Because it does not echolocate, it is found near cave entrances, which are not in total darkness and where it can use its eyes for orientation (Happold, 1987).

Eisentraut (1963) mentioned wild *Ficus* fruits (Moraceae) as a favourite food. Fedden and Macleod (1986) collected many specimens covered in sticky fig seeds and observed that much of the guano at roost sites also contained fig seeds.

Population biology: Data from Nigeria/Cameroun (Eisentraut, 1963; Fedden and Macleod, 1986) and from Congo (Bergmans, 1979) may indicate either continuous breeding with certain peaks connected with the rains, or two more or less distinct peaks separated by non-breeding periods. Eisentraut (1963) observed that breeding females form nurseries that tend to be avoided by adult males.

Summary of threats:

- Deforestation.
- Hunting.

Recommended action:

- Assessment of the occurrence of viable populations in protected areas. Also a study of food habits and reproductive cycle.

R. (L.) a. ruwenzorii Eastern soft-furred fruit bat

Priority Grade: 11 (Not Threatened).

Distribution: Ethiopia; Kenya; Mozambique; Rwanda; southern Sudan; Tanzania; Uganda; north-east and south-east Zaire; Zambia; Zimbabwe. The assignment of populations beyond the Ruwenzori range is largely conjectural.

Status: Not known. Apparently quite common in eastern Zaire near the western Rift and in adjoining Uganda, but rather patchily distributed elsewhere. Threatened by deforestation. Locally, hunting may pose a threat.

Ecology: Gregarious, occurring in small colonies of up to about six together, and in the case of specimens from Umtali in Zimbabwe, associated with far larger numbers of Peter's epauletted fruit bat (*Epomophorus gambianus crypturus*), feeding on guavas (Myrtaceae: *Psidium guajava*) in an orchard (Skinner and Smithers, 1990). In other parts of eastern Zimbabwe, eight were netted together in a forest clearing (Skinner and Smithers, 1990).

In Umtali in Zimbabwe, observed to eat figs (Moraceae: *Ficus* spp.), and orchard fruits such as guavas and mangoes

(**Anacardiaceae**: *Mangifera indica*) (Skinner and Smithers, 1990).

Population biology: Ansell (1974) collected a pregnant female in Zambia in July. Data from museum specimens show that pregnant females were collected in Kenya in December and June, and in Uganda in March and December. Lactating females were collected in Uganda in March, April, June and December.

Occurrence in protected areas:

Kenya

?Mt Elgon National Park

Zaire

Parc National de l'Upemba

Summary of threats:

- Deforestation.
- Hunting.

Recommended action:

- Assessment of the occurrence of viable populations in protected areas. Also a study of the feeding, reproductive and possibly migratory habits.

R. (L.) a. smithii

Little soft-furred fruit bat

Priority Grade: 11 (Not Threatened).

Distribution: Burkina Faso; Ghana; Guinea; Guinea-Bissau; Ivory Coast; Liberia; western Nigeria; Senegal; Sierra Leone; Togo.

Status: See *R. (L.) a. angolensis*.

Ecology: Wolton *et al.* (1982) listed the fruits of *Solarium torvum* and *S. erianthum* (**Solanaceae**) as the favourite food at Mount Nimba between July and September. Dobat and Peikert-Holle (1985) listed *Spathodea campanulata* (**Bignoniaceae**), *Ceiba pentandra* (**Bombacaceae**) and *Parkia roxburghii* (**Leguminosae**) as trees whose flowers attract or may attract this species. In Liberia a specimen was netted in a banana (**Musaceae**: *Musa* spp.) plantation. Fujita and Turtle (1991) also mentioned records of *R. (L.) angolensis* (subspecies unspecified but locality given as 'West Africa') feeding on the fruits of *Adenia cissampeloides* (**Passifloraceae**) and *Solanum verbascifolium* (**Solanaceae**). Thomas (1982) also mentions *Chlorophora* and *Ficus* (**Moraceae**) and *Anthocleista* (**Loganiaceae**) as food plants.

Population biology: Wolton *et al.* (1982), summarizing their own and other information, suggested an extended breeding season, beginning in July, peaking in September, and tailing off

in the latter half of the dry season (March/April). They also found indications that adult males migrate away from the breeding area, resulting in all female nursery colonies (apart from juvenile males), as had also been found by Eisentraut (1963) in the Mount Cameroun region.

Occurrence in protected areas:

Ghana

Mole National Park

Summary of threats:

- Deforestation.
- Hunting.

Recommended action:

- Assessment of occurrence of viable populations in protected areas, taking into account possible migratory movements noted by Wolton *et al.* (1982).
- Gazetting of such protected areas so as to include such populations.
- A study of ecological requirements, especially food habits, reproductive cycle(s) and male migration.

Principal authors for this species: W. Bergmans, S. Sowler.

Subgenus *Rousettus* (8 species)

Rousettus (Rousettus) aegyptiacus

Priority Grade: 11 (Not Threatened).

Number of subspecies: 4.

R. (R.) a. aegyptiacus

Egyptian rousette

Priority Grade: 11 (Not Threatened).

Distribution: Cyprus; Egypt; Israel; Lebanon; Syria; Turkey.

Status: **Cyprus** Boye *et al.* (1990) reported that specimens were recorded near Paphos, Episkopi and Kyrenia, north of Limassol, west of Nicosia and at Famagusta. Most observations concerned 1-3 animals and there were no colonies numbering more than 20 bats. In a cave in Limassol district, a colony of 300-400 was reported a few years ago by local people, but recently only one bat has been seen there (Boye *et al.*, 1990). It seems likely that there has been a significant decline in population numbers, probably due to shooting. Spitzenberger (1979) found that the Ministry of Agriculture was responsible for a yearly decimation campaign, during which bats were disturbed at their roosts and subsequently shot. She observed that of a colony near Apsiou consisting of about 400-500 bats, about 200 were killed during one shooting session, but believed the colony would be able to recover from such tolls. These campaigns are no longer organized

by local authorities but may still be practised privately by farmers. This is indicated by the presence of a number of abandoned roosts, which show marks of shot and soot (Boye *et al.*, 1990).

On the whole probably not endangered, although regarded as a pest in Turkey (Spitzenberger, 1979), Israel (Spitzenberger, 1979; Makin and Mendelsson, 1986) and Egypt (K. Wassif, pers. comm.) and treated accordingly. Local abundance may vary with that of food (Lewis and Harrison, 1962).

Fruit farmers are the most important threat to populations. In Turkey and Israel, *Rousettus* caves have been fumigated or closed off by walls (Spitzenberger, 1979). In Israel, this species is listed as 'noxious' under wildlife laws and caves have been fumigated with Lindane (= gamma HCH) (Makin and Mendelsson, 1987) including some inside nature reserves, but recently attitudes towards bats have improved (Makin and Mendelsohn, 1987; Sowler, 1988a, 1988b). In Egypt, it is also destroyed by farmers (K. Wassif, pers. comm.), but no details are known.

A new threat to bats in Israel may arise through problems with bat droppings accumulating on the walls of buildings (D. Makin, pers. comm.).

Ecology: In Cyprus in the winter, roosts in caves, and in March some colonies move to open sites, such as tall trees or large buildings (Boye *et al.*, 1990). In Israel has been found roosting in caves and deserted buildings (Makin, 1990).

Feeds on the following plants (Unger and Kotschy, 1865; Bate, 1903; Lewis and Harrison, 1962; Kaisila, 1966; Spitzenberger, 1979; Dobat and Peikert-Holle, 1985; Makin and Mendelsson, 1986): **Bombacaceae:** *Bombax ceiba* (FL); Leguminosae: *Ceratonia siliqua* (FR); **Moraceae:** *Ficus religiosa* (FR,L), *F. sycamorus* (FR), *Morus alba* (S); Musaceae: *Musa* sp. (FL); **Palmae:** *Phoenix* sp. (FR); **Rutaceae:** *Citrus* spp. (FR).

In Israel, bats show a high locality fidelity both in roosting and foraging. Migration from the north or within Israel has not been demonstrated (Makin, 1990).

In Israel, the causes of mortality are many. A large number of predators prey on *Rousettus*, cats being the most common (Makin, 1990). It appears that extreme winter conditions cause many casualties (Makin, 1990) and there is the added factor of persecution by fruit growers (see above).

Population biology: Spitzenberger (1979) found two breeding cycles per year in a Cyprus population. These cycles overlap: about half of adult females were about to give birth by the end of March or beginning of April although some had given birth already, while the other half and all subadult females each bore a small embryo (up to a fortnight old in a gestation of about 4 months). As a rule, a particular female would take part in only one cycle per year. Harrison (1964) observed suckling infants as well as half-grown young in Carmel Caves in Israel in October. Makin (1990) observed two main birth peaks in Israel, one in the first two weeks of April and the second in late August and early September. In June, most (67%) of the parous females

were pregnant and lactating, indicating that there was a post-partum oestrus (Makin, 1990). Makin (1990) estimated that some females first conceived at the age of 7-8 months and others did so only at 15-16 months. Males born in the April season matured at the age of 18 months, those born in August-September matured earlier at the age of 14-18 months. Gaisler *et al.* (1972) collected 11 females, 8 of which carried one embryo each, and 8 males, 5 of which were in breeding condition, in April in Cairo, Egypt. According to Kingdon (1974), *Rousettus* would breed throughout the year in Egypt.

Occurrence in protected areas:

Israel

Occurs in all nature reserves (D. Makin, pers. comm.) including: Beitan Aharon Nature Reserve
Carmel Nature Reserve

Summary of threats:

- Persecution because of supposed damage to fruit crops.

Recommended action:

- Wherever there are campaigns to decimate populations, it should be established whether or not the species is responsible for substantial damage to fruit or trees and if this damage can be prevented by other means. If it cannot, humane culling methods should be encouraged. At the same time, the possibilities of information and education programmes must be examined.

R. (R.) a. arabicus
Arabian rousette

Priority Grade: 6 (Rare).

Distribution: ?Eastern Ethiopia; Iran; Oman; Pakistan,; Saudi Arabia; Yemen.

Status: Not common, and apparently rare over a large part of its range.

Ethiopia Known only from a single record (Hayman and Hill, 1971).

Iran Could be abundant in certain caves on Qeshm Island (Blanford, 1876) but it is certainly not very numerous in the very few other localities where it has been found (DeBlase, 1980).

Oman Known from some localities in the north-east (e.g., Muscat; Harrison, 1964) and from several in Dhofar in the south-west, where it does not seem particularly rare (records in Harrison, 1980).

Pakistan Rare and locally distributed (Roberts, 1977).

Saudi Arabia Known from two localities (Yaman, 1966).

Yemen Known from three localities; Yerbury and Thomas (1895) wrote that it occurred 'in great numbers in a cave on the banks of the Wady Jughur near Lahij'.

Threats would come from fruit growers. In Iran, DeBlase (1980) found that farmers were not aware of a fruit-eating bat.

Roberts (1977) reported that in the fruit gardens of Malir, Pakistan, these bats caused 'some damage' but he did not mention whether they were being destroyed. From where it appears to be most numerous, in Oman, nothing has been reported on possible conflicts with man.

Ecology: Feeds on the following plants (Brosset, 1966a; Roberts, 1977; Nader, 1985a): **Anacardiaceae:** *Mangifera indica* (FL); **Bombacaceae:** *Bombax malabarica* (FL); **Caricaceae:** *Carica papaya* (FR); **Meliaceae:** *Azadirachta indica* (FR), *Melia azerdarach* (FR); **Moraceae:** *Ficus religiosa* (FR); **Musaceae:** *Musa* spp.; **Myrtaceae:** *Psidium guajava* (FR); **Paltae:** *Phoenix dactylifera* (FR); **Rutaceae:** *Citrus* spp. (FR).

Population biology Yerbury and Thomas (1895) found a female with a suckling infant near Lahij, Yemen, in March. In Pakistan the majority of young are born in the early spring with a few at the end of the monsoon season in September (Roberts, 1977).

Summary of threats:

- Control methods by fruit growers.

Recommended action:

- Activities to safeguard this bat are possibly best focused on populations in Oman, where it is probably more common than elsewhere, and where conservation is supported by the government. The few available data may be misleading, and certainly the prospects in Yemen, another possible stronghold, should be assessed. It may be sufficient to ensure that viable populations occur in protected areas and that if they forage outside those areas their viability is safeguarded.

R. (R.) a. leachii
Cape rousette

Priority Grade: 11 (Not Threatened).

Distribution: Burundi; Ethiopia; Kenya; Malawi; Mozambique; Rwanda; South Africa; southern Sudan; Tanzania (mainland, Mafia, Pemba, Zanzibar); Uganda; north-east and south-east Zaire; Zambia; Zimbabwe.

Status: Locally abundant and not endangered.

Cave habitats are under pressure from tourists, particularly in Kenya (McWilliam, 1980a, 1980b). Large numbers are collected and used in research (e.g., Baranga, 1978, 1980). These bats are also killed in some areas because of orchard depredations.

Ecology: Highly gregarious, occurring in caves, buildings and tombs in very large numbers (up to several thousand). Highly adaptable and will even colonize newly built buildings in the middle of busy cities, feeding on the fruit of *Ficus* sp. (Moraceae). A primitive form of echolocation click is used to navigate to roosting sites in dark caves/buildings.

Feeds on the following plants (Andersen, 1912; Cunningham van Someren, 1972a, 1972b; Start, 1972; Kingdon, 1974; Jacobsen and Du Plessis, 1976; Herzig-Straschil and Robinson, 1978; Thomas and Fenton, 1978; Dobat and Peikert-Holle, 1985; Herselman and Norton, 1985): **Aloeaceae:** *Aloe dolmitica* (FL); **Anacardiaceae:** *Harpephyllum caffrum* (FR), *Mangifera indica* (FR); **Apocynaceae:** *Acokanthera oppositifolia* (FR); **Bignoniaceae:** *Kigeliapinnata* (FL); **Bombacaceae:** *Adansonia digitata* (FL); **Celastraceae:** *Cassine crocea* (FR); **Ebenaceae:** *Diospyros capensis* (FR); **Leguminosae:** *Erythrina abyssinica* (L); **Meliaceae:** *Ekebergia capensis* (FR); **Moraceae:** *Ficus capensis* (FR), *F. petersii* (FR), *F. sansibarica* (FR); **Myrtaceae:** *Syzygium cordatum* (FR), *S. gerrardii* (FR), *S. jamba* (FR); **Oleaceae:** ?*Olea africana* (FR), *O. capensis* (FR); **Podocarpaceae:** *Podocarpus olinia* (FR); **Rosaceae:** *Eriobotrya japonica* (FR), *Malus sylvestris* (FR), *Prunus africana* (FR), *P. armeniaca* (FR), *P. persica* (FR); **Salvadoraceae:** *Salvadora persica* (FL); **Sapindaceae:** *Litchi chinensis* (FR); **Viscaceae:** *Viscum obscurum* (FR).

Population biology: The breeding patterns change according to locality. From the northern part of its distribution, few data are known. In Ethiopia, a pregnant female was caught in February at Baro (60 km east of Gambela) and a lactating female in late April/May at Lake Abaya. In Sudan a pregnant female was caught on 1 July in Talanga Forest. In Uganda has been reported as bimodally polyoestrus with conceptions in December and June and births in March and September, occurring just before the peak of the two rainy seasons (Mutere, 1968). In south-east Zaire Anciaux de Faveaux (1978) concluded that reproduction was continuous. In the eastern Transvaal, South Africa, Jacobsen and Du Plessis (1976) reported copulation in June to mid-September and births from October to December, with a possible second minor birth peak in March/April. Herzig-Straschil and Robinson (1978), working in southern Cape Province, South Africa, observed births from October until June. The observation by Herselman and Norton (1985) of an infant in early January in this province confirms this.

Occurrence in protected areas:

Kenya

Amboseli Game Reserve
Marsabit National Reserve
Masai Mara Game Reserve
Meru Game Reserve
Mount Elgon National Park
Lake Nakuru National Park
Shimba Hills National Reserve
Tsavo National Park

South Africa

Transvaal
Kruger National Park
Wolkberg Wilderness Area (Rautenbach, 1982)

Natal
Harold Johnson Nature Reserve
Kosi Bay Nature Reserve
Ndumu Game Reserve
Oribi Gorge Nature Reserve
St Lucia Eastern Shores Nature Reserve
Umlalazi Nature Reserve

Cape
Keurbooms Reserve
Table Mountain Nature Reserve (Herselman and Norton, 1985)
Tsitsikama National Parks

Tanzania

Arusha National Park
Ruaha National Park (Kingdon, 1974)
Serengeti National Park

Uganda

Murchison National Park
Queen Elizabeth National Park

Zimbabwe

Chimanimani National Park
Great Zimbabwe Ruins (Smithers and Wilson, 1979)
Inyanga National Park

Summary of threats:

- Roost disturbance.

Recommended action:

- There is an excellent report with management proposals for bat caves on the Kenya coast (McWilliam, 1980b; Pont, 1989) which may serve as a model for other similar situations.
- The introduction of a permit system to restrict numbers collected for research purposes should be considered.
- Information and education concerning the ecological role of fruit bats, and the introduction of alternatives to protect fruit orchards, could help curb numbers killed by fruit growers.

R. (R.) a. unicolor
West African rousette

Priority Grade: 11 (Not Threatened).

Distribution: Angola; Cameroun; Congo; Equatorial Guinea (Bioko, Mбини); Gabon; Gambia; Ghana; Guinea; Ivory Coast; Liberia; Nigeria; São Tomé and Príncipe (São Tomé); Senegal; Sierra Leone; Togo; north-west and south-west Zaire.

Status: Locally abundant and not endangered. It could be threatened by deforestation and possibly locally by hunting.

Ecology: Recorded in both forests and savannahs. Hill and Carter (1941) quoted a field label of a specimen from Angola 'Shot flying to banana flowers [Musaceae: *Musa* spp.], not the

fruit, which was still green'. Eisentraut (1963) collected a large series on Mount Cameroun chiefly in mist-nets set under or in wild fig trees [**Moraceae:** *Ficus* spp.] in fruit. Rosevear (1965) reported that 'cultivated fruit trees, from dates [**Palmae:** *Phoenix dactylifera*] in the subdesert to guavas [**Myrtaceae:** *Psidium guajava*] and mangoes [**Anacardiaceae:** *Mangifera indica*] in the forest, have been recorded as attacked by this species... Wild figs are also a source of food.' Brosset (1966a) wrote that it eats all kind of wild and cultivated fruits, including some that are inedible or even toxic to man. Wolton *et al.* (1982) observed this bat feeding extensively on the fruits of *Solanum torvum* (**Solanaceae**) and *S. erianthum* on Mount Nimba between July and September.

Population biology: Wolton *et al.* (1982) considered that on Mount Nimba the breeding season may be extended with a pregnancy peak between November and December at the end of the rains.

Eisentraut (1963) concluded that in the Mount Cameroun region the breeding period was not strictly seasonal but that it might be restricted to the dry season.

Occurrence in protected areas:

Ghana

Mole National Park

Summary of threats:

- Deforestation.
- Hunting.

Recommended action:

- Assessment of occurrence of viable populations in protected areas. Further action from there on.

Principal authors for this species: W. Bergmans, S. Sowler.

Rousettus (Rousettus) amplexicaudatus

Priority Grade: 11 (Not Threatened).

Number of subspecies: 3.

R. (R.) a. amplexicaudatus
Geoffrey's rousette, Common rousette

Priority Grade: 11 (Not Threatened).

Distribution: Alor; Ambon; Bagabag; Borneo (Brunei, West Kalimantan, Sabah, Sarawak); Burma; Cambodia; Enggano; Halmahera; Kisar; Lombok; Mentawai Islands; Ndao; New Guinea; Peleng; Peninsular Malaysia (including island of Langkawi); Philippines (Balabac, Caluya, Carabao, Cebu, Dinagat, Guimaras, Jolo, Lubang, Luzon, Mindanao, Mindoro, Negros, Palawan, Panay, Polillo, Samal, Samar, Siargao, Simunul, Sulu Archipelago [Bongao, Sanga Sanga, Sibutu,



Rousettus amplexicaudatus amplexicaudatus (Photo by P. A. Morris)

Tawitawi]; Rote; Savu; Seram; Sulawesi; Sumba; Ternate; Thailand; Timor; Yapen.

Status: **Borneo** Payne *et al.* (1985) listed records: from Pulau Balembangan, Sukau, Madai Caves and Tawau in Sabah; Tasek Merimbun in Brunei; Sungai Baram and Niah Caves in Sarawak; Sungai Landak in West Kalimantan.

Lombok Kitchener *et al.* (1990) reported that it was moderately abundant in all habitats from sea-level to 400 m.

New Guinea Common (Flannery, 1990). Widespread on mainland New Guinea; Flannery (1990) did not record it above 300 m on the mainland, although Ziegler (1982) recorded it as possibly only below 600 m. Has been recorded as far east as Milne Bay Province. In Irian Jaya its western extent is not clear, although it is present in the Moluccas and could be expected to occur commonly as far west as the Vogelkop (Flannery, 1990).

Peninsular Malaysia Medway (1978) recorded it as known from scattered localities at all elevations, including roosts in Batu Caves, Selangor, and on Gunung Brinchang, Patang. It

was also recorded on Langkawi. He considered it to be uncommon.

Philippines Rare in submontane forest on Negros, where it made up about 2% of captures (Heideman and Heaney, 1989). Captured three times more frequently in clearings and secondary growth than in forest. In contrast, 40-90% of captures in orchards and other agricultural habitats were of this species (Guerrero and Alcala, 1973; Heaney *et al.*, 1989; unpubl. data). Apparently prefers disturbed habitats and areas with cultivated fruit trees (banana (Musaceae: *Musa* sp), mango (**Anacardiaceae:** *Mangifera indica*), chico (**Sapotaceae:** *Pouteria sapota*), guava (**Myrtaceae:** *Psidium guajava*), and cultivated figs (**Moraceae:** *Ficus* spp). Although successful in association with agriculture, populations on Negros and other areas of the Philippines are apparently declining. Caves that had held large numbers in 1981 contained very few bats in 1987; in one cave a large pile of dried wings cut from these and other species was found. Can be a pest in fruit orchards (Guerrero and Alcala, 1973), although mostly ripe or over-ripe fruit is taken and the fruits that are commercially most important are usually harvested while unripe. Where cave colonies have been destroyed because of supposed damage to commercial fruit crops, the small economic benefits of such measures are negated by the loss of associated *Eonycteris spelaea* as well as many species of insectivorous bats, all of which are beneficial.

Although populations in some areas of the Philippines appear to be declining, it remains abundant. Given the expansion of disturbed habitats and orchards, there are now probably as many or more individuals in the Philippines as there were several hundred years ago.

Sulawesi Hunted for food in north Sulawesi (Bergmans and Rozendaal, 1988).

Thailand Yenbutra and Felten (1986) listed records from the provinces of Chiang Mai, Chon Buri, Chanthaburi, Lop Buri, Saraburi, Phetchaburi and Ranong.

Timor Goodwin (1979) only found this species roosting in caves, concentrated in chambers close to entrances, with up to 800 individuals in a colony.

Ecology: Roosts in caves, and can echolocate in a rudimentary manner. One female netted at Yapsiei in 1986 was carrying a ripe fig (Moraceae: *Ficus* sp.) in its mouth. Often a lactating female and a subadult animal were caught close together in the same net, suggesting a close association between mother and quite advanced offspring (Flannery, 1990). Flannery (1990) netted bats most often in open areas with little tall or overhanging vegetation. In the Philippines it fed on a number of cultivated fruit trees. Presumably also feeds on the fruits of wild plants, including secondary growth species.

On Timor, Goodwin (1979) observed bats feeding on *Muntingia* fruit (**Flacourtiaceae**), with as many as 50 individuals feeding on a single tree at the one time.

May travel long distances to forage; Lekagul and McNeely (1977) collected evidence to suggest that it may commute 25 km a night to feed. At orchard sites in Dumaguete City in the Philippines, *Rousettus* did not arrive until one or more hours

after dark, implying similarly long commuting distances (authors' pers. obs.).

In the Philippines, individuals fed almost silently in fruit trees. In orchards, they often remained in the fruit trees to consume fruit, perhaps because most of the cultivated fruits were too large to carry to a feeding roost. Heideman and Heaney (1989) estimated that at least 525, and possibly several thousand, individuals were feeding at least occasionally in an orchard of several hundred fruit trees on Negros, but there were many fewer there on any one night, and these individuals were probably foraging over a very wide area.

Population biology: In the Philippines, females probably produce two young per year, one in each of two birth periods separated by 4-5 months. There is some variation in timing of births among islands (Heideman, 1987). The duration of gestation is about 3.5-4.5 months; that of lactation approximately 2.5-3 months.

Young females produce their first young at an age of 8-12 months, females generally becoming pregnant at 6-9 months. Although males on Negros in the Philippines had moderately large and apparently functional testes at an age of 1 year, these animals weighed 30-50% less than older males and lacked their extensive orange-red throat ruff. On Negros, most or all of the females produced only one young in their first year (Heideman, 1987). Start (1974) reported that bats in Peninsular Malaysia were in reproductive condition all year, but he seems to have used a very broad definition of 'breeding' that implies either a synchronous or seasonally polyoestrus pattern or an asynchronous and aseasonal polyoestry. Lim (1973) reported pregnant females only from December through to June in a different Peninsular Malaysian population, suggesting a seasonal reproductive pattern. Kitchener *et al.* (1990) reported that in October 1987 on Lombok, it appeared that the birth season had recently finished. None of the nine females caught was pregnant, but seven were lactating. In May 1988 a single female caught on Lombok was lactating. A juvenile female was collected at the same time. On Timor Goodwin (1979) reported that most of the adult specimens collected in March, April and May were in breeding condition with many of the females pregnant, recently parturient, or lactating. On Sulawesi, two females caught in March were pregnant and an adult female caught in early December was apparently lactating at the time of capture (Bergmans and Rozendaal, 1988).

In New Guinea, out of seven females caught at Yapsiei, West Sepik Province in January 1984, four were in an advanced stage of pregnancy and the remainder were subadult (Flannery, 1990). On a return visit in late April 1986, a further 16 animals were taken. Only three of these were males, two definitely subadult. Of the 13 females, six were lactating, and four were subadult. These data suggest highly seasonal breeding in West Sepik Province, and a perplexing absence of adult males from the area after the birth of the young (Flannery, 1990). Gestation in South East Asia is said to last 15 weeks, and the young feed on solid food by the age of 3 months.

Occurrence in protected areas:

Seram

Manusela National Park

Sulawesi

Dumoga-Bone National Park

Summary of threats:

- Hunting, especially at roosts.
- Destruction of roosts because of supposed damage to commercial fruit crops.

Recommended action:

- Surveys to assess status, particularly in protected areas, in Alor, Ambon, Bagabag, Burma, Enganno, Halmahera, Kisar, the Mentawai Islands, Ndao, Peleng, Rote, Savu, Seram, Sulawesi, Sumba, Ternate and Yapen.
- Monitor efforts to reduce populations (because of threats to fruit crops) to ensure that the many other bat species and swifts that share their roost caves are not destroyed.

Principal authors for this subspecies: T. Flannery, P. D. Heideman, L. R. Heaney.

R. (R.) a. brachyotis

Priority Grade: 11 (Not Threatened).

Distribution: Bismarck Archipelago (Duke of York, Emirau, New Britain, Tabar); Bougainville; ?Halmahera; Solomon Islands (Choiseul, Fauro, Guadalcanal, Kolombangara, Malaita, Santa Isabel, Vella Lavella).

Population biology: On Bougainville, McKean (1972) reported pregnant females in July and September and a lactating female in September.

Summary of threats:

- Lack of information on status.

Recommended action:

- Surveys to assess status, particularly in protected areas.

R. (R.) a. infumatus

Priority Grade: 11 (Not Threatened).

Distribution: Bali; Flores; Jawa; Krakatau Islands (Lang); Penida; Sumatra.

Summary of threats:

- Lack of information on status.

Recommended action:

- Surveys to assess status, particularly in protected areas.

Rousettus (Rousettus) celebensis
Sulawesi rousette

Priority Grade: 11 (Not Threatened).

Distribution: Sangir Islands (Sangir, Siau, Tahulandang); Sulawesi.

Status: **Sulawesi** Bergmans and Rozendaal (1988) commented that in the Tangkoko-Batuangus Nature Reserve, it was, along with *Cynopterus brachyotis*, the most numerous fruit bat mist-netted along the forest edge and in coastal bush. Within primary forest it was netted in smaller numbers. In this reserve *R. (R.) celebensis* was observed to roost in numbers in a shallow, coastal cave close to the tide line at Tanjung Mandera. Hunted for food in north Sulawesi.

Population biology: An adult female caught by Bergmans and Rozendaal (1988) in March 1985 in Sungei Tumpah (Dumoga-Bone National Park) gave birth to a single young while in captivity. In April 1983 a female nursing a young bat was observed in a roost in a shallow cave at Tanjung Mandera (Bergmans and Rozendaal, 1988). In lowland forest in the Tangkoko-Batuangus reserve two females carrying young were caught in April.

Occurrence in protected areas:

Sulawesi

Dumoga-Bone National Park
Tangkoko-Batuangus reserve

Summary of threats:

- Unknown.

Recommended action:

- Surveys to assess status and to investigate biology and ecology.

Rousettus (Rousettus) lanosus
Ruwenzori long-haired rousette

Priority Grade: 11 (Not Threatened)

Number of subspecies: 2. The two currently recognized subspecies are separated by differences in dentition and fur colour. As many more localities have become known, and as these, because of the montane character of the species, tend to be isolated from one another, intraspecific variation is to be expected for other populations. Subspecific divisions can be assessed only by reviewing of all known material.

R. (R.) l. kempi

Priority Grade: 11 (Not Threatened).

Distribution: Eastern Ethiopia; Kenya; south-eastern Sudan; Tanzania.

Status: Unknown. Locally abundant but few observations.

Granvik (1924) related how on and around Mount Elgon in Kenya in 1920 a local wandering tribe, the Wanderoboos, 'when sojourning for a longer or shorter time in the caves, live to a great extent on these fruit-bats.' Allen and Loveridge (1927) reported that bats were also hunted and eaten by local people in the Uluguru Mountains in Tanzania. Locally, the easy hunting of cave-inhabiting fruit bats will certainly still occur and may pose a threat to populations.

Furthermore, the destruction of relict patches of montane forest will have an adverse effect. It is not known whether caves harbouring this bat are among those known to be affected by tourist pressures.

Ecology: Roosts in damp, dark caves in montane forest, where it assembles in hundreds and occasionally shares roosts with *Rousettus (Rousettus) aegyptiacus* and/or *Rousettus (Lissonycteris) angolensis*. Its long hair with fine woolly underfur is probably an adaptation to the cold regions in which it lives.

Occurrence in protected areas:

Kenya

Mount Elgon National Park

Summary of threats:

- Deforestation.
- Hunting.
- ?Tourist pressure on cave roosts.

Recommended action:

- Assessment of occurrence of viable populations in protected areas. As so little is known of its biology and ecology, a project to obtain general information about food preferences, roosting sites, movements and, over a wide geographic range, reproductive strategies, is needed to draw up an effective conservation plan.

R. (R.) l. lanosus

Priority Grade: 11 (Not Threatened).

Distribution: Burundi; Rwanda; Uganda; north-east and south-east Zaire.

Status: Unknown. Locally abundant, but few observations.

It presumably would be threatened by the same problems as those faced by *R. (R.) l. kempi*.

Ecology: In Rwanda seen feeding at the flowers of *Lobelia (Campanulaceae)* (J. R. Wilson, pers. comm.). At Fort Portal, in Uganda, a specimen was collected in a banana plantation (**Musaceae: Musa** sp.).

Occurrence in protected areas:

Rwanda

Parc National de Volcans

Uganda

Bwindi (Impenetrable) Forest Reserve
Queen Elizabeth National Park

Zaire

Parc National de Virunga

Summary of threats:

- Hunting.
- Deforestation.

Recommended action:

- Assessment of occurrence of viable populations in protected areas. As little is known of its biology and ecology, a project to obtain general information about food preferences, roosting sites, movements and, over a wide geographic area, reproductive strategies, would be needed to draw up an effective conservation plan.

Principal authors for this species: W. Bergmans, S. Sowler.

Rousettus (Rousettus) leschenaulti

Priority Grade: 11 (Not Threatened).

Number of subspecies: 3.

R. (R.) l. leschenaulti

Priority Grade: 11 (Not Threatened).

Distribution: Bangladesh; Burma; Cambodia; south China; Hong Kong; India; Laos; Nepal; Pakistan; Thailand; Vietnam.

Status: **Bangladesh** Uncommon, but found over a wide area. A large colony is known from Kudum Cave, near Whykeong (Khan, 1985).

Thailand Lekagul and McNeely (1977) commented that it was found throughout Thailand and was especially numerous in the fruit-growing areas of Nonburi and Chonburi. This is supported by Yenbutra and Felten (1986) who listed records from the provinces of Chaiyaphum, Chanthaburi, Chiang Mai, Chiang Rai, Chumphon, Kanchanaburi, Loei, Lop Buri, Nakhon Ratchasima, Nakhon Sawan, Nan, Phattalung, Phetchaburi, Prachin Buri, Prachuap Khiri Khan, Ranong, Saraburi, and Songkhla.

Vietnam Van Peenen (1969) listed records from the following localities in southern Vietnam: Phuochai, Mt Sontra and Fyan.

In Nepal this species is given partial protection under wildlife regulations.

Nothing is known of possible threats, although as a cave-

dweller it would presumably face the same pressures as other cave species.

Ecology: In Bangladesh, distribution is limited to forested areas containing dilapidated buildings or ruins. Prefers to roost in dark places (Khan, 1985). In India, it roosts in colonies of 10-2000 in caves and man-made structures such as tunnels, rock-cut caves, wells and rooms in old ruins, not necessarily dark. There is movement between different roosting sites depending on the availability of food. There is usually no sexual segregation in the colonies; however, separate roosts of the sexes have been reported. Juveniles, once independent of their mothers, live in exclusive colonies (Prater, 1971).

Fujita and Tuttle (1991) listed the following food plants: **Anacardiaceae:** *Anacardium occidentale* (FR), *Mangifera indica* (FL); **Annonaceae:** *Annona reticulata* (FR), *A. squamosa* (FR); **Bigoniaceae:** *Heterophragma roxbergii* (FL), *Oroxylum indicum* (FL), *Radermachera xylocarpum* (FL); **Bombacaceae:** *Adansonia digitata* (FL), *Ceiba pentandra* (FL); **Juglandaceae:** *Carya arborea* (FL); **Myrtaceae:** *Psidium guajava* (FR,FL), *Syzygium cumini* (FR,FL); **Sapotaceae:** *Madhuca indica* (FL), *Mimusops hexandra* (FR,FL).

Population biology: Prater (1971) commented that in India the season of copulation is probably between November and March. Two discrete birth seasons, one in March and the second in August are reported. Gopalakrishna and Choudari (1977) found that pregnancies lasted from November to March and from March to July, with females having a post-partum oestrus. A single young is born to each female. The young are carried by their mothers for 2 months and adult size is reached after 1 year. Females are sexually mature at 5 months, while males do not reach sexual maturity until 15 months.

Summary of threats:

- Unknown.

Recommended action:

- Surveys to assess status, particularly in protected areas, in Burma, Cambodia, southern China, Hong Kong, India, Laos, Nepal, and Pakistan.
- Projects to investigate ecology, biology and possible threats.

R. (R.) l. seminudus

Priority Grade: 11 (Not Threatened).

Distribution: Sri Lanka.

Status: Colonies scattered sparsely over the greater part of the lowlands and lower hills, but never reported from Jaffna or northern districts (Phillips, 1980).

This species is fully protected under local wildlife laws.

Ecology: Roosts in the darkest recesses of large caves. Males sometimes live separately (Phillips, 1980).

Feeds on the fruit and flowers of guava (**Myrtaceae**: *Psidium guajava*), plantains (**Musaceae**: *Musa* sp.), loquats (**Rosaceae**: *Eriobotrya japonica*), soursops (**Annonaceae**: *Annona muricata*) and the kapok tree (**Bombacaceae**: *Ceibapentandra*) (Phillips, 1980).

Population biology: Copulates in roosting caves. Gestation is 15 weeks (Phillips, 1980).

Summary of threats:

- No known threats.

Recommended action:

- Survey to assess status, particularly in protected areas.

R. (R) l. shortridgei

Priority Grade: 10 (No Data).

Distribution: ?Aru Islands; Bali; Jawa; Lombok, Simalue Islands; Sumatra.

Population biology: On Lombok, Kitchener *et al.* (1990) reported that two females caught in May 1988 were both pregnant and lactating.

Summary of threats:

- Lack of information on status.

Recommended action:

- Surveys to assess status, particularly in protected areas.

Rousettus (Rousettus) madagascariensis
Madagascar rousette

Priority Grade: 11 (Not Threatened).

Distribution: Madagascar.

Status: At least locally common (M. Nicoll, pers. comm.). Found in all lowland areas with (preferably moist) forest. It is very probably restricted by its need for cave habitats (Bergmans, 1977).

Threatened by deforestation, hunting and poor implementation of protection of reserves such as Ankarana (Wilson, 1987).

Ecology: A specimen was collected 'near a banana plant' (**Musaceae**: *Musa* sp.).

Occurrence in protected areas:

Madagascar

Ankarana Special Reserve

Summary of threats:

- Deforestation.
- Hunting.
- Poor reserve protection.

Recommended action:

- Assessment of occurrence of viable populations in protected areas.
- A project to study biology and ecology, especially reproductive habits.
- Support for a more active protection of reserves.

Principal authors for this species : W. Bergmans, S. Sowler.

Rousettus (Rousettus) obliviosus
Comoro rousette

Priority Grade: 11 (Not Threatened).

Distribution: Comoros (Anjouan, Grande Comore, Moheli).

Status: Apparently common. The Belgian Zoological Missions in 1981 and 1983 collected 64 specimens 'from the many that were caught', and it was a regular catch in the mist-nets set up in the forests (Meirte, 1984b). Carroll (1985) quoted M.Louette, who reported that it was 'quite common, at least on the three westernmost Comoros'. During a trip to the Comoros in late 1989, D. Meitre (pers. comm.) found large numbers on Grande Comore and Moheli.

Threatened by deforestation. The planting of bananas in the lower, deforested regions, where bats apparently forage in important numbers, results in enormous soil erosion. To compensate for this other areas are then deforested (D. Meitre, pers. comm.). Because the majority of the people of the Comoros are Muslims, bats are probably not threatened by hunting. Possible damage to fruit crops may lead to destruction of colonies in caves, but it is not known whether such damage occurs or whether bats are being destroyed. The Belgian expeditions of 1981 and 1983 (Meitre, 1984b) did not find where bats roost by day, which may indicate that they have retreated to higher altitudes.

Ecology: D. Meitre (pers. comm.) considered that bananas (**Musaceae**: *Musa* spp.) are probably the most important food.

Population biology: A female collected in October on Anjouan had one embryo.

Occurrence in protected areas: There are no protected areas in the Comoros.

Summary of threats:

- Deforestation.

Recommended action:

- Assessment of distribution and status. Study of its biology and ecology, especially reproduction and feeding ecology and

including adaptability to developed land. The requirements of this endemic species should be taken into account when planning protected areas.

Rousettus (Rousettus) spinalatus

Priority Grade: 10 (No Data).

Distribution: Western Borneo (Sabah, Sarawak); northern Sumatra.

Status: A roost of about 300 individuals was found in a cave at Batu Timbang in central Sabah. Single individuals have been found in mixed roosts with *R. (R.) amplexicaudatus* at Niah Caves in Sarawak and along the Kinabatangan River in Sabah (Francis, 1989).

Occurrence in protected areas:

Borneo

Sarawak
Niah Caves

Summary of threats:

- Lack of information on status.

Recommended action:

- Surveys to assess status, particularly in protected areas.

Principal author for this species: C. M. Francis.

Genus *Scotonycteris* (2 species)

Scotonycteris ophiodon
Pohle's fruit bat

Priority Grade: 11 (Not Threatened).

Distribution: Cameroun; Congo; Ghana; Liberia.

Status: Known from a few scattered localities. As a forest dweller, it would be threatened by deforestation.

Ecology: A forest dweller. Eisentraut (1960) netted a specimen in a *Ficus* (Moraceae) tree, and found yellowish grains, which were probably fig seeds, in the stomach of another.

Population biology: Hayman (1946) described a female with a very young offspring collected at Oda, Ghana in December. Wolton *et al.* (1982) caught two pregnant females in August and one in September at Mount Nimba.

Summary of threats:

- Deforestation.

Recommended action:

- Assessment of occurrence of viable populations in protected areas. Study of habitat, food requirements and reproductive cycle. Gazetting of protected areas to include this species.

Principal authors for this species: W. Bergmans, S. Sowler.

Scotonycteris zenkeri
Zenker's fruit bat

Priority Grade: 11 (Not Threatened).

The subspecies *S. z. occidentalis* was described on the basis of material from eastern Zaire, but most authors consider this as a synonym of the typical form.

Distribution: Cameroun; Central African Republic; Congo; Equatorial Guinea (Bioko, Mbini); Gabon; Ghana; Ivory Coast; Liberia; Nigeria; north-east and south-east Zaire.

Status: Unknown. As a forest dweller, it would be threatened by deforestation.

Occurrence in protected areas:

Ivory Coast

Tai National Park (Roth and Merz, 1988)

Summary of threats:

- Deforestation.

Recommended action:

- Assessment of occurrence of viable populations in protected areas. Study of habitat, food requirements and reproductive cycle. Gazetting of protected areas to include this species.

Principal authors for this species: W. Bergmans, S. Sowler.

Genus *Sphaerias* (1 species)

Sphaerias blanfordi
Blanford's fruit bat

Priority Grade: 10 (No Data).

Distribution: Bhutan; Burma; south-west China; north India; north Thailand; south-west Tibet.

Summary of threats:

- Lack of information on status.

Recommended action:

- Surveys to assess status, particularly in protected areas.

Genus *Styloctenium* (1 species)

Styloctenium wallacei Stripe-faced fruit bat

Priority Grade: 10 (No Data).

Distribution: Sulawesi.

Status: Hunted for food in north Sulawesi (Bergmans and Rozendaal, 1988).

Occurrence in protected areas:

Sulawesi

Dumoga-Bone National Park

Summary of threats:

- Lack of information on status.

Recommended action:

- Survey to assess status, particularly in protected areas.

Genus *Syconycteris* (3 species)

Syconycteris australis

Priority Grade: 11 (Not Threatened).

Number of subspecies: 7.

S. a. australis Queensland blossom bat

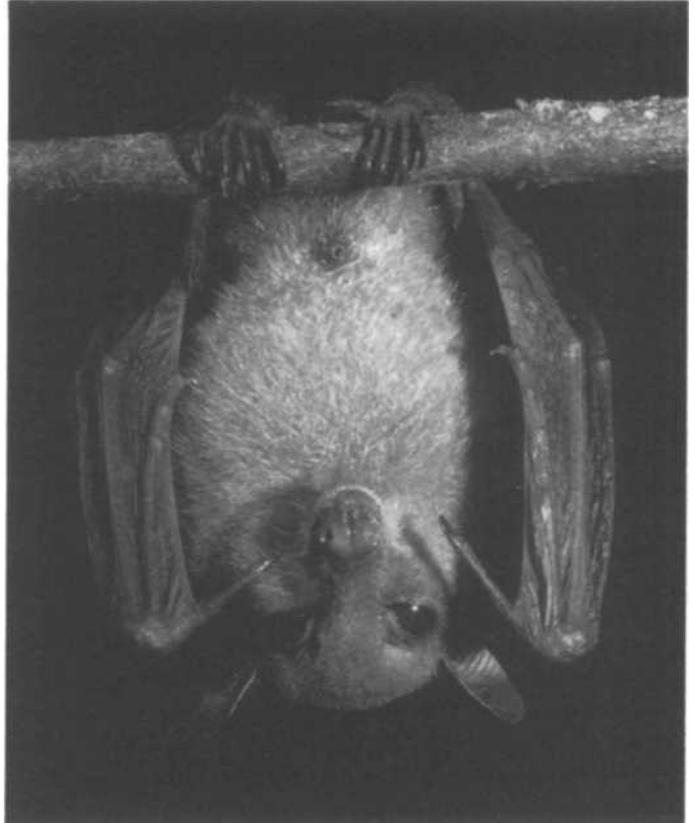
Priority Grade: 11 (Not Threatened).

Distribution: Eastern coast of Australia (Queensland).

Status: Strahan (1983) considered it common in limited habitat.

Ecology: The protection offered by dense foliage in rain forest and adjacent wet sclerophyll forest is used for daytime roosting, but it has also been found in mango trees (**Anacardiaceae:** *Mangifera indica*) (Strahan, 1983).

Has been observed hovering in front of, or feeding on, the blossoms of paperbarks, bottlebrushes (**Myrtaceae:** *Callistemon* spp., *Melaleuca* spp.) banksias (**Proteaceae:** *Banksia* spp.), bloodwoods (**Myrtaceae:** *Eucalyptus* spp.) and cultivated bananas (**Musaceae:** *Musa* spp.) (Strahan, 1983). This small bat is highly specialized for a diet of nectar with a very pointed muzzle and a long, thin tongue. The tongue has minute, brush-like projections along the mid-line for gathering nectar and pollen and there is no doubt this species is an important pollinator.



Syconycteris australis (Photo by A. M. Hutson)

Summary of threats:

- No significant threats.

Recommended action:

- Investigations into biology and ecology and into possible threats.

S. a. crassa

Priority Grade: 10 (No Data).

Distribution: D'Entrecasteaux Islands (Fergusson Island); Trobriand Islands (Kinwina).

Summary of threats:

- Lack of information on status.

Recommended action:

- Surveys to assess status, particularly in protected areas.

S. a. finschi

Priority Grade: 10 (No Data).

Distribution: Bismarck Archipelago (Admiralty Islands [Manus], New Britain, New Ireland).

Summary of threats:

- Lack of information on status.

Recommended action:

- Surveys to assess status, particularly in protected areas.

S. a. keyensis

Priority Grade: 8 (No Data: Limited Distribution).

Distribution: Kai Islands.

Summary of threats:

- Lack of information on status.

Recommended action:

- Survey to assess status, particularly in protected areas.

S. a. major

Priority Grade: 10 (No Data).

Distribution: Ambon; Seram. The range probably includes Buru and other small islands near Ambon.

Occurrence in protected areas:**Seram**

Manusela National Park

Summary of threats:

- Lack of information on status.

Recommended action:

- Surveys to assess status, particularly in protected areas.

S. a. naias

Priority Grade: 8 (No Data).

Distribution: Muyua.

Summary of threats:

- Lack of information on status.

Recommended action:

- Survey to assess status, particularly in protected areas.

S. a. papuana

Priority Grade: 11 (Not Threatened).

Distribution: Aru Islands; Bagabag; Crown; Long; Louisiade Archipelago (Misima Island, Rossel Island, Sudest Island); Misool; New Guinea; Sakar; Tolokiwa; Umboi.

Status: New Guinea Common (Flannery, 1990). When using mist-nets in New Guinea, it is the most commonly captured bat, being abundant at all altitudes, and above 1500 m is often the only species caught (Flannery, 1990).

Ecology: In New Guinea, found in most habitats (Flannery, 1990).

Feeds almost exclusively on nectar and pollen, and is probably an important pollinator (Richards, 1983). There is some evidence that it may become torpid at higher altitudes. In February 1984, Flannery (1990) collected some bats that had been caught in a mist-net at 2200 m on a very cold and rainy night. The animals were wet, cold and stiff, and appeared to be dead. They were placed by a fire and all recovered and became active within three-quarters of an hour.

Population biology: Reproduction appears to be aseasonal in New Guinea (McKean, 1972). A single embryo is usual (McKean, 1972; author's data).

Summary of threats:

- Lack of information on status.

Recommended action:

- Surveys to assess status, particularly in protected areas, in the Louisiade Archipelago, the Aru Islands and Misool.

Principal author for this species: T. Flannery.

Syconycteris carolinae

Priority Grade: 8 (No Data: Limited Distribution).

Distribution: North-west Halmahera.

Summary of threats:

- Lack of information on status.

Recommended action:

- Survey to assess status, particularly in protected areas.

Syconycteris hobbit
Moss-forest blossom bat

Priority Grade: 6 (Rare).

Distribution: New Guinea.

Status: Rare (Flannery, 1990). Reported only from high-altitude forest near the summit of Mount Kaindi, Morobe Province. In this area it is sympatric with *S. australis papuana*. In March 1986, a single specimen collected in a taro (*Araceae: Colocasia esculenta*) garden at 2300 m in the Telefomin area (West Sepik Province). *Nyctimene cyclotis*, *Syconycteris australis* and *Pipistrellus collinus* were taken in nets set in the same garden (Flannery, 1990).

Ecology: Presumed to feed on nectar and pollen, like *S. australis papuana* (Flannery, 1990).

Population biology: Of three females collected in June/July, 1967, one was possibly pregnant with an early stage embryo, while two were actively nursing or had recently ceased lactating (Ziegler, 1982).

Summary of threats:

- Lack of information on status.

Recommended action:

- Survey to assess status, particularly in protected areas.

Genus *Thoopterus* (1 species)

Thoopterus nigrescens
Swift fruit bat

Priority Grade: 10 (No Data).

Distribution: Morotai; ?Philippines (Luzon); Sangir Islands; Sulawesi.

Status: Hunted for food in north Sulawesi (Bergmans and Rozendaal, 1988).

Ecology: In Sulawesi, has been collected in forest at altitudes of between about 50 m and 1800 m. At Bantimurong specimens were collected in a small patch of woodland on a narrow river plain wedged between limestone hills. It is thought that the bats roosted communally, possibly using the same roosts over long periods of time (Bergmans and Rozendaal, 1988). At Malino, specimens were collected while feeding in a fig tree (**Moraceae:** *Ficus* sp.) in a village area together with *Cynopterus bbrachyotis brachyotis*.

Population biology: In Sulawesi, subadult specimens were collected in October, December, January and March. Pregnant females were collected in January (Bergmans and Rozendaal, 1988).

Occurrence in protected areas:

Sulawesi

Bantimurong Protected Area
Dumoga-Bone National Park

Summary of threats:

- Lack of information on status.

Recommended action:

- Surveys to assess status, particularly in protected areas.

Chapter 4. Centres of Biological Diversity

As the destruction of habitat continues, the maintenance of biodiversity has become a high priority. However, decisions must be made about which areas should have the highest priority in protection efforts.

Measurement of biodiversity

The most widely used measure of biodiversity is species richness, which is often combined with some measure of relative abundance. In such measures all species are treated as taxonomically equivalent. However, it is questionable whether it is wise to treat all species as equal. For, if one were to compare two taxa, one of which was a subspecies of an otherwise widely distributed species and the other a species not closely related to other living species, it would seem sensible to give the latter a higher weighting. Similarly, if two sites contained five species, the first with all species from the same genera and the second with species from five different genera, the latter would seem to deserve a greater weighting. It is important, therefore, to have some way of measuring the distinctness of different taxa. This can be done by producing a cladogram, which groups taxa according to their ancestry. A hypothetical cladogram for genera in the Family Pteropodidae is shown in Figure 11. This allows for a biodiversity measure to include a weight related to the taxonomic distinctness of the included fauna. Vane-Wright *et al.* (1991) reviewed how this weighting can be undertaken. The analysis also takes account of the arrangement of the species of *Pteropus* into species groups and follows the scheme of the US Fish and Wildlife Service and National Environmental Protection Board (1989), based on Andersen (1912).

The concept of critical areas

The concept of critical areas arises from the variation in the geographic distribution of species. It is important to be able to identify which areas, if protected, would conserve the greatest biodiversity. The work of Vane-Wright *et al.* (1991; Williams *et al.* 1991, in press) is based on the idea of there being centres

of endemism, or critical faunas and floras, for particular taxonomic groups. The concept of 'critical faunas analysis' was first introduced by Kirkpatrick (1983) and used by Ackery and Vane-Wright (1984) in an account of milkweed butterflies of the world. Addressing the problem of conserving representative populations of all 158 species of milkweed butterflies, they asked the question, 'what is the minimum set of areas, or faunas, which would contain at least one population of each species?' The answer they arrived at was 31. This was obtained by arranging all areas with one or more endemics in sequence, from those with the largest number of endemics to those with one. In this approach all species were treated as taxonomically equal and the list-sequence was dependent on according, *a priori*, high values to endemics. The procedure is based on the principle of complementarity. Once the first choice has been made all further considerations of species included in that choice are eliminated. The procedure continues step by step. At each step the remaining complement of species is reduced through the exclusion of species chosen in the previous steps. The procedure is completed when all species have been accounted for—the total complement. When a taxic weight is introduced the concept of complementarity still applies.

The priority area analysis for the Family Pteropodidae uses information on the distribution of fruit bat species. Subspecies have not been included. *Pteropus pilosus* and *P. subniger* have also been excluded from the analysis because there is not the remotest chance that they are extant. The known distribution was fitted to a system of geographical units. Such units may represent a group of countries, one country, an area within a country, an island group, an individual island, or an area within an island. The geographic units closely follow those developed for milkweed butterflies (R. I. Vane-Wright, unpublished) with the intention of comparing a range of faunas and floras. A full list of these units is given in Appendix 2. The assignment of these units is flexible and they could, for example, be used to weight a selection of sites within a single country. The analysis was run on the WORLDMAP programme (Vane-Wright *et al.*, 1991). Tables 4 and 5 show the results, excluding and including a taxonomic weight, respectively.

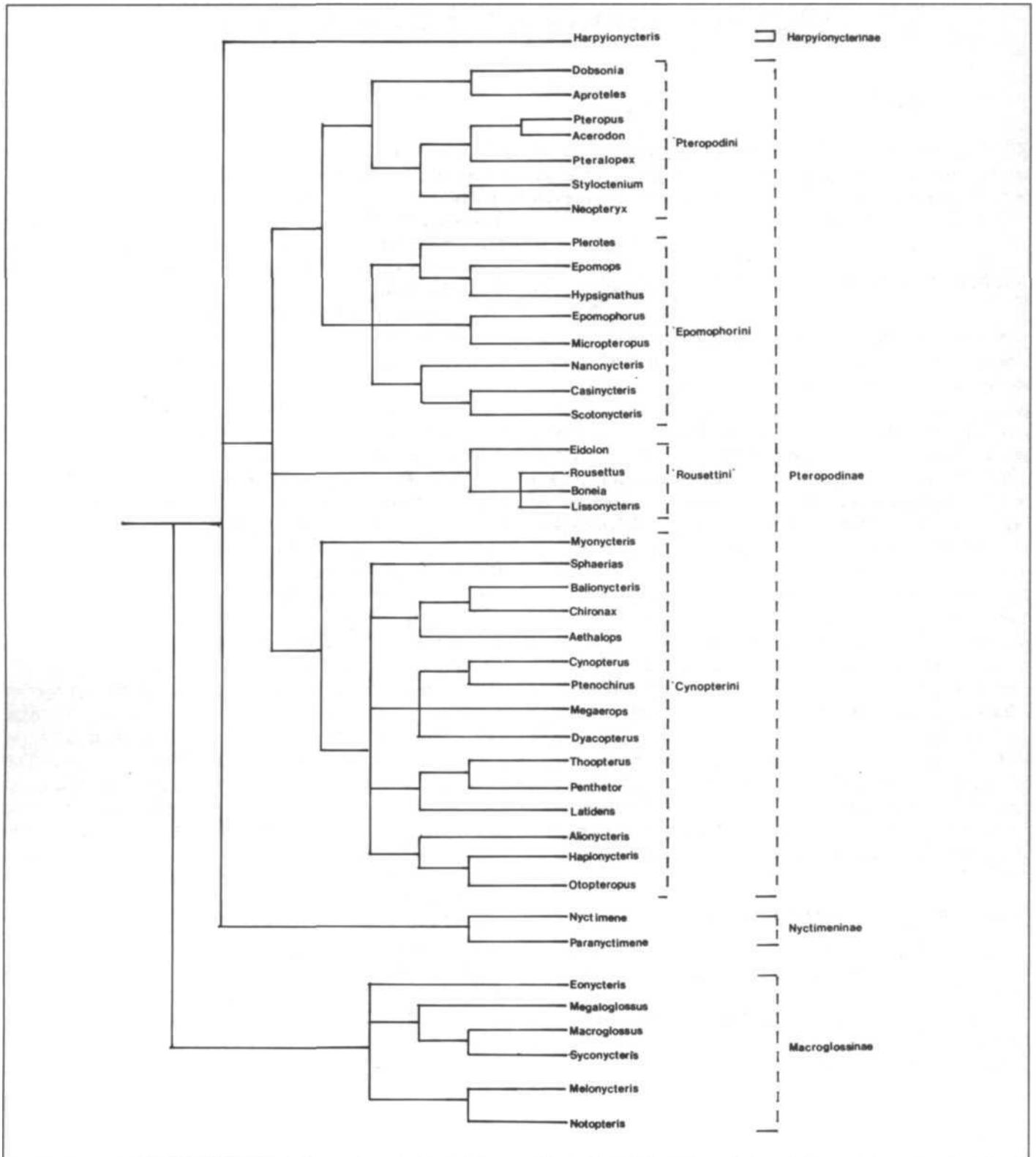


Figure 11. Hypothetical cladogram for the genera of the family Pteropodidae

There is no modern published phylogeny for the family Pteropodidae. This provisional cladogram for its included genera has been prepared by J. Edwards Hill and is based on an informal character analysis, incorporating those genera described since Andersen (1912) provided the last detailed systematic study of the family. It has been constructed for the identification of critical areas in the conservation of the diversity of the Megachiroptera, based not just on species richness, but including a weight related to the taxonomic distinctness of the included fauna, using the system proposed by Vane-Wright et al. (1991).

The subfamilies Harpyioncternae and Nyctimeninae have been retained but are less clearly defined than the Macroglossinae: *Harpyioncteris* seems related to *Dobsonia*, while *Nyctimene* and *Paranyctimene* are evidently allied to *Cynopterus* and its attendant genera.

Discussion

For both measures the 10 geographical areas of highest diversity account for 60% of the total pteropodid diversity and all taxa are represented within 48 geographic areas of highest diversity. Sulawesi, Angola and east Irian Jaya rank in the first three places for both measures. However, with the taxonomic weight, south-west Borneo, Choiseul, New Ireland, Negros and Fiji rank in the top 10, whereas they do not achieve this status on account of their species richness alone. The largest change in rank is shown by New Ireland, which comes at step 32 in the species-richness measure, but at step 7 in the weighted measure. Some sites that rank highly on species richness (e.g., Guadalcanal and New Britain), fare less well in the weighted measure. At the lower end of the table there is again broad agreement between the two measures.

The results produced here are a first step. The next stages might involve revising the geographic units or re-running the program in the light of new distribution data. The procedure could also be repeated on smaller units, such as individual continents or countries. It will not be possible to save all the areas within all the countries listed but it is now possible to target conservation action on areas where it is likely to have the most beneficial results on a world-wide scale.

Table 4. Single step priority areas analysis for the Pteropodidae.
Diversity measure: unweighted number of species.

Choices step	Area	Diversity increment (%) ¹	Cumulative (%) ²	Area name
1	416	12.58	12.58	Sulawesi
2	586	9.43	22.01	Angola
3	423	8.18	30.19	E Irian Jaya
4	310	6.92	37.11	Mindanao
5	304	5.66	42.77	Pen. Thailand
6	391	4.40	47.17	New Britain
7	467	3.14	50.31	Guadalcanal
8	523	3.14	53.46	Lombok
9	504	3.14	56.60	Santa Cruz Is.
10	442	2.52	59.12	Cameroun
11	480	2.52	61.64	Tanzania
12	603	2.52	64.15	Queensland
13	273	1.89	66.04	Negros
14	456	1.89	67.92	Ambon
15	384	1.89	69.81	Halmahera
16	285	1.89	71.70	Fiji
17	624	1.89	73.58	Madagascar
18	517	1.89	75.47	Anjouan (Comoros)
19	414	1.26	76.73	SW Borneo
20	200	1.26	77.99	Luzon
21	393	1.26	79.25	Chioseul
22	302	1.26	80.50	Pen. India
23	575	1.26	81.76	New Caledonia
24	339	1.26	83.02	Nicobar Is.
25	540	1.26	84.28	N Vanuatu
26	129	1.26	85.53	Ryukyu Is.
27	315	1.26	86.79	Biak
28	424	0.63	87.42	Papua
29	406	0.63	88.05	Nigeria
30	521	0.63	88.68	Jawa
31	458	0.63	89.31	Seram
32	355	0.63	89.94	New Ireland
33	392	0.63	90.57	Bougainville
34	395	0.63	91.19	Malaita
35	307	0.63	91.82	Palawan
36	272	0.63	92.45	Panay
37	373	0.63	93.08	Pemba
38	548	0.63	93.71	São Tomé
39	348	0.63	94.34	Talaud Is.
40	351	0.63	94.97	Yapen
41	207	0.63	95.60	Caroline Is.
42	242	0.63	96.23	Palau
43	357	0.63	96.86	Ontong Java
44	171	0.63	97.48	Mariana Is.
45	589	0.63	98.11	Rodrigues
46	625	0.63	98.74	Mauritius
47	356	0.63	99.37	Mortlock Is.
48	130	0.63	100.00	Ogasawara-shato

Footnote to Table 4.

1. The percentage of the overall diversity added at each step. Where two or more sites have an equal increment, they have been graded firstly by the number of species in each site, and secondly, if necessary, by the number of genera. Thus sites with a larger number of species or genera are chosen first. The figures are calculated to more than two places of decimals, hence the difference between two sequential cumulative totals may not exactly equal that of the appropriate increment.
2. The running total of diversity accumulated at each step.

Table 5. Single step priority areas analysis for the Pteropodidae.

Diversity measure: root weighted number of species.

Choices step	Area	Diversity increment (%) ¹	Cumulative (%) ²	Area name
1	416	14.95	14.95	Sulawesi
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8	273	3.61	59.06	Negros
9	285	2.72	61.78	Fiji
10	480	2.70	64.48	Tanzania
11	442	2.31	66.79	Cameroun
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27	548	0.83	89.67	São Tomé
28	575	0.82	90.50	New Caledonia
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46	625	0.41	99.18	Mauritius
47	356	0.41	99.59	Mortlock Is.
48	130	0.41	100.00	Ogasawara-shato

Footnote to Table 5.

1. The percentage of the overall diversity added at each step. Where two or more sites have an equal increment, they have been graded firstly by the number of species in each site, and secondly, if necessary, by the number of genera. Thus sites with a larger number of species or genera are chosen first. The figures are calculated to more than two places of decimals, hence the difference between two sequential cumulative totals may not exactly equal that of the appropriate increment.
2. The running total of diversity accumulated at each step.

Chapter 5. Recommended Action for the Conservation of Threatened Fruit Bats

Introduction

Scope of recommended action section

The following section summarizes the recommended action for the conservation of threatened pteropodids. Recommendations for taxa considered not to be threatened are included, where appropriate, in the individual species accounts. In some cases reference should be made to the appropriate species account for further details.

Structure of recommended action section

The section begins with an overview of the broad objectives of conservation action. There follows a priority grading system for all taxa, which is based on the recognized system used by the International Union for the Conservation of Nature and Natural Resources (IUCN) (IUCN, 1990). Recently, it has been suggested that a revised version of this grading system should be considered (Mace and Lande, 1991), but this Action Plan continues to follow the original IUCN system. The gradings allow for projects to be ordered according to priority. Following this are country accounts in alphabetical order which summarize recommended action under the broad objectives outlined below. Each country account begins with information on the number of species recorded from that country together with any information on endemic species or subspecies. It continues with information on any legislation pertaining to bats, known major threats, information on biodiversity and a list of species that have been recorded from that country. Recommended action is then listed, with the highest priority projects appearing first. Each project entry contains the type of project (for example, survey or research), a brief summary of its objectives, the locality and the species involved.

Recommended projects that are not specific to any country (for example, taxonomic research projects) are listed in a general section at the beginning of the country accounts.

For countries where none of the recorded taxa is considered threatened, information may be given on any existing or potential problems that may threaten fruit bats in the future.

Forest protection - the highest priority

Most fruit bats are dependent to a large degree on forest, particularly primary forest. In consequence their most important threat is from the almost universal problem of forest destruction. Protection of forest and the control of destruction are of the highest priority to ensure the survival of many species.

Broad objectives of recommendations

The recommendations for action can be divided into five major topics: Survey; Improved Management; Research; Education; and Captive breeding and introduction/reintroduction. These are not in order of priority, but because in many cases there is no available information, a survey would be needed before further action could be formulated.

Survey

For many taxa there is very little or no basic information on status, distribution and habitat requirements. Surveys should be instigated to obtain such data. Survey techniques should be improved and, where possible, standardized so that they can be repeated by researchers and local people alike (see chapter on survey techniques). The assessment of the status of bats within protected areas is considered to be of paramount importance. Inventories of important protected areas should include bats. When surveys are undertaken it is important to be aware that, while some bats may roost in large numbers and thus give the appearance of being relatively common, such roosts may represent the entire population for a large area. This fact should be considered particularly where legislative action is based on roost numbers.

Improved management

Improvements in legislation can be implemented at local, national and international levels. At the international level CITES provides protection for species in international trade. The Chiroptera Specialist Group considers that the successful implementation of CITES regulations is vital for the long-term survival of species in trade. However, endangered species may not be covered by CITES, either because they are not in trade or

because their trade is not deemed international. In such cases the promotion of adequate national protection for these species should be encouraged. In many cases, existing national protection does not go far enough - protection should include the bats' habitats as well as the bats. On individual islands, local protection of roosts or habitat may be sufficient to ensure the survival of the species.

The Chiroptera Specialist Group considers that in many cases the ultimate survival of endangered bat species rests with the Protected Areas System. Wherever possible, the setting up of Protected Areas for bats should be a goal of national conservation effort. On some islands with rapidly diminishing populations, this may be the only chance for the survival of species. The Protected Areas System already covers many areas. In such areas the bat interest must be fully promoted. New areas should be designated in collaboration with IUCN.

Hunting needs to be carefully managed, either through total bans or by designating a hunting season or maximum catch. The Chiroptera Specialist Group believes that hunting using guns should be outlawed or severely restricted because of the high incidence of wounding. Other methods of hunting may be acceptable, but in cases where populations have already been seriously depleted by overhunting or habitat loss, even traditional harvests may pose severe threats.

Forests should, wherever possible, be managed with bats in mind. The maintenance of roosting trees (often large canopy trees) and a diverse understorey is vital for bats. Underplanting with species such as bananas is to be discouraged. Many bats rely on areas of mangroves for roosting and feeding and the maintenance of such habitats is a high priority. With the destruction of large areas of lowland forest, montane forest has become an important refuge for many bat species so the protection and management of what areas remain is also a high priority.

Many bat species rely on caves to a greater or lesser degree. Many are already subject to pressures from tourists and commercial interests. Known cave roosts should be carefully managed to limit disturbance. Where sites are being commercially exploited (such as by quarrying, or for bat guano), management agreements need to be implemented to allow sympathetic exploitation. It may be possible to manage some sites carefully for use in an educational role.

The ill-advised management of fruit bats accused of damaging fruit crops has in the past resulted in serious population declines. The significance of fruit bat damage needs to be fully investigated. In cases of serious damage, liaison between fruit growers and bat researchers over management techniques is vital. The Chiroptera Specialist Group is opposed to destructive methods of fruit bat management and believes non-destructive methods should be used where necessitated by the level of damage to commercial fruit.

Research

Research requirements can be divided into the following major topics:

Breeding: Timing and duration of breeding season, duration of

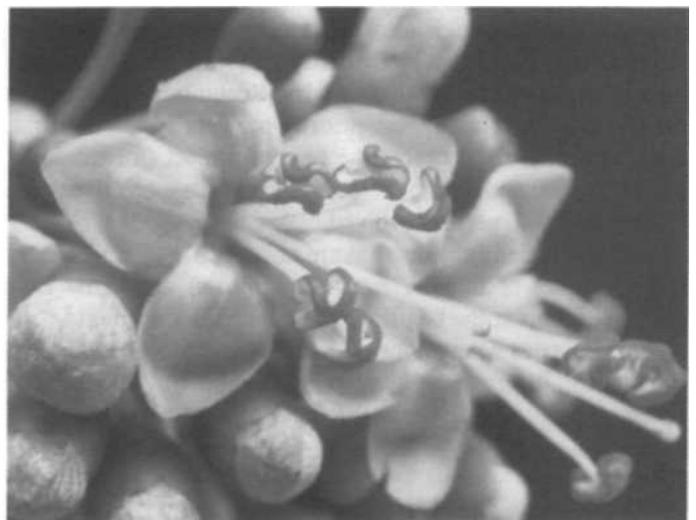
gestation, number of births per year, duration of lactation, and age of sexual maturity.

Feeding: Main food plants and the importance of these to man. The relative importance of commercial fruit in the annual diet of the species. This information could be important both to identify a species's role as a pollinator and seed disperser and also to assess the possible conflicts with man where a species feeds on commercial fruit crops. A general assessment of the significance of fruit damage should be made before any control measures are undertaken.

Movements: Local and seasonal movements to feeding and breeding grounds. Basic information on migratory movements may be required.

Threats: Apart from the well-documented threats from deforestation, roost-site disturbance and hunting, there are others such as epidemics and possible natural predators (such as snakes and birds of prey) about which we have little information. In some cases, little is known about possible threats to species. This is particularly true where tourist pressure is suspected and may be of particular importance to cave-dwelling species that are particularly susceptible to disturbance at their roosts. The extent of hunting and the techniques used allow the importance of this threat to be assessed. Research into the effects of various hunting methods needs to be undertaken. At present, little is known about the levels of hunting that might be acceptable without causing declines in numbers. The significance of non-human predators and of disease have yet to be fully investigated. These may pose serious threats to isolated island populations. The ability of species to withstand habitat destruction and disturbance also needs to be assessed, given that these threats are almost universal.

Habitat requirements: Many taxa occur in primary forest and research is needed to highlight those most susceptible to habitat



Kapok *Ceiba pentandra*, a plant pollinated by fruit bats (Photo by W. E. Rainey)

destruction or degradation.

Long-term population monitoring: This is especially important in the case of taxa where there is some evidence of declines in numbers.

Taxonomy and literature survey: Many species are known only from a few specimens and in a number of cases the taxonomy needs to be reviewed.

Education

This is an almost universal need. Education programmes can be divided into five main types:

- 1. General. Emphasizing the important role bats play in many forest ecosystems, including the economic importance of bats and the plants they service. These would be suitable for all taxa.
- 2. Fruit-damage. Aimed at those involved in the fruit-growing industry. They would emphasize the need for research into fruit damage before any action is taken. They would discuss the various management techniques available and promote non-destructive methods. They would also emphasize the role of bats

as pollinators and seed dispersers and, above all, promote liaison between the fruit-growing industry and bat workers.

- 3. Hunting. Aimed at those involved in hunting, both at a local and commercial level. These would emphasize the destructive nature of many techniques and the threat these pose to bat populations and ultimately to the hunters themselves. They would promote traditional hunting techniques and promote liaison between hunters and bat workers.

- 4. Habitat destruction and roost disturbance. Specifically discussing the threats posed by habitat destruction and roost disturbance and the ultimately serious threat this poses to forest ecosystems, particularly on isolated islands.

- 5. Tourists. Aimed at educating tourists who visit areas where bats may be offered as a culinary delicacy or who may be taken on guided tours of bat roosts, particularly caves. These would emphasize the serious threat this poses to many populations, particularly in the Pacific.

Education techniques: In all the above cases, the techniques used would be similar. Successful education programmes have already been initiated in a number of areas (e.g., Yap and Samoa) and these could be used as models. Publicity material, such as booklets, posters, stickers and slide-packs, could be distributed through a variety of outlets, such as schools, libraries, government departments and conservation organizations. Articles in magazines and newspapers would also be used. Above all, personal contact between bat workers and the public is vital and this can be achieved at all age levels through lectures and interviews.

Captive breeding and introduction/reintroduction

So far the success of captive breeding has been limited to a single species (*Pteropus rodricensis*), which has yet to be released into the wild. Captive breeding should be considered very much as a last resort, when all other methods of protection and management have failed, and where there is overwhelming evidence that the species will become extinct without such intervention. The Chiroptera Specialist Group believes that any captive breeding programme should be implemented only after full consultation between the Chiroptera Specialist Group, the Captive Breeding Specialist Group and any other interested party. A register of accepted breeding establishments should be compiled and stud books maintained for species breeding in captivity. In all cases, the ultimate aim would be to return the animals to their country of origin, or to a nearby suitable area as conditions permit following the guidelines offered by the IUCN Introduction and Reintroductions Specialist Groups. The implementation of a captive breeding programme should not prevent further efforts to promote the establishment of effective management and protection of the species concerned.



Poster produced as part of the campaign to save the Pemba fruit bat *Pteropus Voeltzkowi* (Photo by A. Lucas)

Priority gradings for species action

The following priority gradings are broadly based on those used by the International Union for the Conservation of Nature and Natural Resources (IUCN) (IUCN, 1990). They have been supplemented by the addition of two 'no data' categories and a 'not threatened' category. A distinction has also been made between those taxa with limited distributions and those whose distribution is more widespread. The definitions of the categories used are given below.

Extinct: Priority grading 1

Taxa not definitely located in the wild during the past 50 years (criterion used by the Convention on International Trade in Endangered Species of Wild Fauna and Flora). In some cases a taxon is thought to have become extinct recently and these have been included in a separate category, although they have been given the same priority grading.

Endangered: Priority gradings 1 and 2

Taxa in danger of extinction and whose survival is unlikely if those factors responsible continue to operate.

Included are taxa whose numbers have been reduced to a critical level or whose habitats have been so drastically reduced that they are considered to be in danger of immediate extinction. Also included are taxa that may be extinct but have definitely been seen in the wild in the past 50 years.

Vulnerable: Priority gradings 3 and 4

Taxa believed likely to move into the 'Endangered' category in the near future if those factors responsible continue to operate.

Included are taxa of which most or all of the populations are decreasing because of over-exploitation, extensive destruction of habitat or other environmental disturbance, taxa with populations that have been seriously depleted and whose ultimate security has not yet been assured, and taxa with populations that are still abundant but are under threat from severe adverse factors throughout their range. In practice, 'Endangered' and 'Vulnerable' categories may include, temporarily, taxa whose populations are beginning to recover because of remedial action, but whose recovery is insufficient to justify their transfer to another category.

Rare: Priority gradings 5 and 6

Taxa with small world populations that are not at present 'Endangered' or 'Vulnerable', but are at risk.

These taxa are usually local in occurrence within restricted geographical areas or habitats or are thinly scattered over a more extensive range.

Indeterminate: Priority gradings 7 and 9

Taxa known to be 'Endangered', 'Vulnerable' or 'Rare' but where there is not enough information to determine which of the three categories is appropriate.

No Data: Priority gradings 8 and 10

There are little or no data to assess this taxon's status or conservation needs.

Not Threatened: Priority grading 11

Either the taxon is widespread and common in at least part of its range, or there is no evidence of serious threats to populations.

Species priority gradings

The highest priority taxa have the lowest grading number. Taxa known or thought to be extinct have been given a grading equivalent to endangered species with a limited distribution. Greater priority is given to taxa with apparently limited distributions. A number of taxa are known only from one or a few specimens (these are marked with a 'U') and these have been included in the 'rare' category. It should be noted that the grading given to a species may differ from that given to each of its individual subspecies, in these cases the species has been marked with an asterisk (*).

Extinct

1

Acerodon lucifer

Nyctimene sanctacrucis

Pteropus pilosus

Pteropus subniger

Extinct? (within last 50 years)

1

Dobsonia chapmani

Pteropus brunneus

Pteropus tokudae

Endangered (Limited Distribution)

1

Aproteles bulmerae

Nyctimene rabori

Pteralopex acrodonta

Pteralopex anceps

Pteralopex atrata

Pteropus dasymallus (all subspecies)

Pteropus giganteus ariel

Pteropus hypomelanus maris

Pteropus insularis

Pteropus livingstonii

Pteropus mariannus (all subspecies)

Pteropus mariannus (subspecies unknown)

Pteropus molossinus

Pteropus phaeocephalus

Pteropus rodricensis

Pteropus samoensis samoensis

Pteropus voeltzkowi

Endangered

2

Acerodon jubatus (all subspecies)

Vulnerable (Limited Distribution)

Myonycteris brachycephala
Myonycteris relicta
Pteropus anetianus anetianus
Pteropus anetianus aorensis
Pteropus anetianus bakeri
Pteropus anetianus banksiana
Pteropus anetianus eotinus
Pteropus anetianus motalavae
Pteropus anetianus pastoris
Pteropus mahaganus
Pteropus niger
Pteropus pselaphon
Pteropus seychellensis aldabrensis

Vulnerable

Eonycteris spelaea glandifera
Epomops buettikoferi
Haplonycteris fischeri
Harpyionycteris whiteheadi negrosensis
Notopteris macdonaldii macdonaldii
Pteropus leucopterus
Pteropus pumilus
*Pteropus samoensis **
Pteropus vampyrus lanensis

Rare (Limited Distribution)

Alionycteris paucidentata
Epomophorus grandis (U)
Latidens salimalii (U)
Neopteryx frosti (U)
Pteropus vetulus

Rare

Aethalops alecto ocypte
Dobsonia minor
*Dyacopterus spadiceus ** (U)
Dyacopterus spadiceus spadiceus (U)
Eonycteris major robusta
Epomophorus angolensis
Epomophorus gambianus pousarguesi (U)
Megaerops kusnotoi
Micropteropus intermedius (U)
Nyctimene aello
Nyctimene cyclotis certans
Nyctimene draconilla
Paranyctimene raptor
Plerotes anchietae (U)
Pteropus speciosus
Rousettus (Rousettus) aegyptiacus arabicus
Syconycteris hobbit

Indeterminate (Limited Distribution)

No taxa in this category

3

No Data (Limited Distribution)

Acerodon humilis
Acerodon macklotii aloreensis
Acerodon macklotii floresii
Acerodon macklotii gilvus
Acerodon macklotii prajae
Casinycteris argynnis
Chironax melanocephalus tumulus
Cynopterus brachyotis brachysoma
Cynopterus brachyotis concolor
Cynopterus brachyotis insularum
Cynopterus brachyotis minutus
Cynopterus horsfieldii princeps
Cynopterus sphinx babi
Cynopterus sphinx pagensis
Cynopterus sphinx scherzeri
Cynopterus sphinx serasani
Cynopterus titthaechailus major
Cynopterus titthaechailus terminus
Dobsonia beauforti
Dobsonia emersa
Dobsonia inermis minimus
Dobsonia pannietensis remota
Dobsonia peronii ssp. incertae sedis
Dobsonia peronii peronii
Dobsonia peronii sumbana
Eidolon helvum sabaeum
Eonycteris spelaea rosenbergii
Macroglossus sobrinus fraternus
Melonycteris aurantius
Notopteris macdonaldii neocaledonica
Nyctimene albiventer albiventer
Nyctimene celaeno
Nyctimene major geminus
Nyctimene major lullulae
Nyctimene major major
Nyctimene major scitulus
Nyctimene malaitensis
Nyctimene masalai
Nyctimene minutus varius
Pteropus admiralitatum goweri
Pteropus alecto aterrimus
Pteropus alecto morio
Pteropus argentatus
Pteropus faunulus
Pteropus fundatus
Pteropus gilliardi
Pteropus griseus pallidus
Pteropus howensis
Pteropus hypomelanus annectens
Pteropus hypomelanus canus
Pteropus hypomelanus enganus
Pteropus hypomelanus fretensis
Pteropus hypomelanus geminorum
Pteropus hypomelanus robinsoni
Pteropus hypomelanus simalurus

4

5

6

7

8

Pteropus hypomelanus vulcanius
Pteropus lombocensis lombocensis
Pteropus lombocensis solitarius
Pteropus macrotis macrotis
Pteropus mearnsi
Pteropus melanopogon aruensis
Pteropus melanopogon keyensis
Pteropus melanotus melanotus
Pteropus melanotus modiglianii
Pteropus melanotus niadicus
Pteropus melanotus satyrus
Pteropus melanotus tytleri
Pteropus neohibernicus hilli
Pteropus nitendiensis
Pteropus ornatus auratus
Pteropus ornatus ornatus
Pteropus pohlei
Pteropus rayneri cognatus
Pteropus rayneri grandis
Pteropus rayneri lavellanus
Pteropus rayneri monoensis
Pteropus rayneri rayneri
Pteropus rayneri rennelli
Pteropus rayneri rubianus
Pteropus sanctacrucis
Pteropus temmincki Hops
Pteropus temmincki temmincki
Pteropus tonganus basiliscus
Pteropus tuberculatus
Pteropus vampyrus edulis
Pteropus vampyrus pluton
Rousettus (Boneia) bidens
Syconycteris australis keyensis
Syconycteris australis naias
Syconycteris carolinae

Indeterminate

Aethalops alecto aequalis
Aethalops alecto alecto
Balionycteris maculata seimundi
Cynopterus horsfieldii persimilis
*Dobsonia peronii **
Dobsonia peronii grandis
Megaerops wetmorei albicollis
*Notopteris macdonaldii **
*Nyctimene cyclotis **
Otopteropus cartilagonodus
*Pteropus anetianus **
*Pteropus ornatus **
Pteropus samoensis nawaiensis
Pteropus tonganus tonganus

No Data

Acerodon celebensis
Acerodon leucotis (all subspecies)
Cynopterus brachyotis altitudinis

Cynopterus brachyotis ceylonensis
Cynopterus brachyotis javanicus
Dobsonia exoleta
Dobsonia inermis inermis
Dobsonia moluccense moluccense
*Dobsonia pannietensis **
Dobsonia pannietensis anderseni
Dobsonia pannietensis pannietensis
Dobsonia praedatrix
Dobsonia viridis crenulata
Dobsonia viridis viridis
Dyacopterus spadiceus brooksi
Dyacopterus spadiceus (subspecies unknown)
Harpyionycteris whiteheadi celebensis
Harpyionycteris whiteheadi whiteheadi
Macroglossus minimus microtus
Macroglossus minimus minimus
Megaerops niphanae
Megaerops wetmorei wetmorei
Nyctimene cyclotis cyclotis
Nyctimene minutus minutus
Nyctimene vizcaccia bougainville
Nyctimene vizcaccia vizcaccia
Pteropus admiralitatum admiralitatum
Pteropus admiralitatum colonus
Pteropus admiralitatum solomonis
Pteropus alecto alecto
Pteropus coniceps coniceps
Pteropus coniceps dobsoni
Pteropus chrysoproctus
Pteropus giganteus chinghaiensis
Pteropus giganteus leucocephalus
Pteropus griseus griseus
Pteropus griseus mimus
Pteropus hypomelanus hypomelanus
Pteropus hypomelanus lepidus
Pteropus hypomelanus macassaricus
Pteropus hypomelanus tomesi
Pteropus melanopogon melanopogon
Pteropus ocularis
Pteropus personatus
*Pteropus temmincki **
Pteropus temmincki capistratus
Pteropus vampyrus intermedius
Pteropus woodfordi
Rousettus (Rousettus) leschenaulti shorridgei
Rousettus (Rousettus) spinalatus
Sphaerias blanfordi
Styloctenium wallacei
Syconycteris australis crassa
Syconycteris australis finschi
Syconycteris australis major
Thoopterus nigrescens

9

10

Not Threatened

*Acerodon macklotii **

11

Acerodon macklotii macklotii
Balionycteris maculata *
Balionycteris maculata maculata
Chironax melanocephalus *
Chironax melanocephalus melanocephalus
Cynopterus brachyotis *
Cynopterus brachyotis brachyotis
Cynopterus brachyotis hoffeti
Cynopterus horsfieldii *
Cynopterus horsfieldii harpax
Cynopterus horsfieldii horsfieldii
Cynopterus sphinx *
Cynopterus sphinx angulatus
Cynopterus sphinx gangeticus
Cynopterus sphinx sphinx
Cynopterus titthaecheilus *
Cynopterus titthaecheilus titthaecheilus
*Dobsonia inermis**
Dobsonia moluccense *
Dobsonia moluccense magna
Dobsonia viridis *
Eidolon dupreanum
Eidolon helvum *
Eidolon helvum helvum
Eonycteris major *
Eonycteris major major
Eonycteris spelaea *
Eonycteris spelaea spelaea
Epomophorus gambianus *
Epomophorus gambianus crypturus
Epomophorus gambianus gambianus
Epomophorus labiatus
Epomophorus minor
Epomophorus wahlbergi
Epomops dobsonii
Epomops franqueti
Harpyionycteris whiteheadi *
Hypsignathus monstrosus
Macroglossus minimus *
Macroglossus minimus lagochilus
Macroglossus minimus nanus
Macroglossus minimus pygmaeus
Macroglossus sobrinus *
Macroglossus sobrinus sobrinus
Megaerops ecaudatus
Megaerops wetmorei *
Megaloglossus woermanni
Melonycteris melanops
Melonycteris woodfordi
Micropteropus pusillus
Myonycteris torquata
Nanonycteris veldkampii
Nyctimene albiventer *
Nyctimene albiventer papuanus
Nyctimene cephalotes
Nyctimene major *
Nyctimene minutus *

Nyctimene robinsoni
Nyctimene vizcaccia *
Penthetor lucasi
Ptenochirus jagorii
Ptenochirus minor
Pteropus admiralitatum *
Pteropus alecto *
Pteropus alecto gouldi
Pteropus caniceps *
Pteropus conspicillatus (all subspecies)
Pteropus giganteus *
Pteropus giganteus giganteus
Pteropus griseus *
Pteropus hypomelanus *
Pteropus hypomelanus cagayanus
Pteropus hypomelanus condorensis
Pteropus hypomelanus luteus
Pteropus lombocensis *
Pteropus lylei
Pteropus macrotis *
Pteropus macrotis epularius
Pteropus melanopogon *
Pteropus melanotus *
Pteropus melanotus natalis
Pteropus neohibernicus *
Pteropus neohibernicus neohibernicus
Pteropus poliocephalus
Pteropus rayneri *
Pteropus rufus
Pteropus scapulatus
Pteropus seychellensis *
Pteropus seychellensis comorensis
Pteropus seychellensis seychellensis
Pteropus tonganus *
Pteropus tonganus geddiei
Pteropus vampyrus *
Pteropus vampyrus malaccensis
Pteropus vampyrus natunae
Pteropus vampyrus vampyrus
Rousettus (Lissonycteris) angolensis (all subspecies)
Rousettus (Rousettus) aegyptiacus *
Rousettus (Rousettus) aegyptiacus aegyptiacus
Rousettus (Rousettus) aegyptiacus leachii
Rousettus (Rousettus) aegyptiacus unicolor
Rousettus (Rousettus) amplexicaudatus (all subspecies)
Rousettus (Rousettus) celebensis
Rousettus (Rousettus) lanosus (all subspecies)
Rousettus (Rousettus) leschenautli *
Rousettus (Rousettus) leschenaulti leschenaulti
Rousettus (Rousettus) leschenaulti seminudus
Rousettus (Rousettus) madagascariensis
Rousettus (Rousettus) obliviosus
Scotonycteris ophiodon
Scotonycteris zenkeri
Syconycteris australis *
Syconycteris australis australis
Syconycteris australis papuana

Priority Action

General projects

- Production of a key to the bats in trade in the western Pacific region.
- Investigation of interactions between bats and commercial fruit growers.
- Investigation into sustainable harvesting of bats.
- Investigation of rôle of bats as "keystone species".
- Improvement of bat survey techniques.
- Assessment of taxonomic status of *Pteropus mariannus* on Guam and in the CNMI, the taxonomic relationship between *Pteropus insularis* and *P. phaeocephalus* on Chuuk (FSM), the taxonomic status of *Pteropus brunneus* on Percy Island, Queensland, Australia, the taxonomic status of *Dobsonia peronii* ssp. *incertae sedis* on Alor, Babar, Flores and Wetar, Indonesia, and the taxonomic status of *Dyacopterus spadiceus* on Luzon and Mindanao, Philippines.

Recommended projects listed by country

Recommended action is listed alphabetically by country. France, the United Kingdom and the United States administer a number of overseas territories and these are listed under the following headings:

French administered territories

Mayotte (in the Comoros group)
New Caledonia

Réunion
Wallis and Futuna

UK administered territories

Hong Kong

US administered territories

American Samoa
Belau
Commonwealth of the Northern Mariana Islands
Guam.

Each country account lists:

The number of species recorded from the country.

The number of endemics (sp = species, ssp = subspecies).

Any legislation pertaining to fruit bats.

Known or potential threats.

Areas of high fruit bat biodiversity. This includes areas that appear in the top twelve for root weighted fruit bat biodiversity. For further details see Chapter 4 and Table 5.

Species list including priority gradings and details of any endemics.

Recommended projects in order of priority.

Aldabra Atoll

No. of species: 1
No. of endemics: 1 ssp.

- No legislation pertaining to fruit bats, but Aldabra Atoll is protected as a World Heritage Site.
- No major threats, but its small size makes it vulnerable to any form of development.

Species List with Priority Grades:

Pteropus seychellensis aldabrensis (endemic ssp.) 3

Recommended Projects in Order of Priority:

1. Research. Breeding, feeding, habitat requirements and long-term monitoring of *P. s. aldabrensis*.

Angola

No. of species: 15
No. of endemics: None

- No legislation pertaining to fruit bats.
- Deforestation and neglect of protected areas threatens bats.
- Angola has second highest world score on fruit bat biodiversity (weighted).

Species List with Priority Grades:

Eidolon helvum helvum 11
Epomophorus angolensis 6
E. gambianus crypturus 11
E. grandis 5
E. wahlbergi 11
Epomops dobsonii 11
E. franqueti 11
Hypsignathus monstrosus 11
Megaloglossus woermanni 11
Micropteropus intermedius 6
M. pusillus 11
Myonycteris torquata 11
Plerotes anchietae 6
Rousettus (Lissonycteris) angolensis angolensis 11
R. (Rousettus) aegyptiacus unicolor 11

Recommended Projects in Order of Priority:

1. Survey. *E. grandis*, *M. intermedius* and *P. anchietae*.

2. Improved management. Gazetting and designation of protected areas. In non-protected areas, protection of specific canopy trees as roost sites and maintenance of diversity through controls on logging and underplanting or through re-vegetation. *E. grandis* and *E. angolensis*.

3. Research. Breeding and feeding. *P. anchietae*.

4. Education. General.

Australia

No. of species: 13
No. of endemics: 2 spp. (+1 ?extinct), 3 sspp.

- Legislation:
 New South Wales - *Pteropus poliocephalus* and *P. scapulatus* are unprotected.
 Northern Territory - *P. alecto* and *P. scapulatus* are listed as 'noxious'.
 Queensland - *P. alecto*, *P. conspicillatus*, *P. poliocephalus* and *P. scapulatus* are unprotected.
 Tasmania - All bats are protected.
 Western Australia - *Macroglossus minimus*, *P. alecto* and *P. scapulatus* are unprotected.
- Unprotected or 'noxious' status of some species and conflicts with fruit growers pose future threats.
- Queensland has twelfth highest world score on fruit bat biodiversity (weighted).

Species List with Priority Grades:

Dobsonia moluccense magna 11
Macroglossus minimus pygmaeus (endemic ssp.) 11
Nyctimene cephalotes 11
N. robinsoni (endemic sp.) 11
N. vizcaccia vizcaccia 10
Pteropus alecto gouldi 11
P. brunneus (?extinct: endemic sp.) 1
P. conspicillatus conspicillatus 11
P. macrotis epularius 11
P. melanotis natalis (endemic ssp.) 11
P. poliocephalus (endemic sp.) 11
P. scapulatus 11
Syconycteris australis australis (endemic ssp.) 11

Recommended Projects in Order of Priority:

1. Survey. *P. brunneus* on Percy Island, Queensland.

2. Survey. *N. vizcaccia vizcaccia* in Queensland.

3. Improved management. Encourage establishment of protected areas for fruit bats.

4. Education. General.

Bangladesh

No. of species: 3
No. of endemics: None

- No legislation pertaining to fruit bats.
- No known major threats.

Species List with Priority Grades:

<i>Cynopterus sphinx sphinx</i>	11
<i>Pteropus giganteus giganteus</i>	11
<i>Rousettus (Rousettus) leschenaulti leschenaulti</i>	11

Recommended Action in Order of Priority:

1. Improved management. Encourage establishment of protected areas for fruit bats.

2. Education. General.

Benin

No. of species: 4
No. of endemics: None

- Fruit bats are 'non-game' species and are not covered by wildlife legislation.
- No known major threats.

Species List with Priority Grades:

<i>Eidolon helvum helvum</i>	11
<i>Epomophorus gambianus gambianus</i>	11
<i>Epomops franqueti</i>	11
<i>Micropteropus pusillus</i>	11

Recommended Projects in Order of Priority:

1. Improved management. Encourage establishment of protected areas for fruit bats.

2. Education. General.

Bhutan

No. of species: 1
No. of endemics: None

- No legislation pertaining to fruit bats.
- No known major threats.

Species List with Priority Grades:

<i>Sphaerias blanfordi</i>	10
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Recommended Projects in Order of Priority:

1. Survey. *S. blanfordi*

2. Improved management. Encourage establishment of protected areas for fruit bats.

3. Education. General.

Botswana

No. of species: 2
No. of endemics: None

- No legislation pertaining to fruit bats.
- No known major threats.

Species List with Priority Grades:

<i>Epomophorus gambianus crypturus</i>	11
<i>Epomops dobsonii</i>	11

Recommended Projects in Order of Priority:

1. Improved management. Encourage establishment of protected areas for fruit bats.

2. Education. General.

Brunei

No. of species: 13
No. of endemics: None

- No legislation pertaining to fruit bats.
- Deforestation is a major threat throughout Borneo.
- South-west Borneo (Sarawak and Brunei) has the fourth highest world score for fruit bat biodiversity (weighted).

Species List with Priority Grades:

<i>Aethalops alecto aequalis</i>	9
<i>Balionycteris maculata maculata</i>	11
<i>Chironax melanocephalus melanocephalus</i>	11
<i>Cynopterus brachyotis brachyotis</i>	11
<i>C. horsfieldii persimilis</i>	9
<i>Dyacopterus spadiceus spadiceus</i>	6
<i>Eonycteris major major</i>	11
<i>Macroglossus minimus lagochilus</i>	11
<i>Megaerops ecaudatus</i>	11
<i>M. wetmorei albicollis</i>	9
<i>Penthetor lucasi</i>	11
<i>Pteropus vampyrus natunae</i>	11
<i>Rousettus (Rousettus) amplexicaudatus amplexicaudatus</i>	11

Recommended Projects in Order of Priority:

1. Survey. *A. a. aequalis*, *C. h. persimilis* and *M. w. albicollis*.

2. Research. Breeding, feeding, and long-term monitoring (*D. s. spadiceus*).

3. Research. Threats (*A. a. aequalis*).

4. Improved management. Protection of habitat through controls on logging and underplanting or through re-vegetation (*M. w. albicollis*).

5. Research. Breeding and feeding (*C. h. persimilis*).

Burkina Faso

No. of species: 5
No. of endemics: None

- *Epomophorus gambianus* partially protected under hunting regulations, but other species unprotected.
- No known major threats.

Species List with Priority Grades:

<i>Eidolon helvum helvum</i>	11
<i>Epomophorus gambianus gambianus</i>	11
<i>Hypsignathus monstrosus</i>	11
<i>Micropteropus pusillus</i>	11
<i>Rousettus (Lissonycteris) angolensis smithii</i>	11

Recommended Projects in Order of Priority:

1. Improved management. Encourage establishment of protected areas for fruit bats.

2. Education. General.

Burma

No. of species: 9
No. of endemics: None

- No legislation pertaining to fruit bats.
- Deforestation is potentially a serious threat.

Species List with Priority Grades:

<i>Cynopterus sphinx sphinx</i>	11
<i>Eonycteris spelaea spelaea</i>	11
<i>Macroglossus sobrinus sobrinus</i>	11
<i>Pteropus giganteus giganteus</i>	11
<i>P. hypomelanus geminorum</i>	8
<i>P. vampyrus intermedius</i>	10
<i>Rousettus (Rousettus) amplexicaudatus amplexicaudatus</i>	11
<i>R. (R.) leschenaulti leschenaulti</i>	11
<i>Sphaerias blanfordi</i>	10

Recommended Projects in Order of Priority:

1. Survey. *P. h. geminorum* in the Mergui Archipelago.

2. Improved management. Protection of roosts of *P. h. geminorum* in the Mergui Archipelago.

3. Survey. *P. v. intermedius* and *S. blanfordi* in mainland Burma.

4. Improved management. Encourage establishment of protected areas for fruit bats.

5. Education. General.

Burundi

No. of species: 6
No. of endemics: None

- No legislation pertaining to fruit bats.
- No known major threats.

Species List with Priority Grades:

<i>Eidolon helvum helvum</i>	11
<i>Epomophorus labiatus</i>	11
<i>E. wahlbergi</i>	11
<i>Micropteropus pusillus</i>	11
<i>Rousettus (Rousettus) aegyptiacus leachii</i>	11
<i>R. (R.) lanosus lanosus</i>	11

Recommended Projects in Order of Priority:

1. Improved management. Encourage establishment of protected areas for fruit bats.

2. Education. General.

Cambodia

No. of species: 4
No. of endemics: None

- No legislation pertaining to fruit bats.
- No known major threats.

Species List with Priority Grades:

<i>Pteropus hypomelanus condorensis</i>	11
<i>P. lylei</i>	11
<i>Rousettus (Rousettus) amplexicaudatus amplexicaudatus</i>	11
<i>R. (R.) leschenaulti leschenaulti</i>	11

Recommended Projects in Order of Priority:

1. Improved management. Encourage establishment of protected areas for fruit bats.

2. Education. General.

Cameroun

No. of species: 14
No. of endemics: None

- No legislation pertaining to fruit bats.
- Deforestation may potentially be a serious threat.
- Cameroun has the eleventh highest world score for fruit bat biodiversity (weighted).

Species List with Priority Grades:

<i>Casinycteris argynnis</i>	8
<i>Eidolon helvum helvum</i>	11
<i>Epomophorus gambianus gambianus</i>	11
<i>E. wahlbergi</i>	11
<i>Epomops franqueti</i>	11
<i>Hypsignathus monstrosus</i>	11
<i>Megaloglossus woermanni</i>	11
<i>Micropteropus pusillus</i>	11
<i>Myonycteris torquata</i>	11
<i>Nanonycteris veldkampii</i>	11
<i>Rousettus (Lissonycteris) angolensis angolensis</i>	11
<i>R. (Rousettus) aegyptiacus unicolor</i>	11
<i>Scotonycteris ophiodon</i>	11
<i>S. zenkeri</i>	11

Recommended Projects in Order of Priority:

1. **Survey.** *C. argynnis*.
2. **Research.** Feeding (*C. argynnis*).
3. **Improved management.** Encourage establishment of protected areas for fruit bats.
4. **Education.** General.

Central African Republic

No. of species: 10
No. of endemics: 1 ssp.

- No legislation pertaining to fruit bats.
- No known major threats.

Species List with Priority Grades:

<i>Eidolon helvum helvum</i>	11
<i>Epomophorus gambianus gambianus</i>	11
<i>E. g. pousarguesi</i> (endemic ssp.)	6
<i>Epomops franqueti</i>	11
<i>Hypsignathus monstrosus</i>	11
<i>Megaloglossus woermanni</i>	11
<i>Micropteropus pusillus</i>	11
<i>Myonycteris torquata</i>	11
<i>Nanonycteris veldkampii</i>	11
<i>Rousettus (Lissonycteris) angolensis angolensis</i>	11
<i>Scotonycteris zenkeri</i>	11

Recommended Projects in Order of Priority:

1. **Survey.** *E. g. pousarguesi*.
2. **Research.** Breeding, feeding, and habitat requirements (*E. g. pousarguesi*).
3. **Improved management.** Encourage establishment of

protected areas for fruit bats.

4. Education. General.**Chad**

No. of species: 4
No. of endemics: None

- No legislation pertaining to fruit bats.
- No known major threats

Species List with Priority Grades:

<i>Eidolon helvum helvum</i>	11
<i>Epomophorus gambianus gambianus</i>	11
<i>E. labiatus</i>	11
<i>Micropteropus pusillus</i>	11

Recommended Projects in Order of Priority:

1. **Improved management.** Encourage establishment of protected areas for fruit bats.
2. **Education.** General.

China

No. of species: 5
No. of endemics: 1 ssp.

- No legislation pertaining to fruit bats.
- No known major threats.

Species List with Priority Grades:

<i>Cynopterus sphinx angulatus</i>	11
<i>Eonycteris spelaea spelaea</i>	11
<i>Pteropus giganteus chinghaiensis</i> (endemic ssp.)	10
<i>Rousettus (Rousettus) leschenaulti leschenaulti</i>	11
<i>Sphaerias blanfordi</i>	10

Recommended Projects in Order of Priority:

1. **Survey.** *P. g. chinghaiensis* and *S. blanfordi*.
2. **Improved management.** Encourage establishment of protected areas for fruit bats.
3. **Education.** General.

Comoros

No. of species: 3
No. of endemics: 2 spp.

- No legislation pertaining to fruit bats.

- Deforestation is a serious threat, particularly to *Pteropus livingstonii*.

Species List with Priority Grades:

<i>Pteropus livingstonii</i> (endemic sp.)	1
<i>P. seychellensis comorensis</i>	11
<i>Rousettus (Rousettus) obliviosus</i> (endemic sp.)	11

Recommended Projects in Order of Priority:

- 1. Captive breeding.** *P. livingstonii*.
- 2. Improved management** Gazetting and designation of protected areas (*P. livingstonii*).
- 3. Education.** General, habitat destruction and roost disturbance (*P. livingstonii*).
- 4. Improved management.** Maintenance of diversity in non-protected areas through protection of specific canopy trees as roost sites (*P. livingstonii*).
- 5. Survey.** *P. livingstonii*.
- 6. Research.** Breeding, feeding, and long-term monitoring (*P. livingstonii*).

Congo

No. of species: 13
No. of endemics: None

- No legislation pertaining to fruit bats.
- No known major threats.

Species List with Priority Grades:

<i>Eidolon helvum helvum</i>	11
<i>Epomophorus grandis</i>	5
<i>E. labiatus</i>	11
<i>E. wahlbergi</i>	11
<i>Epomops franqueti</i>	11
<i>Hypsignathus monstrosus</i>	11
<i>Megaloglossus woermanni</i>	11
<i>Micropteropus pusillus</i>	11
<i>Myonycteris torquata</i>	11
<i>Rousettus (Lissonycteris) angolensis angolensis</i>	11
<i>R. (Rousettus) aegyptiacus unicolor</i>	11
<i>Scotoonycteris ophiodon</i>	11
<i>S. zenkeri</i>	11

Recommended Projects in Order of Priority:

- 1. Survey.** *E. grandis*.
- 2. Improved management.** Gazetting and designation of protected areas (*E. grandis*).

3. Education. General.

Cook Islands

No. of species: 1
No. of endemics: None

- No legislation pertaining to fruit bats.
- Hunting may be posing a serious threat.

Species List with Priority Grades:

<i>Pteropus tonganus tonganus</i>	9
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Recommended Projects in Order of Priority:

- 1. Improved management.** Control of hunting through bans or quotas (*P. t. tonganus*).
- 2. Education.** General, hunting, and tourists (*P. t. tonganus*).
- 3. Survey.** *P. t. tonganus*.
- 4. Improved management** Gazetting and designation of protected areas (*P. t. tonganus*).
- 5. Research.** Breeding, feeding, threats, and long-term monitoring (*P. t. tonganus*).

Cyprus

No. of species: 1
No. of endemics: None

- No legislation pertaining to fruit bats.
- Persecution by Ministry of Agriculture may pose future threat.

Species List with Priority Grades:

<i>Rousettus (Rousettus) aegyptiacus aegyptiacus</i>	11
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Recommended Projects in Order of Priority:

- 1. Improved management.** Encourage establishment of protected areas for fruit bats.
- 2. Education.** General, fruit-damage.

Egypt

No. of species: 1
No. of endemics: None

- No legislation pertaining to fruit bats.
- Persecution by fruit farmers may pose a threat.

Species List with Priority Grades:*Rousettus (Rousettus) aegyptiacus aegyptiacus* 11**Recommended Projects in Order of Priority:****1. Improved management.** Encourage establishment of protected areas for fruit bats.**2. Education.** General, fruit-damage.**Equatorial Guinea****No. of species:** 10**No. of endemics:** None

- No legislation pertaining to fruit bats.
- No known major threats.

Species List with Priority Grades*Eidolon helvum helvum* 11*Epomophorus wahlbergi* 11*Epomops franqueti* 11*Hypsignathus monstrosus* 11*Megaloglossus woermanni* 11*Micropteropus pusillus* 11*Myonycteris torquata* 11*Rousettus (Lissonycteris) angolensis angolensis* 11*R. (Rousettus) aegyptiacus unicolor* 11*Scotonycteris zenkeri* 11**Recommended Projects in Order of Priority****1. Improved management.** Encourage establishment of protected areas for fruit bats.**2. Education.** General.**Ethiopia****No. of species:** 9**No. of endemics:** None

- All fruit bats receive total protection.
- No known major threats.

Species List with Priority Grades:*Eidolon helvum helvum* 11*Epomophorus gambianus gambianus* 11*E. labiatus* 11*E. minor* 11*?E. wahlbergi* 11*Micropteropus pusillus* 11*Rousettus (Lissonycteris) angolensis ruwenzorii* 11*?R. (Rousettus) aegyptiacus arabicus* 6*R. (R.) a. leachii* 11*R. (R.) lanosus kempii* 11**Recommended Projects in Order of Priority:****1. Improved management.** Encourage establishment of protected areas for fruit bats.**2. Education.** General.**Federated States of Micronesia****No. of species:** 4**No. of endemics:** 3 spp., 3 sspp.

- *Pteropus mariannus ulthiensis* and *P. m. yapensis* are protected from hunting on Yap.
- Commercial hunting has been a major threat. Deforestation is a serious problem on Chuuk.

Species List with Priority Grades:*Pteropus insularis* (endemic sp.) 1*P. mariannus ualanus* (endemic ssp.) 1*P. m. ulthiensis* (endemic ssp.) 1*P. m. yapensis* (endemic ssp.) 1*P. molossinus* (endemic sp.) 1*P. phaeocephalus* (endemic sp.) 1**Recommended Projects in Order of Priority:****1. Improved management.** Control of hunting through bans or quotas and strengthening of legal protection for bats (Chuuk [*P. insularis*, *P. molossinus* and *P. phaeocephalus*], Kosrae [*P. m. ualanus*], Pohnpei [*P. molossinus*], Yap [*P. m. ulthiensis* and *P. m. yapensis*]).**2. Education. General and hunting.** (Chuuk [*P. insularis*, *P. molossinus* and *P. phaeocephalus*], Kosrae [*P. m. ualanus*], Pohnpei [*P. molossinus*], Yap [*P. m. ulthiensis* and *P. m. yapensis*]).**3. Survey.** (Chuuk [*P. insularis*, *P. molossinus* and *P. phaeocephalus*], Kosrae [*P. m. ualanus*], Pohnpei [*P. molossinus*], Yap [*P. m. ulthiensis* and *P. m. yapensis*]).**4. Improved management.** Gazetting and designation of protected areas (Chuuk [*P. insularis* and *P. molossinus*], Pohnpei [*P. molossinus*]).**5. Research.** Breeding, feeding, and long-term monitoring (Chuuk [*P. insularis*, and *P. molossinus*], Kosrae [*P. m. ualanus*], Pohnpei [*P. molossinus*], Yap [*P. m. ulthiensis* and *P. m. yapensis*]).**6. Research.** Long-term monitoring (Chuuk [*P. phaeocephalus*]).**7. Improved management.** Manage forests for the benefit of

bats (Kosrae [*P. m. ualanus*], Yap [*P. m. ulthiensis* and *P. m. yapensis*]).

Fiji

No. of species: 4
No. of endemics: 1 sp., 1 ssp.

- International trade is prohibited or regulated for *Notopteris macdonaldii* and *Pteropus tonganus*.
- Disturbance of cave sites threatens *Notopteris macdonaldii macdonaldii*.
- Fiji has the ninth highest world score for fruitbat biodiversity (weighted).

Species List with Priority Grades:

<i>Notopteris macdonaldii macdonaldii</i>	4
<i>Pteralopex acrodonta</i> (endemic sp.)	1
<i>Pteropus samoensis nawaiensis</i> (endemic ssp.)	9
<i>P. tonganus tonganus</i>	9

Recommended Projects in Order of Priority:

1. Survey. *P. acrodonta*, *N. m. macdonaldii*, *P. s. nawaiensis*, and *P. t. tonganus*.

2. Captive breeding. *P. acrodonta*.

3. Improved management. Protection of roosts (*N. m. macdonaldii*).

4. Research. Breeding, feeding, threats, habitat requirements, and long-term monitoring (*N. m. macdonaldii*, *P. s. nawaiensis*, and *P. t. tonganus*).

5. Improved management. Control of hunting (*P. t. tonganus*).

6. Education. General, hunting, and tourists (*P. t. tonganus*).

7. Improved management. Gazetting and designation of protected areas (*P. t. tonganus*).

French administered territories

Mayotte (in the Comoros group)

No. of species: 1
No. of endemics: None

- No legislation pertaining to fruit bats.
- Deforestation is a serious threat.

Species List with Priority Grades:

<i>Pteropus seychellensis comorensis</i>	11
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Recommended Projects in Order of Priority:

1. Improved management. Encourage establishment of protected areas for fruit bats.

2. Education. General.

New Caledonia

No. of species: 4
No. of endemics: 2 spp., 1 ssp.

- Fruit bats of the genus *Pteropus* receive partial protection under wildlife regulations.
- Roost disturbance threatens *Notopteris macdonaldii* and hunting threatens this species and possibly *Pteropus tonganus*.

Species List with Priority Grades:

<i>Notopteris macdonaldii neocaledonica</i> (endemic ssp.)	8
<i>Pteropus ornatus auratus</i> (endemic sp.)	8
<i>P. o. ornatus</i>	8
<i>P. tonganus geddiei</i>	11
<i>P. vetulus</i> (endemic sp.)	5

Recommended Projects in Order of Priority:

1. Survey. *P. vetulus*, *N. m. neocaledonica*, *P. o. auratus*, and *P. o. ornatus*.

2. Improved management. Protection of roosts (*N. m. neocaledonica*).

3. Improved management. Protection of habitat through controls on logging or underplanting, or through re-vegetation (*P. o. ornatus*).

4. Research. Breeding, feeding, threats, habitat requirements (*N. m. neocaledonica*).

Réunion

No. of species: 2 (extinct)
No. of endemics: None

- No legislation pertaining to fruit bats
- No known major threats

Species List with Priority Grades:

<i>Pteropus niger</i> (extinct on Reunion)	1
<i>P. subniger</i> (extinct)	1

Wallis and Futuna

No. of species: 1
No. of endemics: None

- No legislation pertaining to fruit bats.
- Deforestation and hunting may be serious threats.

Species List with Priority Grades:

Pteropus tonganus tonganus

9

Recommended Projects in Order of Priority:

1. **Survey.** *P. t. tonganus*.
2. **Improved management.** Gazetting and designation of protected areas (*P. t. tonganus*).
3. **Improved management.** Control of hunting (*P. t. tonganus*).
4. **Education.** General, hunting, and threats (*P. t. tonganus*).
5. **Research.** Breeding, feeding, threats, and long-term monitoring (*P. t. tonganus*).

Gabon

No. of species: 10
No. of endemics: None

- No legislation pertaining to fruit bats.
- No known major threats.

Species List with Priority Grades:

Eidolon helvum helvum 11
Epomophorus wahlbergi 11
Epomops franqueti 11
Hypsignathus monstrosus 11
Megaloglossus woermanni 11
Micropteropus pusillus 11
Myonycteris torquata 11
Rousettus (Lissonycteris) angolensis angolensis 11
R. (Rousettus) aegyptiacus unicolor 11
Scotonycteris zenkeri 11

Recommended Projects in Order of Priority:

1. **Improved management.** Encourage establishment of protected areas for fruit bats.
2. **Education.** General.

Gambia

No. of species: 5
No. of endemics: None

- No legislation pertaining to bats.
- No known major threats.

Species List with Priority Grades:

Eidolon helvum helvum 11
Epomophorus gambianus gambianus 11
?Hypsignathus monstrosus 11
Micropteropus pusillus 11
Rousettus (Rousettus) aegyptiacus unicolor 11

Recommended Projects in Order of Priority:

1. **Improved management** Encourage establishment of protected areas for fruit bats.
2. **Education.** General.

Ghana

No. of species: 13
No. of endemics: None

- No legislation pertaining to bats.
- Deforestation is a serious threat.

Species List with Priority Grades:

Eidolon helvum helvum 11
Epomophorus gambianus gambianus 11
Epomops buettikoferi 4
E. franqueti 11
Hypsignathus monstrosus 11
Megaloglossus woermanni 11
Micropteropus pusillus 11
Myonycteris torquata 11
Nanonycteris veldkampii 11
Rousettus (Lissonycteris) angolensis smithii 11
R. (Rousettus) aegyptiacus unicolor 11
Scotonycteris ophiodon 11
S. zenkeri 11

Recommended Projects in Order of Priority:

1. **Survey.** *E. buettikoferi*.
2. **Improved management.** Encourage establishment of protected areas for fruit bats.
3. **Education.** General.

Guinea

No. of species: 9
No. of endemics: None

- No legislation pertaining to fruit bats.
- Deforestation may be a serious threat.

Species List with Priority Grades:

Eidolon helvum helvum 11

<i>Epomophorus gambianus gambianus</i>	11	<i>Pteropus faunulus</i>	8
<i>Epomops buettikoferi</i>	4	<i>P. giganteus giganteus</i>	11
<i>Megaloglossus woermanni</i>	11	<i>P. g. leucocephalus</i>	10
<i>Micropteropus pusillus</i>	11	<i>P. melanotus melanotus</i> (endemic ssp.)	8
<i>Myonycteris torquata</i>	11	<i>P. m. satyrus</i> (endemic ssp.)	8
<i>Nanonycteris veldkampii</i>	11	<i>P. m. tyleri</i> (endemic ssp.)	8
<i>Rousettus (Lissonycteris) angolensis smithii</i>	11	<i>Rousettus (Rousettus) leschenaulti leschenaulti</i>	11
<i>R. (Rousettus) aegyptiacus unicolor</i>	11	<i>Sphaerias blanfordi</i>	10

Recommended Projects in Order of Priority:

- 1. Survey.** *E. buettikoferi*.
- 2. Improved management.** Encourage establishment of protected areas for fruit bats.
- 3. Education.** General.

Guinea-Bissau

No. of species: 4
No. of endemics: None

- No legislation pertaining to fruit bats.
- Deforestation may be a serious threat.

Species List with Priority Grades:

<i>Eidolon helvum helvum</i>	11
<i>Epomophorus gambianus gambianus</i>	11
<i>Micropteropus pusillus</i>	11
<i>Rousettus (Lissonycteris) angolensis smithii</i>	11

Recommended Projects in Order of Priority:

- 1. Improved management.** Encourage establishment of protected areas for fruit bats.
- 2. Education.** General.

India

No. of species: 10
No. of endemics: 1 sp., 6 sspp.

- Fruit bats listed as 'noxious' in wildlife regulations.
- Above 'noxious' listing may pose a future threat.

Species List with Priority Grades:

<i>Cynopterus brachyotis brachyotis</i>	11
<i>C. b. brachysoma</i> (endemic ssp.)	8
<i>C. sphinx gangeticus</i> (endemic ssp.)	11
<i>C. s. scherzeri</i> (endemic ssp.)	8
<i>C. s. sphinx</i>	11
<i>Eonycteris spelaea spelaea</i>	11
<i>Latidens salimalii</i> (endemic sp.)	5
<i>Megaerops niphanae</i>	10

Recommended Projects in Order of Priority:

- 1. Survey.** Mainland India (*L. salimalii* [south], *M. niphanae* and *P. g. leucocephalus* [north-east], and *S. blanfordi* [north]).
- 2. Survey.** Andaman Islands (*C. b. brachysoma*, *P. m. satyrus*, *P. m. tyleri*).
- 3. Survey.** Nicobar Islands (*C. s. scherzeri*, *P. faunulus*, *P. m. melanotus*).

4. Improved management. Encourage establishment of protected areas for fruit bats.

5. Education. General.

Indonesia

No. of species: 63
No. of endemics: 24 spp., 45 sspp.

- 'Fruit-eating bats' are listed as 'noxious' under the wildlife regulations.
- Deforestation is a major problem throughout Indonesia. Disturbance of cave roosts threatens a number of species in the Lesser Sundas and probably elsewhere.
- Sulawesi has by far the highest world score for fruit bat biodiversity (weighted). East Irian Jaya has the third highest world score for fruit bat biodiversity (weighted). A number of other islands (for example Borneo, Jawa, Lombok and Sumatra) have large and diverse fruit bat faunas. Indonesia also has the largest fruit bat fauna of any country.

Species List with Priority Grades:

<i>Acerodon celebensis</i> (endemic sp.)	10
<i>A. humilis</i> (endemic sp.)	8
<i>A. macklotii aloreensis</i> (endemic sp.)	8
<i>A. m. floresii</i>	8
<i>A. m. gilvus</i>	8
<i>A. m. macklotii</i>	11
<i>A. m. prajae</i>	8
<i>Aethalops alecto alecto</i>	9
<i>A. a. ocypete</i> (endemic ssp.)	6
<i>Balionycteris maculata maculata</i>	11
<i>B. m. seimundi</i>	9
<i>Chironax melanocephalus melanocephalus</i>	11
<i>C. m. tumulus</i> (endemic ssp.)	8

<i>Cynopterus brachyotis brachyotis</i>	11	<i>P. a. gouldi</i>	11
<i>C. b. concolor</i> (endemic ssp.)	8	<i>P. a. morio</i> (endemic ssp.)	8
<i>C. b. insularum</i> (endemic ssp.)	8	? <i>P. argentatus</i> (endemic sp.)	8
<i>C. b. javanicus</i> (endemic ssp.)	10	<i>P. coniceps coniceps</i> (endemic sp.)	10
<i>C. b. minutus</i> (endemic ssp.)	8	<i>P. c. dobsoni</i>	10
<i>C. horsfieldii harpax</i>	11	<i>P. chrysoproctus</i> (endemic sp.)	10
<i>C. h. horsfieldii</i> (endemic ssp.)	11	<i>P. conspicillatus chrysauchen</i>	11
<i>C. h. persimilis</i>	9	<i>P. griseus griseus</i> (endemic ssp.)	10
<i>C. h. princeps</i> (endemic ssp.)	8	<i>P. g. mimus</i>	10
<i>C. sphinx angulatus</i>	11	<i>P. g. pallidus</i> (endemic ssp.)	8
<i>C. s. babi</i> (endemic ssp.)	8	<i>P. hypomelanus annectens</i> (endemic ssp.)	8
<i>C. s. pagensis</i> (endemic ssp.)	8	<i>P. h. canus</i> (endemic ssp.)	8
<i>C. s. serasani</i> (endemic ssp.)	8	<i>P. h. enganus</i> (endemic ssp.)	8
<i>C. titthaecheilus major</i> (endemic ssp.)	8	<i>P. h. fretensis</i>	8
<i>C. t. terminus</i> (endemic ssp.)	8	<i>P. h. hypomelanus</i> (endemic ssp.)	10
<i>C. t. titthaecheilus</i> (endemic ssp.)	11	<i>P. h. lepidus</i>	10
<i>Dobsonia beauforti</i> (endemic sp.)	8	<i>P. h. macassaricus</i> (endemic ssp.)	10
<i>D. emersa</i> (endemic sp.)	8	<i>P. h. simalurus</i> (endemic ssp.)	8
<i>D. exoleta</i> (endemic sp.)	10	<i>P. h. tomesi</i>	10
<i>D. minor</i>	6	<i>P. lombocensis lombocensis</i> (endemic sp.)	8
<i>D. moluccense magna</i>	11	<i>P. l. solitarius</i>	8
<i>D. m. moluccense</i> (endemic ssp.)	10	<i>P. macrotis epularius</i>	11
<i>D. peronii grandis</i> (endemic sp.)	9	<i>P. m. macrotis</i> (endemic ssp.)	8
<i>D. p. peronii</i>	8	<i>P. melanopogon arvensis</i> (endemic sp.)	8
<i>D. p. sumbana</i>	8	<i>P. m. keyensis</i>	8
<i>D. p. ssp. incertae sedis</i>	8	<i>P. m. melanopogon</i>	10
<i>D. viridis crenulata</i> (endemic sp.)	10	<i>P. melanotus modiglianii</i> (endemic ssp.)	8
<i>D. v. viridis</i>	10	<i>P. m. niadicus</i> (endemic ssp.)	8
<i>Dyacocterus spadiceus brooksi</i> (endemic ssp.)	10	<i>P. neohibernicus neohibernicus</i>	11
<i>Eonycteris major major</i>	11	<i>P. ocularis</i> (endemic sp.)	10
<i>E. spelaea glandifera</i>	4	<i>P. personatus</i> (endemic sp.)	10
<i>E. s. rosenbergii</i> (endemic ssp.)	8	<i>P. pohlei</i> (endemic sp.)	8
<i>E. s. spelaea</i>	11	<i>P. pumilus</i>	4
<i>Harpyionycteris whiteheadi celebensis</i> (endemic ssp.)	10	<i>P. speciosus</i>	6
<i>Macroglossus minimus lagochilus</i>	11	<i>P. temmincki Hops</i> (endemic ssp.)	8
<i>M. m. minimus</i> (endemic ssp.)	10	<i>P. t. temmincki</i> (endemic ssp.)	8
<i>M. m. nanus</i>	11	<i>P. vampyrus edulis</i> (endemic ssp.)	8
<i>M. sobrinusfraternus</i> (endemic ssp.)	8	<i>P. v. malaccensis</i>	11
<i>M. s. sobrinus</i>	11	<i>P. v. natunae</i>	11
<i>Megaerops ecaudatus</i>	11	<i>P. v. pluton</i> (endemic ssp.)	8
<i>M. kusnotoi</i> (endemic sp.)	6	<i>P. v. vampyrus</i> (endemic ssp.)	11
<i>Neopteryxfrosti</i> (endemic sp.)	5	<i>Rousettus (Boneia) bidens</i> (endemic sp.)	8
<i>Nyctimene aello</i>	6	<i>R. (Rousettus) amplexicaudatus amplexicaudatus</i>	11
<i>N. albiventer albiventer</i> (endemic ssp.)	8	? <i>R. (R.) a. brachyotis</i>	11
<i>N. a. papuanus</i>	11	<i>R. (R.) a. infumatus</i> (endemic ssp.)	11
<i>N. celaeno</i> (endemic sp.)	8	<i>R. (R.) celebensis</i> (endemic sp.)	11
<i>N. cephalotes</i>	11	<i>R. (R.) leschenaulti shortridgei</i> (endemic ssp.)	10
<i>N. cyclotis certans</i>	6	<i>R. (R.) spinalatus</i>	10
<i>N. c. cyclotis</i> (endemic ssp.)	10	<i>Styloctenium wallacei</i> (endemic sp.)	10
<i>N. draconilla</i>	6	<i>Syconycteris australis keyensis</i> (endemic ssp.)	8
<i>N. minutus minutus</i> (endemic sp.)	10	<i>S. a. major</i> (endemic ssp.)	10
<i>N. m. varius</i>	8	<i>S. a. papuana</i>	11
<i>Paranyctimene raptor</i>	6	<i>S. carolinae</i> (endemic sp.)	8
<i>Penthetor lucasi</i>	11	<i>Thoopterus nigrescens</i>	10
<i>Pteropus alecto alecto</i> (endemic ssp.)	10		
<i>P. a. aterrimus</i> (endemic ssp.)	8		

Recommended Projects in Order of Priority:

- 1. Survey.** Irian Jaya and surrounding islands: Irian Jaya (*N. draconilla*, *D. minor*, *N. c. certans*, *P. raptor*, *N. celaeano*, and *N. c. cyclotis*); Misool (*N. aello* and *D. v. viridis*); Yapen (*D. minor* and *P. pohlei*); Biak and Owii (*D. beauforti* and *D. emersa*); Numfoor (*D. emersa*); Waigeo (*D. beauforti* and *D. v. crenulata*).
- 2. Improved management.** Protection of cave sites and controls on hunting of cave-dwelling species in the Lesser Sundas.
- 3. Survey.** Sulawesi and surrounding islands: Sulawesi (*E. s. glandifera*, *N. frosti*, *D. minor*, *C. m. tumulus*, *E. s. rosenbergii*, *R. (B.) bidens*, *A. celebensis*, *D. exoleta*, *D. v. crenulata*, *H. w. celebensis*, *N. m. minutus*, *P. a. alecto*, *P. c. dobsoni*, *P. g. mimus*, *P. h. macassaricus*, *P. personatus*, *S. wallacei* and *T. nigrescens*); Muna (*E. s. glandifera*); Talaud Islands (*A. humilis* and *P. h. macassaricus*); Salayar (*A. celebensis*, *P. a. alecto* and *P. g. mimus*); Sangir Islands (*A. celebensis*, *D. v. viridis*, *P. h. macassaricus* and *T. nigrescens*); Banggai Islands (*D. v. crenulata*); Togian Islands (*D. v. crenulata*); Bonerate (*P. g. griseus*); Jampea (*P. g. griseus*).
- 4. Survey.** Sumatra (*D. s. brooksi*, *A. a. alecto*, *R. (R.) l. shortridgei* and *R. (R.) spinalatus*).
- 5. Survey.** Bali (*E. s. glandifera*, *P. v. pluton*, *C. b. javanicus*, *M. m. minimus*, and *R. (R.) l. shortridgei*); Penida (*D. p. grandis* and *C. b. javanicus*).
- 6. Survey.** Lombok (*E. s. glandifera*, *A. m. prajae*, *P. v. pluton*, *P. l. lombocensis*, *A. a. alecto*, *D. p. grandis*, *M. m. minimus*, *P. a. alecto* and *R. (R.) l. shortridgei*); Sumbawa (*A. m. floresii*, *P. v. pluton* and *D. p. grandis*).
- 7. Survey.** Sumba (*E. s. glandifera*, *A. m. gilvus*, *D. p. sumbana* and *P. a. morio*).
- 8. Survey.** Timor and surrounding islands: Timor (*E. s. glandifera*, *C. t. terminus*, *D. p. peronii*, *P. v. edulis*, and *P. g. griseus*); Savu (*P. a. morio* and *P. v. edulis*); Semau (*P. g. griseus*); Alor (*A. m. alorensis*, *D. p. ssp. incertae sedis* and *P. l. solitarius*).
- 9. Research.** Threats (*N. frosti* and *E. s. rosenbergii* on Sulawesi).
- 10. Improved management.** Hunting quotas should be implemented for *Pteropus hypomelanus* and *P. vampyrus*. At the very least, monitoring programmes should be undertaken to estimate the number of bats taken/sold on a yearly basis.
- 11. Survey.** Jawa and surrounding islands: Jawa (*E. s. glandifera*, *M. kusnotoi*, *C. b. javanicus*, *M. m. minimus* and *R. (R.) l. shortridgei*); Bawean (*P. a. aterrimus*); Kangean Islands (*C. b. insularum*, *P. a. aterrimus* and *M. m. minimus*); Madura (*C. b. javanicus* and *M. m. minimus*).
- 12. Survey.** Laut Kecil Islands (*P. speciosus* and *C. b. insularum*); Masalembu Besar (*P. speciosus*).
- 13. Research.** Threats (*A. a. aequalis* and *M. kusnotoi* on Jawa).
- 14. Research.** Breeding and feeding: Irian Jaya (*N. aello*, *N. c. certans* and *P. raptor*); Misool (*N. aello* and *P. raptor*).
- 15. Survey.** Aru Islands (*P. m. macrootis*, *P. m. aruensis*, *D. m. moluccense* and *R. (R.) l. shortridgei*); Kai Islands (*P. m. keyensis*, *S. a. keyensis*, *D. m. moluccense* and *D. v. viridis*).
- 16. Survey.** Seram and surrounding islands: Seram (*P. t. temmincki*, *D. m. moluccense*, *D. v. viridis*, *P. chrysoproctus*, *P. m. melanopogon*, *P. ocularis* and *S. a. major*); Ambon (*P. argentatus*, *P. t. temmincki*, *D. m. moluccense*, *D. v. viridis*, *P. chrysoproctus*, *P. m. melanopogon* and *S. a. major*); Banda Islands (*P. g. pallidus*, *D. v. viridis* and *P. m. melanopogon*); Buru (*N. m. varius*, *P. t. liops*, *D. m. moluccense*, *D. v. viridis*, *P. chrysoproctus*, *P. m. melanopogon* and *P. ocularis*); Asilulu (*P. chrysoproctus*); Boana (*P. m. melanopogon*); Gorong (*P. chrysoproctus* and *P. m. melanopogon*); Keffing (*P. chrysoproctus*); Manawoka (*P. m. melanopogon*); Panjang (*P. chrysoproctus*); Saparua (*P. m. melanopogon*); Watubela Islands (*P. chrysoproctus*).
- 17. Survey.** Islands offwest Sumatra: Babi Island (*C. s. babi*); Enggano (*C. b. concolor*, *P. h. enganus* and *P. m. modiglianii*); Mentawai Islands (*C. s. pagensis*, *M. s. fratemus* and *P. h. enganus*); Nias (*C. b. minutus*, *C. h. princeps*, *C. t. major* and *P. m. niadicus*); Simalue Islands (*P. h. simalurus* and *R. (R.) l. shortridgei*).
- 18. Survey.** Tenimber Islands and surrounding islands: Tenimber Islands (*P. m. melanopogon*); Babar (*D. p. ssp. incertae sedis*); Wetar (*D. p. ssp. incertae sedis*).
- 19. Survey.** Flores (*A. m. floresii*, *D. p. ssp. incertae sedis* and *P. l. lombocensis*); Komodo (*D. p. grandis*).
- 20. Survey.** Halmahera and surrounding islands: Halmahera (*N. a. albiventer*, *S. carolinae*, *D. m. moluccense*, *D. v. crenulata*, *P. c. caniceps*, *P. h. hypomelanus* and *P. personatus*); Morotai (*N. a. albiventer*, *D. v. crenulata*, *P. c. caniceps*, *P. personatus* and *T. nigrescens*); Ternate (*N. a. albiventer*, *D. v. crenulata*, *P. c. caniceps*, *P. h. hypomelanus* and *P. personatus*); Bacan (*D. v. crenulata*, *P. c. caniceps* and *P. personatus*); Rau (*D. v. crenulata*).
- 21. Survey.** Natuna Islands and surrounding islands: Natuna Islands (*C. s. serasani*, *P. h. annectens* and *P. h. canus*); Anamba Islands (*P. h. lepidus*); Tambelan Islands (*P. h. lepidus*).

22. Research. Breeding, feeding, and threats (*R. (B.) bidens* and *P. a. alecto* (threats only) on Sulawesi).

23. Research. Breeding, feeding, and long-term monitoring (*D. beauforti* On Biak, Owii and Waigeo).

24. Survey. Islands offeast Sumatra: Berhala (*P. h. fretensis*); Riau Archipelago (*B. m. seimundi*).

25. Survey. Borneo and offshore islands (*G h. persimilis* and *P. h. tomesi*).

26. Research. Breeding and feeding (*C. h. persimilis* on Borneo).

27. Research. Threats (*A. a. alecto* on Bali, Lombok, Muna, Sulawesi, Sumatra, Sumba and Timor).

28. Research. Breeding and feeding (*D. p. grandis* on Bali, Lombok, Komodo, Penida and Sumbawa).

29. Research. Breeding, feeding, and long-term monitoring (*D. s. brooksi* on Sumatra).

30. Survey. Sula Islands (*A. celebensis* and *P. c. caniceps*).

31. Research. Threats (*A. celebensis* and *D. exoleta* on Sulawesi).

Iran

No. of species: 1

No. of endemics: None

- No legislation pertaining to fruit bats.
- No known major threats.

Species List with Priority Grades:

Rousettus (Rousettus) aegyptiacus arabicus 6

Recommended Projects in Order of Priority:

1. Improved management. Encourage establishment of protected areas for fruit bats.

2. Education. General.

Israel

No. of species: 1

No. of endemics: None

- *Rousettus (Rousettus) aegyptiacus* is listed as 'noxious' in the wildlife regulations.
- Conflict with fruit growers could be a future threat.

Species List with Priority Grades:

Rousettus (Rousettus) aegyptiacus aegyptiacus 11

Recommended Projects in Order of Priority:

1. Improved management. Encourage establishment of protected areas for fruit bats.

2. Education. General, fruit-damage.

Ivory Coast

No. of species: 12

No. of endemics: None

- Fruit bats are an 'unprotected taxon' under wildlife regulations.
- Deforestation may be a serious threat.

Species List with Priority Grades:

Eidolon helvum helvum 11

Epomophorus gambianus gambianus 11

Epomops buettikoferi 4

E. franqueti 11

Hypsignathus monstrosus 11

Megaloglossus woermanni 11

Micropteropus pusillus 11

Myonycteris torquata 11

Nanonycteris veldkampii 11

Rousettus (Lissonycteris) angolensis smithii 11

Rousettus (Rousettus) aegyptiacus unicolor 11

Scotoonycteris zenkeri 11

Recommended Projects in Order of Priority:

1. Survey. *E. buettikoferi*.

2. Improved management. Encourage establishment of protected areas for fruit bats.

3. Education. General.

Japan

No. of species: 3

No. of endemics: 1 sp., 5 sspp.

- *Pteropus dasymallus dasymallus* and *P. pselaphon* are both protected as national monuments by the Japanese government.
- Deforestation is a serious threat.

Species List with Priority Grades:

Pteropus dasymallus daitoensis (endemic ssp.) 1

P. d. dasymallus (endemic ssp.) 1

P. d. inopinatus (endemic ssp.) 1

P. d. yayeyamae (endemic ssp.) 1

<i>P. mariannus loochoensis</i> (endemic ssp.)	1
<i>P. pselaphon</i> (endemic sp.)	3

Recommended Projects in Order of Priority:

- 1. Survey.** Ryukyu Archipelago (*P. d. daitoensis*, *P. d. dasymallus*, *P. d. inopinatus*, *P. d. yayeyamae*, *P. m. loochoensis*).
- 2. Improved management** Protection of habitat and roosts (*P. d. daitoensis*, *P. d. dasymallus*, *P. d. inopinatus*, and *P. d. yayeyamae* in the Ryukyu Archipelago).
- 3. Improved management.** Gazetting and designation of **protected areas** (*P. d. daitoensis*, *P. d. dasymallus*, *P. d. inopinatus*, *P. d. yayeyamae* and *P. m. loochoensis* in the Ryukyu Archipelago).
- 4. Improved management.** Tighter regulations protecting bats (*P. d. yayeyamae* in the Ryukyu Archipelago).
- 5. Research. Threats** (*P. d. daitoensis*, *P. d. dasymallus*, *P. d. inopinatus*, and *P. d. yayeyamae* in the Ryukyu Archipelago).
- 6. Research.** Long-term monitoring (*P. m. loochoensis* in the Ryukyu Archipelago).
- 7. Survey.** Kazan-retto and Ogasawara-shato (*P. pselaphon*).
- 8. Improved management.** Control of hunting (*P. pselaphon* in Kazan-retto and Ogasawara-shato).
- 9. Improved management.** Protection of habitat through controls on logging or underplanting or through re-vegetation (*P. pselaphon* in Kazan-retto and Ogasawara-shato).

Kenya

No. of species:	10
No. of endemics:	None

- No legislation pertaining to fruit bats.
- Habitat degradation threatens *Myonycteris relicta*.

Species List with Priority Grades:

<i>Eidolon helvum helvum</i>	11
<i>Epomophorus labiatus</i>	11
<i>E. minor</i>	11
<i>E. wahlbergi</i>	11
<i>Hypsignathus monstrosus</i>	11
<i>Micropteropus pusillus</i>	11
<i>Myonycteris relicta</i>	3
<i>Rousettus (Lissonycteris) angolensis ruwenzorii</i>	11
<i>R. (Rousettus) aegyptiacus leachii</i>	11
<i>R. (R.) lanosus kempfi</i>	11

Recommended Projects in Order of Priority:

- 1. Survey.** Shimba Hills (*M. relicta*).
- 2. Improved management.** Gazetting and designation of protected areas in the Shimba Hills (*M. relicta*).
- 3. Research.** Breeding, feeding, habitat requirements, and long-term monitoring (*M. relicta*).

Laos

No. of species:	1
No. of endemics:	None

- No legislation pertaining to fruit bats.
- No known major threats.

Species List with Priority Grades:

<i>Rousettus (Rousettus) leschenaulti leschenaulti</i>	11
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Recommended Projects in Order of Priority:

- 1. Improved management.** Encourage establishment of protected areas for fruit bats.
- 2. Education. General.**

Lebanon

No. of species:	1
No. of endemics:	None

- No legislation pertaining to fruit bats.
- No known major threats.

Species List with Priority Grades:

<i>Rousettus (Rousettus) aegyptiacus aegyptiacus</i>	11
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Recommended Projects in Order of Priority:

- 1. Improved management.** Encourage establishment of protected areas for fruit bats.
- 2. Education. General.**

Liberia

No. of species:	12
No. of endemics:	None

- No legislation pertaining to fruit bats.
- Deforestation may be a serious threat.

Species List with Priority Grades:

<i>Eidolon helvum helvum</i>	11
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<i>?Epomophorus gambianus gambianus</i>	11
<i>Epomops buettikoferi</i>	4
<i>Hypsignathus monstrosus</i>	11
<i>Megaloglossus woermanni</i>	11
<i>Micropteropus pusillus</i>	11
<i>Myonycteris torquata</i>	11
<i>Nanonycteris veldkampii</i>	11
<i>Rousettus (Lissonycteris) angolensis smithii</i>	11
<i>R. (Rousettus) aegyptiacus unicolor</i>	11
<i>Scotoonycteris ophiodon</i>	11
<i>S. zenkeri</i>	11

Recommended Projects in Order of Priority:

- 1; Survey.** *E. buettikoferi*.
- 2. Improved management.** Encourage establishment of protected areas for fruit bats.
- 3. Education.** General.

Madagascar

No. of species: 3
No. of endemics: 3 spp.

- A fee is required for the taking of *Pteropus rufus* by holders of commercial permits.
- Deforestation is a serious threat.

Species List with Priority Grades:

<i>Eidolon dupreanum</i> (endemic sp.)	11
<i>Pteropus rufus</i> (endemic sp.)	11
<i>Rousettus (Rousettus) madagascariensis</i> (endemic sp.)	11

Recommended Projects in Order of Priority:

- 1. Improved management.** Encourage establishment of protected areas for fruit bats.
- 2. Education.** General.

Malawi

No. of species: 7
No. of endemics: None

- No legislation pertaining to fruit bats.
- No known major threats.

Species List with Priority Grades:

<i>Eidolon helvum helvum</i>	11
<i>Epomophorus gambianus crypturus</i>	11
<i>E. labiatus</i>	11
<i>E. minor</i>	11
<i>E. wahlbergi</i>	11

<i>Epomops dobsonii</i>	11
<i>Rousettus (Rousettus) aegyptiacus leachii</i>	11

Recommended Projects in Order of Priority:

- 1. Improved management.** Encourage establishment of protected areas for fruit bats.
- 2. Education.** General.

Malaysia

No. of species: 18
No. of endemics: 2 spp.

- *Pteropus hypomelanus* and *P. vampyrus* receive partial protection under the wildlife regulations.
- Deforestation and development are major threats throughout Malaysia.
- South-west Borneo (Sarawak and Brunei) has the fourth highest world score for fruit bat biodiversity (weighted).

Species List with Priority Grades:

<i>Aethalops alecto aequalis</i>	9
<i>A. a. alecto</i>	9
<i>Balionycteris maculata maculata</i>	11
<i>B. m. seimundi</i>	9
<i>Chironax melanocephalus melanocephalus</i>	11
<i>Cynopterus brachyotis altitudinis</i> (endemic ssp.)	10
<i>C. b. brachyotis</i>	11
<i>C. horsfieldii harpax</i>	11
<i>C. h. persimilis</i>	9
<i>C. sphinx angulatus</i>	11
<i>Dyacopterus spadiceus spadiceus</i>	6
<i>Eonycteris major major</i>	11
<i>E. spelaea glandifera</i>	4
<i>E. s. spelaea</i>	11
<i>Macroglossus minimus lagochilus</i>	11
<i>M. sobrinus sobrinus</i>	11
<i>Megaerops ecaudatus</i>	11
<i>M. wetmorei albicollis</i>	9
<i>Penthetor lucasi</i>	11
<i>Pteropus hypomelanus fretensis</i>	8
<i>P. h. geminorum</i>	8
<i>P. h. lepidus</i>	10
<i>P. h. robinsoni</i> (endemic ssp.)	8
<i>P. h. tomesi</i>	10
<i>P. vampyrus malaccensis</i>	11
<i>P. v. natunae</i>	11
<i>Rousettus (Rousettus) amplexicaudatus amplexicaudatus</i>	11
<i>R. (R.) spinalatus</i>	10

Recommended Projects in Order of Priority:

- 1. Survey.** Borneo (Sabah and Sarawak) (*E. s. glandifera*, *A. a. aequalis*, *C. h. persimilis* and *R. (R.) spinalatus*).

2. Improved management. Protection of roosts (*E. s. glandifera* in Borneo [Sabah and Sarawak]).

3. Research. Breeding, feeding, movements, threats, habitat requirements (*E. s. glandifera* in Borneo [Sabah and Sarawak]).

4. Improved management. Gazetting and designation of protected areas, particularly the Endau-Rompin Park, in **Peninsular Malaysia** (*B. m. seimundi*).

5. Improved management. Selection of various forest sites in lowlands and hills, with emphasis on the Endau-Rompin reserve, Pasoh Forest Reserve, a buffer zone for the National Park Taman Negara, declaration of buffer forest around the Krau Game Reserve, species surveys and pressure for a national park in Ulu Belum, Perak and similarly for a montane Main Range park either north of Cameron Highlands or between Cameron Highlands and Fraser's Hill.

6. Improved management. Protection of lowland habitat in **Peninsular Malaysia** (*M. w. albicollis*).

7. Improved management. Lobby against proposed montane road in **Peninsular Malaysia** (*C. b. altitudinis*).

8. Improved management. Hunting quotas should be implemented for *Pteropus hypomelanus* and *P. vampyrus*. At the very least, monitoring programmes should be undertaken to estimate the number of bats taken/sold on a yearly basis.

9. Research. Threats (*A. a. aequalis* in Borneo [Sabah and Sarawak]).

10. Research. Breeding, feeding, and long-term monitoring (*D. s. spadiceus* in Borneo [Sabah and Sarawak] and Peninsular Malaysia).

11. Survey. Sembilan Islands, off Singapore (*P. h. robinsoni*).

12. Survey. Paya Island, off Kedah (*P. h. geminorum*).

13. Survey. Jerak, west of the Sembilan Islands (*P. h. fretensis*).

14. Improved management. Roost protection (*P. h. geminorum* on Paya Island, off Kedah).

15. Research. Breeding and feeding (*C. h. persimilis* in Borneo [Sabah and Sarawak]).

16. Survey. Peninsular Malaysia (*M. w. albicollis* and *C. b. altitudinis*).

17. Survey. Borneo [islands off Sabah] (*P. h. tomesi* on **Mantanani, Mengalum**).

18. Survey. Islands off Peninsular Malaysia (*P. h. lepidus* on

Aur, Great Redang, Lantanga, Pemanggil, the Perhentians and Tioman).

Maldives

No. of species: 2

No. of endemics: 2 spp.

- No legislation pertaining to fruit bats.
- Major threat comes from large scale culling of fruit bats because they supposedly damage commercial fruit crops.

Species List with Priority Grades:

<i>Pteropus giganteus ariel</i> (endemic ssp.)	1
<i>P. hypomelanus maris</i> (endemic ssp.)	1

Recommended Projects in Order of Priority:

1. Survey. *P. g. ariel* and *P. h. maris*.

2. Education. General and fruit-damage (*P. g. ariel* and *P. h. maris*).

3. Improved management. Review of supposed damage to fruit crops and methods of control (*P. g. ariel* and *P. h. maris*).

4. Research. Feeding, long-term monitoring (*P. g. ariel* and *P. h. maris*).

Mali

No. of species: 3

No. of endemics: None

- No legislation pertaining to fruit bats.
- No known major threats.

Species List with Priority Grades:

<i>Eidolon helvum helvum</i>	11
<i>Epomophorus gambianus gambianus</i>	11
<i>Micropteropus pusillus</i>	11

Recommended Projects in Order of Priority:

1. Improved management. Encourage establishment of protected areas for fruit bats.

2. Education. General.

Mauritius

No. of species: 2

No. of endemics: 2 spp. (+ 1 extinct)

- *Pteropus rodricensis* is totally protected under wildlife regulations.

- Deforestation and hunting are serious threats.

Species List with Priority Grades:

<i>Pteropus niger</i> (endemic sp.)	3
<i>P. rodricensis</i> (endemic sp.)	1
<i>P. subniger</i> (extinct: endemic sp.)	1

Recommended Projects in Order of Priority:

- 1. Introduction.** *P. rodricensis* on to suitable island in the Indian Ocean.
- 2. Improved management.** Ban hunting (*P. rodricensis* on Rodrigues).
- 3. Improved management.** Control deforestation (*P. rodricensis* on Rodrigues).
- 4. Survey.** Mauritius (*P. niger*); Rodrigues (*P. rodricensis*).
- 5. Research.** Feeding and long-term monitoring (*P. rodricensis* on Rodrigues).
- 6. Research.** Threats and long-term monitoring (*P. niger* on Mauritius).

Mozambique

No. of species: 5
No. of endemics: None

- No legislation pertaining to bats.
- No known major threats.

Species List with Priority Grades:

<i>Eidolon helvum helvum</i>	11
<i>Epomophorus gambianus crypturus</i>	11
<i>E. wahlbergi</i>	11
<i>Rousettus (Lissonycteris) angolensis ruwenzorii</i>	11
<i>R. (Rousettus) aegyptiacus leachii</i>	11

Recommended Projects in Order of Priority:

- 1. Improved management.** Encourage establishment of protected areas for fruit bats.
- 2. Education.** General.

Namibia

No. of species: 4
No. of endemics: None

- No legislation pertaining to fruit bats.
- Deforestation threatens *Epomophorus angolensis*.

Species List with Priority Grades:

<i>Eidolon helvum helvum</i>	11
<i>Epomophorus angolensis</i>	6
<i>E. gambianus crypturus</i>	11
<i>E. wahlbergi</i>	11

Recommended Projects in Order of Priority:

- 1. Improved management.** Gazetting and designation of protected areas (*E. angolensis*).
- 2. Improved management.** Protection of habitat through controls on logging or underplanting or through re-vegetation (*E. angolensis*).
- 3. Education.** General.

Nepal

No. of species: 2
No. of endemics: None

- Fruit bats are given partial protection under wildlife regulations.
- There are no known major threats.

Species List with Priority Grades:

<i>Pteropus giganteus leucocephalus</i>	10
<i>Rousettus (Rousettus) leschenaulti leschenaulti</i>	11

Recommended Projects in Order of Priority:

- 1. Survey.** *P. g. leucocephalus*.
- 2. Improved management.** Encourage establishment of protected areas for fruit bats.
- 3. Education.** General.

Niger

No. of species: 2
No. of endemics: None

- No legislation pertaining to fruit bats.
- No known major threats.

Species List with Priority Grades:

<i>Eidolon helvum helvum</i>	11
<i>Epomophorus gambianus gambianus</i>	11

Recommended Projects in Order of Priority:

- 1. Improved management.** Encourage establishment of protected areas for fruit bats.

2. Education. General.

Nigeria

No. of species: 13
 No. of endemics: None

- No legislation pertaining to fruit bats.
- Deforestation may be a serious threat.

Species List with Priority Grades:

<i>Eidolon helvum helvum</i>	11
<i>Epomophorus gambianus gambianus</i>	11
<i>E. labiatus</i>	11
<i>Epomops buettikoferi</i>	4
<i>E. franqueti</i>	11
<i>Hypsignathus monstrosus</i>	11
<i>Megaloglossus woermanni</i>	11
<i>Micropteropus pusillus</i>	11
<i>Myonycteris torquata</i>	11
<i>Nanonycteris veldkampii</i>	11
<i>Rousettus (Lissonycteris) angolensis angolensis</i>	11
<i>R. (L.) a. smithii</i>	11
<i>R. (Rousettus) aegyptiacus unicolor</i>	11
<i>Scotonycteris zenkeri</i>	11

Recommended Projects in Order of Priority:

1. Survey. *E. buettikoferi*.
2. Improved management. Encourage establishment of protected areas for fruit bats.
3. Education. General.

Niue

No. of species: 1
 No. of endemics: None

- No legislation pertaining to fruit bats.
- Hunting poses a serious threat.

Species List with Priority Grades:

<i>Pteropus tonganus tonganus</i>	9
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Recommended Projects in Order of Priority:

1. Survey. *P. t. tonganus*.
2. Improved management. Control of hunting (*P. t. tonganus*).
3. Education. General, hunting, and tourists (*P. t. tonganus*).
4. Improved management. Gazetting and designation of protected areas (*P. t. tonganus*).

5. Research. Breeding, feeding, threats, and long-term monitoring (*P. t. tonganus*).

Oman

No. of species: 1
 No. of endemics: None

- No legislation pertaining to fruit bats.
- No known major threats.

Species List with Priority Grades:

<i>Rousettus (Rousettus) aegyptiacus arabicus</i>	6
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Recommended Projects in Order of Priority:

1. Improved management. Gazetting and designation of protected areas (*R. (R.) a. arabicus*).

2. Education. General.

Pakistan

No. of species: 3
 No. of endemics: None

- Fruit bats are exempted from international trade regulations and *Pteropus giganteus* is unprotected in the Punjab.
- No known major threats.

Species List with Priority Grades:

<i>Pteropus giganteus giganteus</i>	11
<i>Rousettus (Rousettus) aegyptiacus arabicus</i>	6
<i>R. (R.) leschenaulti leschenaulti</i>	11

Recommended Projects in Order of Priority:

1. Improved management. Encourage establishment of protected areas for fruit bats.

2. Education. General.

Papua New Guinea

No. of species: 34
 No. of endemics: 7 spp., 11 ssp.

- Fruit bats receive partial protection under wildlife regulations.
- Deforestation is a serious threat.
- New Ireland has the seventh highest world score for fruit bat biodiversity (weighted). New Guinea, New Britain and Bougainville also have large and diverse fruit bat faunas.

Species List with Priority Grades:

<i>Aproteles bulmerae</i> (endemic sp.)	1
<i>Dobsonia inermis inermis</i>	10

<i>D. minor</i>	6	4. Improved management. Protection of remaining colonies of
<i>D. moluccense magna</i>	11	<i>A. bulmerae</i> .
<i>D. pannietensis anderseni</i> (endemic sp.)	10	
<i>D. p. pannietensis</i>	10	5. Improved management. Control of hunting (<i>A. bulmerae</i> on
<i>D. p. remota</i>	8	New Guinea).
<i>D. praedatrix</i> (endemic sp.)	10	
<i>Macroglossus minimus microtus</i>	10	6. Education. Hunting (<i>A. bulmerae</i>).
<i>M. m. nanus</i>	11	
<i>Melonycteris melanops</i> (endemic sp.)	11	7. Survey. Bismarck Archipelago, particularly the Admiralty
<i>M. woodfordi</i>	11	Islands, Duke of York, New Britain and New Ireland (<i>N. c.</i>
<i>Nyctimene aello</i>	6	<i>certans</i> , <i>N. m. major</i> , <i>N. masalai</i> , <i>P. gilliardi</i> , <i>P. n. hilli</i> , <i>D. p.</i>
<i>N. albiventer papuanus</i>	11	<i>anderseni</i> , <i>D. praedatrix</i> , <i>N. v. vizcaccia</i> , <i>P. a. admiralitatum</i> ,
<i>N. cephalotes</i>	11	<i>P. t. capistratus</i> , <i>S. a. finschi</i>).
<i>N. cyclotis certans</i>	6	
<i>N. draconilla</i>	6	8. Research. Breeding and feeding (<i>N. aello</i> and <i>P. raptor</i> on
<i>N. major geminus</i> (endemic ssp.)	8	New Guinea).
<i>N. m. lullulae</i> (endemic ssp.)	8	
<i>N. m. major</i> (endemic ssp.)	8	9. Research. Breeding and feeding (<i>N. c. certans</i> on New
<i>N. masalai</i> (endemic sp.)	8	Guinea).
<i>N. vizcaccia bougainville</i>	10	
<i>N. v. vizcaccia</i>	10	10. Survey. Islands off north New Guinea: Bagabag (<i>D. minor</i>);
<i>Paranyctimene raptor</i>	6	Karkar Island (<i>P. t. basiliscus</i>); Manam (<i>P. h. vulcanius</i>);
<i>Pteralopex anceps</i>	1	Schouten Islands (<i>P. t. basiliscus</i>).
<i>Pteropus admiralitatum admiralitatum</i> (endemic ssp.)	10	
<i>P. alecto gouldi</i>	11	11. Survey. D'Entrecasteaux Islands and Louisiade Archipelago
<i>P. conspicillatus chrysauchen</i>	11	(<i>N. m. geminus</i> , <i>D. p. pannietensis</i> , <i>M. m. microtus</i> , <i>S. a.</i>
<i>P. c. conspicillatus</i>	11	<i>crassa</i>).
<i>P. gilliardi</i> (endemic sp.)	8	
<i>P. hypomelanus luteus</i>	11	12. Survey. Buka (<i>P. r. grandis</i>).
<i>P. h. vulcanius</i> (endemic ssp.)	8	
<i>P. macrotis epularius</i>	11	13. Survey. Muyua (<i>N. m. lullulae</i> , <i>S. a. naias</i> and <i>D. p.</i>
<i>P. mahaganus</i>	3	<i>pannietensis</i>).
<i>P. neohibernicus hilli</i> (endemic ssp.)	8	
<i>P. n. neohibernicus</i>	11	14. Survey. Trobriand Islands (<i>D. p. remota</i> , <i>N. m. geminus</i> and
<i>P. rayneri grandis</i>	8	<i>S. a. crassa</i>).
<i>P. scapulatus</i>	11	
<i>P. temmincki capistratus</i> (endemic ssp.)	10	15. Improved management. Gazetting and designation of
<i>P. tonganus basiliscus</i> (endemic ssp.)	8	protected areas (<i>P. t. basiliscus</i> on Karkar Island and the
<i>Rousettus (Rousettus) amplexicaudatus amplexicaudatus</i>	11	Schouten Islands).
<i>R. (R.) a. brachyotis</i>	11	
<i>Syconycteris australis crassa</i> (endemic ssp.)	10	16. Research. Breeding, feeding, threats and long-term
<i>S. a. finschi</i> (endemic ssp.)	10	monitoring (<i>P. t. basiliscus</i> on Karkar Island and the Schouten
<i>S. a. naias</i> (endemic ssp.)	8	Islands).
<i>S. a. papuana</i>	11	
<i>S. hobbit</i> (endemic sp.)	6	17. Education. General (<i>P. t. basiliscus</i> on Karkar Island and
		the Schouten Islands).
		18. Survey. Umboi (<i>D. p. anderseni</i> and <i>N. v. vizcaccia</i>).

Recommended Projects in Order of Priority:

1. Survey. Bougainville (*P. anceps*, *P. mahaganus*, *P. r. grandis*, *D. i. inermis*, *M. m. microtus*, *N. v. bougainville*).

2. Survey. New Guinea (*A. bulmerae*, *D. minor*, *N. c. certans*, *N. draconilla*, *P. raptor*, *D. i. inermis*, *N. v. vizcaccia*).

3. Captive breeding. (*A. bulmerae* on New Guinea; *P. anceps* on Bougainville).

Philippines

No of species: 24 (+ 1 ?extinct, + 1 extinct)

No. of endemics: 10 spp. (+ 1 ?extinct, + 1 extinct), 6 sspp.

- No legislation pertaining to fruit bats.
- Deforestation is a major problem in the Philippines, and

hunting threatens a number of species, particularly cave-dwellers.

- Negros has the eighth highest world score for fruit bat biodiversity (weighted). A number of other islands (for example Leyte, Luzon, and Mindanao) have large and diverse fruit bat faunas.
- The Philippines fruit bat fauna contains a high percentage of threatened taxa.

Species List with Priority Grades:

<i>Acerodon jubatusjubatus</i> (endemic sp.)	2
<i>A. j. mindanensis</i>	2
<i>A. leucotis leucotis</i> (endemic sp.)	10
<i>A. l. obscurus</i>	10
<i>A. lucifer</i> (extinct: endemic sp.)	1
<i>Alionycteris paucidentata</i> (endemic sp.)	5
<i>Cynopterus brachyotis brachyotis</i>	11
<i>Dobsonia chapmani</i> (?extinct: endemic sp.)	1
<i>Dyacopterus spadiceus</i> (subspecies unknown)	10
<i>Eonycteris major robusta</i> (endemic sp.)	6
<i>E. spelaea glandifera</i>	4
<i>E. s. spelaea</i>	11
<i>Haplonycteris fischeri</i> (endemic sp.)	4
<i>Harpyionycteris whiteheadi negrosensis</i> (endemic ssp.)	4
<i>H. w. whiteheadi</i> (endemic ssp.)	10
<i>Macroglossus minimus lagochilus</i>	11
<i>Megaerops wetmorei wetmorei</i> (endemic ssp.)	10
<i>Nyctimene rabori</i> (endemic sp.)	1
<i>Otopteropus cartilagonodus</i> (endemic sp.)	9
<i>Ptenochirus jagorii</i> (endemic sp.)	11
<i>P. minor</i> (endemic sp.)	11
? <i>Pteropus griseus mimus</i>	10
<i>P. hypomelanus cagayanus</i> (endemic ssp.)	11
<i>P. h. tomesi</i>	10
<i>P. leucopterus</i> (endemic sp.)	4
<i>P. mearnsi</i> (endemic sp.)	8
<i>P. pumilus</i>	4
<i>P. speciosus</i>	6
<i>P. vampyrus lanensis</i> (endemic ssp.)	4
<i>Rousettus (Rousettus) amplexicaudatus amplexicaudatus</i>	11
? <i>Thoopterus nigrescens</i>	10

Recommended Projects in Order of Priority:

- 1. Survey.** Negros (*N. rabori* and *D. chapmani*); Panay (*N. rabori*, *A. lucifer* and *D. chapmani*).
- 2. Improved management.** Protection of roost sites (*A. j. jubatus*; *A. j. mindanensis*, *E. s. glandifera*, *P. v. lanensis* and *E. m. robusta*).
- 3. Improved management.** Protection of habitat through controls on logging or underplanting or through re-vegetation (*N. rabori*, *H. fischeri* and *P. pumilus*).
- 4. Survey.** Cebu (*D. chapmani*).

5. Captive breeding. (*N. rabori*, *A. j. jubatus*, *A. j. mindanensis*, *P. leucopterus*, *P. pumilus*, *P. v. lanensis* and *A. lucifer* and *D. chapmani* if they are both not already extinct).

6. Improved management. Control of hunting (*A. j. jubatus*, *A. j. mindanensis* and *P. v. lanensis*).

7. Survey. Dinagat (*P. leucopterus*).

8. Survey. Mindanao (*A. paucidentata*, *P. speciosus* (6), *P. mearnsi*, *D. spadiceus* (ssp. unknown), *H. w. whiteheadi*, and *M. w. wetmorei*); Camiguin (*H. w. whiteheadi*).

9. Improved management. Protection of montane forest through controls on logging or underplanting or through re-vegetation (*H. w. negrosensis* and *H. w. whiteheadi*).

10. Survey. Luzon (*E. s. glandifera*, *P. leucopterus*, *O. cartilagonodus*, *D. spadiceus* (ssp. unknown), *P. g. mimus* and *T. nigrescens*); Catanduanes (*P. leucopterus*).

11. Survey. Palawan (*E. s. glandifera* and *A. l. obscurus*).

12. Survey. Basilan (*P. speciosus*); Malanipa (*P. speciosus*); Sulu Archipelago (*P. speciosus* and *P. h. tomesi*).

13. Research. Habitat requirements (*O. cartilagonodus* on Luzon; *M. w. wetmorei* on Mindanao).

14. Survey. Balabac (*A. l. leucotis*).

15. Survey. Busuanga (*A. l. leucotis*).

Rwanda

No. of species: 7

No. of endemics: None

- No legislation pertaining to fruit bats.
- No known major threats.

Species List with Priority Grades:

<i>Eidolon helvum helvum</i>	11
<i>Epomophorus labiatus</i>	11
<i>E. minor</i>	11
<i>Epomops dobsonii</i>	11
<i>Rousettus (Lissonycteris) angolensis ruwenzorii</i>	11
<i>R. (Rousettus) aegyptiacus leachii</i>	11
<i>R. (R.) lanosus lanosus</i>	11

Recommended Projects in Order of Priority:

- 1. Improved management.** Encourage establishment of protected areas for fruit bats.
- 2. Education.** General.

São Tomé and Príncipe

No. of species: 3
No. of endemics: 1 sp.

- No legislation pertaining to fruit bats.
- Deforestation is a serious threat.

Species List with Priority Grades:

<i>Eidolon helvum helvum</i>	11
<i>Myonycteris brachycephala</i> (endemic sp.)	3
<i>Rousettus (Rousettus) aegyptiacus unicolor</i>	11

Recommended Projects in Order of Priority:

- 1. Survey.** São Tomé (*M. brachycephala*).
- 2. Research.** Breeding, feeding and habitat requirements (*M. brachycephala* on São Tomé).
- 3. Improved management.** Encourage establishment of protected areas for fruit bats.
- 4. Education.** General.

Saudi Arabia

No. of species: 2
No. of endemics: None

- No legislation pertaining to fruit bats.
- No known major threats.

Species List with Priority Grades:

<i>Eidolon helvum sabaenum</i>	8
<i>Rousettus (Rousettus) aegyptiacus arabicus</i>	6

Recommended Projects in Order of Priority:

- 1. Survey.** (*R. (R.) a. arabicus* and *E. h. sabaenum*).
- 2. Research.** Breeding and feeding (*E. h. sabaenum*).
- 3. Improved management.** Encourage establishment of protected areas for fruit bats.
- 4. Education.** General.

Senegal

No. of species: 5
No. of endemics: None

- No legislation pertaining to fruit bats.
- No known major threats.

Species List with Priority Grades:

<i>Eidolon helvum helvum</i>	11
<i>Epomophorus gambianus gambianus</i>	11
<i>Micropteropus pusillus</i>	11
<i>Rousettus (Lissonycteris) angolensis smithi</i>	11
<i>R. (Rousettus) aegyptiacus unicolor</i>	11

Recommended Projects in Order of Priority:

- 1. Improved management.** Encourage establishment of protected areas for fruit bats.
- 2. Education.** General.

Seychelles

No. of species: 1
No. of endemics: 1 ssp.

- No legislation pertaining to fruit bats.
- No known major threats.

Species List with Priority Grades:

<i>Pteropus seychellensis seychellensis</i> (endemic ssp.)	11
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Recommended Projects in Order of Priority:

- 1. Improved management.** Encourage establishment of protected areas for fruit bats.
- 2. Education.** General, tourists.

Sierra Leone

No. of species: 9
No. of endemics: None

- No legislation pertaining to fruit bats.
- No known major threats.

Species List with Priority Grades:

<i>Eidolon helvum helvum</i>	11
<i>Epomophorus gambianus gambianus</i>	11
<i>Epomops buettikoferi</i>	4
<i>Hypsignathus monstrosus</i>	11
<i>Micropteropus pusillus</i>	11
<i>Myonycteris torquata</i>	11
<i>Nanonycteris veldkampii</i>	11
<i>Rousettus (Lissonycteris) angolensis smithii</i>	11
<i>R. (Rousettus) aegyptiacus unicolor</i>	11

Recommended Projects in Order of Priority:

- 1. Survey.** *E. buettikoferi*.
- 2. Improved management.** Encourage establishment of

protected areas for fruit bats.

3. Education. General.

Singapore

No. of species: 5
No. of endemics: None

- No legislation pertaining to fruit bats.
- No known major threats.

Species List with Priority Grades:

<i>Cynopterus brachyotis brachyotis</i>	11
<i>Eonycteris spelaea spelaea</i>	11
<i>Macroglossus minimus lagochilus</i>	11
<i>Penthetor lucasi</i>	11
<i>Pteropus vampyrus malaccensis</i>	11

Recommended Projects in Order of Priority:

1. Improved management. Encourage establishment of protected areas for fruit bats.

2. Education. General.

Solomon Islands

No. of species: 20 (+1 extinct)
No. of endemics: 8 spp. (+ 1 extinct) 11 spp.

- No legislation pertaining to fruit bats.
- Disturbance from an increasing human population is a serious threat.
- Choiseul has the fifth highest world score for fruit bat biodiversity (weighted).

Species List with Priority Grades:

<i>Dobsonia inermis inermis</i>	10
<i>D. i. minimus</i> (endemic ssp.)	8
<i>Macroglossus minimus microtus</i>	10
<i>Melonycteris aurantius</i> (endemic sp.)	8
<i>M. woodfordi</i>	11
<i>Nyctimene major scitulus</i> (endemic ssp.)	8
<i>N. malaitensis</i> (endemic sp.)	8
<i>N. sanctacrucis</i> (extinct: endemic sp.)	1
<i>N. vizcaccia bougainville</i>	10
<i>Pteralopex anceps</i>	1
<i>P. atrata</i> (endemic sp.)	1
<i>Pteropus admiralitatum colonus</i> (endemic ssp.)	10
<i>P. a. goweri</i> (endemic ssp.)	8
<i>P. a. solomonis</i> (endemic ssp.)	10
<i>P. howensis</i> (endemic sp.)	8
<i>P. hypomelanus luteus</i>	10
<i>P. mahaganus</i>	3
<i>P. nitendiensis</i> (endemic sp.)	8

<i>P. rayneri cognatus</i> (endemic ssp.)	8
<i>P. r. grandis</i>	8
<i>P. r. lavellanus</i> (endemic ssp.)	8
<i>P. r. monoensis</i> (endemic ssp.)	8
<i>P. r. rayneri</i> (endemic ssp.)	8
<i>P. r. rennelli</i> (endemic ssp.)	8
<i>P. r. rubianus</i> (endemic ssp.)	8
<i>P. sanctacrucis</i> (endemic sp.)	8
<i>P. tonganus geddiei</i>	11
<i>P. tuberculatus</i> (endemic sp.)	8
<i>P. woodfordi</i> (endemic sp.)	10
<i>Rousettus (Rousettus) amplexicaudatus brachyotis</i>	11

Recommended Projects in Order of Priority:

1. Survey. Solomon Islands particularly Choiseul, Fauro, Guadalcanal, Kolombangara, Malaita, Nggela Sule, Santa Isabel and Vella Lavella (*N. sanctacrucis*, *P. anceps*, *P. atrata*, *P. mahaganus*, *D. i. minimus*, *M. aurantius*, *N. m. scitulus*, *N. malaitensis*, *P. a. goweri*, *P. howensis*, *P. nitendiensis*, *P. rayneri* (all subspecies), *P. sanctacrucis*, *P. tuberculatus*, *D. i. inermis*, *M. m. microtus*, *N. v. bougainville*, *P. a. colonus*, *P. a. solomonis*, and *P. woodfordi*).

2. Captive breeding. *P. anceps*, *P. atrata* and *N. sanctacrucis*.

3. Improved management. Encourage establishment of protected areas for fruit bats.

4. Education. General.

Somalia

No. of species: 3
No. of endemics: None

- No legislation pertaining to fruit bats.
- No known major threats.

Species List with Priority Grades:

<i>?Eidolon helvum helvum</i>	11
<i>Epomophorus minor</i>	11
<i>E. wahlbergi</i>	11

Recommended Projects in Order of Priority:

1. Improved management. Encourage establishment of protected areas for fruit bats.

2. Education. General.

South Africa

No. of species: 4
No. of endemics: None

- Fruit bats are an 'unprotected taxon' in Cape Province, although national and international trade is regulated.
- Conflicts with fruit growers may be a future threat.

Species List with Priority Grades:

<i>Eidolon helvum helvum</i>	11
<i>Epomophorus gambianus crypturus</i>	11
<i>E. wahlbergi</i>	11
<i>Rousettus (Rousettus) aegyptiacus leachii</i>	11

Recommended Projects in Order of Priority:

1. Improved management. Encourage establishment of protected areas for fruit bats.

2. Education. General and fruit-damage.

Sri Lanka

No. of species: 4
No. of endemics: 2 spp.

- *Rousettus (Rousettus) leschenaulti* is totally protected
- No known major threats.

Species List with Priority Grades:

<i>Cynopterus brachyotis ceylonensis</i> (endemic ssp.)	10
<i>C. sphinx sphinx</i>	11
<i>Pteropus giganteus giganteus</i>	11
<i>Rousettus (Rousettus) leschenaulti seminudus</i> (endemic ssp.)	11

Recommended Projects in Order of Priority:

1. Survey. *C. b. ceylonensis*.

2. Improved management. Encourage establishment of protected areas for fruit bats.

3. Education. General.

Sudan

No. of species: 9
No. of endemics: None

- No legislation pertaining to fruit bats
- No known major threats.

Species List with Priority Grades:

<i>Eidolon helvum helvum</i>	11
<i>Epomophorus gambianus gambianus</i>	11
<i>E. labiatus</i>	11
<i>E. minor</i>	11
<i>Epomops franqueti</i>	11
<i>Hypsignathus monstrosus</i>	11

<i>Micropteropus pusillus</i>	11
<i>Rousettus (Lissonycteris) angolensis ruwenzorii</i>	11
<i>R. (R.) a. leachii</i>	11
<i>R. (R.) lanosus kempfi</i>	11

Recommended Projects in Order of Priority

1. Improved management. Encourage establishment of protected areas for fruit bats.

2. Education. General.

Swaziland

No. of species: 1
No. of endemics: None

- No legislation pertaining to fruit bats
- No known major threats.

Species List with Priority Grades:

<i>Epomophorus wahlbergi</i>	11
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Recommended Projects in Order of Priority:

1. Improved management. Encourage establishment of protected areas for fruit bats.

2. Education. General.

Syria

No. of species: 1
No. of endemics: None

- No legislation pertaining to fruit bats
- No known major threats.

Species List with Priority Grades:

<i>Rousettus (Rousettus) aegyptiacus aegyptiacus</i>	11
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Recommended Projects in Order of Priority:

1. Improved management. Encourage establishment of protected areas for fruit bats.

2. Education. General.

Taiwan

No. of species: 1
No. of endemics: 1 ssp.

- Handling is regulated under the wildlife laws.
- Hunting appears to be the major threat.

Species List with Priority Grades:

Pteropus dasymallus formosus (endemic ssp.) 1

Recommended Projects in Order of Priority:

1. **Survey.** *P. d. formosus*.
2. **Improved management.** Control of hunting (*P. d. formosus*).
3. **Improved management.** Habitat and roost protection (*P. d. formosus*).
4. **Improved management.** Gazetting and designation of protected areas (*P. d. formosus*).
5. **Research.** Threats (*P. d. formosus*).

Tanzania

No. of species: 14
No. of endemics: 1 sp.

- No legislation pertaining to fruit bats.
- *Myonyctehs relictus* is threatened by deforestation and *Pteropus voeltzkowi* by deforestation and hunting.

Species List with Priority Grades:

<i>Eidolon helvum helvum</i>	11
<i>Epomophorus gambianus crypturus</i>	11
<i>E. labiatus</i>	11
<i>E. minor</i>	11
<i>E. wahlbergi</i>	11
<i>Epomops dobsonii</i>	11
<i>E. franqueti</i>	11
<i>Micropteropus pusillus</i>	11
<i>Myonycteris relictus</i>	3
<i>Pteropus seychellensis comorensis</i>	11
<i>P. voeltzkowi</i> (endemic sp.)	1
<i>Rousettus (Lissonycteris) angolensis ruwenzorii</i>	11
<i>R. (Rousettus) aegyptiacus leachii</i>	11
<i>R. (R.) lanosus kempfi</i>	11

Recommended Projects in Order of Priority:

1. **Captive breeding.** *P. voeltzkowi* on Pemba.
2. **Survey.** *P. voeltzkowi* on Pemba.
3. **Improved management.** Protection of habitat through controls on logging or underplanting or through re-vegetation (*P. voeltzkowi* on Pemba).
4. **Improved management.** Control of hunting (*P. voeltzkowi* on Pemba).

5. Education. General and habitat destruction (*P. voeltzkowi* on Pemba).

6. Research. Breeding, feeding, habitat requirements, and long-term monitoring (*P. voeltzkowi* on Pemba).

7. Survey. *M. relictus*.

8. Improved management. Gazetting and designation of protected areas (*M. relictus*).

9. Research. Breeding, feeding, habitat requirements, and long-term-monitoring (*M. relictus*).

Thailand

No. of species: 16
No. of endemics: None

- No legislation pertaining to fruit bats.
- Deforestation is the most serious threat.
- Peninsular Thailand has the sixth highest world score for fruit bat biodiversity (weighted).

Species List with Priority Grades:

<i>Balionycteris maculata seimundi</i>	9
<i>Chironax melanocephalus melanocephalus</i>	11
<i>Cynopterus brachyotis brachyotis</i>	11
<i>C. horsfieldii harpax</i>	11
<i>C. sphinx angulatus</i>	11
<i>C. s. sphinx</i>	11
<i>Eonycteris spelaea spelaea</i>	11
<i>Macroglossus minimus lagochilus</i>	11
<i>M. sobrinus sobrinus</i>	11
<i>Megaerops ecaudatus</i>	11
<i>M. niphanae</i>	10
<i>Pteropus hypomelanus condorensis</i>	11
<i>P. h. geminorum</i>	8
<i>P. lylei</i>	11
<i>P. vampyrus intermedius</i>	10
<i>P. v. malaccensis</i>	11
<i>Rousettus (Rousettus) amplexicaudatus amplexicaudatus</i>	11
<i>R. (R.) leschenaulti leschenaulti</i>	11
<i>Sphaerias blanfordi</i>	10

Recommended Projects in Order of Priority:

1. **Survey.** Ko Samui and Ko Tao (*P. h. geminorum*).
2. **Improved management.** Roost protection (*P. h. geminorum* on Ko Samui and Ko Tao).
3. **Survey.** Peninsular Thailand (*M. niphanae*, *P. v. intermedius* and *S. blanfordi*).

4. Improved management. Encourage establishment of protected areas for fruit bats.

5. Education. General.

Tibet

No. of species: 1
No. of endemics: None

- No legislation pertaining to fruit bats
- No known major threats.

Species List with Priority Grades:

Sphaerias blanfordi 10

Recommended Projects in Order of Priority:

- 1. Survey.** *S. blanfordi*.
- 2. Improved management.** Encourage establishment of protected areas for fruit bats.
- 3. Education.** General.

Togo

No. of species: 10
No. of endemics: None

- Bats are not protected under wildlife regulations.
- No known major threats.

Species List with Priority Grades:

Eidolon helvum helvum 11
Epomophorus gambianus gambianus 11
Epomops franqueti 11
Hypsignathus monstrosus 11
Megaloglossus woermanni 11
Micropteropus pusillus 11
Myonycteris torquata 11
Nanonycteris veldkampii 11
Rousettus (Lissonycteris) angolensis smithii 11
R. (Rousettus) aegyptiacus unicolor 11

Recommended Projects in Order of Priority:

- 1. Improved management.** Encourage establishment of protected areas for fruit bats.
- 2. Education.** General.

Tonga

No. of species: 1
No. of endemics: None

- One colony is protected but otherwise there is no legislation pertaining to fruit bats.
- Hunting has been a threat.

Species List with Priority Grades:

Pteropus tonganus tonganus 9

Recommended Projects in Order of Priority:

- 1. Survey.** *P. t. tonganus*.
- 2. Improved management.** Control of hunting (*P. t. tonganus*).
- 3. Education.** General, hunting, and tourists (*P. t. tonganus*).
- 4. Improved management.** Gazetting and designation of protected areas (*P. t. tonganus*).
- 5. Research.** Breeding, feeding, threats, and long-term monitoring (*P. t. tonganus*).

Turkey

No. of species: 1
No. of endemics: None

- No legislation pertaining to fruit bats.
- Conflicts with fruit growers may be a future threat.

Species List with Priority Grades:

Rousettus (Rousettus) aegyptiacus aegyptiacus 11

Recommended Projects in Order of Priority:

- 1. Improved management.** Encourage establishment of protected areas for fruit bats.
- 2. Education.** General and fruit-damage.

Uganda

No. of species: 12
No. of endemics: None

- No legislation pertaining to fruit bats
- No known major threats.

Species List with Priority Grades:

Eidolon helvum helvum 11
Epomophorus labiatus 11
E. minor 11
E. wahlbergi 11
Epomops franqueti 11
Hypsignathus monstrosus 11
Megaloglossus woermanni 11
Micropteropus pusillus 11

<i>Myonycteris torquata</i>	11
<i>Rousettus (Lissonycteris) angolensis ruwenzorii</i>	11
<i>R. (Rousettus) aegyptiacus leachii</i>	11
<i>R. (R.) lanosus lanosus</i>	11

Recommended Projects in Order of Priority:

1. Improved management. Encourage establishment of protected areas for fruit bats.

2. Education. General.

United Kingdom administered territories

Hong Kong

No. of species: 1
No. of endemics: None

- No legislation pertaining to fruit bats
- No known major threats.

Species List with Priority Grades:

Rousettus (Rousettus) leschenaulti leschenaulti 11

Recommended Projects in Order of Priority:

1. Improved management. Encourage establishment of protected areas for fruit bats.

2. Education. General.

United States administered territories

American Samoa

No. of species: 2
No. of endemics: None

- Legislation to restrict local hunting and prohibit export of fruit bats.
- Hunting seriously threatens *Pteropus samoensis samoensis*. Lowland deforestation also a problem.

Species List with Priority Grades:

Pteropus samoensis samoensis 1
P. tonganus tonganus 9

Recommended Projects in Order of Priority:

1. Improved management. Control of hunting through bans or quotas, and stricter enforcement and review of existing laws **protecting bats** (*P. s. samoensis* and *P. t. tonganus*).

2. Education. General, hunting and tourists (*P. s. samoensis* and *P. t. tonganus*).

3. Research. Breeding, feeding, habitat requirements and long-term monitoring (*P. s. samoensis*).

4. Survey. *P. t. tonganus*.

5. Research. Breeding, feeding, threats, habitat requirements and long-term monitoring (*P. t. tonganus*).

6. Improved management. Gazetting and designation of **protected areas** (*P. t. tonganus*).

Belau

No. of species: 1 (+ 1 extinct)
No. of endemics: 1 sp. (extinct), 1 ssp.

- No legislation pertaining to fruit bats.
- Commercial hunting seriously threatens *Pteropus mariannus pelewensis*.

Species List with Priority Grades:

Pteropus mariannus pelewensis (endemic ssp.) 1
P. pilosus (extinct: endemic sp.) 1

Recommended Projects in Order of Priority:

1. Improved management. Legislation controlling hunting through bans or quotas (*P. m. pelewensis*).

2. Education. General and hunting (*P. m. pelewensis*).

3. Survey. *P. m. pelewensis*, checking also for evidence of *P. pilosus*.

4. Improved management. Management of forest habitats for the benefit of bats (*P. m. pelewensis*).

5. Research. Breeding, feeding, and long-term monitoring (*P. m. pelewensis*).

Commonwealth of the Northern Mariana Islands

No. of species: 1
No. of endemics: 1 ssp.

- *P. mariannus* is locally protected in the CNMI.
- Major threat has been commercial hunting.

Species List with Priority Grades:

Pteropus mariannus (subspecies unknown) 1
P. mariannus mariannus 1
P. m. paganensis (endemic ssp.) 1

Recommended Projects in Order of Priority:

- 1. Improved management.** Control of illegal hunting and improvement of legal protection. (*P. mariannus* (ssp. unknown), *P. m. mariannus* and *P. m. paganensis*).
- 2. Education.** General and hunting (*P. mariannus* (ssp. unknown), *P. m. mariannus*, *P. m. paganensis*).
- 3. Improved management.** Gazetting and designation of protected areas (*P. m. paganensis*).
- 4. Survey.** *P. mariannus* (ssp. unknown), *P. m. mariannus*, *P. m. paganensis*.
- 5. Improved management.** Co-operative agreement between CNMI, Guam and the US Fish and Wildlife Service for management and protection of bats (*P. mariannus* (ssp. unknown), *P. m. mariannus*, *P. m. paganensis*).
- 6. Research.** Breeding, feeding, and long-term monitoring (*P. mariannus* (ssp. unknown), *P. m. mariannus*, *P. m. paganensis*).
- 7. Improved management.** Manage forests for the benefit of fruit bats (*P. mariannus* (ssp. unknown), *P. m. mariannus*, *P. m. paganensis*).

Guam

No. of species: 1 (+ 1 ?extinct)
No. of endemics: 1 sp. (?extinct)

- *Pteropus mariannus mariannus* is totally protected on Guam and listed as endangered by the US Fish and Wildlife Service.
- Commercial hunting has been the most serious threat, and illegal hunting continues to threaten *P. m. mariannus*. Predation by tree snakes also seriously threatens this species.

Species List with Priority Grades:

Pteropus mariannus mariannus 1
P. tokudae (?extinct: endemic sp.) 1

Recommended Projects in Order of Priority:

- 1. Improved management.** Stationing of a permanent CITES enforcement officer on Guam to police recently amended CITES regulations.
- 2. Improved management.** Control of predation of bats by brown tree snakes (*P. m. mariannus*).
- 3. Improved management.** Control illegal hunting (*P. m. mariannus*).
- 4. Education.** General and hunting (*P. m. mariannus*).

5. Improved management. List remaining populations of *P. m. mariannus* on Rota, Aguijan, Tinian and Saipan as endangered.

6. Improved management. Designation of protected areas (*P. m. mariannus*).

7. Improved management. Develop a cooperative agreement between Guam, the CNMI and the US Fish and Wildlife Service for the management and protection of bats (*P. mariannus* (ssp. unknown), *P. m. mariannus* and *P. m. paganensis*).

8. Improved management. Develop better liaison between the US Air Force and conservation organizations (*P. m. mariannus*).

9. Survey. *P. m. mariannus*, checking also for *P. tokudae*.

10. Research. Breeding, feeding and long-term monitoring (*P. m. mariannus*).

11. Improved management. Manage forests for the benefit of fruit bats (*P. m. mariannus*).

12. Reintroduction. *P. m. mariannus* into its former habitat on Guam.

13. Research. Check shipments from Belau for evidence of *Pteropus pilosus*.

Vanuatu

No. of species: 4
No. of endemics: 2 spp.

- No legislation pertaining to fruit bats.
- *Pteropus anetianus* is threatened by hunting and *Notopteris macdonaldii* by hunting and roost disturbance.

Species List with Priority Grades:

Notopteris macdonaldii macdonaldii 4
Pteropus anetianus anetianus (endemic sp.) 3
P. a. aorensis 3
P. a. bakeri 3
P. a. banksiana 3
P. a. eotinus 3
P. a. motalave 3
P. a. pastoris 3
P. fundatus (endemic sp.) 8
P. tonganus geddiei 11

Recommended Projects in Order of Priority:

- 1. Survey.** *P. anetianus* (all subspecies), *N. m. macdonaldii*, and *P. fundatus*.
- 2. Improved management.** Gazetting and designation of protected areas (*P. anetianus* - all subspecies).

3. Research. Breeding, feeding, movements, and long-term monitoring (*P. anetianus* - all subspecies).

4. Improved management. Protection of roosts (*N. m. macdonaldii*).

5. Research. Breeding, feeding, threats, and habitat requirements (*N. m. macdonaldii*).

Vietnam

No. of species: 9

No. of endemics: 1 ssp.

- No legislation pertaining to bats.
- No known major threats.

Species List with Priority Grades:

<i>Cynopterus brachyotis hoffeti</i> (endemic ssp.)	11
<i>Eonycteris spelaea spelaea</i>	11
<i>Macroglossus minimus lagochilus</i>	11
<i>Megaerops ecaudatus</i>	11
? <i>M. niphanae</i>	10
<i>Pteropus hypomelanus condorensis</i>	11
<i>P. lylei</i>	11
<i>P. vampyrus malaccensis</i>	11
<i>Rousettus (Rousettus) leschenaulti leschenaulti</i>	11

Recommended Projects in Order of Priority:

1. Survey. *M. niphanae*.

2. Improved management. Encourage establishment of protected areas for fruit bats.

3. Education. General.

Western Samoa

No. of species: 2

No. of endemics: None

- There are regulations restricting local hunting and prohibiting export of fruit bats.
- Deforestation and hunting are the most serious threats.

Species List with Priority Grades:

<i>Pteropus samoensis samoensis</i>	1
<i>P. tonganus tonganus</i>	9

Recommended Projects in Order of Priority:

1. Improved management. Control of hunting and enforcement and review of laws protecting bats (*P. s. samoensis* and *P. t. tonganus*).

2. Education. General, hunting, and tourists (*P. s. samoensis* and *P. t. tonganus*).

3. Research. Breeding, feeding, habitat requirements, and long-term monitoring (*P. s. samoensis*).

4. Survey. *P. t. tonganus*.

5. Improved management. Gazetting and designation of protected areas (*P. t. tonganus*).

6. Research. Breeding, feeding, threats, and long-term monitoring (*P. t. tonganus*).

Yemen

No. of species: 2

No. of endemics: None

- No legislation pertaining to fruit bats.
- No known major threats.

Species List with Priority Grades:

<i>Eidolon helvum sabaicum</i>	8
<i>Rousettus (Rousettus) aegyptiacus arabicus</i>	6

Recommended Projects in Order of Priority:

1. Improved management. Gazetting and designation of protected areas (*R. (R.) a. arabicus*).

2. Survey. *E. h. sabaicum*.

3. Research. Breeding and feeding (*E. h. sabaicum*).

4. Education. General.

Zaire

No. of species: 18

No. of endemics: None

- No legislation pertaining to fruit bats.
- Deforestation is the most serious threat.
- Zaire has a very large and diverse bat fauna and the country is the most important single area for fruit bats in Africa.

Species List with Priority Grades:

<i>Casinycteris argynnis</i>	8
<i>Eidolon helvum helvum</i>	11
<i>Epomophorus gambianus crypturus</i>	11
<i>E. labiatus</i>	11
<i>E. minor</i>	11
<i>E. wahlbergi</i>	11
<i>Epomops dobsonii</i>	11
<i>E. franqueti</i>	11

<i>Hypsignathus monstrosus</i>	11
<i>Megaloglossus woermanni</i>	11
<i>Micropteropus intermedius</i>	6
<i>M. pusillus</i>	11
<i>Myonycteris torquata</i>	11
<i>Plerotes anchietae</i>	6
<i>Rousettus (Lissonycteris) angolensis angolensis</i>	11
<i>R. (L.) a. ruwenzorii</i>	11
<i>R. (Rousettus) aegyptiacus leachii</i>	11
<i>R. (R.) a. unicolor</i>	11
<i>R. (R.) lanosus lanosus</i>	11
<i>Scotoonycteris zenkeri</i>	11

Recommended Projects in Order of Priority:

- 1. Survey.** *M. intermedius*, *P. anchietae* and *C. argynnis*.
- 2. Research.** Breeding and feeding. *P. anchietae* and *C. argynnis* (feeding only).
- 3. Improved management.** Encourage establishment of protected areas for fruit bats.
- 4. Education. General.**

Zambia

No. of species: 11
No. of endemics: None

- No legislation pertaining to fruit bats.
- No known major threats.

Species List with Priority Grades:

<i>Eidolon helvum helvum</i>	11
<i>Epomophorus gambianus crypturus</i>	11
<i>E. minor</i>	11
<i>E. wahlbergi</i>	11
<i>Epomops dobsonii</i>	11
<i>E. franqueti</i>	11

<i>Micropteropus pusillus</i>	11
<i>Myonycteris torquata</i>	11
<i>Plerotes anchietae</i>	6
<i>Rousettus (Lissonycteris) angolensis ruwenzorii</i>	11
<i>R. (Rousettus) aegyptiacus leachii</i>	11

Recommended Projects in Order of Priority:

- 1. Survey.** *P. anchietae*.
- 2. Research.** Breeding and feeding (*P. anchietae*).
- 3. Improved management.** Encourage establishment of protected areas for fruit bats.
- 4. Education. General.**

Zimbabwe

No. of species: 6
No. of endemics: None

- No legislation pertaining to fruit bats.
- No known major threats.

Species List with Priority Grades:

<i>Eidolon helvum helvum</i>	11
<i>Epomophorus gambianus crypturus</i>	11
<i>E. wahlbergi</i>	11
<i>Epomops dobsonii</i>	11
<i>Rousettus (Lissonycteris) angolensis ruwenzorii</i>	11
<i>R. (Rousettus) aegyptiacus leachii</i>	11

Recommended Projects in Order of Priority:

- 1. Improved management.** Encourage establishment of protected areas for fruit bats.
- 2. Education. General.**

Chapter 6. Survey Techniques for Fruit Bats

A detailed review of survey and census methods for bats is given by Kunz (1988).

Survey methods that have been used for fruit bats can be broadly divided into three categories: 1) counts at known roost sites; 2) counts away from roosts; and 3) opportunistic methods.

Counts at known roost sites

Some bats (particularly the larger *Pteropus* and *Rousettus* species) are highly gregarious, roosting in large numbers in canopy trees or caves. Roosts are particularly suitable for survey or census studies because a) they are relatively easy to find, b) they contain moderate to large numbers of individuals, c) they can be relatively permanent and d) in the case of caves, they may be logistically simple to study (Kunz, 1988). By locating these roosts, an estimate can be made of the population size for a given area. To do this, more information than simple roost counts is required. Thus, the researcher should a) establish the geographic limits of the study region, b) determine the number and size of roosts present in the study region, c) be certain that all the roosts have been located, d) determine the level of dispersal of individuals within and outside of the study region and e) determine whether individuals from other areas disperse into the study region (Kunz, 1988). This survey method has been successful on smaller islands (e.g., Seychelles (Nicoll and Racey, 1981), the Mariana Islands (Wiles, 1987a; Wiles *et al.*, 1989), Yap (Engbring, 1985) and Ulithi Atoll (Wiles *et al.*, 1991). Bats can be very noisy at their roosts and Wiles (1987a) estimated that they could be easily heard 400 m away and faintly heard up to 800 m. In good light conditions bats are highly visible when roosting and flying and are recognizable up to 1000 m away (Wiles, 1987a). By stationing observers at vantage points that have a clear view of sections of forest, roosts can be located using binoculars or a spotting scope (Wiles, 1987a). In the small islands of Ulithi Atoll, observers stationed on the beach at dawn and dusk were able to locate colonies by the number of bats seen flying over the forest canopy or between islands (Wiles *et al.*, 1991). In the Mariana Islands a boat was used to circle the smaller islands and roosts were located by observers on deck using binoculars (Wiles *et al.*, 1989). Once roosts have been located three methods have been used to estimate the size of the roost: a) dispersal counts; b) disturbance counts; and c) direct roost counts. In the Seychelles, all three methods were evaluated (Racey, 1979; Nicoll and Racey, 1981).

Dispersal counts

In the Seychelles, roosts, which in the case of *Pteropus seychellensis* are situated close to ridge crests, were surrounded

by several counters positioned in the valleys. Each had responsibility for counting those bats leaving the roost at dusk and flying to feed in a particular arc of the forest encircling the roost. Good light-gathering binoculars were essential because failing light often makes counts difficult. Nevertheless, the method gave good results (Racey, 1979; Nicoll and Racey, 1981).

In the Mariana Islands, counts were conducted from 1-3 hours before darkness until nightfall. Observers were positioned where bats would be silhouetted against the sky or ocean. Departures were recorded in 10-minute intervals. Departure rates were greatest from 10-40 minutes after sunset, when darkness prevented further counting (Wiles *et al.*, 1989). Bats continued to emerge after dark and therefore, the counts were a minimum estimate. Also, young bats clinging to their mothers or remaining at the roosts were not visible to the observers (Wiles *et al.*, 1989).

In Yap, Engbring (1985) conducted both morning and evening dispersal counts from vantage points. Bats and their flight directions were recorded and subtalled at 10-minute intervals. Bats that were milling around but did not fly in and out of the observation area were recorded separately. Bats that could not be assigned to any particular flyway or roost site were classed as 'miscellaneous'.

Cave roosting bats will have a limited number of exit points and these can make convenient locations for making visual counts. Individuals entering and leaving the roost can be tallied with hand counters. It is important to keep track of bats that re-enter the roost either early in the counting period or later after foraging as any double counting will affect the final result. With single species roosts, counting individuals is not difficult and relatively large numbers can be accurately recorded. The upper size of a 'manageable' colony depends on the number of exits and the rate at which bats emerge. Jacobsen and DuPlessis (1976) reported counts as high as 9000 *Rousettus (Rousettus) aegyptiacus*. At roosts numbering in the hundreds, counts can be extremely accurate. It is likely that the accuracy of counts decreases when the colony sizes exceed 500, and it may be important to have two independent observers at large colonies to verify accuracy (Kunz, 1988).

Where numbers of bats overwhelm the observer, bats can be counted at intervals (for example, 1 minute every 5 minutes). This approach does assume that bats emerge as a continuous stream rather than in bursts. When these counts are plotted against time, the area under the curve represents an estimate (without confidence limits) of a total population (Norton and Van der Merwe, 1978) (Kunz, 1988).

Where visual emergence counts are not possible, electronic counting devices such as photo-electric 'beam splitters' may

prove valuable. Kunz (1988) discusses the use and drawbacks of such methods.

Photographic methods can be used in situations where the numbers emerging are very large. Sections of the emerging column can be photographed at intervals. The numbers of bats in each of these photographs can then be counted and an estimate made of colony size (Kunz, 1988). Such techniques are best used in situations where large numbers of bats form a cohesive column of small diameter and relatively homogeneous density and are less likely to be useful at multi-species roosts or at roosts where the bats disperse widely at the exit (Kunz, 1988).

Mist-nets or harp traps set to cover roost exits may capture some or all of the individuals leaving the roost. In most situations, however, some individuals will avoid being captured. More importantly, repeated use of these techniques may lead to abandonment of sites (Kunz, 1988).

Disturbance counts

In the Seychelles, one or two light-footed field workers entered the roost. This was accomplished with difficulty because the substrate was carpeted with dry palm fronds, which broke noisily underfoot when trodden on. At a pre-arranged time, those who had entered the roost made as loud a noise as possible by shouting and clapping hands. The bats took flight and were photographed through a wide angle lens by another field worker at a vantage point some distance from the roost. A single sweep of the camera was made through the flyways used, taking care that successive exposures included overlapping topographical features. Bats were subsequently counted on projected slides. The success of this method depended on the skill of those entering the roost, because if some of the bats were disturbed prematurely, they were slow to settle again and may also have stimulated a more extensive disturbance. Conversely, the method also produces underestimates because some bats do not react to the disturbance and remain in the roost.

In Yap, Engbring (1985) conducted disturbance counts at three colonies and compared the data with that obtained from dispersal counts. In two cases the estimates obtained from the two methods were similar, but in one case the estimate from the disturbance count was twice that from the dispersal count. Based on this, Engbring (1985) concluded that more data were needed before the accuracy of this method could be assessed.

Direct roost counts

In the Seychelles, bats in a roost could be counted directly using binoculars and hand tally counters. This was the least successful method because bats were often hidden from view by vegetation and one another (Racey, 1979; Nicoll and Racey, 1981).

On Guam, in the Mariana Islands, counts at roosts were conducted in the mornings, but not during rain or heavy winds. Only adult bats were counted during these censuses. Because some bats were concealed in thick foliage and not visible to the observer, the total number of animals counted at roosts was increased by 10 to 20%, based on previous observations, to

account for hidden individuals (Wiles, 1987a).

Mutere (1980) used two different techniques to estimate the size of an *Eidolon helvum* colony in Kampala, Uganda. In one approach he counted the number of bats roosting in 'average trees' and arrived at a total by counting the number of occupied trees. In another approach he counted the number of bats roosting in average 'patches' and multiplied this by the number of 'patches' in the roost. Although the results of the two methods differed by as much as 33%, they were generally in good agreement with neither technique consistently over- or underestimating colony size (Kunz, 1988).

All of the above methods have been successful to varying degrees where bats are present in large roosts. However, locating small roosts or individual bats is a problem. On some islands in the Marianas no colonies were located and counts of solitary bats were made from the ship, on hillsides or along the shore (Wiles *et al.*, 1989). Censusing was very difficult because bats often flew out from a number of places within a survey area and travelled in a variety of directions; thus some bats may have been counted twice. Recorded sightings in such cases may have overestimated the actual number of bats present (Wiles *et al.*, 1989).

Once the roost counts have been made it is necessary to convert them into estimates of population size. Wiles *et al.* (1989) based their estimates on several factors, including the number of bats recorded during counts, the size of an island, the amount of forest cover, and food plant diversity and abundance. On larger islands, where dispersal counts were the main censusing technique, population estimates were often much higher than the actual number of bats counted. The rationale for this was that dispersal counts would not account for all bats in the colony or the bats not associated with colonies. On smaller islands with no colonies estimates tended to be similar or lower than the number of bats counted (Wiles *et al.*, 1989). On Ulithi Atoll, estimates of population size (Wiles *et al.*, 1991) were based on the percentage of the island covered by observers, the quality and amount of forest on the island and the amount of feeding evidence found. Each estimate was given an arbitrary measure of variability (i.e., 5 bats for populations of <40 animals, 10 bats for populations of 40-100 and 25 for populations of >100). In the Seychelles all three methods gave direct counts of minimum numbers of bats - the first two gave comparable numbers sufficiently repeatable from month to month to provide a minimum number of 2000 *P. seychellensis* on Praslin and La Digue (Racey, 1979; Nicoll and Racey, 1981). This was later supplemented by roost counts of 2500 bats on Mahe (Racey and Nicoll, 1984). Although this latter figure was a considerable underestimate, these counts were low enough for *P. seychellensis* to be considered 'vulnerable' in the IUCN Red List category.

Counts away from roost sites

In cases where the location of roost sites is difficult or the species concerned are not gregarious, other survey methods have been

used. These can be broadly divided into those using some form of transect, and those involving netting.

Transect methods

The use of transects has long been a favoured method for censusing bird populations. One method that has been suggested for potential use in bat surveys is the variable circular plot technique extensively used for birds. In this method, the observer walks along a transect stopping for set times at a number of points. At each point, the observer records how many birds are seen or heard within predefined sized circles whose centre is the recording point. The technique requires a good knowledge of bird song as well as an ability to accurately estimate the horizontal distance to a particular animal. The number of birds within each of the pre-selected circles at each point allows for an estimation of population parameters. Examples of the use of this technique are given by Anderson and Ohmart (1981), DeSante(1981), Edwards *et al.* (1981) and Bibby *et al.* (1985). Its usefulness for bat surveys has yet to be established, especially because bats, unlike birds, do not produce a variety of songs that would aid identification.

Mist netting and trapping

These are specialist techniques, which have the advantage of recording species that may not otherwise be located by techniques discussed above. The techniques are particularly suitable for small species, which forage within the forest canopy, as opposed to the larger species (such as *Pteropus*), which fly well above the canopy. Munn (1991) describes techniques for constructing and erecting mist nets within the forest canopy. Heaney *et al.* (1989) used mist-nets to obtain information on bat species present on Philippine islands. Nets were set on ridgetops and across trails and streams in forest, and among fruit trees in agricultural areas. Eight species were captured and data allowed for estimations of relative abundance of species. Data from a long-term netting scheme on Negros in the Philippines allowed for calculation of population size, density and survivorship (Heideman and Heaney, 1989).

Netting can be used as part of capture-mark-recapture techniques for estimating population size and structure. A detailed review of capture-mark-recapture techniques is given by Brownie *et al.* (1978), Otis *et al.* (1978), Pollock (1981) and White *et al.* (1982). All capture-mark-recapture models assume: a) animals carrying marks must not suffer higher mortality than those not carrying marks; b) once released, marked animals must mix at random with the study population; c) marked animals must be no more or less easily captured than unmarked 'naive' animals; d) marks must not be lost or overlooked in samples; and e) some models permit no additions to or deletions from the population through birth, immigration, death and/or emigration during the study period. These techniques have rarely been used in bat studies. Herzig-Straschil and Robinson (1978) used the Lincoln Index to estimate a *Rousettus (Rousettus) aegyptiacus* population and, although their recapture rate was

low, they achieved comparable results on two recapture occasions (Kunz, 1988).

Opportunistic methods

These methods may provide information on the species of bats present within an area, although they are unlikely to provide any quantitative information on population sizes.

Questionnaires and postal surveys

In Vanuatu, Chambers and Esrom (1989) report that a questionnaire sent to field-workers revealed information on the presence or absence of bats, methods of hunting, and a broad idea of whether bat numbers had increased, decreased or not changed in the recent past. In Australia, Richards (1990a) used a postal survey of bat researchers to pinpoint roosts of *Pteropus conspicillatus*.



Fruit bats on sale in Imandi market, Sulawesi (Photo by M. Argeloo)

Information from hunters

In Yap, Falanruw (1988a) used specimens from hunters' kills to obtain information on the resident fruit bat species, *Pteropus mariannus yapensis*. The sample was, however, biased towards mature females.

Information from markets

In northern Sulawesi, Bergmans and Rozendaal (1988) obtained a large proportion of their specimens from the food market at Imandi, on the edge of a forest where many of them were caught. Some of the species obtained were previously rare in collections. While this could not provide any quantitative data on bat numbers, it did illustrate that a wide variety of species is hunted.

Conclusions

As yet, there is no one single survey method that could be considered suitable for all bat species in a variety of situations. For gregarious species estimates can be made of population sizes, although their accuracy is very much dependent on topography. In Australia, Richards (1990a) found that accurate roost counts could be made only in a few situations, the bias against accuracy increasing as either the number of animals or

the roost area increased, or in rain forest and paperbark swamps, as accessibility through the understorey of the roost area decreased. However, the biggest problem is to survey large areas where bats may be present at a very low density. This may need a combination of methods and there is an urgent need for an evaluation of the available censusing techniques to produce a method that is easy to undertake by both amateurs and professional counters/census takers and, above all, that produces reliable and repeatable results.

Chapter 7. Captive Breeding and Translocation of Fruit Bats

Captive breeding

Policy

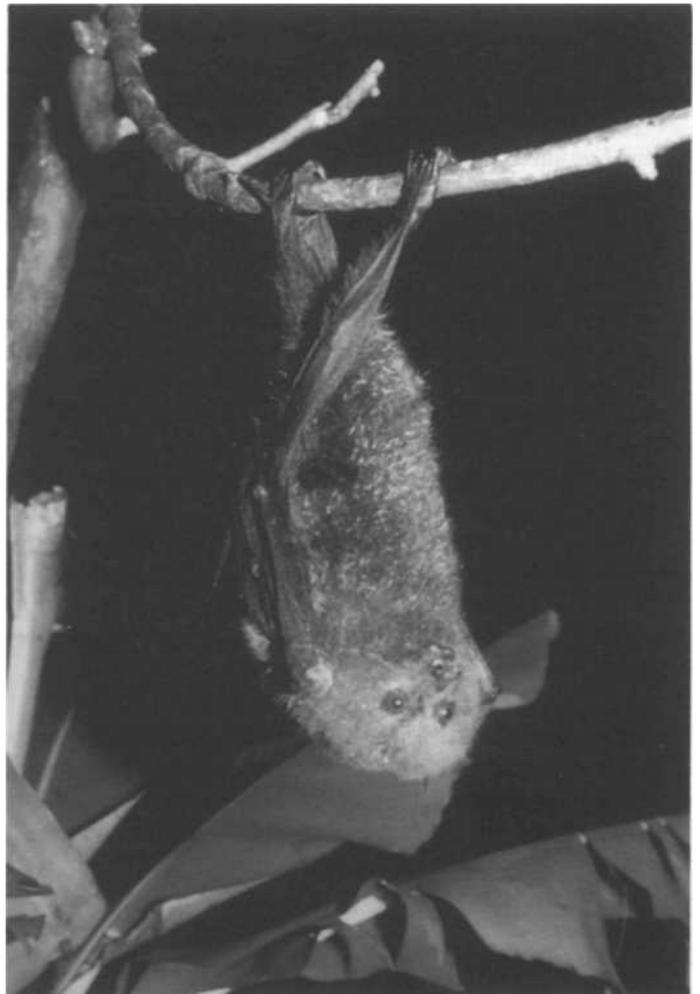
The Chiroptera Specialist Group considers that the captive breeding of endangered fruit bats should be considered very much as a last resort, when all other means of preventing the probable extinction of a taxon have been exhausted. Notwithstanding this, the Chiroptera Specialist Group fully supports the IUCN Policy Statement on Captive Breeding approved at the 22nd Meeting of the IUCN Council on 4th September 1987. The Chiroptera Specialist Group identifies the following as being of particular importance when contemplating captive breeding programmes:

- The specific problems of the taxon concerned need to be considered, and appropriate aims for a captive breeding programme made explicit
- The recognition of potentially critical situations is vital, and is dependent on information on the status of wild populations. Captive populations need to be established preferably when the wild population is still in the thousands. Those taxa with a current census below 1000 individuals require close and swift co-operation between field conservationists and captive-breeding specialists, if the extinction of these taxa is to be avoided.
- Captive populations should be founded and managed according to sound principles of breeding and management for the primary purpose of securing the survival of taxa through stable, self-sustaining captive populations and with the ultimate goal of ensuring a secure wild population.
- The IUCN/SSC Captive Breeding Specialist Group is the appropriate advisory body concerning captive breeding protocols and resources and any proposed programme should be agreed after full consultation between the Chiroptera Specialist Group and the Captive Breeding Specialist Group.
- Captive breeding programmes involving taxa at risk should be conducted primarily for the benefit of the taxon and without commercial transactions. Acquisition of animals for such programmes should not encourage commercial ventures or trade. Captive breeding programmes should be carried out in parallel with field studies and conservation efforts aimed at the species in its natural environment.

Captive breeding of *Pteropus rodricensis*

The following account is based on information given by Carroll and Mace (1988).

Only one endangered fruit bat has been successfully bred in captivity as part of a scheme aimed towards its reintroduction into the wild. In 1974 the Rodrigues fruit bat (*Pteropus rodricensis*) was described as 'probably the rarest bat in the world' with an estimated wild population of 75-80. In 1976 the Jersey Wildlife Preservation Trust in co-operation with the Mauritian Government initiated a captive-breeding programme. Two captive breeding colonies were established, in Jersey (three males and seven females) and Mauritius (three males and five females). By 1991 the captive population had increased to about 250 at nine locations. At the end of 1990 the wild population was estimated to be greater than 1000 individuals (J. B. Carroll,



Pteropus rodricensis (Photo by T. H. Kunz)

pers. comm.). A cyclone hit the island in February 1991 and a count in the summer of 1991 indicated the wild population had suffered a serious decline to around 350 individuals (J. B. Carroll, pers. comm.). The captive population remains an important safeguard against the threat of extinction and provides a reservoir of genetic variability.

Breeding biology

Almost all fruit bats of the genus *Pteropus* live in colonies and are highly gregarious. In the Rodrigues fruit bat, social aggregations consist either of harem groups with one male associating with up to eight females, or as mixed-sex sub-adult groups of up to 15 animals. Within the colony there may also be lone individuals, usually males but sometimes females. These groupings occur only in the inactive daytime phase. At night, in captivity at least, new groupings are formed for feeding. Thus one male may associate with several different females throughout a 24-hour period. Observations in captivity suggest harem groups disperse into smaller subgroups, which may share feeding sites with animals not tolerated in their roosting areas.

In captivity harem females defend their roosting areas with vigilance. Harem males and other adult males hold feeding territories and with them access to feeding stations. It is difficult for a sub-adult male or sub-dominant male to encroach on the territory of a dominant male, but non-group females are tolerated by males within roosting and feeding areas. This behaviour has several repercussions:

- firstly, it reduces the potential for the manipulation of the social groups; small subgroups could be formed with only one male, but the effects of this on fecundity and infant-rearing is unknown.
- secondly, without the application of sophisticated molecular methods, or maintaining single male breeding groups the paternity of the offspring cannot be known. The species is promiscuous and a female may copulate with more than one male within a few minutes. For most captive-bred animals, therefore, only the mother is known.
- thirdly, particularly pertaining to the Jersey colony, marking of individuals did not begin until 1982, thus the parentage of many captive-bred animals is completely unknown.

The problems facing any captive management programme are clear:

- firstly, it is difficult to manipulate the population to ensure as many individuals as possible contribute their genes to the next generation.
- secondly, at best only the mother of any individual is known.

Development of the captive breeding programme

The original Jersey colony expanded without loss between 1976 and the end of 1980, but in following years an increasing number of neonatal and juvenile deaths occurred. In the last few

years these have been declining in frequency. An outbreak of enteritis in 1986 killed 13 animals, including three female founders and eight other adults. The Mauritius colony had grown to 63 animals by March 1987. M. R. Brambell (pers. comm.) noted that infant mortality was reduced when the number of feeding bowls was increased allowing females access to bowls that had hitherto been defended by males.

At the beginning of 1982 the increasing frequency with which mothers rejected their young and the increasing incidence of juvenile mortality led to the suggestion that density dependent factors might be operating and the colony was divided. A subgroup of 17 animals was founded, which included one wild-caught male and two wild-caught females, which, it appeared, had not bred in the main group. The first satellite colony of captive-bred bats was set up at Chester Zoo in 1983 with six males and four females captive-bred at Jersey. By 1988, this colony had increased to 20 individuals with five breeding females.

Two further colonies were established in 1987, one at Bronx Zoo, New York, and one at Brookfield Zoo, Chicago, using captive-bred animals from both Mauritius and Jersey. To guard against inbreeding in the first generation, males from Jersey were mixed with females from Mauritius and vice versa. There are, however, still only two colonies containing some wild-caught stock. By 1991 further colonies had been established at Paignton Zoo and London Zoo in England, and Folsome Childrens Zoo in Nebraska and the Lube Foundation, both in the United States.

The management programme detailed below is based on information from Jersey, the longest established and most successful breeding colony.

Growth rate of the population

A detailed demographic analysis is not possible, but regular censuses and detailed observations make it possible to assess demographic and genetic status. Since 1976 there have been 149 births, 82 deaths and 25 individuals moved to new locations. The population has continued to increase its size. By estimating 'r', the intrinsic rate of increase, an estimate of how rapidly the population might be expected to grow can be made. In 10 years time, the population could be expected to have grown to between 313 and 368 individuals, this rising to between 1665 and 2293 individuals after 20 years. These figures are probably overestimates because the method of calculation is somewhat crude and because the effects of density will eventually come into play and new colonies will have to be established. There is also a great variation in 'r' and a few years of high or low values could have significant effects on the population. Nevertheless, it does appear that the population is growing rapidly.

Genetic status of the population

In general terms, the rate of loss of genetic variation from a population depends on the population size and on the number of generations over which the population is maintained. Estimates

are, however, based on ideal populations, which do not share the characteristics of real populations either in their structure or in the way in which breeding is distributed among individuals or between the sexes. By estimating the effective population size, or the size of an ideal population that is equivalent to the actual population, it is possible to estimate rates of loss of genetic variation.

The population could be managed either as a single unit or could be sub-divided into a series of distinct sub-populations between which some movement is allowed. Management as a single randomly breeding population is unrealistic and probably not desirable as it would increase the risks of extinction through disease or some other calamity. There would also be no other controls on the distribution of genes within the population. It is suggested that four sub-populations be established. Each would be managed independently. Each sub-population should contain 75-100 individuals divided into colonies of 25-40. Between these colonies there should be regular interchange of individuals to minimize inbreeding and genetic drift. To maintain the genetic advantages of subdivision, movement of one individual per generation into each subpopulation should be the maximum and probably one individual over all subpopulations would be more appropriate. It would seem appropriate that the animals moved be females because their reproductive performance is the most easily monitored.

Conclusions

The above management plan is close to being a reality. Currently there are three sub-populations established; one in Britain (with four existing colonies), one in the USA (with four colonies) and one in Mauritius (which has already been subdivided and may be further subdivided in the future).

The breeding programme for the Rodrigues fruit bat has been successful and the management programme outlined above should ensure its continued success.

Introduction, reintroduction, and restocking

The Chiroptera Specialist Group fully supports the IUCN Position Statement on the Translocation of Living Organisms as approved by the 22nd Meeting of the IUCN Council on 4th September 1987. This concerns introduction, reintroduction and restocking. These are defined by IUCN as follows:

Introduction

The intentional or accidental dispersal by human agency of a living organism outside its historically known native range.

Reintroduction

The intentional movement of an organism into a part of its native range from which it has disappeared or become extirpated

in historic times as a result of human activities or natural catastrophe.

Restocking

The movement of numbers of plants or animals with the intention of building up the number of individuals of that species in an original habitat.

As stressed by IUCN, these are very powerful tools which, properly used, are effective (e.g. as with the Arabian Oryx *Oryx leucoryx*), but, like other powerful tools, they have the potential to cause enormous damage if misused.

Introductions

In the past, the introduction of non-native species to areas where they did not formerly exist has been directly harmful to native species. Islands are especially vulnerable to introductions because their often simple ecosystems offer refugia for species that are not aggressive competitors. As a result of their isolation, islands often have high levels of endemism, as clearly shown by pteropodids. Thus, any suggested introduction of these bats needs to be carefully planned and the following stages are recommended:

- an assessment phase culminating in a decision on the desirability of the introduction;
- a pilot, controlled trial;
- the extensive introduction phase with monitoring and follow-up.

The assessment phase

The assessment phase should take the following factors into account:

- No species should be considered for introduction to a new habitat until the factors that limit its distribution and abundance in its native range have been thoroughly studied and understood by competent ecologists and its probable dispersal pattern appraised.
- The impact on indigenous fauna and flora must be fully investigated.
- No introduction should be made for which a control does not exist or is not possible. A risk-and-threat analysis should be undertaken, including the availability of methods for the control of the introduction should it have unpredicted undesirable effects.
- When the above questions have been answered and the problems carefully considered, it should be decided whether the species can be reasonably expected to survive in its new habitat, and if so, can reasonably be expected to enhance the fauna and flora of the area, or the economic or aesthetic value of the area, and whether these benefits outweigh the possible disadvantages revealed by the investigators.

The pilot controlled trial

The following guidelines should be observed:

- test animals should be from the same stock as those intended to be extensively introduced, but should be a non-breeding group (e.g., all of the same sex).
- they should be free from diseases and parasites communicable to native species or to man and his livestock.
- the performance of introduced species with respect to the factors considered in 'the Assessment Phase' should be compared with the pre-trial assessment, and the suitability of the species for introduction should be reviewed in light of the comparison.

The extensive introduction

If the introduced species behaves as predicted under the trial conditions, then extensive introductions should commence but must be closely monitored.

The results of all phases of the introduction operation should be made public and available to scientists.

Reintroductions

Reintroductions should take place only when the original causes of extinction have been removed and should also occur only where the habitat requirements of the species are satisfied. There should be no reintroduction if a species became extinct because of habitat change that remains unremedied, or where significant habitat deterioration has occurred since the extinction. The species should be reintroduced only if measures have been taken to restore the habitat to a state suitable for the species.

The basic programme for reintroduction should consist of:

- a feasibility study;
- a preparation phase;
- release or introduction phase;
- follow-up phase.

The feasibility study

An ecological study should assess the previous relationship of the species to the habitat, and the extent to which the habitat has changed since the species's extinction in that habitat. Possible changes in the ability of captive-bred animals to re-adapt to their traditional habitat must be considered.

The attitude of local people must be taken into account, particularly if the animals were previously persecuted, and if necessary, education programmes should be established.

The animals involved in the reintroduction must preferably be the same race as that previously occurring in the area or the closest available race or type to the original stock.

Before commencing a re-introduction project, sufficient funds must be available to ensure the project can be completed, including the follow-up phase.

The preparation and release or introductory phases

Successful reintroduction requires that the biological needs of an animal can be fulfilled in the area where release is planned. This requires a detailed knowledge of both the needs of the animal and the ecological dynamics of the area of introduction. The best scientific advice available should be taken at all stages of a species reintroduction.

Follow-up phase

Monitoring of released animals must be an integral part of any programme. There should be long-term research to determine the rate of adaptation and dispersal, the need for further releases, and identification of the reasons for success or failure of the programme. The species's impact on the habitat should be monitored and any action needed to improve conditions identified and taken. Efforts should be made to make available information on both successful and unsuccessful reintroduction programmes.

Restocking

This may be a useful tool where:

- it is feared that a small, reduced population is becoming dangerously inbred; or
- where a population has dropped below critical levels and recovery by natural growth will be dangerously slow; or
- where artificial exchange and artificially high rates of immigration are required to maintain outbreeding between small isolated populations on islands.

In such cases care should be taken to ensure that the apparent non-viability of the population results from the genetic constitution of the population and not from poor species management. With good management the need for restocking should be avoidable, but where restocking is contemplated the following points should be observed:

- Restocking to conserve a dangerously reduced population should only be attempted when the causes of the reduction have been largely removed and natural increase can be excluded.
- Before deciding on restocking, the capacity of the area it is proposed to restock should be investigated to assess whether the level of population desired is sustainable. If it is, further work should be undertaken to discover the reasons for the existing low population levels. Action should then be taken to help the resident population expand to the desired level. Only if this fails should restocking be used.

Where there are compelling reasons for restocking the following points should be observed:

- attention should be paid to the genetic constitution of stocks used for restocking. In general, genetic manipulation of wild stocks should be kept to a minimum, and genetically impoverished or cloned stocks should not be used for restocking;
- the animals used for restocking must be of the same race as those in the population into which they are to be released;
- with widely distributed species, only individuals from similar ecological or climatic zones should be used for restocking;
- where stock is introduced from zoos, the breeding history and origin of the animals must be known, and care should be taken to avoid introducing new diseases into populations.

All forms of translocation of animals must be done within the framework of existing national and international legislation, and preferably should be subject to a permit system.

Chapter 8. Twenty High Priority Projects

The 20 projects listed below are of the highest priority for the conservation of fruit bats. They are not listed in any particular order and exclusion of a project from the list does not imply that it is not of high priority. The list is intended to provide a selection of projects that would produce positive identifiable results.

1. Survey of Taiwan, and islands off Japan

A survey to assess the status of bats should be conducted in Taiwan and islands off Japan (Ryukyu Archipelago, Ogasawara-shato and Kazan-retto). Little is known about the status of *Pteropus dasymallus*, *P. mariannus loochoensis* and *P. pselaphon* in these areas, but it has been suggested that they are highly endangered. The project could be undertaken in collaboration with the University of the Ryukyus.

2. Survey of the Maldives

A survey to assess the status of *Pteropus hypomelanus maris* and *P. giganteus ariel* in the Maldives is needed in view of the control measures undertaken in the 1980s because of supposed fruit damage. The project could include an assessment of the degree of damage caused by fruit bats and also a review of methods of control. This would involve close liaison with the relevant authorities in the Maldives.

3. Survey of the Solomon Islands

A survey is needed to assess the status of bats in the Solomon Islands where two species of *Pteralopex* are believed to be highly endangered. There is a large number of other species about which little is known. The project could also identify the most suitable islands for designation as protected areas for bats and other endangered animals and plants.

4. Survey of Bougainville

A survey in Bougainville is needed to ascertain the status of one endangered *Pteralopex* and the threatened *Pteropus mahaganus* as well as other threatened species. The project should also identify potential sites for protected areas. While geographically part of the Solomon Islands, politically the island is part of Papua New Guinea. It would thus be easier to survey this island separately rather than incorporating it in project 3.

5. Survey of western Pacific Ocean islands

Surveys to assess the status of bats in Chuuk, Pohnpei, Belau and Kosrae are needed. There are five highly endangered species on these islands: *Pteropus insularis* and *P. phaeocephalus* on Chuuk; *P. molossinus* on Pohnpei; *P. mariannuspelewensis* on Belau; and *P. mariannus ualanus* on Kosrae. The hunting season should be curtailed and hunting quotas restricted in collaboration with local communities.

6. Survey of Negros and Panay

The islands of Negros and Panay in the Philippines need to be surveyed specifically to establish the status of the highly endangered *Nyctimene rabori*. The project could also assess the need and feasibility of a captive-breeding programme for this species.

7. Captive breeding of *Pteropus voeltzkowi*

A captive breeding programme is required for *Pteropus voeltzkowi* on Pemba. While evidence in late 1989 suggested the situation may not be as serious as thought earlier that year, this species is still highly endangered. The experience with *P. rodricensis* would provide a model.

8. Captive breeding of *Pteropus livingstonii*

A captive breeding programme should be established for *Pteropus livingstonii* in the Comoros. The known population size is very small and suitable habitat has all but disappeared. As with Project 7, experience with *P. rodricensis* would provide a model.

9. Introduction of *Pteropus rodricensis*

Pteropus rodricensis should be introduced on to a suitable island in the Indian Ocean. It is vital to demonstrate the feasibility of taking bats from the wild, breeding them in captivity and introducing them to the wild to establish a self-sustaining population.

10. Key to bats in trade

An identification key to bats in trade is needed urgently to help Customs officials to make correct identifications and thus enforce the regulations relating to trade in bats and to monitor trade. The key should be easily understood by Customs officers, who are not necessarily trained biologists.

11. Permanent enforcement officer on Guam

The CITES regulations that came into effect in 1990 require effective implementation. The position of enforcement officer on Guam should be made permanent.

12. Drafting of new local laws

Apart from the enforcement of international regulations, local wildlife regulations are needed to give adequate protection to endangered bats on Belau, Pohnpei, Chuuk and Kosrae. In addition populations need to be monitored.

13. Gazetting and designation of protected areas

Gazetting and designation of protected areas would ensure the survival of the endangered *Pteropus mariannus mariannus* in Guam and the Commonwealth of the Northern Mariana Islands and may prevent the extinction of *Pteropus livingstonii* on the Comoros. In the CNMI these actions should be accompanied by controls on hunting.

14. Protection of roosts of *Acerodon jubatus*

The roosts of the highly endangered *Acerodon jubatus* in the Philippines need effective protection. This would require liaison with conservation organizations and government authorities coupled with wide-ranging educational programmes.

15. Control of hunting in Samoa

Effective controls to limit hunting in Samoa would ensure the survival of the highly endangered *Pteropus samoensis samoensis*. While the effects of commercial harvest may be reduced as a result of the new CITES regulations, local harvesting still poses a serious threat. Educational programmes are needed to try to limit such hunting. Legislation to ban the use of firearms may also be required.

16. Protected areas within sites of high bat biodiversity

Protected areas should be gazetted and designated in the ten highest ranking sites for biodiversity: Sulawesi, Angola, east Irian Jaya, south-west Borneo, Choiseul, peninsular Thailand, New Ireland, Negros, Fiji, and Tanzania.

17. Investigation of bat survey techniques

Further investigations of bat survey techniques are required in order to establish standardized techniques that could be used in a variety of habitats by both amateurs and professionals. The review should cover techniques that have already been used as well as examine other potential methods.

18. Review of interaction between bats and commercial fruit growers

An assessment of the economic impact of bats on fruit orchards is required as well as a review of control techniques in order to devise effective, non-destructive control methods. The project could be based in an area where fruit damage is considered a serious problem, such as Israel, Australia, South Africa or the Maldives. It should be carried out in co-operation with fruit growers.

19. Sustainable harvesting of bats

As yet there is little or no information on whether there is a level of harvest that would have no long-term impact on populations of fruit bats. A project to investigate how a sustainable harvest might be calculated would be vital in areas where hunting is a major source of mortality. The IUCN has made an initial attempt to draft a policy statement on criteria and requirements for the sustainable use of wild species.

20. Role of bats as 'keystone species'

More work on the role of bats as 'keystone' species in tropical forests is required. This role has been suggested on islands in the Pacific, and information is also required on the applicability of such a concept in mainland forests.

Addendum

Since the manuscript was completed the following new information has been received.

Genus *Cynopterus*

Kitchener and Maharadatunkamsi (1991) revised the taxonomy of *Cynopterus* and described a new species *Cynopterus nusatenggara* whose distribution is Adonara, Flores, Komodo, Lembate, Lombok, Moyo, Sumba and Sumbawa. The type locality is Desa Belo, Jerewah, west Sumbawa (8°52'S, 116°50'E). It was mist-netted from the boundary between tall, mixed evergreen rainforest and ricefields at an altitude of around 40 m. It is common in both rainforest and disturbed situations such as native gardens. Females are pregnant with a single foetus in September and October, just before the monsoon rains. It is suggested the species is seasonally polyoestrous. It eats pollen and substantial amounts of plant epidermis. *C. luzoniensis* (Peters), formerly considered a synonym of *C. brachyotis brachyotis* (Muller), is elevated to a full species. *C. minutus* Miller, formerly considered a subspecies of *C. brachyotis*, is also elevated to a full species. The authors also question the validity of the remaining subspecies of *C. brachyotis* and *sphinx*.

Genus *Epomophorus*

Claessen and de Vree (1990a) revised the taxonomy of *Epomophorus gambianus*. They considered *Epomophorus crypturus*, formerly a subspecies of *E. gambianus*, a full species. *Epomophorus pousarguesi*, here regarded as a subspecies of *E. gambianus*, is considered a synonym of *E. gambianus gambianus*. They also listed a new distribution record for *Epomophorus wahlbergi* from Sudan.

Claessen and de Vree (1990b) revised the taxonomy of the *E. anurus-labiatus-minor* complex. They described a new species *Epomophorus minimus*, from Ethiopia, Kenya, Somalia, Tanzania and Uganda. The type locality is Shewa Province, Ethiopia. *Epomophorus minor* is now considered a synonym of *Epomophorus labiatus* whose distribution is Burundi, Chad, Congo, Ethiopia, Kenya, Malawi, Nigeria, Rwanda, Sudan, Tanzania, Uganda, Zaire and Zambia. *Epomophorus anurus* continues to be recognised as a synonym of *E. labiatus*. *E. minutus* is not thought to be threatened (D. Kock, pers. comm.) and would be given a priority grading of 11.

Genus *Macroglossus*

Macroglossus sobrinus sobrinus has been recorded from Darjeeling and the state of Arunachal Pradesh, both in north-east India (S. Mistry, pers. comm.).

Genus *Nyctimene*

Peterson (1991) revised the taxonomy of *Nyctimene cyclotis*. He

recognized two species *N. cyclotis* and *N. certans*. The latter had formerly been considered a subspecies of *N. cyclotis*.

Genus *Pteralopex*

Flannery (1991) described a new species *Pteralopex pulchra* recorded only from Guadalcanal in the Solomon Islands. The type locality is Makarakomburu (9°44'S 160°01'E). The only known specimen was a lactating female caught in May 1990 in forest at 1230 m elevation. The forest where the animal was captured was low (a canopy height of about 4 m) with emergent *Metrosideros collina* (Myrtaceae) reaching 10 to 15 m. The *Metrosideros* was flowering at the time of the visit. The forest was very mossy, with abundant tree ferns. Prior to the capture an animal presumed to be *P. pulchra* was seen hanging in an *M. collina* tree. Despite extensive mist-netting and spotlighting, *P. pulchra* was not found below 1200 m. Flannery (1991) postulated that the species does not occur below this altitude and replaces *P. atrata* altitudinally above around 1200 m on the island. At present, the species must be considered endangered with a limited distribution and thus would be given a priority grade of 1.

Genus *Pteropus*

In 1992 an expedition from Bristol University visited the Comoros for the purposes of studying the ecology of *Pteropus livingstonii* and obtaining a number of individuals for a captive breeding programme based at the Jersey Wildlife Preservation Trust. They estimated a total population of around 150 with four roosts on Anjouan and 30-35 bats on Moheli. Six animals were captured and transferred to Jersey (J. B. Carroll, pers. comm.).

The proceedings of the Pacific Island Flying Fox Conference held in Hawaii in February 1990 have been published by the US Fish and Wildlife Service (Wilson and Graham, 1992). Twenty-five papers present information on flying fox biology and ecology, threats, status, policies and protection and future educational and conservation needs.

Survey techniques

A new publication on bird census techniques has been produced by the Royal Society for the Protection of Birds and the British Trust for Ornithology (Bibby *et al.*, 1992). Some of these techniques may be relevant for bat surveys.

General information

The publication date of Gray (1870) has been revised to 1871 in accordance with Sherborn (1934). This change is followed by Corbet and Hill (1992) which includes guides to identification, a revised classification, nomenclatural lists and a comprehensive bibliography.

References

- Ackery, P.R., and R.I. Vane-Wright, 1984. *Milkweed butterflies*. British Museum (Natural History), London.
- Adam, J.-P., and F. le Pont, 1974. Les chiroptères cavernicoles de la république populaire du Congo. Notes bioécologiques et parasitologiques. *Annls Spéleol.* **29(1)**: 143-154.
- Alcala, A.C., 1976. *Philippine land vertebrates*. New Day Publishers, Quezon City, Philippines.
- Allen, G.M., 1939. *Bats*. (Reprint ed. 1962) Dover, New York.
- Allen, G.M., and A. Loveridge, 1927. Mammals from the Uluguru and Usambara Mountains, Tanganyika Territory. *Proc. Boston Soc. not. Hist.* **38(9)**: 413-441.
- Amerson, A.B., Jr., W.A. Whistler, and T.D. Schwaner, 1982. *Wildlife and wildlife habitat of American Samoa, II. Accounts of flora and fauna*. US Fish and Wildlife Service, Washington, DC.
- Anciaux de Faveaux, M., 1972. *Répartition biogéographique et cycles annuels des chiroptères d'Afrique Centrale, I, II*. Unpublished PhD thesis, University of Paris.
- Anciaux de Faveaux, M., 1978. Définition de l'Équateur biologique en fonction de la reproduction de Chiroptères d'Afrique Centrale. *Annls Soc. r. zool. Belg.* **107(1-2)**: 79-89.
- Andersen, K., 1908. Twenty new forms of *Pteropus*. *Ann. Mag. nat. Hist.* **(8) 2**: 361-370.
- Andersen, K., 1912. *Catalogue of the Chiroptera in the collections of the British Museum, 2nd. edition. I. Megachiroptera*. British Museum (Natural History), London.
- Anderson, B.W., and R.D. Ohmart, 1981. Comparisons of avian census results using variable distance transect and variable circular plot techniques. In: *Estimating numbers of terrestrial birds* (eds. Ralph, C.J., and J.M. Scott), pp. 186-192. Studies in Avian Biology No. 6. Cooper Ornithological Society.
- Andrews, C.W., 1900. *A monograph of Christmas Island (Indian Ocean)*. British Museum (Natural History), London.
- Andrews, C.W., 1909. On the fauna of Christmas Island. *Proc. zool. Soc. Lond.* **1909**: 101-103.
- Anon., 1983. Aerial electric fence system thwarts flying fox problem. *Qld. Country Life* **14 April 1983**.
- Anon., 1988a. Ibises in the "Obó". *WldBirdwatch* **10(3-4)**: 5.
- Anon., 1988b. In praise of fried fruit bat. *Pacif. Isl. Monthly* **February 1988**.
- Anon., 1988c. Memorable meals and magic moments. *Pacif. Panor. Winter, 1988*: 21-24.
- Ansell, W.F.H., 1960. Some fruit bats from Northern Rhodesia, with the description of a new race of *Epomophorus gambianus* Ogilby. *Revue Zool. Bot. afr.* **61**: 160-166.
- Ansell, W.F.H., 1974. Some mammals from Zambia and adjacent countries. *Puku, Suppl.* **1**: 1-48.
- Armstrong, J.A., 1979. Biotic pollination mechanisms in the Australian flora: a review. *N.Z. Jl Bot.* **17**: 467-508.
- Ardell, S.A., 1964. *Patterns of mammalian reproduction*. Cornell University Press, Ithaca.
- Ash, J., 1987. Demography, dispersal and production of *Pandanus tectorius* (Pandanaeaceae) in Fiji. *Aust. J. Bot.* **35**: 313-330.
- Aston, H.I., 1987. Influx of the grey-headed flying fox (*Pteropus poliocephalus*) (Chiroptera: Pteropodidae) in the Melbourne area, Victoria, in 1986. *Victoria Nat.* **104**: 9-13.
- Ayensu, E.S., 1974. Plant and bat interactions in West Africa. *Ann. Mo. bot. Gdn.* **61**: 702-727.
- Baker, H.G., 1951. The avifauna of Micronesia, its origin, evolution, and distribution. *Univ. Kans. PublsMus. nat. Hist.* **3**: 1-359.
- Baker, H.G., and B.J. Harris, 1957. The pollination of *Parkia* by bats and its attendant evolutionary problems. *Evolution* **11**: 449-460.
- Baker, H.G., and B.J. Harris, 1959. Bat-pollination of the silk-cotton tree, *Ceiba pentandra* (L.) Gaertn. (*Sensu lato*) in Ghana. *Jl W. Afr. Sci. Ass.* **5**: 1-9.
- Baker, J.R., and Z. Baker, 1936. The seasons in a tropical rain-forest (New Hebrides). Part 3. Fruit-bats (Pteropidae). *J. Linn. Soc., Zool.* **40**: 123-141.
- Baker, R.H., 1948. Comments on conservation problems in Micronesia. In: *Conservation in Micronesia* (ed. H.J. Coolidge), pp. 53-55. National Research Council, Washington, DC.
- Baker, R.J., M.J. Novacek, and N.B. Simmons, 1991. On the monophyly of bats. *Syst. Zool.* **40(2)**: 216-231.
- Balfour, J.B., 1879. [The collections from Rodrigues] Botany. *Phil. Trans. R. Soc.* **168**: 302-387.
- Baranga, J., 1978. Splenic weights and their possible relationships to adreno-cortical function in a wild population of *Rousettus aegyptiacus* E. Geoffroy. *E. Afr. Wildl. J.* **16(1)**: 49-58.
- Baranga, J., 1980. The adrenal weight changes of a tropical fruit bat, *Rousettus aegyptiacus* E. Geoffroy. *Z. Säugetierk.* **45(6)**: 321-336.
- Baranga, J. and B. Kiregyera, 1982. Estimation of fruit bat population in the Kampala bat valley, Uganda. *Afr. J. Ecol.* **20**: 223-229.
- Bartholomew, G.A., W.R. Dawson, and R.C. Lasiewski, 1970. Thermoregulation and heterothermy in some of the smaller flying foxes (Megachiroptera) of New Guinea. *Z. vergl. Physiol.* **70**: 196-209.
- Bate, D., 1903. The mammals of Cyprus. *Proc. zool. Soc. Lond.* **1903 (ii)**: 341-348.
- Beck, A.J., and B.L. Lim, 1973. Reproductive biology of *Eonycteris spelaea*, Dobson (Megachiroptera) in West Malaysia. *Acta Trop.* **30**: 251-260.
- Bergmans, W., 1975a. On the differences between sympatric *Epomops franqueti* (Tomes, 1860) and *Epomops buettikoferi* (Matschie, 1899), with additional notes on the latter species (Mammalia, Megachiroptera). *Beaufortia* **23(304)**: 141-152.
- Bergmans, W., 1975b. A new species of *Dobsonia* Palmer 1898 (Mammalia: Megachiroptera) from Waigeo, with notes on other members of the genus. *Beaufortia* **23(295)**: 1-13.
- Bergmans, W., 1977. Notes on new material of *Rousettus madagascariensis* Grandidier, 1929 (Mammalia, Megachiroptera). *Mammalia* **41(1)**: 67-74.
- Bergmans, W., 1978a. Rediscovery of *Epomophorus pousarguesi* Trouessart, 1904 in the Central African Empire (Mammalia, Megachiroptera). *J. nat. Hist.* **12(6)**: 681-687.
- Bergmans, W., 1978b. Review of drinking behaviour of African fruit bats (Mammalia: Megachiroptera). *Bull. Carnegie Mus. nat. Hist.* **6**: 20-25.
- Bergmans, W., 1978c. On *Dobsonia* Palmer 1898 from the Lesser Sunda Islands (Mammalia: Megachiroptera). *Senckenberg. biol.* **59(1/2)**: 1-18.
- Bergmans, W., 1979. Taxonomy and zoogeography of the fruit bats of the People's Republic of Congo, with notes on their reproductive

- biology (Mammalia, Megachiroptera). *Bijdr. Dierk.* **48(2)**: 161-186.
- Bergmans, W., 1980. A new fruit bat of the genus *Myonycteris* Matschie, 1899, from eastern Kenya and Tanzania. *Zool. Meded. Leiden* **55**: 171-181.
- Bergmans, W., 1988. Taxonomy and biogeography of African fruit bats (Mammalia, Megachiroptera). 1. General introduction; material and methods; results: the genus *Epomophorus* Bennett, 1836. *Beaufortia* **38(5)**: 75-146.
- Bergmans, W., 1989. Taxonomy and biogeography of African fruit bats (Mammalia, Megachiroptera). 2. The genera *Micropteropus* Matschie, 1899, *Epomops* Gray, 1870, *Hypsignathus* H. Allen, 1861, *Nanonycteris* Matschie, 1899, and *Plerotes* Andersen, 1910. *Beaufortia* **39(4)**: 89-153.
- Bergmans, W., 1990. Taxonomy and biogeography of African fruit bats (Mammalia, Megachiroptera). 3. The genera *Scotonycteris* Matschie, 1894, *Casinycteris* Thomas, 1910, *Pteropus* Brisson, 1762, and *Eidolon*, Rafinesque, 1815. *Beaufortia* **40(7)**: 111-177.
- Bergmans, W., and P.J.H. van Bree, 1972. The taxonomy of the African bat *Megaloglossus woermanni* Pagenstecher, 1885 (Megachiroptera, Macroglorinae). *Biologia gabon.* **3-4**: 291-299.
- Bergmans, W., and F.G. Rozendaal, 1988. Notes on collections of fruit bats from Sulawesi and some off-lying islands (Mammalia, Megachiroptera). *Zool. Verh. Leiden* **248**: 5-74.
- Bhat, J.R., 1942. The mating of flying foxes (*Pteropus giganteus*). *J. Bombay nat. Hist. Soc.* **43**: 514-516.
- Bhat, H.R., M.A. Sreenivasan, and P.G. Jacob, 1980. Breeding cycle of *Eonycteris spelaea* (Dobson, 1871) (Chiroptera, Pteropidae, Macroglorinae) in India. *Mammalia* **40**: 343-347.
- Bibby, C.J., B.N. Phillips, and A. J.E. Seddon, 1985. Birds of restocked conifer plantations in Wales. *J. appl. Ecol.* **22**: 619-633.
- Bibby, C.J., N.D. Burgess, and D.A. Hill, 1992. *Bird census techniques*. Published for the British Trust for Ornithology and the Royal Society for the Protection of Birds. Academic Press, London.
- Blanford, W.T., 1876. *Eastern Persia, an account of the journey of the Persian Boundary Commission 1870-71-72. II. The zoology and geology*. London.
- Booth, A.H., 1959. On the mammalian fauna of the Accra Plain. *Jl W. Afr. Sci. Ass.* **5(1)**: 26-36.
- Boulger, L.R., and J.S. Porterfield, 1958. Isolation of a virus from Nigerian fruit bats. *Trans. R. Soc. trop. Med. Hyg.* **52**: 421-424.
- Boye, P., B. Pott-Dorfer, K. Dorfer, and A. Demetropoulos, 1990. New records of bats (Chiroptera) from Cyprus and notes on their biology. *Myotis* **28**: 93-100.
- Bradbury, J.W., 1977. Lek mating behaviour in the hammer-headed bat. *Z. Tierpsychol.* **45**: 225-255.
- Bradbury, J.W., 1981. The evolution of lek. In: *Natural selection and social behaviour* (eds. R.D. Alexander, and D.W. Tinkle), pp. 138-169. Chiron Press, New York.
- Brass, L.J., 1956. Results of the Archbold Expeditions No. 75. Summary of the Fourth Archbold Expedition to New Guinea (1953). *Bull. Am. Mus. nat. Hist.* **111**: 80-152.
- Brass, L.J., 1964. Results of the Archbold Expeditions No. 86. Summary of the Sixth Archbold Expedition to New Guinea (1959). *Bull. Am. Mus. nat. Hist.* **127**: 147-215.
- Bräutigam, A., 1988. Flying foxes in danger. *Species* **11**: 11-12.
- Bräutigam, A., 1989 (ed). *Analyses of proposals to amend the CITES appendices*. Submitted to the Seventh Meeting of the Conference of the Parties, Lausanne (Switzerland), 9-20 October 1989.
- Bräutigam, A., and T. Elmquist, 1990. Conserving Pacific island flying foxes. *Oryx* **24**: 81-89.
- Brosset, A., 1966a. *La biologie des chiropteres*. Masson & Cie., Paris.
- Brosset, A., 1966b. Les chiropteres du Haut-Ivindo (Gabon). *Biologia gabon.* **2(1)**: 47-86.
- Brownie, C., D.R. Anderson, K.P. Burnham, and D.S. Robson, 1978. *Statistical inference from band recovery data: A handbook*. US Fish and Wildlife Service Research Publication.
- Bruner, P.L., and H.D. Pratt, 1979. Notes on the status and natural history of Micronesian bats. *Elepaio* **40**: 1-4.
- Burg, S.P., 1962. The physiology of ethylene formation. *A. Rev. Pl. Physiol.* **13**: 265-302.
- Burg, S.P. and E.A. Burg, 1965. Ethylene action and the ripening of fruits. *Science N. Y.* **148**: 1190-1196.
- Calaby, J.H., 1966. Mammals of the Upper Richmond and Clarence Rivers, New South Wales. *Tech. Pap. Div. Wildl. Res. C.S.I.R.O. Aust.* **10**.
- Calford, M.B., and K.I. McAnally, 1987. Hearing in flying foxes (Chiroptera: Pteropodidae). *Aust. Mamm.* **10**: 97-100.
- Carroll, J.B., 1984. The conservation and wild status of the Rodrigues fruit bat (*Pteropus rodricensis*). *Myotis* **21-22**: 148-154.
- Carroll, J.B., 1985. The flying foxes (*Pteropus* spp.) of the western Indian Ocean islands (and a footnote on *Rousettus obliviosus*). *Bat News* **4**: 4-5.
- Carroll, J.B., and G.M. Mace, 1988. Population management of the Rodrigues fruit bat *Pteropus rodricensis* in captivity. *Int. Zoo Yb.* **27**: 70-78.
- Cassin, J., 1858. *Mammalogy and ornithology (U.S. Exploring Expedition, 1838-1842)*, Vol. 8. J.B. Lippincott & Co., Philadelphia.
- Chambers, M.R., and D. Esrom, 1988. *The flying foxes of Vanuatu, with notes on their cultural and social importance*. Report, Ministry of Lands, Vanuatu.
- Chambers, M.R., and D. Esrom, 1989. The flying foxes of Vanuatu with notes on their cultural and social importance. *Naika* **30**: 6-13.
- Chambers, M.R., and D. Esrom, 1991. The fruit bats of Vanuatu. *Bat News* **20**: 4-5.
- Cheke, A.S., and J.F. Dahl, 1981. The status of bats on western Indian Ocean Islands with special reference to *Pteropus*. *Mammalia* **45**: 205-238.
- Chen, J.T.F., 1984. *A synopsis of the vertebrates of Taiwan*. Vol 3. Revised and enlarged edition by M.J. Yu. Commercial Press, Taipei. (in Chinese).
- Claessen, C.J., and F. de Vree, 1990a. Systematic and distributional notes on the larger species of the genus *Epomophorus* Bennett, 1836 (Chiroptera: Pteropodidae). In: *Vertebrates in the tropics* (eds. Peters, G. and R. Hutterer), pp. 177-186. Proceedings of the International Symposium on Vertebrate Biogeography and Systematics in the Tropics, Bonn, June 5-8, 1989. Zoologisches Forschungsinstitut und Museum Alexander Koenig, Bonn.
- Claessen, C.J., and F. de Vree, 1990b. Systematic and taxonomic notes on the *Epomophorus anurus-labiatus-minor* complex with the description of a new species (Mammalia: Chiroptera: Pteropodidae). *Senckenberg. biol.* **71**: 209-238.
- Corbet, G.B., and J. Edwards Hill, 1991. *A world list of mammalian species*. 3rd edition. British Museum Publications and Oxford University Press.
- Corbet, G.B., and J.E. Hill, 1992. *Mammals of the Indo Malayan region - a systematic review*. British Museum Publications and Oxford University Press.
- Cook, J.A., 1979. The feeding ecology of the Seychelles fruit bat (*Pteropus seychellensis*). In: *Aberdeen University Expedition to*

- the Seychelles 1977. Report.* (ed. P.A. Racey), pp. 12-42. University of Aberdeen, Department of Zoology. Cyclostyled.
- Coultas, W.F., 1931. *Whitney South Seas Expedition journals, Vol. W. Journal and letters, Vol. II, of William F. Coultas, November, 1930 to December, 1931.* American Museum of Natural History, New York. Unpublished.
- Cox, P.A., 1983. Observations on the natural history of Samoan bats. *Mammalia* **47**: 519-523.
- Cox, P.A., 1984a. Chiropterophily and ornithophily in *Freycinetia* (Pandanaeae) in Samoa. *Pl. Syst. Evol.* **144**: 277-290.
- Cox, P.A., 1984b. Flying fox nearly extinct in Samoa. *Bats* **1(4)**: 1-2.
- Cox, P.A., 1987. [MS] The effects of Hurricane Tusi on rain forest vegetation in Ta'u, American Samoa.
- Cox, P.A., T. Elmquist, E.D. Pierson, and W.E. Rainey, 1991. Flying foxes as strong interactors in South Pacific island ecosystems: a conservation hypothesis. *Cons. Biol.* **5(4)**: 448-454.
- Cox, P.A., T. Elmquist, E.D. Pierson, and W.E. Rainey, 1992. Flying foxes as pollinators and seed dispersers in Pacific island ecosystems. In: *Pacific island flying foxes: proceedings of an international conservation conference.* (eds. D.E. Wilson and G.L. Graham), pp. 18-23. US Fish and Wildlife Service Biological Report 90(23). US Department of the Interior, Fish and Wildlife Service, Washington DC.
- Crampton, H.E., 1921. A journey to the Mariana Islands - Guam and Saipan. *J. Amer. Mus. nat. Hist.* **21**: 127-145.
- Craven, I., 1988. Finding solutions. *Bats* **6(1)**: 12-13.
- Crawford-Cabral, J., 1989. A list of Angolan Chiroptera with notes on their distribution. *Garcia de Orta, Zool.* **13(for 1986)(1-2)**: 748.
- Cunningham van Someren, G.R., 1972a. Pollination of *Kigelia* flowers by bats. *Bull. E. Afr. nat. Hist. Soc.* **January**: 9-72.
- Cunningham van Someren, G.R., 1972b. Some fruit bats eat leaves. *Bull. E. Afr. nat. Hist. Soc.* February: 24-25.
- Dahl, J.F., 1979a. Description and comparison of *Lemur* and *Pteropus* behavior patterns by application of spatial- sequential techniques. [Paper given at the Annual Meeting of the American Association of Physical Anthropologists, San Francisco, April 5-7, 1979]. *Am. J. phys. Anthropol.* **March, 1979** (Abstract).
- Dahl, J.F., 1979b. Behavior of the Comorian flying fox (*Pteropus seychellensis comorensis*) and an evaluation of the fossil bat *Archaeopteropus transiens*. [Paper given at the Meeting of the Animal Behavior Society, New Orleans, June, 1979.]
- Dammerman, K.W. 1948. Mammalia (Fauna of Krakatau). *Verh. K. ned. Akad. Wet.* **44(2)**: 314-325.
- Daschbach, N., 1990. After the hurricane. *Bats* **8(3)** 14-15.
- DeBlase, A.F., 1980. The bats of Iran: systematics, distribution, ecology. *Fieldiana Zool, N.S.* **4**: 1-424.
- DeFrees, S.L., and D.E. Wilson, 1988. *Eidolon helvum*. *Mammalian Spec.* **132**: 1-5.
- Degener, O., 1949. *Naturalist's South Pacific expedition: Fiji. Paradise of the Pacific Ltd., Honolulu, Hawaii.*
- DeSante, D.F., 1981. A field test of the variable circular-plot censusing technique in a California coastal scrub breeding community. In: *Estimating numbers of terrestrial birds* (eds. Ralph, C.J., and J.M. Scott), pp. 177-185. Studies in Avian Biology No. 6. Cooper Ornithological Society.
- Deville, A., 1977. *Projet de Programme pour le futur developpement forestier dans l'Archipel des Comores.* Rapport de Mission PNUD/FAO, July 1974.
- Diamond, J.M., 1988. Red books or green lists? *Nature, Lond.* **332**: 304-305.
- Dillon, R.S., 1960. Behaviour of flying foxes in coastal New Guinea. *J. Mammal.* **41**: 264-265.
- Dobat, K., and T. Peikert-Holle, 1985. *Blüten und Fledermäuse.* Waldemar Kramer, Frankfurt and Main.
- Dobson, G.E., 1878. *Catalogue of the Chiroptera in the Collection of the British Museum.* British Museum (Natural History), London.
- Dolbeer, R.R., 1987. *Vertebrate pest management in the Maldives* FAO Unpublished Final Report No. 1, TCP/MDV/4506T, Rome.
- Dolbeer, R.R., L.R. Fielder, and H. Rasheed, 1988. Management of fruit bat and rat populations in the Maldive Islands, Indian Ocean. In: *Proceedings of the Thirteenth Vertebrate Pest Conference.* (eds. A.C. Crabb and R.E. Marsh), pp. 112-118. University of California, Davis.
- Dwyer, P.D., 1975. Notes on *Dobsonia moluccensis* (Chiroptera) in the New Guinea highlands. *Mammalia* **39**: 113-118.
- Eby, P., in press. Seasonal movements of grey-headed flying-foxes (Chiroptera: Pteropodidae) from two maternity camps in northern New South Wales. *Aust. Wildl. Res.*
- Edwards, D.K., G.L. Dorsey, and J.A. Crawford, 1981. A comparison of three avian census methods. In: *Estimating numbers of terrestrial birds* (eds. Ralph, C.J., and J.M. Scott), pp. 170-176. Studies in Avian Biology No. 6. Cooper Ornithological Society.
- Eisentraut, M., 1941. Beitrag zur Ökologie Kameruner Chiropteren. *Mitt. zool. Mus. Berl.* **25**: 245-273.
- Eisentraut, M., 1960. Zur Kenntnis der westafrikanischen Flughundgattung *Scotonycteris*. *Bonn. zool. Beitr.* **10**: 298-309.
- Eisentraut, M., 1963. *Die Wirbeltiere des Kammerungebirges.* Paul Parey, Hamburg and Berlin.
- Eldredge, L.G., R.T. Tsuda, P. Moore, N. Chernin, and S. Neudecker, 1977. A natural history of Maug, northern Mariana Islands. *Univ. Guam Marine Lab. Tech. Rep.* **43**: 1-87.
- Elliot, D.G., 1896. On sundry collections of mammals. *Field Clumbian Mus. Zool.* **1**: 67-82.
- Elmqvist, T., P.A. Cox, W.E. Rainey, and E.D. Pierson, in press. Restricted pollination on oceanic islands: pollination of *Ceiba pentandra* by flying foxes in Samoa. *Biotropica*.
- Engbring, J., 1985. *A 1984 survey of the fruit bat (maga 'lau) on Yap.* US Fish and Wildlife Service, Honolulu, Hawaii. Unpublished report.
- Engbring, J., 1986. *A survey of the bats on Yap and Ulithi.* US Fish and Wildlife Service, Honolulu, Hawaii. Unpublished report.
- Engbring, J., 1989. [MS] Observations of fruit bats in Samoa, with emphasis of the status of the Samoan fruit bat (*Pteropus samoensis*). US Fish and Wildlife Service, Honolulu, Hawaii. Unpublished report.
- Faegri, K., and L. van der Pijl, 1979. *The principles of pollination ecology.* 3rd edition. Pergamon Press, Oxford.
- Falanruw, M.V.C., 1988a. On the status, reproductive biology and management of fruit bats on Yap. *Micronesica* **21**: 39-51.
- Falanruw, M.V.C., 1988b. Management of the fruit bats on Yap: past and future challenges. *Trans. West. Sec. Wildl. Soc.* **24**: 38-41.
- Fayenuwo, J.O., and L.B. Halstead, 1974. Breeding cycle of the straw- coloured fruit bat, *Eidolon helvum*, at Ife-Ife, Nigeria. *J. Mammal.* **55(2)**: 453-454.
- Fedden, M.O., and H.L. Macleod, 1986. Bat Research in western Cameroon. In: *Conservation of Cameroon montane forests* (ed. S.N. Stuart), pp. 175-195. International Council for Bird Preservation, Cambridge.
- Feiler, A., 1988. Die Säugetiere der Inseln im Golf von Guinea und ihre Beziehungen zur Säugetierfauna der westafrikanischen

- Festlandes (Mammalia). *Zool. Abh. st. Mus. Tierk., Dresden* **44(1)**: 83-88.
- Felten, H., and D. Kock, 1972. Weitere Flughunde der Gattung *Pteropus* von den Neuen Hebriden, sowie den Banks - und Torres-Inseln, Pazifischer Ozean. *Senckenberg. biol.* **53**: 179-188.
- Flannery, T.F., 1989. Flying foxes in Melanesia: populations at risk. *Bats* **7(4)**: 5-7.
- Flannery, T.F., 1990. *Mammals of New Guinea*. The Australian Museum. Robert Brown and Associates, Queensland, Australia.
- Flannery, T.F., 1991. A new species of *Pteralopex* (Chiroptera: Pteropodidae) from montane Guadalcanal, Solomon Islands. *Rec. Aust. Mus.* **43**: 123-129.
- Fleming, P.J.S., and D. Robinson, 1987. Flying foxes (Chiroptera: Pteropodidae) on the north coast of New South Wales: damage to stonefruit crops and control methods. *Aust. Mamm.* **10**: 143-147.
- Fleming, T.H., 1988. *The short-tailed fruit bat: a study in plant-animal interactions*. University of Chicago Press, Chicago.
- Fleming, T.H., R. Breitwisch, and G.H. Whitesides, 1987. Patterns of tropical frugivore diversity. *A. Rev. Ecol. Syst.* **18**: 91-109.
- Francis, C.M., 1989. Notes on fruit bats (Chiroptera, Pteropodidae) from Malaysia and Brunei, with the description of a new subspecies of *Megaerops wetmorei* Taylor, 1934. *Can. J. Zool.* **67**: 2878-2882.
- Friend, G.R., and R.W. Braithwaite, 1986. Bat fauna of Kakadu National Park, Northern Territory. *Aust. Mamm.* **9**: 43-52.
- Fryer, J.C.F., 1911. The Percy Sladen Trust Expedition to the Indian Ocean 1905 under the leadership of Mr. J. Stanley Gardiner, M. A. Vol. HI, no. XIX - The structure and formation of Aldabra and Neighbouring islands with notes on their fauna and flora. *Trans. Linn. Soc. Lond. (Zool.)* (2) **14**: 397-442.
- Fujita, M.S., 1988. Flying foxes and economics. *Bats* **6(1)**: 4-9.
- Fujita, M.S. and M.D. Turtle, 1991. Flying foxes (Chiroptera: Pteropodidae): threatened animals of key ecological and economic importance. *Cons. Biol.* **5(4)**: 455-463. A complete list of plant and bat species, observation locations, specific bat-plant interactions, plant products and uses and full references can be obtained from Bat Conservation International, PO Box 162603, Austin Tx 78716, USA.
- Funakoshi, K., 1989. Northernmost populations of the flying fox. *Shizen Aigo* **15**: 1-6. (in Japanese).
- Funakoshi, K., 1990. Chiropteran fauna of the Tokara Islands. *Shizen Aigo* **16**: 3-6. (in Japanese).
- Funmilayo, O., 1976. Diet and roosting damage and environmental pollution by the straw-coloured fruit bat in south-western Nigeria. *Niger. Fld* **41**: 136-142.
- Funmilayo, O., 1978. Fruit bats for meat: are too many taken? *Oryx* **14(4)**: 377-378.
- Funmilayo, O., 1979. Ecology of the straw-coloured fruit bat in Nigeria. *Rev. Zool. afr.* **93(3)**: 589-600.
- Gaisler, J., G. Madkour, and J. Pelikán, 1972. On the bats (Chiroptera) of Egypt. *Acta. Sc. nat. Brno* **6(8)**: 1-40.
- Gardner, A.L., 1977. Feeding habits. In: *Biology of bats of the New World Family Phyllostomidae* Vol. 2 (eds. R.J. Baker, J.K. Jones Jr., and D.C. Carter), pp. 293-350. Lubbock: Special Publications of the Museum, No. 13. Texas Tech. University.
- Gibson-Hill, C.A., 1947. Contributions to the natural history of Christmas Island. *Bull. Raffles Mus.* **18**.
- Gill, B.J., 1987. Notes on the birds, reptiles and mammals of Tongatapu and 'Eua (Tonga). *Notornis* **34**: 217-223.
- Girschner, M., 1912. Die Karolinen insel Namoluk und ihre Bewohner. *Baessler Archiv.* **2**: 123-215.
- Glass, P.O., J.D. Reichel, E.C. Villagomez, W. Taisacan, and D. Aldan, 1987. [MS]. Five year progress report, FY 1983-1987, Pitman-Robertson federal aid in wildlife restoration program. Commonwealth of the Northern Mariana Islands Division of Fish and Wildlife. Unpublished report.
- Goodwin, R.E., 1979. The bats of Timor: Systematics and Ecology. *Bull. Am. Mus. nat. Hist.* **163**: 75-122.
- Gopalakrishna, A., and P.N. Choudhari, 1977. Breeding habits and associated phenomena in some Indian bats. Part 1. *Rousettus leschenaulti* (Megachiroptera). *J. Bombay nat. Hist. Soc.* **74(1)**: 1-16.
- Gould, E., 1977. Foraging behaviour of *Pteropus vampyrus* on the flowers of *Durio zibethinus*. *Malay NatJ.* **30**: 53-57.
- Gould, E., 1978. Foraging behaviour of Malaysian nectar-feeding bats. *Biotropica* **10**: 184-193.
- Granvik, H., 1924. On mammals from the eastern slopes of Mount Elgon, Kenya Colony. Mammals collected by the Swedish Mount Elgon Expedition 1920. *Acta Univ. lund* **21(3)**: (1) 1-32.
- Gray, J.E., 1870. *Catalogue of monkeys, lemurs and fruit-eating bats in the collection of the British Museum*. British Museum, London.
- Green, A.A., 1983. Rodents and bats of Arli and Pendjar National Parks, Upper Volta and Benin. *Niger. Fld* **47**: 185-194.
- Greig-Smith, P.W., 1975. Notes on a collection of bats and their ectoparasites from the Sepik District, Papua New Guinea. *Sci. New Guin.* **3**: 117-122.
- Guerrero, L., and A.C. Alcalá, 1973. Food habits of Pteropid bats. *Philipp. Biota* **7**: 139-142.
- Hall, L.S., 1987. Identification, distribution and taxonomy of Australian flying-foxes (Chiroptera: Pteropodidae). *Aust. Mamm.* **10**: 75-79.
- Hall, L.S., and G.C. Richards, 1979. *Bats of Eastern Australia*. Queensland Museum booklet No. 12.
- Halstead, L.B., 1977. Fruit bats - an example of wildlife management. *Niger. Fld* **42(2)**: 50-56.
- Halstead, L.B., and A.O. Segun, 1975. *Dissection guides of common tropical animals, 3 Fruit bat (Eidolon helvum)*. Publication No 6. Ethiope Publishing House, Benin City.
- Happold, D.C.D., 1987. *The mammals of Nigeria*. Clarendon Press, Oxford.
- Happold, D.C.D., and M. Happold, 1978. The fruitbats of Western Nigeria. *Niger. Fld* **43(1)**: 30-37, **(2)**: 72-77, **(3)**: 121-127.
- Harris, B.J., and H.G. Baker, 1958. Pollination in *Kigelia africana* Benth. *Jl W. Afr. Sci. Ass.* **4**: 25-30.
- Harris, B.J., and H.G. Baker, 1959. The pollination of flowers by bats in Ghana. *Niger. Fld* **24**: 151-159.
- Harrison, D.L., 1964. *The mammals of Arabia. I. Introduction; Insectivora; Chiroptera; Primates*. Ernest Benn Ltd., London.
- Harrison, D.L., 1980. The mammals obtained in Dhofar by the 1977 Oman Flora and Fauna Survey. In: *The scientific results of the Oman Flora and Fauna Survey 1977 (Dhofar)*. (eds. S.N. Shaw Reade, J.B. Sale, M.D. Gallagher, and R.H. Daly), pp. 387-397. Journal of Oman Studies Special Report No. 2.
- Hasuo, Y., 1969. Animals of the Ogasawara Islands, with special interests in birds and mammals. In: *Survey report on the nature and landscape of the Ogasawara Islands* (eds. Tokyo Prefectural Government), pp. 111-138. (in Japanese).
- Hasuo, Y., 1970a. Animals of the Ogasawara Islands. In: *Survey report on the nature and landscape of the Ogasawara Islands*. (eds. Tokyo Prefectural Government) 2nd Version, pp. 192-213. (in Japanese).
- Hasuo, Y., 1970b. Terrestrial mammals. In: *Nature of Ogasawara*. (Hirokawa Shoten, Tokyo), pp. 143-153. (in Japanese).

- Hayman, R.W., 1946. A new *Scotoonycteris*, with notes on other Gold Coast bats. *Ann. Mag. nat. Hist.* (11) **12**: 766-775.
- Hayman, R.W., and J. Edwards Hill, 1971. Order Chiroptera. In: *The mammals of Africa, an identification manual, part 2*. (eds. J. Meester, and H.W. Setzer), pp. 1-73. Smithsonian Institution Press, Washington.
- Hayman, R.W., X. Misonne, and W. Verheyen, 1966. The bats of the Congo and of Rwanda and Burundi. *Anns. Mus. r. Afr. cent., Sci. zool.* **154**: 1-105.
- Heaney, L.R., 1986. Biogeography of the mammals of Southeast Asia: estimates of colonisation, extinction and speciation. *Biol. J. Linn. Soc.* **28**: 127-165.
- Heaney, L.R., and P.D. Heideman, 1987. Philippine fruit bats: Endangered and extinct. *Bats* **5** (1): 3-5.
- Heaney, L.R., P.D. Heideman, and K.M. Mudar, 1981. Ecological notes on mammals in the Lake Balinsasayao Region, Negros Oriental, Philippines. *Silliman J.* **28**: 122-131.
- Heaney, L.R., P.D. Heideman, E.R. Rickart, R.C.B. Uzzurum, and J.H.S. Klompen, 1989. Elevational zonation of mammals in the central Philippines. *J. trop. Ecol.* **5**: 259-280.
- Heideman, P.D., 1987. *The reproductive ecology of a community of Philippine fruit bats (Pteropodidae: Megachiroptera)*. Unpublished Ph.D. thesis, University of Michigan, Ann Arbor.
- Heideman, P.D., 1988. The timing of reproduction in *Haplonycteris fischeri* Lawrence (Pteropodidae): Geographic variation and delayed development. *J. Zool., Lond.* **215**: 577-595.
- Heideman, P.D., 1989. Delayed development in a paleotropical fruit bat, *Haplonycteris fischeri* (Pteropodidae). *J. Reprod. Fert.* **85**: 363-382.
- Heideman, P.D., and L.R. Heaney, 1989. Population biology and estimates of abundance of fruit bats (Pteropodidae) in Philippine submontane rainforest. *J. Zool., Lond.* **218**: 565-586.
- Heideman, P.D., L.R. Heaney, K.R. Erickson, and R.L. Thomas, 1987. Patterns of faunal diversity and species abundance of non-volant small mammals on Negros Island, Philippines. *J. Mammal.* **68**: 888-892.
- Heithaus, E.R., and T.H. Fleming, 1978. Foraging movements of a frugivorous bat, *Carollia perspicillata* (Phyllostomatidae). *Ecol. Monogr.* **48**: 127-143.
- Herbert, T., 1638. *Some yeares travels into Africa and Asia the Great*. 2nd edition. Blome and Bishop, London.
- Herselman, J.C., and P.M. Norton, 1985. The distribution and status of bats (Mammalia: Chiroptera) in the Cape Province. *Ann. Cape prov. Mus. (nat. Hist.)* **16**(4): 73-126.
- Herzig-Straschil, B., and G.A. Robinson, 1978. On the ecology of the fruit bat, *Rousettus aegyptiacus leachi* (A. Smith, 1829) in the Tsitsikama Coastal National Park. *Koedoe* **21**: 101-110.
- Hill, J. Edwards, 1983. Bats (Mammalia: Chiroptera) from Indo-Australia. *Bull. Br. Mus. nat. Hist. Zool.* **45**: 103-208.
- Hill, J. Edwards, in press. Bats (Mammalia: Chiroptera) from the Togian Islands, Sulawesi, Indonesia. *Bull. Am. Mus. nat. Hist.*
- Hill, J. Edwards, and W.N. Beckon, 1978. A new species of *Pteralopex* Thomas, 1888 (Chiroptera: Pteropodidae) from the Fiji Islands. *Bull. Br. Mus. nat. Hist. Zool.* **34**(20): 65-82.
- Hill, J. Edwards, and J.D. Smith, 1984. *Bats, a natural history*. British Museum (Natural History), London.
- Hill, J. Eric, and T.D. Carter, 1941. The mammals of Angola, Africa. *Bull. Am. Mus. nat. Hist.* **78**(1): 1-211.
- Honacki, J.H., K.E. Kinman, and J.W. Koepl (eds.), 1982. *Mammal species of the world: a taxonomic and geographic reference*. Allen Press and the Association of Systematics Collections, Lawrence, Kansas.
- Horikawa, Y., 1932. *A monograph on the mammals of Formosa*. Zoological Society of Formosa. (in Japanese).
- Holthius, L.B., 1963. Contributions to New Guinea carcinology. IV. Further data on the occurrence of *Birgus latro* (L.) in west New Guinea (Crustacea, Decapoda, Paraguridea). *Nova Guinea* **18**: 355-359.
- Hood, C.S., and J.D. Smith, 1989. Sperm storage in a tropical nectar-feeding bat, *Macroglossus minimus* (Pteropodidae). *J. Mammal.* **70**: 404-406.
- Huggel-Wolf, H., and M.L. Huggel-Wolf, 1965. La biologie d'*Eidolon helvum* (Kerr) (Megachiroptera). *Acta trop.* **22**(1): 1-10.
- Hutson, A.M., 1990. Tourism threatens Thailand bat cave. *Bat News* **18**: 5.
- Hutson, A.M., 1991. Is the Pemba flying fox in danger? *Bat News* **21**: 4-5.
- Hyde, R.L., J.C. Pernetta, and T. Senabe, 1984. Exploitation of wild animals. In: *The research report of the Simbu Land Use Project, Vol. 4. South Simbu: studies in demography, nutrition and subsistence*, pp. 291-380. I.A.S.E.R., Port Moresby.
- Hyndman, D., and D.D. Menzies, 1980. *Aproteles bulmerae* (Chiroptera: Pteropodidae) of New Guinea is not extinct. *J. Mammal.* **61**: 159-160.
- Iakopo, M., 1985. [MS]. Forestry development in Western Samoa: country presentation to second international seminar on forest management and administration. Forestry Division, Department of Agriculture, Apia, Western Samoa. Unpublished report.
- Dcehara, S., 1973. Terrestrial vertebrates of the Daito Islands. In: *Reports from the survey on the natural monuments of the Daito Islands*. (eds. Japan Agent of Culture), pp. 52-63. (in Japanese).
- Dcehara, S., T. Abe, M. Chinen, Y. Yonashiro, Y. Chigira, K. Higoshi, and K. Mitsui, 1981. Survey report on the present status of *Diplothrix legata*. In: *Survey report on the natural monuments of Okinawa Prefecture XXII*. (eds. Educational Committee of Okinawa Prefecture). Educational Committee of Okinawa Prefecture, Naha. (in Japanese).
- Dcehara, S., and M. Shimojana, 1975. *Terrestrial animals of Okinawa*. Fudokisha, Naha. (in Japanese).
- Dcehara, S., Y. Yonashiro, K. Miyagi, and M. Toyama, 1984. *Terrestrial vertebrates. Field guide to animals of Okinawa*. Ser. 1. Shinseitoshu, Naha. (in Japanese).
- Imaizumi, Y., 1970. *The handbook of Japanese land mammals. Vol. 1*. Shin-Shicho-Sha Co., Tokyo.
- Imboden, C., 1987. São Tomé and Príncipe birds increase. *Wld Birdwatch* **9**(4): 1-2.
- International Union for the Conservation of Nature and Natural Resources, 1990. *1990 IUCN Red List of threatened animals*. World Conservation Monitoring Centre, Cambridge.
- International Union for the Conservation of Nature and Natural Resources Environmental Law Centre, 1986. *African wildlife laws*. IUCN Environmental Policy and Law Occasional Paper No. 3. International Union for Conservation of Nature and Natural Resources, Switzerland.
- Ishii, N., 1983. Mammals of Minami-Iwojima Island. In: *Nature of Minami-Iwojima Island*. (eds. Nature Conservation Branch, Environmental Agency), pp. 225-242. (in Japanese, with English summary).
- Jacobsen, N.H.G., and E. Du Plessis, 1976. Observations on the ecology and biology of the Cape fruit bat *Rousettus aegyptiacus*

- leachi* in the Eastern Transvaal. *S. Afr. J. Sci.* **72**: 270-273.
- Jackson, W.B., 1962. Area of study. In: *Pacific island rat ecology*. (ed. T.I. Storer), pp. 14-20. B.P. Bishop Museum, Honolulu, Hawaii.
- Jaegar, P. 1954. Les aspects actuels du problème de Cheiroptèrogamie. *Bull. Inst. fond. Afr. noire ser. A* **16**: 796-821.
- Jamieson, G.I., 1988. Fruit losses from flying-foxes in Queensland. *Macroderma* **4**: 34-42.
- Jeffrey, S.M., 1975. Notes on mammals from the high forest of western Ghana (excluding Insectivora). *Bull. Inst. fond. Afr. noire, ser. A* **37(4)**: 950-973.
- Jenkins, J.M., 1983. The native forest birds of Guam. *Orn. Monogr.* **31**: 1-61.
- Jones, C., 1971. The bats of Rio Muni, West Africa. *J. Mammal.* **52(1)**: 121-140.
- Jones, C., 1972. Comparative ecology of the three pteropid bats in Rio Muni, West Africa. *J. Zool., Lond.* **167**: 353-370.
- Jones, C., 1980. *The conservation of the endemic birds and bats of Mauritius and Rodrigues (a progress report and proposal for future activities)*. International Council for Bird Preservation, Mauritius and Washington. Cyclicly typed.
- Kaisila, J., 1966. The Egyptian fruit bat, *Rousettus aegyptiacus* Geoffr. (Megachiroptera, Pteropodidae) visiting flowers of *Bombax malabaricum*. *Annl. zool. fenn.* **3(1)**: 1-3.
- Kano, T., 1934. Animals, plants and natives of the island of Botel Tobago. *Kagaku Chishiki* (Scientific Knowledge) **14(7)**: 815-819. (in Japanese).
- Khan, R., 1985. *Mammals of Bangladesh*. Nazma Reza, Dhaka.
- Kingdon, J., 1974. *East African mammals. An atlas of evolution in Africa. II, A (insectivores and bats)*. Academic Press, London and New York.
- Kirkpatrick, J. B., 1983. An iterative method for establishing priorities for the selection of nature reserves: an example from Tasmania. *Biol. Cons.* **25**: 127-134.
- Kishida, K., 1924. On the Formosan Chiroptera, *Zool. Mag. Tokyo* **36**: 30-49. (in Japanese).
- Kitchener, D.J., B. Boeadi, L. Charlton, and Maharadatunkamsi, 1990. *Wildmammals of Lombok Island: Nusa Tenggara, Indonesia: systematics and natural history*. Records of the Western Australian Museum, Supplement No. 33.
- Kitchener, D.J., and Maharadatunkamsi, 1991. Description of a new species of *Cynopterus* (Chiroptera: Pteropodidae) from Nusa Tenggara, Indonesia. *Rec. West Aust. Mus.* **15**: 307-363.
- Knowles, W.C., 1988. [MS]. The status of the wildlife and wildlife habitats in American Samoa. Report to the Department of Marine and Wildlife Resources, American Samoa.
- Kock, D., 1969. Eine neue Gattung und Art cynopteriner Flughunde von Mindanao, Philippinen (Mammalia, Chiroptera). *Senckenberg. biol.* **50**: 319-327.
- Kock, D., 1972. Fruit-bats and bat-flowers. *Bull. E. Afr. nat. Hist. Soc.* **1972**: 123-126.
- Koopman, K.F., 1979. Zoogeography of mammals from islands off the northeastern coast of New Guinea. *Am. Mus. Novit.* **2690**: 1-17.
- Koopman, K.F., 1982. Results of the Archbold Expeditions. No. 109. Bats from east Papua and the eastern Papuan islands. *Am. Mus. Novit.* **2747**: 1-34.
- Koopman, K.F., R.E. Mumford, and J.F. Heisterberg, 1978. Bat records from Upper Volta, West Africa. *Am. Mus. Novit.* **2643**: 1-6.
- Kress, J.W., 1985. Bat pollination of an Old World Heliconia. *Biotropica* **17**: 302-308.
- Kulzer, von E., 1969. African fruit eating cave bats. Part I. *Afr. Wild Life* **23**: 39-46; Part II. *Afr. Wild Life* **23**: 129-138.
- Kunisaki, T., and T. Kamishikirei, 1988. *Erabu flying fox on Kuchinerabujima, Kagoshima Prefecture*. Educational Committee of Kamiyaku-cho Town, Kagoshima Prefecture. (in Japanese).
- Kunz, T.H. (ed.), 1988. *Ecological and behavioral methods for the study of bats*. Smithsonian Institution Press, Washington DC.
- Kuroda, N., 1921. On three new mammals from Japan. *J. Mammal.* **2(4)**: 208-211.
- Kuroda, N., 1930. Mammals found in the Bonin Islands - Fauna of the Bonin Islands. *Bull. biogeogr. Soc. Japan* **1**: 13-19. (in Japanese).
- Kuroda, N., 1932. *A list of the Japanese mammals*. L.M. Zoological Society Japan, Tokyo.
- Kuroda, N., 1933. A revision of the genus *Pteropus* found in the islands of the Riu Kiu chain. *Jap. J. Mammal.* **14(4)**: 312-316.
- Kuroda, N., 1940. *A monograph of the Japanese mammals, exclusive of Sirenia and Cetacea*. Sanseido, Tokyo and Osaka.
- Lang, H., and J.P. Chapin, 1917. The American Museum Congo expedition collection of bats. III. Field notes. *Bull. Ant. Mus. nat. Hist.* **37(18)**: 497-563.
- La Nux, J.B. de, 1772. (Letter on *Rousettes* and *Rougettes*). Published, apparently with only a few minor excisions, on pp. 253-262 of Buffon, 1776 (q.v.).
- Lawrence, B.L., 1939. Collections from the Philippine Islands. *Mammals. Bull. Mus. comp. Zool. Harv.* **86**: 38-73
- Layard, T., 1829. Description of *Pteropus pselaphon*. In the zoology of Captain Beechey's Voyage to the Pacific and Behring's Straits, performed in H.M.S. Blossom under the command of Captain Beechey in the years 1825-1828. *Zool. J., Lond.* **4**: 457.
- Lekagul, B., and J.A. McNeely, 1977. *Mammals of Thailand*. Sahankarnbhat, Bangkok.
- Lemke, T.O., 1986. Marianas fruit bats near extinction. *Bats* **3(1)**: 1-2.
- Lewis, R.E., and D.L. Harrison, 1962. Notes on bats from the Republic of Lebanon. *Proc. zool. Soc. Lond.* **138(3)**: 473-486.
- Lim, B.L., 1966. Abundance and distribution of Malaysian bats in different ecological habitats. *Fedn Mus. J.* **9**: 61-76.
- Lim, B.L., 1973. Breeding pattern, food habits and parasitic infestation of bats in Gunong Brinchang. *Malay. Nat. J.* **26**: 6-13.
- Loebel, M.R., and G. Sanewski, 1987. Flying foxes (Chiroptera: Pteropodidae) as orchard pests. *Aust. Mammal.* **10**: 147-150.
- Louette, M., 1975. A fruit bat as prey of the African hawk-eagle. *Bull. Br. Orn. Club* **95**: 172-173.
- Lyster, S., 1985. *International wildlife law*. Grotius Publications Ltd., Cambridge.
- Mabberley, D.J., 1987. *The plant book. A portable dictionary of the higher plants*. Cambridge University Press, Cambridge.
- MacArthur, R.H. and E.O. Wilson, 1967. *The theory of island biogeography*. Princeton University Press, Princeton, New Jersey.
- Mace, G.M., and R. Lande, 1991. Assessing extinction threats: toward a reevaluation of IUCN threatened species categories. *Cons. Biol.* **5(2)**: 148-157.
- Makin, D., 1990. *Aspects of the biology of the fruit bat Rousettus aegyptiacus in Israel*. Unpublished Ph.D. thesis, Tel Aviv University, Israel.
- Makin, D., and H. Mendelssohn, 1986. Israel wipes out its bats. *Ecologist* **16(1)**: 46-47.
- Makin, D., and H. Mendelssohn, 1987. The fruit-bat issue in Israel. *Bat News* **11**: 4-5.
- Malangnoux, M., and J.C. Gautun, 1976. A pest of *Araucaria*

- plantations in the Ivory Coast. *Bois et For. Trop.* **165**: 35-38.
- Marshall, A.G., 1983. Bats, flowers, and fruit: evolutionary relationships in the Old World. *Biol. J. Linn. Soc.* **20**: 115-135.
- Marshall, A.G., 1985. Old World phytophagous bats (Megachiroptera) and their food plants: a survey. *Zool. J. Linn. Soc.* **83**: 351-369.
- Marshall, A.G., and A.N. McWilliam, 1982. Ecological observations on epomophorine fruit-bats (Megachiroptera) in West African savanna woodland. *J. Zool., Lond.* **198**: 53-67.
- Marshall, A.J., 1947. The breeding cycle of an equatorial bat (*Pteropus giganteus*) of Ceylon. *Proc. Linn. Soc. Lond.* **159**: 103-111.
- Marshall, M., 1975. The natural history of Namoluk Atoll, eastern Caroline Islands. *Atoll Res. Bull.* **189**: 1-53.
- Martin, L., P.A. Towers, M.A. McGuckin, L. Little, H. Luckhoff, and A.W. Bradshaw, 1987. Reproductive biology of flying foxes (Chiroptera, Pteropodidae). *Aust. Mamm.* **10**: 115-118.
- Maruyama, K., 1980. *An ecological study of Pteropus dasymallus inopinatus in captivity*. Unpublished thesis, Department of Biology, College of Science and Engineering, University of the Ryukyus. (in Japanese).
- Maruyama, K., 1982. Notes on the rest site and activity of *Pteropus dasymallus inopinatus* in March. *Majaa* **2**: 27-29. (in Japanese).
- Mason, G.E., 1907. On an extinct undescribed fruit-bat of the genus *Pteropus* from the Mascarenes. *Ann. Mag. nat. Hist.* (7) **20**: 220-222.
- Matsumoto, T., 1978. Ecology of terrestrial vertebrates of Hahajima Island, Ogasawara Group. *A. Rep. Ogasawara Res.* **2**: 29-39. (in Japanese).
- Matsumoto, T., 1980. The status of *Pteropus pselaphon* on Hahajima Island, Ogasawara Group. *Surv. Rep. nat. Envir. Ogasawara Is.* **1**: 15-24. (in Japanese).
- Matsuura, K., 1920. *Catalogue of the natural history collection of the Tokyo Imperial Museum (vertebrates)*. Tokyo Imperial Museum.
- McCann, C., 1940. Notes on the fulvous fruit-bat (*Rousettus leschenaulti* Desm.). *J. Bombay nat. Hist. Soc.* **41**: 805-816.
- McClure, H.E., B.L. Lim, and S.E. Winn., 1967. Fauna of the Dark Caves, Batu Caves, Kuala Lumpur, Malaysia. *Pacif. Insects* **9**: 399-428.
- McCoy, M., 1990. Pollination of eucalypts by flying foxes in northern Australia. Flying-fox workshop. *Proc. New South Wales Agric. Fish., Lismore* 33-37.
- McKean, J.L., 1972. Notes on some collections of bats (order Chiroptera) from Papua New Guinea and Bougainville Island, Australia. *CSIRO Div. Wildl Res. Tech. Pap.* **26**.
- McKean, J.L., 1983. Northern blossom bat. In: *the Australian Museum complete book of Australian mammals* (ed., R. Strahan) pp. 290. Angus and Robertson, Sydney.
- McWilliam, A.N., 1980a. *Conservation of bats and their cave habitats on the Kenya coast*. Department of Zoology, University of Aberdeen. Cyclostyled.
- McWilliam, A.N., 1980b. *Conservation of bats, their cave habitats and surrounding relictual forest in coastal Kenya. Management proposals*. Department of Zoology, University of Aberdeen. Cyclostyled.
- McWilliam, A.N., 1985-86. The feeding ecology of *Pteropus* in north-eastern New South Wales, Australia. *Myotis* **23-24**: 201-208.
- Medway, Lord, 1972. Phenology of a tropical rain forest in Malaya. *Biol. J. Linn. Soc.* **4**: 117-146.
- Medway, Lord, 1977. *Mammals of Borneo. Field keys and an annotated checklist*. Kuala Lumpur MBRAS, Royal Asiatic Society Monographs No. 7, 1965, 1977 reprint.
- Medway, Lord, 1978. *The wild mammals of Malaya (Peninsular Malaysia) and Singapore*. Oxford University Press, Kuala Lumpur.
- Medway, Lord, 1983. *The wild mammals of Malaya (Peninsular Malaysia) and Singapore*. 2nd Edition Oxford University Press, Kuala Lumpur.
- Medway, Lord, and A.G. Marshall, 1975. Terrestrial vertebrates of the New Hebrides: origin and distribution. *Phil. Trans. R. Soc. B.* **272**: 432-465.
- Meirte, D., 1984a. New data on *Casinycteris argynnis* Thomas, 1910. (Megachiroptera, Pteropodidae). *Annls Mus. r. Afr. Cent.* **237**: 9-17.
- Meirte, D., 1984b. De vleermuizen van de Comoren. *Afr. Tervuren* **30(1-4)**: 50-57.
- Menkhorst, P.W., and J.M. Dixon, 1985. Influxes of the grey-headed flying fox, *Pteropus poliocephalus* (Chiroptera: Pteropodidae) to Victoria in 1981 and 1982. *Aust. Mamm.* **8**: 117-121.
- Menzies, J.J., 1977. Fossil and subfossil fruit bats from the mountains of New Guinea. *Aust. J. Zool.* **25**: 329-336.
- Mertens, R., 1936. Die Säugetiere der Inseln Bali, Lombok, Sumbawa und Flores. (Beiträge zur Fauna der Kleinen Sunda- Inseln, II). *Zool. Jb. Syst.* **68**: 273-324.
- Milne-Edwards, A., 1877. Observations sur les chauves-souris des îles Seychelles. *Bull. Soc. philomath. Paris ser.* **7, 2**: 221-222.
- Milne-Edwards, A., and E. Oustalet, 1888. Études sur les mammifères et les oiseaux des Îles Comores. *Nouv. Archs Mus. Hist. nat. Paris* (2) **10**: 219-297.
- Monard, A., 1935. Contribution à la mammalogie d'Angola et prodrome d'une faune d'Angola. *Archos Mus. Bocage* **6**: 1-314.
- Morrison, D.W., 1978. Influence of habitat on foraging distances of the fruit bat, *Artibeus jamaicensis*. *J. Mammal.* **59**: 622-624.
- Motteler, L.S., 1986. *Pacific island names. A map and name guide to the new Pacific*. Bishop Museum Miscellaneous Publications No. 34. Bishop Museum Press, Honolulu.
- Mountfort, G., 1974. *So small a world*. Hutchinson, London.
- Mudar, K.M., and M.S. Allen, 1986. A list of bats from northeastern Luzon, Philippines. *Mamm.* **50**: 219-225.
- Muller, S., 1841. In: Temminck, C.J., 1839-1844. *Natuurkundige Commissie in Oost-Indie. Verhandlungen over de Natuurlijke Geschiedenis der Nederlandse overzeesche bezittingen, door de Leden der Natuurkundige Commissie in Indie en Andere Schrijvers*. Leiden.
- Munn, C.A., 1991. Tropical canopy netting and shooting lines over tall trees. *J. Fld Orn.* **62(4)**: 454-463.
- Musser, G.G., K.F. Koopman, and D. Calafia, 1982. The Sulawesi *Pteropus arquatus* and *P. argentatus* are *Acerodon celebensis*; the Philippine *P. leucotis* is an *Acerodon*. *J. Mammal.* **63**: 319-328.
- Mutere, F.A., 1966. On the bats of Uganda. *Uganda J.* **30**: 75-79.
- Mutere, F.A., 1967. The breeding biology of equatorial vertebrates: reproduction of the fruit bat *Eidolon helvum* at latitude 0° 20' N. *J. Zool., Lond.* **153(2)**: 153-161.
- Mutere, F.A., 1968. The breeding biology of the fruit bat, *Rousettus aegyptiacus* E. Geoffroy living at 0° 22' S. *Acta trop.* **25(2)**: 97-108.
- Mutere, F.A., 1980. *Eidolon helvum* revisited. In: *Proceedings of the Fifth International Bat Research Conference*. (eds. D.E. Wilson and A.L. Gardner), pp. 145-150. Lubbock: Texas Tech Press.
- Nader, I.A., 1985a. On the bats (Chiroptera) of the Kingdom of Saudi Arabia. *J. Zool., Lond.* **176**: 331-340.
- Nader, I.A., 1985b. First record of *Eidolon helvum sabaeum* (K. Andersen, 1907) for the Kingdom of Saudi Arabia (Chiroptera: Pteropodidae). *Mammalia* **49(3)**: 429-431.

- Nagai, K., 1929. On a fruit bat of Takarajima Island. *Lansania* **1**: 146. (in Japanese).
- Nakane, T., S. Takano, and M. Shigei, 1970. Zoological views. In: *Report from scientific survey of natural monuments of the Ogasawara Islands* (ed. Japan Agency of Culture), pp. 89-91.
- Nelson, J.E., 1965a. Behaviour of Australian Pteropodidae (Megachiroptera). *Anim. Behav.* **13**: 544-547.
- Nelson, J.E., 1965b. Movements of Australian flying foxes (Pteropodidae: Megachiroptera). *Aust. J. Zool.* **13**: 53-73.
- Neuweiler, V.G., 1969. Verhaltensbeobachtungen an einer indischen Flughundkolonie (*Pteropus g. giganteus* Brunn.). *Z. Tierpsychol.* **26**: 166-199.
- Ng, F.S.P., 1980. Legumes in forestry. In: *Proc. Symp. legumes in the tropics* (Faculty of Agricultural University Pertanian Malaysia), pp. 449-456.
- Nichols, D.G. Jnr., K.F. Fuller, E. McShane-Caluzi, and E. Klerner-Eckenrode, eds. A.L. Gaski and G. Hemley, 1991. *Wildlife trade laws of Asia and Oceania*. TRAFFIC (USA), World Wildlife Fund, Washington DC, USA.
- Nicoll, M.E., and P.A. Racey, 1981. The Seychelles fruit bat, *Pteropus seychellensis seychellensis*. *Afr. J. Ecol.* **19**: 361-364.
- Norton, P.H., and M. Van der Merwe, 1978. Winter activity of bats in a Transvaal highveld cave. *S. Afr. J. Sci.* **74**: 216-220.
- Nowak, R.M., 1991. *Walker's mammals of the world*. 5th edition. John Hopkins University Press, Baltimore and London.
- Okoa, N.O., 1974a. The breeding pattern of the eastern epauletted bat, - *Epomophorus anurus* Heuglin, in Uganda. *J. Reprod. Fert.* **37(1)**: 27-31.
- Okoa, N.O., 1974b. Breeding in Franquet's bat, *Epomops franqueti* (Tomes) in Uganda. *J. Mammal.* **55(2)**: 462-465.
- Okon, E.E., 1974. Fruit bats at Ife: their roosting and food preferences. *Niger. Fld* **39**: 33-40.
- O'Shea, T.J., and T.A. Vaughan, 1980. Ecological observations on an East African bat community. *Mammalia* **44(4)**: 485-496.
- Osmaston, H.A., 1965. Pollen and seed dispersal in *Chlorophora excelsa* and other Moraceae and in *Parkia fillicoides* (Mimosaceae) with special reference to the role of the fruit bat, *Eidolon helvum*. *Commonw. For. Rev.* **44**: 96-104.
- Otis, D.L., K.P. Bumham, G.C. White and D.R. Anderson, 1978. Statistical inference from capture data on closed animal populations. *Wildl. Monogr.* **62**: 1-135.
- Owen, D., D. Bilton, K. Lonsdale, and S. Strathdee, 1987. *Proyek Kelelawar. A study of bats and invertebrates in an archipelago's caves*. Final report of the Oxford University expedition to the Togian Islands, Sulawesi, Indonesia, Summer [July 12th - October 1st] 1987. Published by the compilers.
- Owen, R.P., 1977. *Terrestrial vertebrate fauna of the Palau Islands*. Conservation Office, Trust Territory of the Pacific Islands, Koror, Palau. Unpublished report.
- Pakarnseree, L., 1986. Food of Thai bats: studies of stomach contents of fruit-eating and nectarivorous bats in Thailand (Mammalia: Megachiroptera). *Cour. Forsch. Inst. Senckenberg* **87**: 73-89.
- Pakenham, R.H.W., 1984. *The mammals of Zanzibar and Pemba Islands*. Published by the author.
- Palmer, R.H., 1987. Flying foxes (Chiroptera: Pteropodidae) in the Coffs Harbour district of New South Wales. *Aust. Mamm.* **10**: 141-142.
- Parry-Jones, K., and M.L. Augee, in press. Food selection by grey-headed flying foxes (*Pteropus poliocephalus*) occupying a summer colony site near Gosford, N.S.W. *Aust. Wildl. Res.*
- Payne, J., C.M. Francis, and K. Phillips, 1985. *A field guide to the mammals of Borneo*. Sabah Society, Kota Kinabalu.
- Perez, G.S.A., 1968. Notes on Palau fruit bats. *J. Mammal.* **49**: 758.
- Perez, G.S.A., 1972. Observations on Guam bats. *Micronesica* **8**: 141-149.
- Perez, G.S.A., 1973. Notes on the ecology and life history of Pteropidae on Guam. *Periodicum biol.* **75**: 163-168.
- Pemetta, J.C., and L. Hill, 1984. Traditional use and conservation of resources in the Pacific Basin. *Ambio* **13**: 359-364.
- Pernetta, J.C., and D. Watling, 1978. The introduced and native terrestrial vertebrates of Fiji. *Pacif. Sci.* **32**: 223-244.
- Peters, W.C.H., 1869. Säugethiere und Amphibien. In: *Baron Carl Claus von der Decken's reisen in Ost-Afrika 3 (1)*, (ed. O. Kersten), pp. 1-18. C.F. Winter, Leipzig & Heidelberg.
- Peterson, R.L., 1991. Systematic variation in the megachiropteran tube-nosed bats *Nyctimene cyclotis* and *N. certans*. *Bull. Am. Mus. nat. Hist.* **206**: 26-41.
- Pettigrew, J.D., 1986. Flying primates? Megabats have the advanced pathway from eye to midbrain. *Science, N.Y.* **231**: 1304-1306.
- Pettigrew, J.D., 1991. Wings or brain? Convergent evolution in the origins of bats. *Syst. Zool.* **40(2)**: 199-216.
- Pettigrew, J.D., B.G.M. Jamieson, S.K. Robson, L.S. Hall, K.I. McAnally, and H.M. Cooper, 1989. Phylogenetic relations between microbats, megabats and primates (Mammalia: Chiroptera, Primates). *Phil. Trans. R. Soc. B* **325**: 489-559.
- Phillips, W.W.A., 1924. Guide to the mammals of Ceylon. *Spolia zeylan.* **13**: 1-63.
- Phillips, W.W.A., 1980. *Manual of the mammals of Ceylon*. 2nd Edition. Wildlife and Protection Society of Sri Lanka.
- Pienaar, U. de V., I.L. Rautenbach, and G. de Graaf, 1980. *The small mammals of the Kruger National Park*. National Parks Board of South Africa.
- Pierson, E.D., 1984. Can Australia's flying foxes survive? *Bate* **1(4)**: 1-4.
- Pierson, E.D., and W.E. Rainey, 1992. The biology of flying foxes of the genus *Pteropus*: a review. In: *Pacific island flying foxes: Proceedings of an international conservation conference* (eds. D.E. Wilson and G.L. Graham), pp. 1-17. US Fish and Wildlife Service Biological Report 90(23). US Department of the Interior, Fish and Wildlife Service, Washington DC.
- Poche, R.M., 1975. The bats of National Park W, Niger, Africa. *Mammalia* **39**: 39-50.
- Pollock, K.H., 1981. Capture-recapture models: a review of current methods, assumptions and experimental design. In: *Estimating numbers of terrestrial birds* (eds. Ralph, C.J., and J.M. Scott), pp. 426-435. Studies in Avian Biology No. 6. Cooper Ornithological Society.
- Pont, S.M., 1989. *A survey of cave-dwelling bats on the south coast of Kenya*. Report of the 1988 Aberdeen University Expedition. Laser printed, privately circulated.
- Prater, S.H., 1971. *The book of Indian animals*. Third (revised) edition. Bombay Natural History Society, Bombay.
- Prociv, P., 1983. Seasonal behaviour of *Pteropus scapulatus* (Chiroptera: Pteropodidae). *Aust. Mamm.* **6**: 45-46.
- Rabor, D.S., 1952. Two new mammals from Negros Island, Philippines. *Chicago Acad. Sci. nat. Hist. Misc.* **96**: 1-7.
- Rabor, D.S., 1977. *Philippine birds and mammals*. University of the Philippines Press, Quezon City.
- Racey, P.A., 1973. Environmental factors affecting the gestation in heterothermic bats. *J. Reprod. Fert. Suppl.* **19**: 175-189.
- Racey, P.A., 1979. Two bats in the Seychelles. *Oryx* **15**: 148-152.
- Racey, P.A., and M.E. Nicoll, 1984. Mammals of the Seychelles. In:

- Biogeography and ecology of the Seychelle Islands*, (ed. D.R. Stoddart), pp. 607-626. Junk, The Hague.
- Rainey, W.E., 1990. The flying fox trade: becoming a rare commodity. *Bats* **8(1)**: 6-9.
- Ratcliffe, F.N., 1931. The flying fox (*Pteropus*) in Australia. *CSIR Bull.* **53**: 1-81.
- Ratcliffe, F.N., 1932. Notes on the fruit bats (*Pteropus* spp.) of Australia. *J. anim. Ecol.* **1**: 32-57.
- Rautenbach, I.L., 1982. *Mammals of the Transvaal*. Ecoplan Monograph No. 1. Ecoplan, Pretoria, South Africa.
- Recher, H.F., 1981. Nectar-feeding and its evolution among Australian vertebrates. In: *Ecological biogeography of Australia*. Vol. 3 (ed. A. Keast), pp. 1637-1648. Junk, The Hague.
- Rensch, B., 1936. *Die Geschichte des Sundabogens*. Eine tiergeographische Untersuchung. Berlin.
- Revilliod, P., 1914. Les mammifères de la Nouvelle-Calédonie et des Îles Loyalty. In: *Nova Caledonia, Zool. I.* (eds., F. Sarasin and J. Roux), pp. 341-365.
- Reyne, A., 1939. On the food habits of the coconut crab (*Birgus latro* L), with notes on its distribution. *Archs neerl. Zool.* **3**: 283-320.
- Richards, G.C., 1983. Queensland Blossom-bat. In: *The Australian Museum complete book of Australian mammals* (ed. R. Strahan) pp. 289. Angus and Robertson, Sydney.
- Richards, G.C., 1986a. Notes on the natural history of the Queensland tube-nosed bat, *Nyctimene robinsoni*. *Macroderma* **2**: 64-67.
- Richards, G.C., 1986b. *Dobsonia* flight and ecology: more on lift at low speed. *Macroderma* **2**: 20-21.
- Richards, G.C., 1987. Aspects of the ecology of spectacled flying foxes, *Pteropus conspicillatus* (Chiroptera: Pteropodidae), in tropical Queensland. *Aust. Mamm.* **10**: 87-88.
- Richards, G.C., 1990a. The spectacled flying fox, *Pteropus conspicillatus*, (Chiroptera: Pteropodidae), in north Queensland 1. Roost sites and distribution patterns. *Aust. Mamm.* **13**: 17-24.
- Richards, G.C., 1990b. The spectacled flying fox, *Pteropus conspicillatus*, (Chiroptera: Pteropodidae), in north Queensland 2. Diet, seed dispersal and feeding ecology. *Aust. Mamm.* **13**: 25-31.
- Rickart, E.A., P.D. Heideman, and R.B. Uzzurum, 1989. Tent-roosting by *Scotophilus kuhlii* (Chiroptera: Vespertilionidae) in the Philippines. *J. trop. Ecol.* **5**: 433-436.
- Ridley, H.N., 1930. *The dispersal of plants throughout the world*. Reeve, Ashford.
- Roberts, P., and W.A. Seabrook, 1989. A relationship between black rats (*Rattus rattus*), Seychelles fruit bats (*Pteropus seychellensis aldabrensis*) and the coccoid (*Icerya seychellarum*) (Insecta, Homoptera) on Aldabra Atoll, Seychelles. *J. Zool., Lond.* **218**: 332-334.
- Roberts, T.J., 1977. *The mammals of Pakistan*. Ernest Benn Ltd., London and Tonbridge.
- Rosevear, D.R., 1965. *The bats of West Africa*. British Museum (Natural History), London.
- Roth, H.H., and G. Merz, 1988. Vorkommen und relative Häufigkeit von Säugetieren im Tai-Regenwald. *Säugetierk. Mitt.* (for 1986) **33(2-3)**: 171-193.
- Sanborn, C.C., 1931. Bats from Polynesia, Melanesia and Malaysia. *Fld Mus. nat. Hist., Zool. Ser.* **18(2)**: 7-29.
- Sanborn, C.C., 1952. Philippine zoological expedition 1946-1947. *Mammals. Fieldiana Zool.* **33 (2)**: 89-158.
- Sanborn, C.C., and A.J. Nicholson, 1950. Bats from New Caledonia, the Solomon Islands, and New Hebrides. *Fieldiana Zool.* **31(36)**: 313-338.
- Savidge, J.A., 1987. Extinction of an island forest avifauna by an introduced snake. *Ecology, Brooklyn, NY.* **68**: 600-668.
- Schlitter, D.A., and S.B. McLaren, 1981. An additional record of *Myonycteris relicta* Bergmans, 1980, from Tanzania (Mammalia: Chiroptera). *Ann. Carneg. Mus.* **50(16)**: 385-389.
- Seehausen, O., 1990. Vom Aussterben bedroht: Der Pemba Flughund. *Zool. Ges. f. Arten- und Populationsschutz* **6(1)**: 12-16.
- Seehausen, O., in press. Zur Struktur der Saugergesellschaft und zur Ökologie des Pemba-Flughundes. *Zool. Ges. f. Arten- und Populationsschutz*
- Sherborn, C.D., 1934. Dates of publication of catalogues of natural history post-1850 issued by the British Museum. *Ann. Mag. nat. Hist.* **10(13)**: 308-312.
- Shimajana, M., 1978. Cave fauna of Minami and Kita-daitojima Islands, and the southern part of Okinawajima Island. In: *Survey report of the caves of the Okinawa Prefecture I* (ed. Educational Committee of Okinawa Prefecture), pp. 75-111. Educational Committee of Okinawa Prefecture, Naha. (in Japanese).
- Shiroma, H., K. Maruyama, and K. Sasaki, 1981. Some observations on *Pteropus dasymallus inopinatus*. *Yamaaji* **2**: 1-3. (in Japanese).
- Shoga, O.A., 1974. *An analysis of the vertebrates found in ju-ju stalls at Ibadan*. Unpublished manuscript, Department of Zoology, University of Ibadan.
- Shorridge, G.C., 1934. *The mammals of South West Africa*. Vols I & II. Heinemann, London
- Siebold, P.F. von, 1824. *De Historiae Naturalis in Japonia statu*. Bataviae.
- Singh, B., 1986. Protected natural areas in the South Pacific. *Forest Bird* **17(2)**: 12-13.
- Skinner, J.D., and R.H.N. Smithers, 1990. *The mammals of the Southern African subregion* 2nd edition. University of Pretoria, Pretoria.
- Smalley, M.E., 1984. Predation by pied crows *Corvus albus* on Gambian epauletted fruit bats *Epomophorus gambianus*. *Bull. Br. Orn. Club* **104**: 107-109.
- Smith, D.S., and C.S. Hood, 1981. Preliminary notes on bats from the Bismarck Archipelago (Mammalia: Chiroptera). *Sci. NewGuin.* **8**: 81-121.
- Smith, J.D., and G. Madkour, 1980. Penial morphology and the question of chiropteran phylogeny. In: *Proceedings of the Fifth International Bat Research Conference*. (eds. D.E. Wilson and A.L. Gardner) pp. 347-365. Texas Tech Press, Lubbock.
- Smith, L.A., 1988. *Lycodon aulicus capucinus* a colubrid snake introduced to Christmas Island, Indian Ocean. *Rec. West Aust. Mus.* **14**: 251-252.
- Smithers, R.H.N., 1986. South African red data book: terrestrial mammals. S.A. *National Scientific Programmes Report No.* **125**: 1-216. C.S.I.R., Pretoria.
- Smithers, R.H.N., and V.J. Wilson, 1979. *Check list and atlas of the mammals of Zimbabwe Rhodesia*. Trustees of the National Museums and Monuments, Salisbury, Zimbabwe Rhodesia.
- Snow, D.W., 1971. Evolutionary aspects of fruit-eating by birds. *Ibis* **113**: 194-202.
- Sody, H.J.V., 1936. Seventeen new generic and subspecific names for Dutch East Indian mammals. *Natuurk. Tijdschr. Ned-Indie* **96**: 42-55.
- Sowler, S.G., 1984. *Growth and reproduction in the fruit bat Epomophorus wahlbergi*. Unpublished Ph.D. thesis, University of Natal.
- Sowler, S.G., 1988a. *The Israeli bat problem*. Report on a visit to Israel as representative of the Species Survival Commission

- Chiroptera Specialist Group of the IUCN 17/3/88 - 28/3/88.
- Sowler, S.G., 1988b. *Report on a follow-up visit to Israel*. Dates 20/10/88 - 31/10/88.
- Spencer, H.J., and T.H. Fleming, 1989. Roosting and foraging behaviour of the Queensland tube-nosed bat, *Nyctimene robinsoni* (Pteropodidae): Preliminary radio-tracking observations. *Aust. Wildl Res.* **16**: 413-420.
- Spitzenberger, F., 1979. Die Säugetierfauna Zyperns. Teil II: Chiroptera, Lagomorpha, Carnivora und Artiodactyla. *Annln naturh. Mus. Wien* **82**: 439-465.
- Start, A.N., 1972. Pollination of the baobab (*Adansonia digitata* L.) by the fruit bat *Rousettus aegyptiacus* E. Geoffroy. *E. Afr. Wildl. J.* **10(1)**: 71-72.
- Start, A.N., 1974. *The feeding biology in relation to food sources of nectarivorous bats (Chiroptera: Macroglossinae) in Malaysia*. Unpublished Ph.D. thesis, University of Aberdeen.
- Start, A.N., and A.G. Marshall, 1976. Nectarivorous bats as pollinators of trees in west Malaysia. In: *Tropical trees: variation, breeding, and conservation* (eds. J. Burley and B. Styles), pp. 141-150. Academic Press, London.
- Stinson, D.W., P.O. Glass, and E.M. Taisacan, 1992. Declines and trade in fruit bats on Saipan, Tinian, Aguijan and Rota. In: *Pacific island flying foxes: Proceedings of an international conservation conference* (eds. D.E. Wilson and G.L. Graham), pp. 61-67. US Fish and Wildlife Service Biological Report 90(23). US Department of the Interior, Fish and Wildlife Service, Washington DC.
- Stoddart, D.R., and J.D.M. Ferrari, 1983. Aldabra atoll: a stunning success story for conservation. *Nature Resources* **19(1)**: 20-28.
- Strahan, R., 1983 (ed.). *The Australian Museum complete book of Australian mammals*. Angus and Robertson, London, Sydney and Melbourne.
- Stuart, S.N., and R.J. Adams, 1989. *Biodiversity in Africa and its islands. Its conservation, management and sustainable use (first draft)*. International Union for the Conservation of Nature and Natural Resources, International Council for Bird Preservation, Conservation International, and World Wide Fund for Nature.
- Takara, T., 1976. Distinguished mammals of Okinawa. In: *Splendid nature of Okinawa* (ed. Branch of Environmental and Public Health, Okinawa Prefectural Government), pp. 57-60. Okinawa Prefecture. (in Japanese).
- Tate, G.H.H., 1934. Bats from the Pacific Islands, including a new fruit bat from Guam. *Am. Mus. Novit.* **713**: 1-3.
- Tate, G.H.H., 1942. Results of the Archbold Expeditions. No. 48. Pteropodidae (Chiroptera) of the Archbold Collections. *Bull. Am. Mus. nat. Hist.* **80**: 331-347.
- Tate, G.H.H., 1951. *Harpyionycteris*, a genus of rare fruit bats. *Am. Mus. Novit.* **1522**: 1-9.
- Taylor, E.H., 1934. Philippine land mammals. *Monogr. Bur. Sci (Manila)*. **30**: 1-548.
- Temminck, C.J., 1825. *Monographies de Mammalogie. I*. Paris.
- Thomas, D.W., 1982. *The ecology of an African savanna fruit bat community: resource partitioning and role in seed dispersal*. Unpublished Ph.D. thesis, University of Aberdeen.
- Thomas, D.W., 1983. The annual migrations of three species of West African fruit bats (Chiroptera: Pteropodidae). *Can. J. Zool.* **61(10)**: 2266-2273.
- Thomas, D.W., and M.B. Fenton, 1978. Notes on the dry season roosting and foraging behaviour of *Epomophorus gambianus* and *Rousettus aegyptiacus* (Chiroptera: Pteropodidae). *J. Zool., Lond.* **186**: 403-406.
- Thomas, D.W., and A.G. Marshall, 1984. Reproduction and growth in three species of West African fruit bats. *J. Zool., Lond.* **202**: 265-281.
- Thomas, M.O., 1900. Description of a new fruit bat from New Guinea. *Ann. Mag. nat. Hist.* (7) **5**: 216-217.
- Thomas, M.O., 1922. New mammals from New Guinea and neighbouring islands. *Ann. Mag. nat. Hist.* (9) **9**: 261-265.
- Thomas, O., 1882. Description of two new species of *Pteropus* from the Caroline Islands. *Proc. zool. Soc. Lond.* **1882**: 755-757.
- Thonglongya, K. 1972. A new genus and species of fruit bat from south India (Chiroptera: Pteropodidae). *J. Bombay. nat. Hist. Soc.* **69(1)**: 151-158.
- Thorpe, I., 1988. *University of East Anglia Comoro Islands Expedition 1988, final report*. Unpublished.
- Thorpe, I., 1989. *University of East Anglia Comoro Islands Expedition 1989, final report*. Unpublished.
- Tidemann, C.R., 1985. *The status, habitat requirements and management of the two species of bat on Christmas Island (Indian Ocean)*. Unpublished report of Australian National Parks and Wildlife Service, Canberra.
- Tidemann, C.R., 1987. Notes on the flying fox, *Pteropus melanotus* (Chiroptera: Pteropodidae) on Christmas Island, Indian Ocean. *Aust. Mamm.* **10**: 89-91.
- Tidemann, C.R., 1989. *Survey of the terrestrial mammals on Christmas Island (Indian Ocean)*. Unpublished report to the Australian National Parks and Wildlife Service, Canberra.
- Tidemann, C.R., and J.E. Nelson, 1987. Flying foxes (Chiroptera: Pteropodidae) and bananas: some interactions. *Aust. Mamm.* **10**: 133-136.
- Tidemann, C.R., D.J. Kitchener, R.A. Zann, and I.W.B. Thornton, in press. Recolonisation of the Krakatau Islands and adjacent areas of West Java, Indonesia, by bats (Chiroptera) (1883-1986). Times Atlas of the World, The, 1990. 8th edition. Times Books Ltd., London
- Toledo, V.M., 1977. Pollination of seed rain forest plants by non-hovering birds in Veracruz, Mexico. *Biotropica* **9**: 262-267.
- Turtle, M.D., 1985. Gentle fliers of the African night. *Natn. Geogr. Mag.* **169**: 540-558.
- Uchida, T.A., 1963. Mammal fauna of Ryukyu Archipelago, ecological notes of *Rattus* and zoogeographical remarks. *Rep. Comm. for scient. Res. Kyushu Univ.* **1**: 117-130. (in Japanese).
- Unger, F., and T. Kotschy, 1865. *Die Insel Cypern ihrer physischen und organischen Natur nach mit Rücksicht auf ihre frühere Geschichte*. Braumuller, Vienna.
- US Fish and Wildlife Service, 1985. Endangered and threatened wildlife and plants; findings on two petitions and review of three species. *Fed. Register* **50(129)**: 27637-27638.
- US Fish and Wildlife Service, 1988. Notice of findings on pending petitions. *Fed. Register* **53(130)**: 25511-25515.
- US Fish and Wildlife Service, in press. *Recovery plan for the Marianas fruit bat and the little Marianas fruit bat on Guam*. US Fish and Wildlife Service, Portland, Oregon.
- US Fish and Wildlife Service (USFWS) and National Environmental Protection Board (Statens Naturvardsverk [SNV]), 1989. *Amendments to Appendices I and II of CITES. Transfer of Pteropus insularis, P. mariannus, P. molossinus, P. phaeocephalus, P. pilosus, P. samoensis (dead specimens and parts only) from Appendix II to Appendix I and inclusion of Acerodon spp. and Pteropus spp. in Appendix II*. Proposal presented to the Seventh Meeting of the Conference of the Parties to CITES, Lausanne, Switzerland, 8-20 October, 1990.
- Utzurum, R.B., 1984. *Figfruit consumption and seed dispersal by*

- frugivorous bats in the primary forest of Lake Balinsasayao, Negros Oriental, Philippines. Unpublished M.S. thesis., Silliman University, Dumaguete, Philippines.
- Utzurum, R.B., and P.D. Heideman, 1991. Differential ingestion of viable vs nonviable *Ficus* seeds by fruit bats. *Biotropica* **23**(3): 311-312.
- van der Pijl, L., 1956. Remarks on pollination by bats in the genera *Freyinetia*, *Duabanga*, and *Haplophragma*, and on chiropterophily in general. *Acta bot. neerl.* **5**: 135-144.
- van der Pijl, L., 1957. The dispersal of plants by bats (chiropterchory). *Acta bot. neerl.* **6**: 291-315.
- Van Peenen, P.F.D., 1969. *Preliminary identification manual for mammals of South Vietnam*. US National Museum, Smithsonian Institution, City of Washington.
- Vane-Wright, R.I., C.J. Humphries, and P.H. Williams, 1991. What to protect - systematics and the agony of choice. *Biol. Cons.* **55**: 235-254.
- Verschuren, J., 1957. Écologie, biologie et systématique des Cheiroptères. *Explor. Parc. natn. Garamba Miss. H. deSaeger* **7**: 1-473.
- Verschuren, J., 1965. Cheiroptères. *Explor. Parc. natn. Kagera, DieuxSer.* **1**(2): 65-75.
- Verschuren, J., 1985. Note sur les mammifères des Seychelles. Un facteur de mortalité de la roussette endémique, *Pteropus seychellensis*. *Mammalia* **49**(3): 424-426.
- Vestjens, W.J.M., and L.S. Hall, 1977. Stomach contents of forty-two species of bats from the Australian region. *Aust. Wildl Res.* **4**: 25-35.
- Voeltzkow, A., 1904. Berichte über eine Reise nach Ost Afrika zur Untersuchung der Bildung und des Aufbaues der Riffe und Inseln des indischen westlichen Ozeans. III Mafia und Zanzibar, IV Die Comoren. *Z. Ges. Erdk., Berl.* **39**: 274- 301.
- Waithman, J., 1979. A report on the collection of mammals from southwest Papua. 1972-1973. *Aust. Zool.* **20**: 313-326.
- Watson, B., 1982. Flying foxes in north Queensland. Control by carbide and strobe lights. *Aust. Hort.* **September, 1982**.
- Wheeler, M.E., 1980. The status of the Marianas fruit bat on Sapan, Tinian and Rota. *Elepaio* **40**: 109-113.
- Wheeler, M.E., and C.F. Aguon, 1978. The current status and distribution of the Marianas fruit bat on Guam. *Div. Ag. Wildl. Res. Tech. Rep.* **1**: 1-29.
- White, C.M., D.J. Brimm, and F. Clunie, 1988. A study of peregrines in the Fiji Islands, South Pacific Ocean. In: *Peregrine falcon populations: their management and recovery* (eds. Cade, T.J., J.H. Enderson, C.G. Thelander, and C.M. White), pp. 275-288. The Peregrine Fund, Inc., Boise, Idaho.
- White, G.C., D.R. Anderson, K.P. Burnham, and D.L. Otis, 1982. *Capture-recapture and removal methods for sampling closed populations*. Los Alamos National Laboratory, Los Alamos, New Mexico.
- Wickler, W., and U. Seibt, 1976. Field studies of the African fruit bat *Epomophorus wahlbergi* (Sundevall), with special reference to male calling. *Z. Tierpsychol.* **40**(4): 345-376.
- Wiles, G.J., 1986. The current status, distribution and natural history of Marianas fruit bats. In: *Guam Division of Aquatic and Wildlife Resources annual report, FY 1986*, pp. 111-121. Department of Agriculture, Guam.
- Wiles, G.J., 1987a. The status of fruit bats on Guam. *Pacif. Sci.* **41**: 148-157.
- Wiles, G.J., 1987b. Current research and future management of Marianas fruit bats (Chiroptera; Pteropodidae) on Guam. *Aust. Mamm.* **10**: 93-95.
- Wiles, G.J., 1987c. Natural history, biology, and habitat protection for the Marianas fruit bats. In: *Guam Division of Aquatic and Wildlife Resources annual report, FY 1987*, pp. 124-135. Department of Agriculture, Guam.
- Wiles, G.J., 1988. Natural history, biology and habitat protection for the Marianas fruit bat. In: *Guam Division of Aquatic and Wildlife Resources annual report, FY 1988*, pp. 122-123. Department of Agriculture, Guam.
- Wiles, G.J., 1990. Giving flying foxes a second chance. *Bats* **8**(3):3-4.
- Wiles, G.J., 1992. Recent trends in the fruit bat trade on Guam. In: *Pacific island flying foxes: Proceedings of an international conservation conference* (eds. D.E. Wilson and G.L. Graham), pp. 53-60. US Fish and Wildlife Service Biological Report 90(23). US Department of the Interior, Fish and Wildlife Service, Washington DC.
- Wiles, G.J., and P.J. Conry., 1990. Terrestrial vertebrates of the Ngerukewid Islands Wildlife Preserve, Palau Islands. *Micronesica* **23**: 41-66.
- Wiles, G.J., J. Engbring, and M.V.C. Falanruw., 1991. Population status and natural history of *Pteropus mariannus* on Ulithi Atoll, Caroline Islands. *Pacif. Sci.* **45**(1): 76-84
- Wiles, G.J. and M.S. Fujita, 1992. Food plants and economic importance of flying foxes on Pacific islands. In: *Pacific island flying foxes: Proceedings of an international conservation conference* (eds. D.E. Wilson and G.L. Graham), pp. 24-35. US Fish and Wildlife Service Biological Report 90(23). US Department of the Interior, Fish and Wildlife Service, Washington DC.
- Wiles, G.J. and P.O. Glass, 1990. Interisland movements of fruit bats (*Pteropus mariannus*) in the Mariana Islands. *Atoll Res. Bull.* **343**: 1-6.
- Wiles, G.J., T.O. Lemke, and N.H. Payne, 1989. Population estimates of fruit bats (*Pteropus mariannus*) in the Mariana Islands. *Cons. Biol.* **3**: 66-76.
- Wiles, G.J., and N.H. Payne, 1986. The trade in fruit bats, *Pteropus* spp. on Guam and other Pacific islands. *Biol. Cons.* **38**: 143-161.
- Williams, P.H., C.J. Humphries, and R.I. Vane-Wright, 1991. Measuring biodiversity: taxonomic relatedness for conservation priorities. *Aust. Syst. Bot.* **4**: 665-679.
- Williams, P.H., R.I. Vane-Wright, and C.J. Humphries, in press. Measuring biodiversity for choosing conservation areas. In: *Hymenoptera and biodiversity* (eds. J. LaSalle and I. Gould). CAB International, Wallingford.
- Wilson, D.E., 1990. Pacific flying foxes surveyed. *Endangered Spec. tech. Bull.* **15**: 4.
- Wilson, D.E., and G.L. Graham (eds), 1992. *Pacific island flying foxes: proceedings of an international conservation conference*. US Fish and Wildlife Service Biological Report 90(23). US Department of the Interior, Fish and Wildlife Service, Washington DC.
- Wilson, J., 1987 (ed.). The Crocodile Caves of Ankarana: Expedition to Northern Madagascar, 1 86. *Cave Sci.* **14**(3): 107-119.
- Wilson, P., 1985. Does *Dobsonia* (Chiroptera: Pteropodidae) have a fling? *Macroderma* **1**: 53-55.
- Wodzicki, K., and H. Felten, 1975. The peka, or fruit bat (*Pteropus tonganus*) (Mammalia: Chiroptera), of Niue Island, South Pacific. *Pacif. Sci.* **29**: 131-138.
- Wodzicki, K., and H. Felten, 1980. Fruit bats of the genus *Pteropus* from the islands Rarotonga and Mangaia, Cook Islands, Pacific Ocean. *Senckenberg. biol.* **61**: 143-151.

- Wolf, D.E., 1984. Ayers' hawk eagle *Hieraaetus dubius* feeding on a fruit bat. *Scopus* **8**: 44.
- Wolton, R.J., P.A. Arak, H.C.J. Godfray, and R.P. Wilson, 1982. Ecological and behavioural studies of the Megachiroptera at Mount Nimba, Liberia, with notes on Microchiroptera. *Mammalia* **46(4)**: 419-448.
- Worcester, D.C., 1899. *The Philippine islands and their people*. Macmillan Co., New York.
- Yamagata, Y., 1929. On a fruit bat in Kagoshima Prefecture. *Lasania* **1**: 130-139. (in Japanese).
- Yaman, I.K.A., 1966. Insect pests of Saudi Arabia. *Z. angew. Entomol.* **58**: 266-278.
- Yang, S.F., 1981. Biosynthesis of ethylene and its regulation. In: *Recent advances in the biochemistry of fruits and vegetables*. (eds. Friend, J, and M.J.C. Rhodes) pp. 89-106. Academic Press, London.
- Yenbutra, S., and H. Felten, 1986. Bat species and their distribution in Thailand according to the collections in TISTR and SMF. *Cour. ForschInst. Senckenberg* **87**: 9-45.
- Yerbury, J.W., and O. Thomas, 1895. On the mammals of Aden. *Proc. zool. Soc. Lond.* **1895**: 542-555.
- Yoshiyuki, M., 1989. *A systematic study of the Japanese Chiroptera*. National Science Museum, Tokyo.
- Ziegler, A.C., 1982. An ecological checklist of New Guinea recent mammals. In: *Biogeography and ecology of New Guinea* (ed. J.L. Gressitt) pp. 863-894. Junk, The Hague.

Appendix 1. Plants Utilized by Fruit Bats

The following table has been compiled from information presented in this document. It lists the genera of plants positively identified as being food plants of fruit bats. Taxonomy follows that given in

Mabberley (1987). "Other" under "Source of food" refers to buds, sap, seeds or other parts of plants; "Taxa" is the number of fruit bat taxa recorded as feeding on plants of this genus.

Family/genus	Source of food				Taxa	Family/genus	Source of food				Taxa
	Fruit	Flowers	Leaves	Other			Fruit	Flowers	Leaves	Other	
Actinidiaceae											
<i>Actinidia</i>	+				1	<i>Radermachera</i>		+			1
						<i>Spathodea</i>		+			4
Agavaceae						Bombacaceae					
<i>Agave</i>		+			4	<i>Adansonia</i>	+	+			9
<i>Furcraea</i>		+			1	<i>Bombax</i>		+			7
						<i>Ceiba</i>	+	+			24
Aloeaceae						<i>Durio</i>		+			6
<i>Aloe</i>		+			1	<i>Ochroma</i>		+			1
Anacardiaceae						Bromeliaceae					
<i>Anacardium</i>	+	+			8	<i>Ananas</i>	+			+	1
<i>Camptosperma</i>	+	+			1						
<i>Harpephyllum</i>	+				1	Burseraceae					
<i>Mangifera</i>	+	+			39	<i>Canarium</i>	+				1
<i>Pseudospondias</i>	+				1						
<i>Rhus</i>		+			2	Campanulaceae					
<i>Sclerocarya</i>	+				1	<i>Lobelia</i>			+		1
<i>Semecarpus</i>	+				1						
<i>Spondias</i>	+				2	Caricaceae					
						<i>Carica</i>	+	+			22
Annonaceae						Casuarinaceae					
<i>Annona</i>	+	+			11	<i>Casuarina</i>		+		+	1
<i>Cananga</i>	+	+			3						
<i>Polyalthia</i>	+				2	Ceceropinaceae					
<i>Rollinia</i>	+				1	<i>Musanga</i>	+				2
<i>Uvaria</i>	+				1						
Apocynaceae						Celastraceae					
<i>Acokanthera</i>	+				1	<i>Cassine</i>	+	+			2
<i>Alstonia</i>		+			1						
<i>Cerbera</i>	+				1	Chrysobalanaceae					
<i>Melodinus</i>	+				1	<i>Maranthes</i>			+		3
<i>Neisosperma</i>	+				5	<i>Parinari</i>	+	+			7
<i>Ochrosia</i>	+				2						
<i>Rauvolfia</i>	+				1	Combretaceae					
						<i>Lumnitzera</i>			+		1
Araliaceae						<i>Terminalia</i>	+	+			17
<i>Schefflera</i>				+	1						
Bignoniaceae						Compositae					
<i>Crescentia</i>		+			1	unidentified					1
<i>Dolichandrone</i>					2						
<i>Heterophragma</i>		+			1	Convolvulaceae					
<i>Kigelia</i>		+			8	<i>Ipomoea</i>			+		2
<i>Markhamia</i>					1						
<i>Oroxylum</i>		+			3						

Family/genus	Source of food				Taxa	Family/genus	Source of food				Taxa
	Fruit	Flowers	Leaves	Other			Fruit	Flowers	Leaves	Other	
Cunoniaceae						Lauraceae					
<i>Codia</i>					1	<i>Neolitsea</i>		+			1
<i>Schizomeria</i>	+				1	<i>Persea</i>	+	+			5
Cupressaceae						unidentified	+				1
<i>Callitris</i>				+	1	Lecythidaceae					
Cycadaceae						<i>Barringtonia</i>		+			4
<i>Cycas</i>	+				2	<i>Planchonia</i>		+			1
Ebenaceae						Leguminosae					
<i>Diospyros</i>	+	+			10	<i>Albizia</i>		+	+		4
Elaeagnaceae						<i>Bauhinia</i>		+		+	2
<i>Elaeagnus</i>	+		+		1	<i>Castanospermum</i>		+			4
Elaeocarpaceae						<i>Ceratonia</i>	+				1
<i>Elaeocarpus</i>	+	+		+	6	<i>Cynometra</i>		+	+		1
Ericaceae						<i>Eperua</i>					1
<i>Pieris</i>	+				1	<i>Erythrina</i>		+	+		6
Euphorbiaceae						<i>Erythrophleum</i>		+			1
<i>Bischofia</i>	+			+	1	<i>Inocarpus</i>	+	+			3
<i>Bridelia</i>	+				1	<i>Intsia</i>		+			1
<i>Glochidion</i>		+			1	<i>Mucuna</i>		+			3
<i>Hevea</i>		+			1	<i>Parkia</i>		+			9
<i>Macaranga</i>		+			1	<i>Tamarindus</i>	+				2
<i>Sapium</i>	+				1	unidentified					2
<i>Uapaca</i>	+				2	Liliaceae					
Fagaceae						<i>Collospermum</i>	+				1
<i>Castanopsis</i>			+		1	Loganiaceae					
Flacourtiaceae						<i>Anthocleista</i>	+				3
<i>Aphloia</i>					1	<i>Fagraea</i>	+	+			3
<i>Muntingia</i>	+				3	Loranthaceae					
Gingkoaceae						<i>Amyema</i>		+			1
<i>Ginkgo</i>			+		1	<i>Loranthus</i>		+			2
Guttiferae						Melastomataceae					
<i>Calophyllum</i>	+	+			7	<i>Melastoma</i>	+				1
<i>Garcinia</i>	+				2	Meliaceae					
<i>Mammea</i>	+	+			1	<i>Aglaiia</i>	+				1
<i>Pentadesma</i>		+			1	<i>Azadirachta</i>	+	+			3
Heliconiaceae						<i>Dysoxylum</i>	+	+			2
<i>Heliconia</i>		+			1	<i>Ekebergia</i>	+				1
Hernandiaceae						<i>Lansium</i>	+				2
<i>Hernandia</i>	+				1	<i>Melia</i>	+	+			4
Juglandaceae						<i>Sandoricum</i>	+				1
<i>Carya</i>		+			2	<i>Trichilia</i>	+				1
						Moraceae					
						<i>Antiaris</i>	+				1
						<i>Artocarpus</i>	+	+	+	+	13
						<i>Chlorophora</i>	+		+		4
						<i>Cudrania</i>	+				1
						<i>Ficus</i>	+		+	+	64
						<i>Morus</i>	+		+	+	5

Family/genus	Source of food				Taxa	Family/genus	Source of food				Taxa	
	Fruit	Flowers	Leaves	Other			Fruit	Flowers	Leaves	Other		
Morinaceae						Pittosporaceae						
<i>Morina</i>	+				1	<i>Pittosporum</i>	+				1	
Musaceae						Podocarpaceae						
<i>Musa</i>	+	+			37	<i>Podocarpus</i>	+				1	
Myristicaceae						Proteaceae						
<i>Pycnathus</i>	+				1	<i>Banksia</i>		+			4	
Myrsinaceae						<i>Grevillea</i>		+			5	
<i>Ardisia</i>	+				1	<i>Protea</i>		+			1	
Myrtaceae						Rhamnaceae						
<i>Angophora</i>			+		3	<i>Berchemia</i>	+				1	
<i>Callistemon</i>			+		2	<i>Maesopsis</i>					1	
<i>Decaspermum</i>	+				1	<i>Rhamnus</i>	+				1	
<i>Eucalyptus</i>	+				6	<i>Ziziphus</i>	+				1	
<i>Eugenia</i>	+	+			14	Rhizophoraceae						
<i>Leptospermum</i>			+		1	<i>Rhizophora</i>			+		1	
<i>Lophostemon</i>			+		3	Rosaceae						
<i>Metrosideros</i>			+		1	<i>Cydonia</i>	+				1	
<i>Melaleuca</i>			+	+	6	<i>Eriobotrya</i>	+	+			4	
<i>Psidium</i>	+	+			27	<i>Malus</i>	+				2	
<i>Syncarpia</i>			+		4	<i>Prunus</i>	+				5	
<i>Syzygium</i>	+	+			12	<i>Pyrus</i>					1	
Oleaceae						<i>Rhaphiolepis</i>			+		1	
<i>Olea</i>	+				1	Rubiaceae						
Palmae						<i>Aidia</i>	+	+			1	
<i>Archontophoenix</i>	+				2	<i>An thocephalus</i>	+				1	
<i>Areca</i>	+				1	<i>Coffea</i>	+				1	
<i>Arecastrum</i>	+				1	<i>Guettarda</i>	+	+	+		2	
<i>Arenga</i>		+			1	<i>Morinda</i>	+	+			2	
<i>Borassus</i>	+				2	<i>Nauclea</i>	+	+			3	
<i>Carpentaria</i>		+			1	<i>Pyrostria</i>					1	
<i>Clinostigma</i>	+				1	<i>Randia</i>	+				1	
<i>Cocos</i>	+	+		+	21	Rutaceae						
<i>Elaeis</i>					1	<i>Acronychia</i>	+				1	
<i>Gulubia</i>			+		1	<i>Citrus</i>	+				8	
<i>Hyophorbe</i>					1	Salicaceae						
<i>Latania</i>					1	<i>Populus</i>			+	+	+	2
<i>Livistona</i>			+		3	Salvadoraceae						
<i>Phoenix</i>	+				6	<i>Salvadora</i>	+	+			2	
Unidentified		+	+		1	Sapindaceae						
Pandanaceae						<i>Cupaniopsis</i>	+				1	
<i>Freycinetia</i>	+	+		+	5	<i>Dimocarpus</i>	+				1	
<i>Pandanus</i>	+	+	+		8	<i>Diploglottis</i>		+			1	
Passifloraceae						<i>Litchi</i>	+				5	
<i>Adenia</i>	+				5	<i>Nephelium</i>	+				4	
<i>Passiflora</i>	+				3	<i>Pometia</i>	+				1	
<i>Smeathmannia</i>	+				1	<i>Tristiropsis</i>	+	+			3	
Piperaceae						<i>Xanthoceras</i>					1	
<i>Piper</i>	+				2							

Family/genus	Source of food				Taxa
	Fruit	Flowers	Leaves	Other	
Sapotaceae					
<i>Chrysophyllum</i>	+				1
<i>Madhuca</i>	+	+			2
<i>Manilkara</i>	+				1
<i>Mimusops</i>	+	+			3
<i>Northea</i>	+				1
<i>Palaquium</i>	+				3
<i>Planchonella</i>	+	+			3
<i>Pouteria</i>	+				1
<i>Sideroxylon</i>	+				1
<i>Vitellaria</i>	+	+			4
Simaroubaceae					
<i>Irvingia</i>	+				1
Smilacaceae					
<i>Smilax</i>				+	1
Solanaceae					
<i>Cestrum</i>	+				1
<i>Physalis</i>		+			1
<i>Solatium</i>	+				8
Sonneratiaceae					
<i>Duabanga</i>		+			2
<i>Sonneratia</i>	+	+	+		7
Sterculiaceae					
<i>Cola</i>					1
<i>Theobroma</i>			+		1
Strelitziaceae					
<i>Ravenala</i>		+			1

Family/genus	Source of food				Taxa
	Fruit	Flowers	Leaves	Other	
Tamaricaceae					
<i>Tamarix</i>		+	+	+	1
Theaceae					
<i>Eurya</i>	+				1
<i>Schima</i>				+	1
Ulmaceae					
<i>Celtis</i>	+				2
<i>Trenta</i>					1
Urticaceae					
<i>Dendrocnidne</i>	+	+			2
<i>Pipturus</i>	+	+			2
Verbenaceae					
<i>Avicennia</i>		+	+		3
<i>Faradaya</i>	+				1
<i>Premna</i>	+				1
<i>Vitex</i>	+				2
Viscaceae					
<i>Viscum</i>	+				1
Vitaceae					
<i>Cissus</i>	+				1
Xanthorrhoeaceae					
<i>Xanthorrhoea</i>		+			1
Zingiberaceae					
<i>Alpinia</i>	+			+	1
Zygopyllaceae					
<i>Balanites</i>			+		1

Appendix 2. Geographical Units Used in Biodiversity Analysis

Area No.	Name	Other sites included	Area No.	Name	Other sites included
128	Taiwan		333	Senegal	Gambia
129	Ryukyu Arch.		334	Mali	
130	Ogasawara-shato	Kazan-retto	335	Uganda	
164	Batan	Camiguin	337	Seychelles	
171	Mariana Is.		338	Sri Lanka	
193	Turkey		339	Nicobar Is.	
198	SE China	Hong Kong	340	N Pen. Malaysia	
200	Luzon		345	Basilan	
201	Polillo		346	Sangir Is.	
202	Catanduanes		348	Talud Islands	Sarangani, Miangas
207	Caroline Is.	Pohnpei, Yap	349	Waigeo	
228	Cyprus		350	Numfoor	
229	Middle East	Israel, Lebanon, Syria	351	Yapen	
230	NW India		353	Admiralty Islands	
231	Tibet		355	New Ireland	Boang, Lihir, Tabar
232	SW China		356	Mortlock Islands	
236	Tablas	Carabao	357	Ontong Java Atoll	N'Dai
237	Masbate	Maripipi	368	Sierra Leone	
239	Leyte	Biliran	369	Ivory Coast	
240	Samar		370	Burkina Faso	
242	Belau	Kosrae	371	Rwanda	
243	Chuuk		372	Ethiopia	
249	Rotuma	Wallis and Futuna	373	Pemba	
250	W. Samoa		375	Mergui Arch.	
251	Am. Samoa		376	S Pen. Malaysia	
264	Egypt		377	E Pen. Malaysian Is.	Aur, Great Redang, Lang Tengah, Perhentians, Tioman
265	Pen. Arabia	Saudi Arabia, Yemen, Oman			
266	Nepal		378	Natuna Islands	Tambelan Islands
267	NE India	Pakistan	379	Balabac	Banggi
268	Burma		380	Sulu Arch.	Bongao, Jolo, Sanga Sanga, Sibutu, Simunul, Tawitawi
271	Mindoro	Lubang			
272	Panay	Caluya, Guimaras	382	Siau	
273	Negros		383	Ternate	
274	Cebu		384	Halmahera	
275	Bohol		385	Morotai	Rau
285	Fiji		386	Salawati	Batanta
286	Tonga		387	W Irian Jaya	
287	Cook Is.	Niue	388	Manam	Schouten Islands
298	Niger		389	Karkar Island	Bagabag
299	Chad		390	Umboi	Crown, Long, Sakar, Tolokiwa
300	Sudan		391	New Britain	Duke of York
302	Pen. India		392	Bougainville	Buka
303	Andaman Is.		393	Choiseul	
304	Pen. Thailand		394	Santa Isabel	
305	Indo-China	Vietnam, Laos, Cambodia	395	Malaita	
307	Palawan	Busuanga, Culion, Cuyo	404	Liberia	
308	Cagayan		405	Ghana	
310	Mindanao	Malanipa, Samal	406	Nigeria	
311	Dinagat	Siargao	407	Burundi	
315	Biak	Owii	408	Somalia	
318	Emirau		409	Mafia	
332	Guinea	Ginea-Bissau	410	Maldives	

Area No.	Name	Other sites included	Area No.	Name	Other sites included
411	Langkawi		492	Wetar	
412	Singapore		494	Banda Islands	
413	Anamba Islands		495	Kai Islands	
414	SW Borneo	Sarawak, Brunei	498	Misima Island	Heath Island, Panaeati Island
415	N Borneo	Sabah	499	Tagula Rossel Island	
416	Sulawesi	Togian Islands	502	Rennell	
417	Banggai Islands	Peleng	504	Santa Cruz Islands	
418	Sula Islands		513	Gabon	
419	Bacan		514	NW Zaire	
420	Obi		515	NE Zaire	
421	Gebe		516	Malawi	
422	Misool		517	Anjouan (Comoros)	Moheli
423	E Irian Jaya		519	Mentawai Islands	
424	Papua		520	S Sumatra	
426	Trobriand Islands		521	Jawa	Madura
427	Muyua	Alcester Island	522	Bali	Penida
428	Shortland	Alu, Fauro, Mono	523	Lombok	
429	Vella Lavella		524	Sumbawa	
430	New Georgia		525	Flores	
431	Florida Islands		527	Alor	
432	San Cristobal	Uki Ni Masi	528	Kisar	
441	Togo		529	Babar	
442	Cameroun		530	Tenimber Islands	
443	Central African Rep.		531	Aru Islands	
444	Kenya		539	Loyalty Islands	
445	Aldabra Atoll		540	N Vanuatu	
447	Simalue Islands		548	São Tomé	Príncipe
448	Riau Islands		549	Pagalu (Eq. Guinea)	
449	Lingga Islands	Berhala	550	SW Zaire	
450	Kalimantan	Central and West Kalimantan	551	SE Zaire	
451	Laut	East and South Kalimantan	552	Mozambique	
452	Salayar		553	Mayotte (Comoros)	
453	Buton	Muna	555	Enganno	
455	Buru		556	Krakatau Islands	Sebesi
456	Ambon	Asilulu, Keffing, Panjang, Watubela Islands	557	Christmas Island	
457	Saparua		560	Komodo	
458	Seram	Boana	561	Sumba	
459	Geser	Gorong, Manawoka	563	Timor	Ndao, Rote, Semau, Savu
462	Goodenough		575	New Caledonia	
463	Fergusson	Normanby	576	C Vanuatu	
464	Ranongga	Simbo	586	Angola	
465	Kolombangara	Ghizo	587	Zambia	
467	Guadalcanal	Russell Islands: Mbanika, Pavuvu	588	Zimbabwe	
476	Bioko (Eq. Guinea)		589	Rodrigues	
477	Benin		602	Northern Territory	
478	Mbini (Eq. Guinea)		603	Queensland	
479	Congo		612	S Vanuatu	
480	Tanzania		622	Namibia	
481	Grand Comoro		623	Botswana	
483	Nias		624	Madagascar	
484	N Sumatra		625	Mauritius	
485	Bangka		637	Western Australia	
486	Belitung		639	New South Wales	
487	Bawean		659	South Africa	
488	Kangean Islands	Laut Kecil Islands, Masalembu Besar	660	Swaziland	
489	Kalaotoa	Bonerate, Jampea	675	Victoria	

Appendix 3. Distribution of Fruit Bats

The following list is alphabetical by country. Each country entry begins with a complete list of fruit bats recorded from that country. If further distributional information is available this is then listed alphabetically by locality.

Aldabra Atoll

Pteropus seychellensis aldabrensis

American Samoa

Pteropus samoensis samoensis

P. tonganus tonganus

Tutuila

Pteropus samoensis samoensis

Angola

Eidolon helvum helvum

Epomophorus angolensis

E. gambianus crypturus

E. grandis

E. wahlbergi

Epomops dobsonii

E. franqueti

Hypsignathus monstrosus

Megaloglossus woermanni

Micropteropus intermedius

M. pusillus

Myonycteris torquata

Plerotes anchietae

Rousettus (Lissonycteris) angolensis angolensis

R. (Rousettus) aegyptiacus unicolor

Australia

Dobsonia moluccense magna

Macroglossus minimus pygmaeus

Nyctimene cephalotes

N. robinsoni

N. vizcaccia vizcaccia

Pteropus alecto gouldi

P. brunneus (?extinct)

P. conspicillatus conspicillatus

P. macrotis epularius

P. melanotus natalis

P. poliocephalus

P. scapulatus

Syconycteris australis australis

Christmas Island

Pteropus melanotus natalis

New South Wales

Dobsonia moluccense magna

Nyctimene robinsoni

Pteropus alecto gouldi

P. poliocephalus

P. scapulatus

Northern Territory

Macroglossus minimus pygmaeus

Pteropus alecto gouldi

P. scapulatus

Queensland

Dobsonia moluccense magna

Macroglossus minimus pygmaeus

Nyctimene cephalotes

N. robinsoni

N. vizcaccia vizcaccia

Pteropus alecto gouldi

P. brunneus (?extinct)

P. conspicillatus conspicillatus

P. macrotis epularius

P. poliocephalus

P. scapulatus

Syconycteris australis australis

Boigu Islands

Pteropus macrotis epularius

Fitzroy Island

Pteropus conspicillatus conspicillatus

Moa Island

Nyctimene vizcaccia vizcaccia

Murray Island

Macroglossus minimus pygmaeus

Percy Island

Pteropus brunneus (?extinct)

Victoria

Pteropus poliocephalus

P. scapulatus

Western Australia

Macroglossus minimus pygmaeus

Pteropus alecto gouldi

P. scapulatus

Bangladesh

Cynopterus sphinx sphinx
Pteropus giganteus giganteus
Rousettus (Rousettus) leschenaulti leschenaulti

Belau

Pteropus mariannus pelewensis
P. pilosus (extinct)

Benin

Eidolon helvum helvum
Epomophorus gambianus gambianus
Epomops franqueti
Micropteropus pusillus

Bhutan

Sphaerias blanfordi

Botswana

Epomophorus gambianus crypturus
Epomops dobsonii

Brunei

Aethalops alecto aequalis
Balionycteris maculata maculata
Chironax melanocephalus melanocephalus
Cynopterus brachyotis brachyotis
C. horsfieldii persimilis
Dyacopterus spadiceus spadiceus
Eonycteris major major
Macroglossus minimus lagochilus
Megaerops ecaudatus
M. wetmorei albicollis
Penthetor lucasi
Pteropus vampyrus natunae
Rousettus (Rousettus) amplexicaudatus amplexicaudatus

Burkina Faso

Eidolon helvum helvum
Epomophorus gambianus gambianus
Hypsignathus monstrosus
Micropteropus pusillus
Rousettus (Lissonycteris) angolensis smithii

Burma

Cynopterus sphinx sphinx
Eonycteris spelaea spelaea
Macroglossus sobrinus sobrinus
Pteropus giganteus giganteus
P. hypomelanus geminorum
P. vampyrus intermedius
Rousettus (Rousettus) amplexicaudatus amplexicaudatus

R. (R.) leschenaulti leschenaulti
Sphaerias blanfordi

Mergui Archipelago

Pteropus hypomelanus geminorum

South Twin Island

Pteropus hypomelanus geminorum

Burundi

Eidolon helvum helvum
Epomophorus labiatus
E. wahlbergi
Micropteropus pusillus
Rousettus (Rousettus) aegyptiacus leachii
R. (R.) lanosus lanosus

Cambodia

Pteropus hypomelanus condorensis
P. lylei
Rousettus (Rousettus) amplexicaudatus amplexicaudatus
R. (R.) leschenaulti leschenaulti

Cameroun

Casinycteris argynnis
Eidolon helvum helvum
Epomophorus gambianus gambianus
E. wahlbergi
Epomops franqueti
Hypsignathus monstrosus
Megaloglossus woermanni
Micropteropus pusillus
Myonycteris torquata
Nanonycteris veldkampii
Rousettus (Lissonycteris) angolensis angolensis
R. (Rousettus) aegyptiacus unicolor
Scotonycteris ophiodon
S. zenkeri

Central African Republic

Eidolon helvum helvum
Epomophorus gambianus gambianus
E. g. pousarguesi
Epomops franqueti
Hypsignathus monstrosus
Megaloglossus woermanni
Micropteropus pusillus
Myonycteris torquata
Nanonycteris veldkampii
Rousettus (Lissonycteris) angolensis angolensis
Scotonycteris zenkeri

Chad

Eidolon helvum helvum
Epomophorus gambianus gambianus

E. labiatus
Micropteropus pusillus

China

Cynopterus sphinx angulatus
Eonycteris spelaea spelaea
Pteropus giganteus chinghaiensis
Rousettus (Rousettus) leschenaulti leschenaulti
Sphaerias blanfordi

Commonwealth of the Northern Mariana Islands

Pteropus mariannus (subspecies unidentified)
P. mariannus mariannus
P. mariannus paganensis

Agrihan

Pteropus mariannus (subspecies unidentified)

Aguijan

Pteropus mariannus mariannus

Almagan

Pteropus mariannus paganensis

Anatahan

Pteropus mariannus (subspecies unidentified)

Ascuncion

Pteropus mariannus (subspecies unidentified)

Farallon de Medinella

Pteropus mariannus (subspecies unidentified)

Guguan

Pteropus mariannus (subspecies unidentified)

Maug

Pteropus mariannus (subspecies unidentified)

Pagan

Pteropus mariannus paganensis

Rota

Pteropus mariannus mariannus

Saipan

Pteropus mariannus mariannus

Sarigan

Pteropus mariannus (subspecies unidentified)

Tinian

Pteropus mariannus mariannus

Comoros

Pteropus livingstonii
P. seychellensis comorensis

Rousettus (Rousettus) obliviosus

Anjouan

Pteropus livingstonii
P. seychellensis comorensis
Rousettus (Rousettus) obliviosus

Grand Comore

Pteropus seychellensis comorensis
Rousettus (Rousettus) obliviosus

Mafia

Pteropus seychellensis comorensis

Mayotte

Pteropus seychellensis comorensis

Moheli

Pteropus livingstonii
P. seychellensis comorensis
Rousettus (Rousettus) obliviosus

Congo

Eidolon helvum helvum
Epomophorus grandis
E. labiatus
E. wahlbergi
Epomops franqueti
Hypsignathus monstrosus
Megaloglossus woermanni
Micropteropus pusillus
Myonycteris torquata
Rousettus (Lissonycteris) angolensis angolensis
R. (Rousettus) aegyptiacus unicolor
Scotonycteris ophiodon
S. zenkeri

Cook Islands

Pteropus tonganus tonganus

Mangaia

Pteropus tonganus tonganus

Rarotonga

Pteropus tonganus tonganus

Cyprus

Rousettus (Rousettus) aegyptiacus aegyptiacus

Egypt

Rousettus (Rousettus) aegyptiacus aegyptiacus

Equatorial Guinea

Eidolon helvum helvum
Epomophorus wahlbergi

Epomops franqueti
Hypsignathus monstrosus
Megaloglossus woermanni
Micropteropus pusillus
Myonycteris torquata
Rousettus (Lissonycteris) angolensis angolensis
R. (Rousettus) aegyptiacus unicolor
Scotonycteris zenkeri

Bioko

Eidolon helvum helvum
Hypsignathus monstrosus
Megaloglossus woermanni
Myonycteris torquata
Rousettus (Lissonycteris) angolensis angolensis
R. (Rousettus) aegyptiacus unicolor
Scotonycteris zenkeri

Mbini

Eidolon helvum helvum
Epomophorus wahlbergi
Epomops franqueti
Hypsignathus monstrosus
Megaloglossus woermanni
Micropteropus pusillus
Myonycteris torquata
Rousettus (Lissonycteris) angolensis angolensis
R. (Rousettus) aegyptiacus unicolor
Scotonycteris zenkeri

Pagalu

Eidolon helvum helvum

Ethiopia

Eidolon helvum helvum
Epomophorus gambianus gambianus
E. labiatus
E. minor
?E. wahlbergi
Micropteropus pusillus
Rousettus (Lissonycteris) angolensis ruwenzorii
IR (Rousettus) aegyptiacus arabicus
R. (R.) a. leachii
R. (R.) lanosus kempfi

Federated States of Micronesia

Chuuk

Pteropus insularis
?Pteropus molossinus
P. phaeocephalus

Mortlock Islands

Pteropus molossinus
P. phaeocephalus

Kosrae

Pteropus mariannus ualanus

Pohnpei

Pteropus molossinus

Ant Atoll

Pteropus molossinus

Pakin Atoll

Pteropus molossinus

Yap

Pteropus mariannus ulthiensis
P. m. yapensis

Ulithi Atoll

Pteropus mariannus ulthiensis

Fiji

Notopteris macdonaldii macdonaldii
Pteralopex acrodonta
Pteropus samoensis nawaiensis
P. tonganus tonganus

Nayau

Pteropus samoensis nawaiensis

Ovalau

Pteropus samoensis nawaiensis

Taveuni

Pteralopex acrodonta
Pteropus samoensis nawaiensis

Vanua Levu

Pteropus samoensis nawaiensis

Viti Levu

Notopteris macdonaldii macdonaldii
Pteropus samoensis nawaiensis

Gabon

Eidolon helvum helvum
Epomophorus wahlbergi
Epomops franqueti
Hypsignathus monstrosus
Megaloglossus woermanni
Micropteropus pusillus
Myonycteris torquata
Rousettus (Lissonycteris) angolensis angolensis
R. (Rousettus) aegyptiacus unicolor
Scotonycteris zenkeri

Gambia

Eidolon helvum helvum
Epomophorus gambianus gambianus
?Hypsignathus monstrosus
Micropteropus pusillus
Rousettus (Rousettus) aegyptiacus unicolor

Ghana

Eidolon helvum helvum
Epomophorus gambianus gambianus
Epomops buettikoferi
E. franqueti
Hypsignathus monstrosus
Megaloglossus woermanni
Micropteropus pusillus
Myonycteris torquata
Nanonycteris veldkampii
Rousettus (Lissonycteris) angolensis smithii
R. (Rousettus) aegyptiacus unicolor
Scotonycteris ophiodon
S. zenkeri

Guam

Pteropus mariannus mariannus
P. tokudae (extinct)

Guinea

Eidolon helvum helvum
Epomophorus gambianus gambianus
Epomops buettikoferi
Megaloglossus woermanni
Micropteropus pusillus
Myonycteris torquata
Nanonycteris veldkampii
Rousettus (Lissonycteris) angolensis smithii
R. (Rousettus) aegyptiacus unicolor

Guinea-Bissau

Eidolon helvum helvum
Epomophorus gambianus gambianus
Micropteropus pusillus
Rousettus (Lissonycteris) angolensis smithii

Hong Kong

Rousettus (Rousettus) leschenaulti leschenaulti

India

Cynopterus brachyotis brachyotis
C. b. brachysoma
C. sphinx gangeticus
C. s. scherzeri
C. s. sphinx
Eonycteris spelaea spelaea
Latidens salimalii
Megarops niphanae
Pteropus faunulus
P. giganteus giganteus
P. g. leucocephalus
P. melanotus melanotus
P. m. satyrus
P. m. tytleri

Rousettus (Rousettus) leschenaulti leschenaulti
Sphaerias blanfordi

Andaman Islands

Cynopterus brachyotis brachysoma
Eonycteris spelaea spelaea
Pteropus giganteus giganteus
P. melanotus satyrus
P. m. tytleri

Mainland India

Cynopterus sphinx gangeticus
C. sphinx sphinx
Eonycteris spelaea spelaea
Latidens salimalii
Megarops niphanae
Pteropus giganteus giganteus
P. giganteus leucocephalus
Rousettus (Rousettus) leschenaulti leschenaulti
Sphaerias blanfordi

Nicobar Islands

Cynopterus brachyotis brachyotis
C. sphinx scherzeri
Pteropus faunulus
P. melanotus melanotus

Car Nicobar

Cynopterus sphinx scherzeri
Pteropus faunulus
P. melanotus melanotus

Great Nicobar

?*Cynopterus sphinx scherzeri*

Indonesia

Acerodon celebensis
A. humilis
A. macklotii alorensis
A. m. floresii
A. m. gilvus
A. m. macklotii
A. m. prajae
A. a. alecto
A. a. ocypete
Balionycteris maculata maculata
B. m. seimundi
Chironax melanocephalus melanocephalus
C. m. tumulus
Cynopterus brachyotis brachyotis
C. b. concolor
C. b. insularum
C. b. javanicus
C. b. minutus
C. horsfieldii harpax
C. h. horsfieldii
C. h. persimilis
C. h. princeps
C. sphinx angulatus

C. s. babi
C. s. pagensis
C. s. serasani
C. titthaechelilus major
C. t. terminus
C. t. titthaechelilus
Dobsonia beauforti
D. emersa
D. exoleta
D. minor
D. moluccense magna
D. m. moluccense
D. peronii grandis
D. p. peronii
D. p. sumbana
D. p. ssp. incertae sedis
D. viridis crenulata
D. v. viridis
Dyacopterus spadiceus brooksi
Eonycteris major major
E. spelaea glandifera
E. s. rosenbergii
E. s. spelaea
Harpyionycteris whiteheadi celebensis
Macroglossus minimus lagochilus
M. m. minimus
M. m. nanus
M. sobrinus fraternus
M. s. sobrinus
Megaerops ecaudatus
M. kusnotoi
Neopteryx frosti
Nyctimene aello
N. albiventer albiventer
N. a. papuanus
N. celaeno
N. cephalotes
N. cyclotis certans
N. c. cyclotis
N. draconilla
N. minutus minutus
N. m. varius
Paranyctimene raptor
Penthetor lucasi
Pteropus alecto alecto
P. a. aterrimus
P. a. gouldi
P. a. morio
?P. argentatus
P. caniceps caniceps
P. c. dobsoni
P. chrysoproctus
P. conpicillatus chrysauchen
P. griseus griseus
P. g. mimus
P. g. pallidus
P. hypomelanus annectens
P. h. canus
P. h. enganus
P. h. fretensis
P. h. hypomelanus
P. h. lepidus
P. h. macassaricus
P. h. simalurus
P. h. tomesi
P. lombocensis lombocensis
P. l. solitarius
P. macrotis epularius
P. m. macrotis
P. melanopogon aruensis
P. m. keyensis
P. m. melanopogon
P. melanotus modiglianii
P. m. niadicus
P. neohibernicus neohibernicus
P. ocularis
P. personatus
P. pohlei
P. pumilus
P. speciosus
P. temmincki liops
P. t. temmincki
P. vampyrus edulis
P. v. malaccensis
P. v. natunae
P. v. pluton
P. v. vampyrus
Rousettus (Boneia) bidens
R. (Rousettus) amplexicaudatus amplexicaudatus
?R. (R.) a. brachyotis
R. (R.) a. infumatus
R. (R.) celebensis
R. (R.) leschenaulti shorridgei
R. (R.) spinalatus
Styloctenium wallacei
Syconycteris australis keyensis
S. a. major
S. a. papuana
S. carolinae
Thoopterus nigrescens

Alor

Acerodon macklotii alorensis
Dobsonia peronii ssp. incertae sedis
Pteropus lombocensis solitarius
Rousettus (Rousettus) amplexicaudatus amplexicaudatus

Ambon

Dobsonia moluccense moluccense
D. viridis viridis
Macroglossus minimus lagochilus
Nyctimene cephalotes
?Pteropus argentatus
P. chrysoproctus
P. melanopogon melanopogon
P. temmincki temmincki
Rousettus (Rousettus) amplexicaudatus amplexicaudatus
Syconycteris australis major (+ small islands nearby?)

Anamba Islands

Pteropus hypomelanus lepidus
P. vampyrus malaccensis

Jimaja

Pteropus hypomelanus lepidus

Aru Islands

Dobsonia moluccense moluccense
Macroglossus minimus nanus
Pteropus macrotis macrotis
P. melanopogon aruensis
 ?*Rousettus (Rousettus) leschenaulti shortridgei*
Syconycteris australis papuana

Wokam

Pteropus macrotis macrotis

Asilulu (off Ambon)

Pteropus chrysoproctus

Babar

Dobsonia peronii ssp. *incertae sedis*

Babi Island

Cynopterus sphinx babi

Bacan

Dobsonia viridis crenulata
Pteropus caniceps caniceps
P. conspicillatus chrysauchen
P. personatus

Bali

Cynopterus brachyotis javanicus
C. titthaechelus titthaechelus
Eonycteris spelaea glandifera
Macroglossus minimus minimus
Pteropus vampyrus pluton
Rousettus (Rousettus) amplexicaudatus infumatus
R. (R.) leschenaulti shortridgei

Banda Islands

Dobsonia viridis viridis
Macroglossus minimus lagochilus
Pteropus griseus pallidus
P. melanopogon melanopogon

Banggai Islands

Dobsonia viridis crenulata

Bangka

Cynopterus brachyotis brachyotis
Pteropus vampyrus malaccensis

Batanta (south of Waigeo)

Dobsonia moluccense magna

Bawean (north of Jawa)

Pteropus alecto aterrimus

Belitung

Cynopterus brachyotis brachyotis

Berhala (Straits of Malacca)

Pteropus hypomelanus fretensis

Biak (off north-west New Guinea)

Dobsonia beauforti
D. emersa

Boano

Pteropus melanopogon melanopogon

Bonerate

Pteropus griseus griseus

Borneo

Balionycteris maculata maculata
Cynopterus brachyotis brachyotis
C. horsfieldii persimilis
C. sphinx angulatus
Eonycteris major major
E. spelaea glandifera
Macroglossus minimus lagochilus
Megaerops ecaudatus
Penthetor lucasi
Pteropus hypomelanus tomesi (offshore islands only)
P. vampyrus natunae
Rousettus (Rousettus) amplexicaudatus amplexicaudatus

Central Kalimantan

Cynopterus brachyotis brachyotis
C. horsfieldii persimilis
C. sphinx angulatus
Penthetor lucasi
Pteropus vampyrus natunae

East Kalimantan

Cynopterus brachyotis brachyotis
Eonycteris major major
E. spelaea glandifera
Macroglossus minimus lagochilus
Megaerops ecaudatus
Penthetor lucasi
Pteropus hypomelanus tomesi
P. vampyrus natunae
 Bilang Bilang: *Pteropus hypomelanus tomesi*

South Kalimantan

Cynopterus brachyotis brachyotis
C. horsfieldii persimilis
Eonycteris major major
E. spelaea glandifera
Macroglossus minimus lagochilus
Penthetor lucasi
Pteropus vampyrus natunae

West Kalimantan

Balionycteris maculata maculata
Cynopterus brachyotis brachyotis

C. horsfieldii persimilis
Macroglossus minimus lagochilus
Megaerops ecaudatus
Penthetor lucasi
Pteropus vampyrus natunae
Rousettus (Rousettus) amplexicaudatus amplexicaudatus

Buru

Dobsonia moluccense moluccense
D. viridis viridis
Macroglossus minimus lagochilus
Nyctimene cephalotes
N. minutus varius
Pteropus chrysoproctus
P. melanopogon melanopogon
P. ocularis
P. temmincki liops
?Syconycteris australis major

Enggano

Cynopterus brachyotis concolor
Pteropus hypomelanus enganus
P. melanotus modiglianii
Rousettus (Rousettus) amplexicaudatus amplexicaudatus

Flores

Acerodon macklotii floresii
Dobsonia peronii ssp. incertae sedis
Pteropus lombocensis lombocensis
Rousettus (Rousettus) amplexicaudatus infumatus

Gebe

Pteropus conspicillatus chrysauchen
P. neohibernicus neohibernicus

Gorong Islands

Pteropus chrysoproctus
P. melanopogon melanopogon

Manawoka

Pteropus melanopogon melanopogon

Panjang

Pteropus chrysoproctus

Halmahera

Dobsonia moluccense moluccense
D. viridis crenulata
Nyctimene albiventer albiventer
Pteropus caniceps caniceps
P. hypomelanus hypomelanus
P. personatus
Rousettus (Rousettus) amplexicaudatus amplexicaudatus
?R. (R.) a. brachyotis
Syconycteris carolinae

Irian Jaya

Dobsonia minor
D. moluccense magna
Macroglossus minimus nanus

Nyctimene aello
N. albiventer papuanus
N. celaeno
N. cephalotes
N. cyclotis certans
N. c. cyclotis
N. draconilla
Paranyctimene raptor
Pteropus alecto gouldi
P. conspicillatus chrysauchen
P. macrotis epularius
P. neohibernicus neohibemicus
Rousettus (Rousettus) amplexicaudatus amplexicaudatus
Syconycteris australis papuana

Jampea

Pteropus griseus griseus

Jawa

Aethalops alecto ocypete
Chironax melanocephalus melanocephalus
Cynopterus brachyotis javanicus
C. horsfieldii horsfieldii
C. titthaecheilus titthaecheilus
Eonycteris spelaea glandifera
E. s. spelaea
Eonycteris spelaea spelaea
Macroglossus minimus minimus
M. sobrinus sobrinus
Megaerops kusnotoi
Pteropus vampyrus vampyrus
Rousettus (Rousettus) amplexicaudatus infumatus
R. (R.) leschenaulti shortridgei

Kai Islands

Dobsonia moluccense moluccense
D. viridis viridis
Macroglossus minimus nanus
Nyctimene albiventer papuanus
Pteropus melanopogon keyensis
Syconycteris australis keyensis

Little Kai

Pteropus melanopogon keyensis

Kangean Islands

Cynopterus brachyotis insularum
Macroglossus minimus minimus
Pteropus alecto aterrimus

Keffing (off south-east Seram)

Pteropus chrysoproctus

Kisar (north-east of Timor)

Rousettus (Rousettus) amplexicaudatus amplexicaudatus

Komodo

Dobsonia peronii grandis

Krakatau Islands

Cynopterus tiithaecheilus tiithaecheilus
Macroglossus sobrinus sobrinus
Pteropus vampyrus vampyrus
Rousettus (Rousettus) amplexicaudatus infumatus

Lang

Rousettus (Rousettus) amplexicaudatus infumatus

Krakatau

Macroglossus sobrinus sobrinus

Sebesi

Pteropus vampyrus vampyrus

Sebuku

Pteropus vampyrus vampyrus

Sertung

Pteropus vampyrus vampyrus

Laut Kecil Islands (off south Borneo)

Cynopterus brachyotis insularum
Pteropus speciosus

Lingga Islands

Pteropus vampyrus malaccensis

Lombok

Acerodon macklotii prajae
Aethalops alecto alecto
Cynopterus brachyotis brachyotis
C. horsfieldii horsfieldii
C. tiithaecheilus tiithaecheilus
Dobsonia peronii grandis
Eonycteris spelaea glandifera
Macroglossus minimus minimus
Pteropus alecto alecto
P. lombocensis lombocensis
P. vampyrus pluton
Rousettus (Rousettus) amplexicaudatus amplexicaudatus
R. (R.) leschenaulti shortridgei

Madura

Cynopterus brachyotis javanicus
Macroglossus minimus minimus

Masalembu Besar

Pteropus speciosus

Mentawai Islands

Cynopterus sphinx pagensis
Macroglossus sobrinus fraternus
Pteropus hypomelanus enganus
P. vampyrus malaccensis
Rousettus (Rousettus) amplexicaudatus amplexicaudatus

Pagai Islands

Cynopterus sphinx pagensis
Pteropus vampyrus malaccensis

Siberut

Cynopterus sphinx pagensis
Macroglossus sobrinus fraternus
Pteropus hypomelanus enganus

Sipura

Cynopterus sphinx pagensis
Macroglossus sobrinus fraternus
Pteropus hypomelanus enganus
P. vampyrus malaccensis

Miangas (formerly in the Philippines)

Pteropus pumilus

Misool

Dobsonia moluccense magna
D. viridis viridis
Macroglossus minimus nanus
Nyctimene aello
Pteropus conspicillatus chrysauchen
P. neohibernicus neohibernicus
Syconycteris australis papuana

Morotai

Dobsonia viridis crenulata
Nyctimene albiventer albiventer
Pteropus caniceps caniceps
P. conspicillatus chrysauchen
P. personatus
Thoopterus nigrescens

Muna (off south-east Sulawesi)

Eonycteris spelaea glandifera

Natuna Islands

Cynopterus sphinx serasani
Macroglossus minimus lagochilus
Pteropus hypomelanus annectens
P. hypomelanus cartus
P. vampyrus natunae

Bunguran Besar

?*Macroglossus minimus lagochilus*
Pteropus vampyrus natunae

Laut

Pteropus hypomelanus canus

Pandak

Pteropus hypomelanus canus

Panjang

Pteropus hypomelanus canus

Serasan

Cynopterus sphinx serasani
Macroglossus minimus lagochilus
Pteropus hypomelanus annectens

Subi Besar

Pteropus hypomelanus annectens

Ndao (south-west of Rote)

Rousettus (Rousettus) amplexicaudatus amplexicaudatus

Nias

Chironax melanocephalus melanocephalus

Cynopterus brachyotis minutus

C. horsfieldii princeps

C. titthaecheilus major

Macroglossus minimus lagochilus

M. sobrinus sobrinus

Pteropus melanotus niadicus

Numfoor

?*Dobsonia emersa*

Nyctimene cephalotes

Obi

Pteropus conspicillatus chrysauchen

Owii (off north-west New Guinea)

Dobsonia beauforti

D. emersa

Peleng

Macroglossus minimus lagochilus

Rousettus (Rousettus) amplexicaudatus amplexicaudatus

Penida

Cynopterus brachyotis javanicus

Dobsonia peronii grandis

Rousettus (Rousettus) amplexicaudatus infumatus

Rau

Dobsonia viridis crenulata

Riau Archipelago

Balionycteris maculata seimundi

Cynopterus brachyotis brachyotis

Penthetor lucasi

Pteropus vampyrus malaccensis

Durian

Balionycteris maculata seimundi

Galang

Balionycteris maculata seimundi

Rote

Rousettus (Rousettus) amplexicaudatus amplexicaudatus

Salawati

Pteropus conspicillatus chrysauchen

Salayar

Acerodon celebensis

Pteropus alecto alecto

P. griseus mimus

Sangir Islands

Acerodon celebensis

Dobsonia viridis viridis

Macroglossus minimus lagochilus

Pteropus hypomelanus macassaricus

Rousettus (Rousettus) celebensis

Thoopterus nigrescens

Sangir

Macroglossus minimus lagochilus

Rousettus (Rousettus) celebensis

Siau

Rousettus (Rousettus) celebensis

Tahulandang

Rousettus (Rousettus) celebensis

Saparua

Pteropus melanopogon melanopogon

Savu

Pteropus alecto morio

P. vampyrus edulis

Rousettus (Rousettus) amplexicaudatus amplexicaudatus

Sebesi

Cynopterus titthaecheilus titthaecheilus

Semau

Pteropus griseus griseus

Seram

Dobsonia moluccense moluccense

D. viridis viridis

Macroglossus minimus lagochilus

Nyctimene cephalotes

Pteropus chrysoproctus

P. melanopogon melanopogon

P. ocularis

P. temmincki temmincki

Rousettus (Rousettus) amplexicaudatus amplexicaudatus

Syconycteris australis major

Simalue Islands

Pteropus hypomelanus simalurus

Rousettus (Rousettus) leschenaulti shortridgei

Tapeh Islet

Pteropus hypomelanus simalurus

Sula Islands

Acerodon celebensis

Pteropus caniceps caniceps

Sula Mangole

Acerodon celebensis

Sulabesi

Pteropus caniceps caniceps

Sulawesi

Acerodon celebensis
Chironax melanocephalus tumulus
Cynopterus brachyotis brachyotis
Dobsonia exoleta
D. minor
D. viridis crenulata
Eonyncteris spelaea glandifera
E. s. rosenbergii
Harpyionycteris whiteheadi celebensis
Macroglossus minimus lagochilus
Neopteryx frosti
Nyctimene cephalotes
N. minutus minutus
Pteropus alecto alecto
P. caniceps dobsoni
P. griseus mimus
P. hypomelanus macassaricus
?P. personatus
Rousettus (Boneia) bidens
R. (Rousettus) amplexicaudatus amplexicaudatus
R. (R.) celebensis
Styloctenium wallacei
Thoopterus nigrescens

Sumatra

Aethalops alecto alecto
Chironax melanocephalus melanocephalus
Cynopterus brachyotis brachyotis
C. horsfieldii harpax
C. sphinx angulatus
C. titthaecheilus titthaecheilus
Dyacopecterus spadiceus brooksi
Eonyncteris spelaea spelaea
Macroglossus sobrinus sobrinus
Megaerops ecaudatus
Penthetor lucasi
Pteropus vampyrus malaccensis
Rousettus (Rousettus) amplexicaudatus infumatus
R. (R.) leschenaulti shortridgei
R. (R.) spinalatus

Sumba

Acerodon macklotii gilvus
Dobsonia peronii sumbana
Eonyncteris spelaea glandifera
Pteropus alecto morio
Rousettus (Rousettus) amplexicaudatus amplexicaudatus

Sumbawa

Acerodon macklotii floresii
Dobsonia peronii grandis
Pteropus vampyrus pluton

Talau Islands

Acerodon humilis
Cynopterus brachyotis brachyotis (and adjacent small islands)
Pteropus hypomelanus macassaricus

Tambelan Islands

Pteropus hypomelanus lepidus

Saddle Island

Pteropus hypomelanus lepidus

Tenimber Islands

Nyctimene cephalotes
Pteropus melanopogon melanopogon

Ternate

Dobsonia viridis crenulata
Nyctimene albiventer albiventer
Pteropus caniceps caniceps
P. conspicillatus chrysauchen
P. hypomelanus hypomelanus
P. personatus
Rousettus (Rousettus) amplexicaudatus amplexicaudatus

Timor

Acerodon macklotii macklotii
Cynopterus titthaecheilus terminus
Dobsonia peronii peronii
Eonyncteris spelaea glandifera
Macroglossus minimus lagochilus
Nyctimene cephalotes
Pteropus griseus griseus
P. vampyrus edulis
Rousettus (Rousettus) amplexicaudatus amplexicaudatus

Togian Islands

Dobsonia viridis crenulata

Waigeo

Dobsonia beauforti
D. moluccense magna
D. viridis crenulata

Watubela Islands

Pteropus chrysoproctus

Wetar

Dobsonia peronii ssp. incertae sedis

Yapen

Dobsonia minor
Pteropus pohlei
Rousettus (Rousettus) amplexicaudatus amplexicaudatus

Iran

Rousettus (Rousettus) aegyptiacus arabicus

Israel

Rousettus (Rousettus) aegyptiacus aegyptiacus

Ivory Coast

Eidolon helvum helvum
Epomophorus gambianus gambianus
Epomops buettikoferi
E. franqueti
Hypsignathus monstrosus
Megaloglossus woermanni
Micropteropus pusillus
Myonycteris torquata
Nanonycteris veldkampii
Rousettus (Lissonycteris) angolensis smithii
R. (Rousettus) aegyptiacus unicolor
Scotonycteris zenkeri

Japan

Pteropus dasymallus daitoensis
P. d. dasymallus
P. d. inopinatus
P. d. yayeyamae
P. mariannus loochoensis
P. pselaphon

Kazan-retto

Pteropus pselaphon

Kita-iwojima
Pteropus pselaphon

Iwojima
Pteropus pselaphon

Minami-iwojima
Pteropus pselaphon

Ogasawara-shato

Pteropus pselaphon

Chichijima
Pteropus pselaphon

Hahajima
Pteropus pselaphon

Ryukyu Archipelago

Pteropus dasymallus daitoensis
P. d. dasymallus
P. d. inopinatus
P. d. yayeyamae
P. mariannus loochoensis

Kita-daitojima
Pteropus dasymallus daitoensis

Minajima
Pteropus dasymallus inopinatus

Minami-daitojima
Pteropus dasymallus daitoensis

Miyako Group
Pteropus dasymallus yayeyamae
Taramajima: *P. d. yayeyamae*

Okinawajima
Pteropus dasymallus inopinatus
P. mariannus loochoensis

Oosumi Group
Pteropus dasymallus dasymallus
Kuchinoerabujima: *P. d. dasymallus*

Tokara Group
Pteropus dasymallus dasymallus
Akusekijima: *P. d. dasymallus*
Nakanoshima: *P. d. dasymallus*
Tairajima: *P. d. dasymallus*
Takarajima: *P. d. dasymallus*

Yaeyama Group
Pteropus dasymallus yayeyamae
Haterumajima: *P. d. yayeyamae*
Hatomajima: *P. d. yayeyamae*
Iriomotejima: *P. d. yayeyamae*
Ishigakijima: *P. d. yayeyamae*
Kohamajima: *P. d. yayeyamae*
Kuroshima: *P. d. yayeyamae*
Taketomijima: *P. d. yayeyamae*
Yonagunijima: *P. d. yayeyamae*

Kenya

Eidolon helvum helvum
Epomophorus labiatus
E. minor
E. wahlbergi
Hypsignathus monstrosus
Micropteropus pusillus
Myonycteris relicta
Rousettus (Lissonycteris) angolensis ruwenzorii
R. (Rousettus) aegyptiacus leachii
R. (R.) lanosus kempfi

Laos

Rousettus (Rousettus) leschenaulti leschenaulti

Lebanon

Rousettus (Rousettus) aegyptiacus aegyptiacus

Liberia

Eidolon helvum helvum
Epomophorus gambianus gambianus
Epomops buettikoferi
Hypsignathus monstrosus
Megaloglossus woermanni
Micropteropus pusillus
Myonycteris torquata

Nanonycteris veldkampii
Rousettus (Lissonycteris) angolensis smithii
R. (Rousettus) aegyptiacus unicolor
Scotonycteris ophiodon
S. zenkeri

Madagascar

Eidolon dupreanum
Pteropus rufus
Rousettus (Rousettus) madagascariensis

Malawi

Eidolon helvum helvum
Epomophorus gambianus crypturus
E. labiatus
E. minor
E. wahlbergi
Epomops dobsonii
Rousettus (Rousettus) aegyptiacus leachii

Malaysia

Aethalops alecto aequalis
A. a. alecto
Balionycteris maculata maculata
B. m. seimundi
Chironax melanocephalus melanocephalus
Cynopterus brachyotis altitudinis
C. b. brachyotis
C. horsfieldii harpax
C. h. persimilis
C. sphinx angulatus
Dyacopterus spadiceus spadiceus
Eonycteris major major
E. spelaea glandifera
E. spelaea spelaea
Macroglossus minimus lagochilus
M. sobrinus sobrinus
Megaerops ecaudatus
M. wetmorei albicollis
Penthetor lucasi
Pteropus hypomelanus fretensis
P. h. geminorum
P. h. lepidus
P. h. robinsoni
P. h. tomesi
P. vampyrus malaccensis
P. v. natunae
Rousettus (Rousettus) amplexicaudatus amplexicaudatus
R. (R.) spinalatus

Borneo

Aethalops alecto aequalis
Balionycteris maculata maculata
Chironax melanocephalus melanocephalus
Cynopterus brachyotis brachyotis
C. horsfieldii persimilis
Dyacopterus spadiceus spadiceus

Eonycteris major major
E. spelaea glandifera
Macroglossus minimus lagochilus
Megaerops ecaudatus
Penthetor lucasi
Pteropus hypomelanus tomesi
P. vampyrus natunae
Rousettus (Rousettus) amplexicaudatus amplexicaudatus
R. (R.) spinalatus

Sabah

Aethalops alecto aequalis
Balionycteris maculata maculata
Chironax melanocephalus melanocephalus
Cynopterus brachyotis brachyotis
C. horsfieldii persimilis
Dyacopterus spadiceus spadiceus
Eonycteris major major
E. spelaea glandifera
Macroglossus minimus lagochilus
Megaerops ecaudatus
Penthetor lucasi
Pteropus hypomelanus tomesi
P. vampyrus natunae
Rousettus (Rousettus) amplexicaudatus amplexicaudatus
R. (R.) spinalatus
Balambangan: *Pteropus vampyrus natunae*
Banggi: *Pteropus vampyrus natunae*
Mengalum: *Pteropus hypomelanus tomesi*
Mantanani: *Pteropus hypomelanus tomesi*

Sarawak

Aethalops alecto aequalis
Balionycteris maculata maculata
Cynopterus brachyotis brachyotis
C. horsfieldii persimilis
Dyacopterus spadiceus spadiceus
Eonycteris major major
E. spelaea glandifera
Macroglossus minimus lagochilus
Megaerops ecaudatus
Penthetor lucasi
Pteropus vampyrus natunae
Rousettus (Rousettus) amplexicaudatus amplexicaudatus
R. (R.) spinalatus

Peninsular Malaysia

Aethalops alecto alecto
Balionycteris maculata seimundi
Chironax melanocephalus melanocephalus
Cynopterus brachyotis altitudinis
C. brachyotis brachyotis
C. horsfieldii harpax
C. sphinx angulatus
Dyacopterus spadiceus spadiceus
Eonycteris spelaea spelaea
Macroglossus minimus lagochilus
M. sobrinus sobrinus
Megaerops ecaudatus
M. wetmorei albicollis

Penthetor lucasi
Pteropus hypomelanus fretensis
P. h. geminorum
P. h. lepidus
P. h. robinsoni
P. vampyrus malaccensis
Rousettus (Rousettus) amplexicaudatus amplexicaudatus

Aur
Pteropus hypomelanus lepidus

Babi
Cynopterus brachyotis brachyotis

Great Redang
Cynopterus brachyotis brachyotis
Pteropus hypomelanus lepidus

Jerak (west of the Sembilan Islands, Straits of Malacca)
Pteropus hypomelanus fretensis

Langkawi
Cynopterus brachyotis brachyotis
Eonycteris spelaea spelaea
Macroglossus minimus lagochilus
Rousettus (Rousettus) amplexicaudatus amplexicaudatus

Lang Tengah
Pteropus hypomelanus lepidus

Pangkor
Cynopterus brachyotis brachyotis

Paya Island (south-east of Langkawi, off Kedah)
Pteropus hypomelanus geminorum

Pemanggil
Pteropus hypomelanus lepidus

Penang
Cynopterus brachyotis brachyotis
C. horsfieldii harpax

Perhentians
Pteropus hypomelanus lepidus

Pisang (off Johore)
Cynopterus brachyotis brachyotis

Sembilan Islands
Pteropus hypomelanus robinsoni
Lallang: *P. h. robinsoni*
Rumbia: *P. h. robinsoni*

Sri Buat (=Rawa)
Cynopterus brachyotis brachyotis
Macroglossus minimus lagochilus

Tinggi
Cynopterus brachyotis brachyotis

Tioman
Cynopterus brachyotis brachyotis
Eonycteris spelaea spelaea
Macroglossus minimus lagochilus
Pteropus hypomelanus lepidus

Tulai (near Tioman)
Cynopterus brachyotis brachyotis

Maldives

Pteropus giganteus ariel
P. hypomelanus marts

Mali

Eidolon helvum helvum
Epomophorus gambianus gambianus
Micropteropus pusillus

Mauritius

Pteropus niger
P. rodricensis (extinct on Mauritius)
P. subniger (extinct)

Mauritius

Pteropus niger
P. rodricensis (extinct)
P. subniger (extinct)

Rodrigues

Pteropus rodricensis

Mozambique

Eidolon helvum helvum
Epomophorus gambianus crypturus
E. wahlbergi
Rousettus (Lissonycteris) angolensis ruwenzorii
R. (Rousettus) aegyptiacus leachii

Namibia

Eidolon helvum helvum
Epomophorus angolensis
E. gambianus crypturus
E. wahlbergi

Nepal

Pteropus giganteus leucocephalus
Rousettus (Rousettus) leschenaulti leschenaulti

New Caledonia

Notopteris macdonaldii neocaledonica
Pteropus ornatus auratus
P. o. ornatus

P. tonganus geddiei
P. vetulus

Loyalty Islands

Pteropus ornatus auratus
P. tonganus geddiei
P. vetulus

Lifou

Pteropus ornatus auratus

Mare

Pteropus ornatus auratus

New Caledonia

Pteropus ornatus ornatus
P. vetulus

Niger

Eidolon helvum helvum
Epomophorus gambianus gambianus

Nigeria

Eidolon helvum helvum
Epomophorus gambianus gambianus
E. labiatus
Epomops buettikoferi
E. franqueti
Hypsignathus monstrosus
Megaloglossus woermanni
Micropteropus pusillus
Myonycteris torquata
Nanonycteris veldkampii
Rousettus (Lissonycteris) angolensis angolensis
R. (L.) angolensis smithii
R. (Rousettus) aegyptiacus unicolor

Scotonycteris zenkeri

Niue

Pteropus tonganus tonganus

Oman

Rousettus (Rousettus) aegyptiacus arabicus

Pakistan

Pteropus giganteus giganteus
Rousettus (Rousettus) aegyptiacus arabicus
R. (R.) leschenaulti leschenaulti

Papua New Guinea

Aproteles bulmerae
Dobsonia inermis inermis
D. minor
D. moluccense magna

D. pannietensis anderseni
D. p. pannietensis
D. p. remota
D. praedatrix
Macroglossus minimus microtus
M. m. nanus
Melonycteris melanops
M. woodfordi
Nyctimene aello
N. albiventer papuanus
N. cephalotes
N. cyclotis certans
N. draconilla
N. major geminus
N. m. lullulae
N. m. major
N. masalai
N. vizcaccia bougainville
N. v. vizcaccia
Paranyctimene raptor
Pteralopex anceps
Pteropus admiralitatum admiralitatum
P. alecto gouldi
P. conspicillatus chrysauchen
P. c. conspicillatus
P. gilliardi
P. hypomelanus luteus
P. h. vulcanius
P. macrotis epularius
P. mahaganus
P. neohibernicus hilli
P. n. neohibernicus
P. rayneri grandis
P. scapulatus
P. temmincki capistratus
P. tonganus basiliscus
Rousettus (Rousettus) amplexicaudatus amplexicaudatus
R. (R.) a. brachyotis
Syconycteris australis crassa
S. a. finschi
S. a. naias
S. a. papuana
S. hobbit

Alcester Island

Pteropus conspicillatus conspicillatus

Bagabag

Dobsonia minor
Rousettus (Rousettus) amplexicaudatus amplexicaudatus
Syconycteris australis papuana

Bismarck Archipelago

Dobsonia pannietensis anderseni
D. praedatrix
Macroglossus minimus nanus
Melonycteris melanops
Nyctimene albiventer papuanus
N. cyclotis certans
N. major major

N. masalai
N. vizcaccia vizcaccia
Pteropus admiralitatum admiralitatum
P. gilliardi
P. hypomelanus luteus
P. neohibernicus hilli
P. n. neohibernicus
P. temmincki capistratus
Rousettus (Rousettus) amplexicaudatus brachyotis
Syconycteris australis finschi

Admiralty Islands

Dobsonia pannietensis anderseni
Macroglossus minimus nanus
Nyctimene albiventer papuanus
N. vizcaccia vizcaccia
Pteropus admiralitatum admiralitatum
P. neohibernicus hilli
Syconycteris australis finschi
Manus: *D. p. anderseni*, *S. a. finschi*

Boang

Dobsonia pannietensis anderseni

Duke of York

Dobsonia pannietensis anderseni
D. praedatrix
Melonycteris melanops
Nyctimene major major
Pteropus neohibernicus neohibernicus
P. temmincki capistratus
Rousettus (Rousettus) amplexicaudatus brachyotis

Emirau

Dobsonia pannietensis anderseni
Pteropus admiralitatum admiralitatum
Rousettus (Rousettus) amplexicaudatus brachyotis

Lihir

Dobsonia pannietensis anderseni

Mioko (near Duke of York)

Pteropus neohibernicus neohibernicus

New Britain

Dobsonia pannietensis anderseni
D. praedatrix
Macroglossus minimus nanus
Melonycteris melanops
Nyctimene albiventer papuanus
N. cyclotis certans
N. major major
Pteropus admiralitatum admiralitatum
P. gilliardi
P. hypomelanus luteus
P. neohibernicus neohibernicus
P. temmincki capistratus
Rousettus (Rousettus) amplexicaudatus brachyotis
Syconycteris australis finschi

New Ireland

Dobsonia praedatrix
Melonycteris melanops
Nyctimene major major
N. masalai
Pteropus neohibernicus neohibernicus
P. temmincki capistratus
Syconycteris australis finschi

Tabar

Dobsonia pannietensis anderseni
Pteropus admiralitatum admiralitatum
Rousettus (Rousettus) amplexicaudatus brachyotis

Bougainville

Dobsonia inermis inermis
Macroglossus minimus microtus
Melonycteris woodfordi
Nyctimene vizcaccia bougainville
Pteralopex anceps
Pteropus mahaganus
P. rayneri grandis
Rousettus (Rousettus) amplexicaudatus brachyotis

Buka

Pteropus rayneri grandis

Crown (off north-east New Guinea)

Syconycteris australis papuana

D'Entrecasteaux Islands

Dobsonia pannietensis pannietensis
Macroglossus minimus microtus
Nyctimene major geminus
Pteropus conspicillatus conspicillatus
P. hypomelanus luteus
Syconycteris australis crassa

Fergusson Island

Dobsonia pannietensis pannietensis
Macroglossus minimus microtus
Nyctimene major geminus
Syconycteris australis crassa

Goodenough Island

Dobsonia pannietensis pannietensis
Nyctimene major geminus

Normanby Island

Dobsonia pannietensis pannietensis

Karkar Island

Pteropus neohibernicus neohibernicus
P. tonganus basiliscus

Long (off north-east New Guinea)

Syconycteris australis papuana

Louisiade Archipelago

Dobsonia pannietensis pannietensis

Nyctimene major geminus
Pteropus conspicillatus conspicillatus
P. hypomelanus luteus
Syconycteris australis papuana

Logeia Island
Nyctimene major geminus

Misima Island
Dobsonia pannietensis pannietensis
Syconycteris australis papuana

Panaeati Island
Dobsonia pannietensis pannietensis

Rossel Island
Dobsonia pannietensis pannietensis
Syconycteris australis papuana

Sudest Island
Dobsonia pannietensis pannietensis
Syconycteris australis papuana

Manam (=Vulcan)
Pteropus hypomelanus vulcanius

Muyua
Dobsonia pannietensis pannietensis
Nyctimene major lullulae
Pteropus conspicillatus conspicillatus
Syconycteris australis naias

New Guinea
Aproteles bulmerae
Dobsonia inermis inermis
D. minor
D. moluccense magna
Macroglossus minimus nanus
?Melonycteris melanops
Nyctimene aello
N. albiventer papuanus
N. cephalotes
N. cyclotis certans
N. draconilla
?N. vizcaccia vizcaccia
Paranyctimene raptor
Pteropus alecto gouldi
P. conspicillatus conspicillatus
P. hypomelanus luteus
P. macrotis epularius
P. neohibernicus neohibernicus
P. scapulatus
Rousettus (Rousettus) amplexicaudatus amplexicaudatus
Syconycteris australis papuana
S. hobbit

Sakar
Pteropus neohibernicus neohibernicus
Syconycteris australis papuana

Schouten Islands
Pteropus conspicillatus chrysauchen
P. tonganus basiliscus

Koilo Island
Pteropus tonganus basiliscus

Tolokiwa
Syconycteris australis papuana

Trobriand Islands
Dobsonia pannietensis remota
Nyctimene major geminus
Pteropus conspicillatus conspicillatus
P. hypomelanus luteus
Syconycteris australis crassa

Kiriwina
Dobsonia pannietensis remota
Nyctimene major geminus
Pteropus conspicillatus conspicillatus
P. hypomelanus luteus
S. australis crassa

Umboi
Dobsonia pannietensis anderseni
Nyctimene cephalotes
N. vizcaccia vizcaccia
Pteropus neohibernicus neohibernicus
Syconycteris australis papuana

Philippines

Acerodon jubatus jubatus
A. j. mindanensis
A. leucotis leucotis
A. l. obscurus
A. lucifer (extinct)
Alionycteris paucidentata
Cynopterus brachyotis brachyotis
Dobsonia chapmani (?extinct)
Dyacopecterus spadiceus (subspecies unknown)
Eonycteris major robusta
E. spelaea glandifera
Haplonycteris fischeri
Harpyionycteris whiteheadi negrosensis
H. w. whiteheadi
Macroglossus minimus lagochilus
Megaerops wetmorei wetmorei
Nyctimene rabori
Otopterus cartilagonodus
Ptenochirus jagorii
P. minor
?Pteropus griseus griseus
P. hypomelanus cagayanus
P. h. tomesi
P. leucopterus
P. mearnsi
P. pumilus
P. speciosus

P. vampyrus lanensis
Rousettus (Rousettus) amplexicaudatus amplexicaudatus
?Thoopterus nigrescens

Balabac

Acerodon leucotis leucotis
Cynopterus brachyotis brachyotis
Rousettus (Rousettus) amplexicaudatus amplexicaudatus

Balut

Pteropus pumilus

Basilan

Acerodon jubatus jubatus
Pteropus mearnsi
P. speciosus

Biliran

Acerodon jubatus jubatus
Eonycteris major robusta
Harpyionycteris whiteheadi whiteheadi
Ptenochirus jagorii
P. minor

Bohol

Ptenochirus jagorii
Pteropus vampyrus lanensis

Cagayan Sulu

Macroglossus minimus lagochilus
Pteropus hypomelanus cagayanus

Calamian Group

Acerodon leucotis leucotis
Cynopterus brachyotis brachyotis

Busuanga

Acerodon leucotis leucotis
Cynopterus brachyotis brachyotis

Caluya

Rousettus (Rousettus) amplexicaudatus amplexicaudatus

Camiguin

Harpyionycteris whiteheadi whiteheadi
Ptenochirus jagorii
Pteropus pumilus

Canon

Pteropus vampyrus lanensis

Carabao

Eonycteris spelaea spelaea
Ptenochirus jagorii
Rousettus (Rousettus) amplexicaudatus amplexicaudatus

Catanduanes

Pteropus leucopterus
P. vampyrus lanensis

Cebu

Acerodon jubatus jubatus
Dobsonia chapmani
Eonycteris spelaea glandifera
Pteropus vampyrus lanensis
Rousettus (Rousettus) amplexicaudatus amplexicaudatus

Culion

Cynopterus brachyotis brachyotis

Cuyo

Macroglossus minimus lagochilus

Dinagat

Acerodon jubatus jubatus
Haplonycteris fischeri
Ptenochirus jagorii
P. minor
Pteropus hypomelanus cagayanus
P. leucopterus
P. vampyrus lanensis
Rousettus (Rousettus) amplexicaudatus amplexicaudatus

Guimaras

Pteropus hypomelanus cagayanus
Rousettus (Rousettus) amplexicaudatus amplexicaudatus

Jolo

Rousettus (Rousettus) amplexicaudatus amplexicaudatus

Leyte

Acerodon jubatus jubatus
Eonycteris major robusta
Haplonycteris fischeri
Harpyionycteris whiteheadi whiteheadi
Ptenochirus jagorii
P. minor
Pteropus hypomelanus cagayanus
P. pumilus
P. vampyrus lanensis

Lubang

Eonycteris major robusta
Rousettus (Rousettus) amplexicaudatus amplexicaudatus

Luzon

Acerodon jubatus jubatus
Cynopterus brachyotis brachyotis
Dyacopterus spadiceus (subspecies unknown)
Eonycteris major robusta
E. spelaea glandifera
Haplonycteris fischeri
Otopterus cartilagonodus
Ptenochirus jagorii
?Pteropus griseus griseus
P. hypomelanus cagayanus
P. leucopterus
P. vampyrus lanensis
Rousettus (Rousettus) amplexicaudatus amplexicaudatus
?Thoopterus nigrescens

Malanipa*Pteropus speciosus***Marinduque***Eonycteris spelaea glandifera***Maripipi***Cynopterus brachyotis brachyotis**Eonycteris major robusta**Harpyionycteris whiteheadi whiteheadi**Ptenochirus jagorii**Pteropus hypomelanus cagayanus**P. pumilus***Mindanao***Acerodon jubatus mindanensis**Alionycteris paucidentata**Dyacopterus spadiceus* (subspecies unknown)*Eonycteris major robusta**E. spelaea glandifera**Haplonycteris fischeri**Harpyionycteris whiteheadi whiteheadi**Macroglossus minimus lagochilus**Megaerops wetmorei wetmorei**Ptenochirus jagorii**P. minor**Pteropus hypomelanus cagayanus**P. mearnsi**P. speciosus**P. vampyrus lanensis**Rousettus (Rousettus) amplexicaudatus amplexicaudatus***Mindoro***Acerodon jubatus jubatus**Haplonycteris fischeri**Harpyionycteris whiteheadi whiteheadi**Ptenochirus jagorii**Pteropus pumilus**P. vampyrus lanensis**Rousettus (Rousettus) amplexicaudatus amplexicaudatus***Negros***Acerodon jubatus jubatus**Cynopterus brachyotis brachyotis**Dobsonia chapmani**Eonycteris major robusta**E. spelaea glandifera**Haplonycteris fischeri**Harpyionycteris whiteheadi negrosensis**Macroglossus minimus lagochilus**Nyctimene rabori**Ptenochirus jagorii**Pteropus hypomelanus cagayanus**P. pumilus**P. vampyrus lanensis**Rousettus (Rousettus) amplexicaudatus amplexicaudatus***Palawan***Acerodon leucotis obscurus**Cynopterus brachyotis brachyotis**Eonycteris spelaea glandifera**Pteropus vampyrus lanensis**Rousettus (Rousettus) amplexicaudatus amplexicaudatus***Panay***Acerodon jubatus jubatus**A. lucifer**Macroglossus minimus lagochilus**Pteropus hypomelanus cagayanus**Rousettus (Rousettus) amplexicaudatus amplexicaudatus***Polillo***Cynopterus brachyotis brachyotis**Rousettus (Rousettus) amplexicaudatus amplexicaudatus***Samal***Rousettus (Rousettus) amplexicaudatus amplexicaudatus***Samar***Acerodon jubatus jubatus**Macroglossus minimus lagochilus**Pteropus vampyrus lanensis**Rousettus (Rousettus) amplexicaudatus amplexicaudatus***Sarangani Islands***Pteropus pumilus***Siargao***Eonycteris major robusta**E. spelaea glandifera**Ptenochirus jagorii**Rousettus (Rousettus) amplexicaudatus amplexicaudatus***Siquijor***Eonycteris spelaea spelaea***Simunul***Rousettus (Rousettus) amplexicaudatus amplexicaudatus***Sulu Archipelago***Acerodon jubatus jubatus**E. spelaea glandifera**Ptenochirus jagorii**Pteropus hypomelanus tomesi**P. pumilus**P. speciosus**Rousettus (Rousettus) amplexicaudatus amplexicaudatus***Bongao***Acerodon jubatus jubatus**Pteropus pumilus**Rousettus (Rousettus) amplexicaudatus amplexicaudatus***Sanga Sanga***Acerodon jubatus jubatus**Eonycteris spelaea glandifera**Ptenochirus jagorii**Pteropus pumilus**Rousettus (Rousettus) amplexicaudatus amplexicaudatus*

Sibutu
Acerodon jubatus jubatus
Pteropus hypomelanus tomesi
Rousettus (Rousettus) amplexicaudatus amplexicaudatus

Tawitawi
Acerodon jubatus jubatus
Pteropus pumilus
Rousettus (Rousettus) amplexicaudatus amplexicaudatus

Tablas
Eonycteris spelaea spelaea
Macroglossus minimus lagochilus
Ptenochirus jagorii
Pteropus pumilus

Réunion

Pteropus niger (extinct)
P. subniger (extinct)

Rwanda

Eidolon helvum helvum
Epomophorus labiatus
E. minor
Epomops dobsonii
Rousettus (Lissonycteris) angolensis ruwenzorii
R. (Rousettus) aegyptiacus leachii
R. (R.) lanosus lanosus

São Tomé and Príncipe

Eidolon helvum helvum
Myonycteris brachycephala
Rousettus (Rousettus) aegyptiacus unicolor

Príncipe
Eidolon helvum helvum

São Tomé
Eidolon helvum helvum
Myonycteris brachycephala
Rousettus (Rousettus) aegyptiacus unicolor

Saudi Arabia

Eidolon helvum sabaeum
Rousettus (Rousettus) aegyptiacus arabicus

Senegal

Eidolon helvum helvum
Epomophorus gambianus gambianus
Micropteropus pusillus
Rousettus (Lissonycteris) angolensis smithii
R. (Rousettus) aegyptiacus unicolor

Seychelles

Pteropus seychellensis seychellensis

Cousin

Pteropus seychellensis seychellensis

Curieuse

Pteropus seychellensis seychellensis

La Digue

Pteropus seychellensis seychellensis

Felicité

Pteropus seychellensis seychellensis

Mahé

Pteropus seychellensis seychellensis

Marianne

Pteropus seychellensis seychellensis

Praslin

Pteropus seychellensis seychellensis

Silhouette

Pteropus seychellensis seychellensis

Sierra Leone

Eidolon helvum helvum
Epomophorus gambianus gambianus
Epomops buettikoferi
Hypsignathus monstrosus
Micropteropus pusillus
Myonycteris torquata
Nanonycteris veldkampii
Rousettus (Lissonycteris) angolensis smithii
R. (Rousettus) aegyptiacus unicolor

Singapore

Cynopterus brachyotis brachyotis
Eonycteris spelaea spelaea
Macroglossus minimus lagochilus
Penthetor lucasi
Pteropus vampyrus malaccensis

Solomon Islands

Dobsonia inermis inermis
D. i. minimus
Macroglossus minimus microtus
Melonycteris aurantius
M. woodfordi
Nyctimene major scitulus
N. malaitensis
N. sanctacrucis (extinct)
N. vizcaccia bougainville
Pteralopex anceps

P. atrata
Pteropus admiralitatum colonus
P. a. goweri
P. a. solomonis
P. howensis
P. hypomelanus luteus
P. mahaganus
P. nitendiensis
P. rayneri cognatus
P. r. grandis
P. r. lavellanus
P. r. monoensis
P. r. rayneri
P. r. rennelli
P. r. rubianus
P. sanctacrucis
P. tonganus geddiei
P. tuberculatus
P. woodfordi
Rousettus (Rousettus) amplexicaudatus brachyotis

Alu (near Shortland)
Dobsonia inermis inermis
Melonycteris woodfordi
Pteropus rayneri grandis

Choiseul
Dobsonia inermis minimus
Macroglossus minimus microtus
Melonycteris aurantius
M. woodfordi
Nyctimene major scitulus
N. vizcaccia bougainville
Pteralopex anceps
Pteropus admiralitatum colonus
P. rayneri grandis
Rousettus (Rousettus) amplexicaudatus brachyotis

Fauro
Dobsonia inermis inermis
Macroglossus minimus microtus
Melonycteris woodfordi
Nyctimene vizcaccia bougainville
Pteropus woodfordi
Rousettus (Rousettus) amplexicaudatus brachyotis

Ghizo
Pteropus admiralitatum solomonis
P. rayneri lavellanus

Guadalcanal
Dobsonia inermis inermis
Macroglossus minimus microtus
Melonycteris woodfordi
Nyctimene major scitulus
N. vizcaccia bougainville
Pteralopex atrata
Pteropus admiralitatum solomonis
P. rayneri rayneri
P. woodfordi

Rousettus (Rousettus) amplexicaudatus brachyotis

Kolombangara
Macroglossus minimus microtus
Nyctimene vizcaccia bougainville
Pteropus admiralitatum solomonis
P. rayneri rubianus
P. woodfordi
Rousettus (Rousettus) amplexicaudatus brachyotis

Malaita
Dobsonia inermis inermis
Macroglossus minimus microtus
Nyctimene major scitulus
N. malaitensis
Pteropus admiralitatum solomonis
P. rayneri rayneri
P. tonganus geddiei
Rousettus (Rousettus) amplexicaudatus brachyotis

Mono
Pteropus admiralitatum colonus
P. rayneri monoensis

N'Dai (=Gower)
Pteropus admiralitatum goweri

New Georgia
Dobsonia inermis inermis
Nyctimene major scitulus
Pteropus rayneri rubianus
P. woodfordi

Nggela Sule
Dobsonia inermis inermis
Macroglossus minimus microtus
Melonycteris aurantius
Nyctimene major scitulus
Pteropus woodfordi

Ontong Java Atoll
Pteropus howensis

Ranonggo
Pteropus admiralitatum solomonis
P. rayneri lavellanus

Renneli
Pteropus rayneri rennelli
P. tonganus geddiei

Russell Islands
Melonycteris woodfordi
Pteropus admiralitatum solomonis
P. hypomelanus luteus
P. woodfordi

Mbanika
Pteropus admiralitatum solomonis
P. woodfordi

Pavuvu

Melonycteris woodfordi
Pteropus woodfordi

San Cristobal

Dobsonia inermis inermis
Macroglossus minimus microtus
Pteropus rayneri cognatus

Santa Cruz Islands

Nyctimene sanctacrucis (extinct)
Pteropus nitendiensis
P. sanctacrucis
P. tonganus geddiei
P. tuberculatus

Nendo

Pteropus nitendiensis

Vanikoro

Pteropus tuberculatus

Santa Isabel

Dobsonia inermis minimus
Macroglossus minimus microtus
Nyctimene vizcaccia bougainville
Pteralopex atrata
Pteropus mahaganus
P. rayneri grandis
Rousettus (Rousettus) amplexicaudatus brachyotis

Shortland

Dobsonia inermis inermis
Nyctimene major scitulus
Pteropus admiralitatum colonus
P. rayneri grandis

Simbo

Pteropus admiralitatum solomonis
P. rayneri rubianus

Uki Ni Masi

Dobsonia inermis inermis
Pteropus rayneri cognatus

Vella Lavella

Dobsonia inermis inermis
Macroglossus minimus microtus
Pteropus admiralitatum solomonis
P. rayneri lavellanus
Rousettus (Rousettus) amplexicaudatus brachyotis

Somalia

?*Eidolon helvum helvum*
Epomophorus minor
E. wahlbergi

South Africa

Eidolon helvum helvum
Epomophorus gambianus crypturus
E. wahlbergi
Rousettus (Rousettus) aegyptiacus leachii

Sri Lanka

Cynopterus brachyotis ceylonensis
C. sphinx sphinx
Pteropus giganteus giganteus
Rousettus (Rousettus) leschenaulti seminudus

Sudan

Eidolon helvum helvum
Epomophorus gambianus gambianus
E. labiatus
E. minor
Epomops franqueti
Hypsignathus monstrosus
Micropteropus pusillus
Rousettus (Lissonycteris) angolensis ruwenzorii
R. (R.) a. leachii

R. (R.) lanosus kempi

Swaziland

Epomophorus wahlbergi

Syria

Rousettus (Rousettus) aegyptiacus aegyptiacus

Taiwan

Pteropus dasymallus formosus

Kashoto (=Lutao)

Pteropus dasymallus formosus

Tanzania

Eidolon helvum helvum
Epomophorus gambianus crypturus
E. labiatus E. minor
E. wahlbergi
Epomops dobsonii
E. franqueti
Micropteropus pusillus
Myonycteris relicta
Pteropus seychellensis comorensis
P. voeltzkowi
Rousettus (Lissonycteris) angolensis ruwenzorii
R. (Rousettus) aegyptiacus leachii
R. (R.) lanosus kempi
Mafia
Eidolon helvum helvum

Pteropus seychellensis comorensis
Rousettus (Rousettus) aegyptiacus leachii

Pemba

Eidolon helvum helvum
Epomophorus wahlbergi
Pteropus voeltzkowi
Rousettus (Rousettus) aegyptiacus leachii

Zanzibar

Eidolon helvum helvum
Epomophorus minor
E. wahlbergi
Rousettus (Rousettus) aegyptiacus leachii

Thailand

Balionycteris maculata seimundi
Chironax melanocephalus melanocephalus
Cynopterus brachyotis brachyotis
C. horsfieldii harpax
C. sphinx angulatus
C. s. sphinx
Eonycteris spelaea spelaea
Macroglossus minimus lagochilus
M. sobrinus sobrinus
Megaerops ecaudatus
M. niphanae
Pteropus hypomelanus condorensis
P. h. geminorum
P. lylei
P. vampyrus intermedius
P. v. malaccensis
Rousettus (Rousettus) amplexicaudatus amplexicaudatus
R. (R.) leschenaulti leschenaulti
Sphaerias blanfordi

Ko Samui

Pteropus hypomelanus geminorum

Ko Tao

Pteropus hypomelanus geminorum

Tibet

Sphaerias blanfordi

Togo

Eidolon helvum helvum
Epomophorus gambianus gambianus
Epomops franqueti
Hypsignathus monstrosus
Megaloglossus woermanni
Micropteropus pusillus
Myonycteris torquata
Nanonycteris veldkampii
Rousettus (Lissonycteris) angolensis smithii
R. (Rousettus) aegyptiacus unicolor

Tonga

Pteropus tonganus tonganus

Turkey

Rousettus (Rousettus) aegyptiacus aegyptiacus

Uganda

Eidolon helvum helvum
Epomophorus labiatus
E. minor
E. wahlbergi
Epomops franqueti
Hypsignathus monstrosus
Megaloglossus woermanni
Micropteropus pusillus
Myonycteris torquata
Rousettus (Lissonycteris) angolensis ruwenzorii
R. (Rousettus) aegyptiacus leachii
R. (R.) lanosus lanosus

Vanuatu

Notopteris macdonaldii macdonaldii
Pteropus anetianus anetianus
P. a. aorensis
P. a. bakeri
P. a. banksiana
P. a. eotinus
P. a. motalave
P. a. pastoris
P. fundatus
P. tonganus geddiei

Anatom

Pteropus anetianus anetianus

Aoba (=Oba)

Pteropus anetianus eotinus

Aore

Pteropus anetianus aorensis

Banks Islands

Pteropus anetianus banksiana
P. a. motalave
P. fundatus

Mota Lava

Pteropus anetianus motalave
P. fundatus

Ureparapara

Pteropus anetianus banksiana

Vanua Lava

Pteropus anetianus banksiana

Efate*Pteropus anetianus bakeri***Emae***Pteropus anetianus bakeri***Emao***Pteropus anetianus pastoris***Erromango***Pteropus anetianus anetianus***Espiritu Santo***Pteropus anetianus aorensis***Maewo (=Aurore)***Pteropus anetianus eotinus***Malakula***Pteropus anetianus eotinus***Malo***Pteropus anetianus eotinus***Nguna***Pteropus anetianus bakeri***Pentecost***Pteropus anetianus eotinus***Tongoa***Pteropus anetianus pastoris***Vietnam***Cynopterus brachyotis hoffeti**Eonycteris spelaea spelaea**Macroglossus minimus lagochilus**Megaerops ecaudatus**M. niphanae**Pteropus hypomelanus condorensis**P. lylei**P. vampyrus malaccensis**Rousettus (Rousettus) leschenaulti leschenaulti***Con Son (=Pulau Condor)***Pteropus hypomelanus condorensis***Wallis and Futuna***Pteropus tonganus tonganus***Western Samoa***Pteropus samoensis samoensis**P. tonganus tonganus***Yemen***Eidolon helvum sabaeum**Rousettus (Rousettus) aegyptiacus arabicus***Zaire***Casinycteris argynnis**Eidolon helvum helvum**Epomophorus gambianus crypturus**E. labiatus**E. minor**E. wahlbergi**Epomops dobsonii**E. franqueti**Hypsignathus monstrosus**Megaloglossus woermanni**Micropteropus intermedius**M. pusillus**Myonycteris torquata**Plerotes anchietae**Rousettus (Lissonycteris) angolensis angolensis**R. (L) a. ruwenzorii**R. (Rousettus) aegyptiacus leachii**R. (R.) a. unicolor**R. (R.) lanosus lanosus**Scotonycteris zenkeri***Zambia***Eidolon helvum helvum**Epomophorus gambianus crypturus**E. minor**E. wahlbergi**Epomops dobsonii**E. franqueti**Micropteropus pusillus**Myonycteris torquata**Plerotes anchietae**Rousettus (Lissonycteris) angolensis ruwenzorii**R. (Rousettus) aegyptiacus leachii***Zimbabwe***Eidolon helvum helvum**Epomophorus gambianus crypturus**E. wahlbergi**Epomops dobsonii**Rousettus (Lissonycteris) angolensis ruwenzorii**R. (Rousettus) aegyptiacus leachii*

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