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Onzième Reunion Technique

Papers and Proceedings

Rapports et Proces-verbaux

NEW DELHI, INDIA

25-28 November 1969

VOLUME II

Third Session: Survival Service Commission

PROBLEMS OF THREATENED SPECIES



Published with the assistance of UNESCO

Union Internationale
pour la Conservation de la Nature
et de ses Ressources

Morges, Switzerland, 1970

International Union
for Conservation of Nature
and Natural Resources

The International Union for Conservation of Nature and Natural Resources (IUCN) was founded in 1948 and has its headquarters in Morges, Switzerland; it is an independent international body whose membership comprises states, irrespective of their political and social systems, government departments and private institutions as well as international organizations. It represents those who are concerned at man's modification of the natural environment through the rapidity of urban and industrial development and the excessive exploitation of the earth's natural resources, upon which rest the foundations of his survival. IUCN's main purpose is to promote or support action which will ensure the perpetuation of wild nature and natural resources on a world-wide basis, not only for their intrinsic cultural or scientific values but also for the long-term economic and social welfare of mankind.

This objective can be achieved through active conservation programmes for the wise use of natural resources in areas where the flora and fauna are of particular importance and where the landscape is especially beautiful or striking, or of historical, cultural or scientific significance. IUCN believes that its aims can be achieved most effectively by international effort in co-operation with other international agencies such as UNESCO and FAO.

The World Wildlife Fund (WWF) is an international charitable foundation for saving the world's wildlife and wild places. It was established in 1961 under Swiss law and has headquarters near those of the International Union for Conservation of Nature and Natural Resources (IUCN). Its aim is to support the conservation of nature in all its forms (landscape, soil, water, flora and fauna) by raising funds and allocating them to projects, by publicity and by education of the general public and young people in particular. For all these activities it takes scientific and technical advice from IUCN.

Although WWF may occasionally conduct its own field operations, it tries as much as possible to work through competent specialists or local organizations.

Among WWF projects financial support for IUCN and for the International Council for Bird Preservation (ICBP) have highest priority, in order to enable these bodies to build up the vital scientific and technical basis for world conservation and specific projects. Other projects cover a very wide range from education, ecological studies and surveys, to the establishment and management of areas as national parks and reserves and emergency programmes for the safeguarding of animal and plant species threatened with extinction.

WWF fund-raising and publicity activities are mainly carried out by National Appeals in a number of countries, and its international governing body is made up of prominent personalities in many fields.

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Edited by
C.W.Holloway

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Preface

The Ninth and Tenth Technical Meetings of IUCN held at Nairobi (1963) and Lucerne (1966), were concerned with identifying and assessing some of the more important ecological considerations affecting conservation of nature and natural resources in tropical and temperate regions, respectively. The Eleventh Technical Meeting, held at New Delhi on 25-28th November 1969, adopted a somewhat different approach. Although much of the material presented was appropriately drawn from experience of conservation problems and scientific research in southern Asia, the aim was to use this material, supplemented by a limited number of comparable studies from other parts of the world, to illustrate the activities and interests of each of the five Commissions on which IUCN relies for technical advice, the formulation of its policies and the promotion of its projects.

Thus, with the exception of the Commission on Legislation, whose specialized field of work does not lend itself to this kind of approach, each Commission undertook the organization and supervision of a Session of the Technical Meeting. In addition, reflecting the close community of interests between IUCN and the International Biological Programme, a full Session of the Meeting was devoted to IBP activities and this was also organized by the Commission on Ecology by virtue of its special liaison responsibilities.

The Papers and Proceedings of the Eleventh Technical Meeting are, therefore, being published in five parts. Volume I contains those pertaining to the Commission on Ecology, including the IBP Session material; Volume II has been prepared by the Survival Service Commission; Volume III by the International Commission on National Parks; Volume IV by the Commission on Education and Volume V by the Commission on Landscape Planning.

Two points concerning the arrangement of material in the five volumes call for comment. First, certain of the topics dealt with in Volume I, under the heading of wildlife utilization and management (e.g. 'the role of zoos') and also the problems concerned with the identification and conservation of undisturbed islands, are very much the concern of the Survival Service Commission and of its specialist groups. That they were nevertheless dealt with at the first two Sessions of the Technical Meeting, under the auspices of the Commission on Ecology, was mainly due to the large number of papers on endangered species presented for discussion at the Survival Service Commission's half-day Session (and included in the present volume). It is, however, also an indication of the interdependence of conservation of habitat and species survival, which closely links the work of the two Commissions.

Secondly, a novel feature of the Eleventh Technical Meeting was the presentation and discussion of the reports on what came to be known as the 'pre-Conference Study Tours'. These were in effect six short-term research projects, designed to provide an up to date assessment of a variety of conservation problems of current importance in the host country of India, but typifying problems which frequently come to IUCN's attention. The projects were made possible by the generous financial support of the Smithsonian Institution and were carried out during the week immediately preceding the General Assembly by small groups of experts, representing the appropriate Commissions, working in collaboration with their Indian counter-parts, appointed by the Inspector-General of Forests, who were responsible for all the local arrangements. Two

of the studies were mainly concerned with endangered species, two with National Park development and management, and one each with problems of general ecological and landscape planning significance. The resulting reports were dealt with accordingly at various Sessions of the Technical Meeting, but for ease of reference and because, with one exception, all the studies were sited in existing National Parks or equivalent reserves, it has been deemed convenient to include all the reports and summaries of the discussion on them in Volume III of the Proceedings.

Contents

	<i>Page</i>
Preface to the Proceedings of the XIth Technical Meeting	5
The Third Session: Introduction	9
1. MAMMALS	
a. The Endangered Large Mammals of South Asia. G. B. Schaller & N. M. Simon.	11
b. Conserving the Asiatic Lion. P. Joslin	24
c. The Vanishing Indian Tiger. K. S. Sankhala	34
d. Philippine Tamaraw, Here to Stay. Jesus B. Alvarez Jr.	46
*e. The Swamp Deer of North Kheri. Arjan Singh	52
*f. The Tiger of the Terai with special reference to the Kheri Forests of Uttar Pradesh, India. Arjan Singh	55
SUMMARY OF DISCUSSION	57
2. BIRDS	
a. The Great Indian Bustard <i>Choriotis nigriceps</i> (Vigors): Salim Ali	58
b. The Great Indian Bustard <i>Choriotis nigriceps</i> (Vigors), a vanishing species in India, and some suggestions for its preservation. P.D. Gupta	63
c. A report on the 1969 Status of the Monkey-Eating Eagle of the Philippines. Jeses B. Alvarez Jr.	68
SUMMARY OF DISCUSSION	74
3. REPTILES	
a. A Review of the Present Status and Position of Endangered Species of Indian Reptiles. J. C. Daniel	75
b. The Endangered Crocodiles of India. R.N. Misra	77
SUMMARY OF DISCUSSION	82

* Additional papers to original programme (see Introduction).

	<i>Page</i>
4. PLANTS	
a. Endangered Plant Species and their Habitats. H.Santapau	83
b. The Need for Conservation of Flora and Floral Provinces in Southeast Asia. J.K.Maheshwari	89
c. Protection of Rare and Endangered Plants in the Indian Flora. K.C.Sahni	95
d. Endangered Plants and Conservation in the Islands of the Indian Ocean. R.Melville	103
e. Endangered Plant Species and their Habitats—A Review of the Indian Situation. K. Subramanyam & C. P. Sreemadhavan	108
f. Some Endangered Plants and Threatened Habitats in Southeast Asia. I.M.Qureshi & O.N.Kaul	115
SUMMARY OF DISCUSSION	127

APPENDIX

Conservation Projects for Threatened Species in South Asia.	128
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INDEX

Contributors of Papers and participants in the discussions.	132
---	-----

Introduction

The third session of the XIth Technical Meeting of the International Union for Conservation of Nature and Natural Resources took place in New Delhi, at 09.30-13.00 hours, on Thursday, November 27th, 1969. It was organized by the Survival Service Commission, whose Chairman, Mr Peter Scott, acted as chairman of the meeting, and whose executive officer, Dr C. W. Holloway, acted as rapporteur.

The subject of the meeting was 'Problems of Threatened Species' and, whilst no geographical limitation was included in the title, most papers were concerned with the problems of southern Asia.

The programme was divided into four sections (mammals, birds, reptiles and plants); each of which was followed by a period of discussion.

Very considerable interest was shown in this subject and it became clear when the programme was prepared that more papers would be submitted than could be read in the time available. Delegates who submitted papers after the programme was drawn up, therefore, were requested to refer briefly to the content of their paper from the floor, on the understanding that although their papers were not included in the programme, they would be reproduced in the Proceedings. Papers in this category are marked with an asterisk in the table of contents. These papers and others that were included in the programme but arrived too late to be processed have no resumé in French.

In addition to this session of the Technical Meeting, the Commission organized a very successful open meeting on conservation projects for threatened species in South Asia, which took place on the evening of Saturday, November 29th. Although quite separate from the technical session, the open meeting was in effect, a continuation of it, in that it was concerned with the initiation of action to rectify some of the situations described. The minutes of this open meeting are therefore included in this volume as an appendix.

Morges, 30 June 1970.

C.W.Holloway
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The Endangered Large Mammals of Asia

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INTRODUCTION

The South Asian countries of Bhutan, Ceylon, India, Nepal, and Pakistan have a wildlife heritage which few areas in the world can equal, both in the variety of large mammals and formerly in their numbers. The cats include the tiger *Panthera tigris*, leopard *Panthera pardus*, clouded leopard *Neofelis nebulosa*, lion, cheetah and snow leopard† There are four species of bear *Selenarctos thibetanus*, *Ursus arctos*, *Helarctos malayanus* and *Melursus ursinus*. Wild buffalo, three species of rhinoceros, elephant *Elephas maximus* and gaur *Bos gaurus* inhabit or inhabited the swamps and forests, as do several kinds of deer such as the sambar *Cervus unicolor*, axis deer or chital *Axis axis*, hog deer *Axis porcinus*, and swamp deer, to mention only a few. The open woodlands harbour blackbuck *Antilope cervicapra*, nilgai *Boselaphus tragocamelus* and Indian gazelle or chinkara *Gazella gazella*. The distinctive fauna of the Himalayas include several kinds of wild sheep, wild goats, yak and such species as the serow *Capricornis sumatraensis* and takin *Budorcas taxicolor*.

Not only is the variety large, but some species once occurred in great profusion. Herds of 10,000 blackbuck were reported from the Punjab, and swamp deer crowded the reed-beds of the Indus and Ganges rivers, also in herds of thousands. Reading the hunting accounts of a century ago, one gains the impression that South Asia was an animal paradise comparable to East Africa. These assemblages have now gone, and each species clings to a small vestige of its former range.

FACTORS LEADING TO THE DECLINE

The decline, which has been spectacular, has occurred in all countries, with the possible exception of Bhutan, and can be traced to three main causes.

The most important reason is the destruction or degradation of habitat. The majority of South Asian mammals are forest dwellers. The natural vegetation of the area, too, is forest, except in the high montane regions, but most of it has been removed. Less than 20% of India, for example, still retains its forest cover. Official policy in India is to have 30% of the land under forest, but only 7 out of 20 states and territories have achieved this aim. As late as the 16th century, rhinoceros and buffalo, mammals characteristic of moist conditions, were found in western India, in areas which today are desert or semi-desert. The desiccation of the land is undoubtedly due to misuse of the soil by man. Only 12% of the state of Rajasthan is now covered with forest, mostly with dry thorn scrub.

Even the Gangetic basin retained large forested areas until three centuries ago. The removal of the forests was inevitably related to the increase of the human population, which, in India alone, has risen from 270 to 530 million during the last 35 years. The salient fact is that in most South Asian countries some three quarters of the original

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† To distinguish endangered species, scientific names are omitted but will be found in Appendix A, where these species are listed.

wildlife habitats have been destroyed. A few species, like blackbuck, have adapted to cultivation, but their decline can be attributed to other reasons.

Hunting by man has been the second major cause of the disappearance of wildlife. The Moghul emperors from the 13th to 16th century were famous as hunters. Akbar the Great is said to have kept 1000 cheetah for the chase. Hunts were held only sporadically, however, and the right to kill was strictly guarded by the nobility, with the result that the numbers of most species were not seriously affected.

During the period of British rule, hunting became a pastime of the expatriate administrative officers and soldiers. Nowadays it is fashionable to denigrate them but it should not be forgotten that the soldier or administrative officer was among the first to take a serious interest in the wildlife of the country, and recorded almost all that has come down to us about the wild fauna of that period. Moreover, it was in no small measure due to his interest and influence that game regulations were introduced and applied and the first wildlife sanctuaries established. Thus, in spite of the heavy hunting pressure, few species were threatened with extinction and a fair amount of wildlife survived until after the Second World War.

Independence in 1947 swept long-standing controls away, the process being accentuated by the introduction of a plentiful supply of modern firearms. At a time when the conservation movement in Europe, North America and the USSR was gaining momentum, India and Pakistan—as well as Nepal a few years later—ushered in a period of destruction almost comparable to the uninhibited slaughter on the American prairies in the 1880's. Wildlife which had been able to survive the more or less regulated hunts was unable to withstand unceasing poaching. Under the respectable camouflage of crop protection, wild animals were shot everywhere, even in the few sanctuaries. Within five years much of the wildlife had gone—and the decline continues.

The third factor in the disappearance of the large mammals has been competition between livestock and wildlife. India alone has some 250 million cattle and domestic buffalo, as well as 100 million goats and sheep, of which at least 10% graze exclusively in the forests, where most wildlife survives. Diseases, such as foot-and-mouth and rinderpest, which are endemic, are transmitted to the wild ungulates with the result that many populations of gaur, axis deer and other species have been seriously reduced or wiped out. A recent outbreak of rinderpest occurred in August/September, 1968, in the Bandipur Sanctuary, for example, and in the adjoining Mudumalai Sanctuary of India, both areas noted for their herds of gaur. The animals were seriously depleted and sambar were also reduced in number.

Wildlife and livestock also compete for forage. Many forests are severely overgrazed by livestock, to the extent that little wildlife could exist, even if protected from hunting. In addition to overstocking, considerable illegal cultivation and tree felling also take place within the forests and sanctuaries.

Habitat destruction, hunting and disease have reduced one of the world's great wildlife assemblages to a small remnant within the span of a few years. The task facing the present generation is to ensure the survival of this remnant. It is an urgent task. The human population in the area is now over 650 million. If present trends continue it will be 900 million in ten years.

THE STATUS OF SPECIES

For the purpose of this paper the conservation of the large mammals of South Asia can most conveniently be considered in three broad categories.

First are those species or races which are either extinct or so close to extinction that little if anything can be done for them. They include both the Sumatran and Javan rhinoceroses, hispid hare, cheetah, Malabar civet and the shou (or Sikkim stag). For all practical purposes these animals appear to have passed the point of no return and are not considered further in this paper.

Second are those mammals which through numerical reduction or limitation of habitat are now in danger of extinction. Most species in this category survive only in sanctuaries or can soon be expected to exist only in them. No detailed censuses have been made

of many of the rare or localized species or races, such as, for example, the urial of the Punjab and West Pakistan, the straight-horned markhor of West Pakistan and Afghanistan, the golden langur *Presbytis geei* of Assam and Bhutan, and the Nilgiri langur *Presbytis johni* and lontailed macaque *Macaca silenus* of south India, although Sugiyama (1968) estimated that only 1000 animals of the last-named species survived. The snub-nosed monkey, dugong, Tibetan wild ass and wild yak, all rare and unstudied, occur somewhat peripherally to the region covered by this paper. The snow leopard is by all accounts rare, with Dang (1967) estimating that only 200 to 600 survive in the Indian Himalayas, yet its skins are still offered for sale to tourists by, for example, the Kashmir Government Emporium. On the other hand, the number and distribution of several rare animals are reasonably well known and their status is briefly reviewed below. The international list of rare and endangered mammals of South Asia currently enumerated in the *Red Data Book* Vol. 1 (Simon, 1966) is given in Appendix A.

The third category comprises those mammals which are still relatively widespread and in no immediate danger of extinction. Because this group is large it cannot be given more than passing consideration in this short paper.

ENDANGERED FORMS

One of the particular purposes of this paper is to focus attention on the second category mentioned above, bearing in mind that although only a few species have the dubious distinction of being enrolled on the international list of rare and endangered mammals, many more are locally rare to the extent that they qualify for inclusion on national lists.

Baluchistan bear *Selenarctos thibetanus gedrosianus*

The Baluchistan bear is distinguished from other races of the Himalayan black bear not only by its substantially smaller size but also in its environmental circumstances. Up to 30 years ago it was found in places such as the Kirthar Range in western Sind which were covered with *Juniperus* spp. and *Pinus gerardiana*. It has since been driven from these areas and exists now in arid thorn scrub country. The paucity of forest and natural cover in this semi-desert environment has obliged the bear to supplement its diet by raiding the fields of sorghum and millet as well as stealing dates and occasionally attacking sheep and goats. Such activities have, understandably, brought the bear into direct conflict with man, who treats it as vermin. These factors have reduced the bear numerically; it is now believed to be rare and confined to some low-lying hill ranges of south-central Baluchistan. Few sightings have been made in recent years and there is need for an investigation to determine the animal's status and prospects.

Asiatic lion *Panthera leo persica*

Although the lion was distributed widely over the northern half of the Indian peninsula 150 years ago, it is now confined to the 489 sq. mile Gir Sanctuary in Gujarat, a teak and acacia forest managed by the Forest Department. The sanctuary contains 112 villages with over 5000 people and some 16,000 buffalo and cattle. An additional 30 to 80 thousand head of livestock are admitted into the forest when forage in the surrounding area is scarce.

Several attempts have been made to census the lion population. In 1936 the estimate was 287; in 1955 it was 290; in 1963 it was 255. The most thorough census was made by the Forest Department in 1968 when a figure of about 175 was derived. The accuracy of the earlier censuses is questionable, and there is no basis for assuming that the number has decreased during the past 30 years.

Because of the dearth of wild ungulate prey species in the Gir area, the lions subsist almost entirely on domestic livestock. Except for a few lions which are poisoned by irate villagers and the possible slow deterioration of the habitat due to overgrazing by livestock, the lions seem to be reasonably secure at present. P. Joslin and T. Hodd of Edinburgh and Aberdeen Universities, respectively, are currently engaged in a long-term ecological study of the Gir lion.

Ceylon elephant *Elephas maximus maximus*

The elephant once occurred throughout Ceylon but its range is now substantially reduced, and the total population numbers now 2500-3000 individuals. The decline is attributable to the reduction of habitat due to human expansion, and to direct destruction by man in the interests of crop protection.

Three national parks—Ruhuna, Wilpattu and Gal Oya—have been set aside for the protection of the animal, but the elephant's wandering propensities continue to bring it into conflict with man, especially in those areas where recent agricultural development has cut across migratory routes.

The Smithsonian Institution recently completed a field study designed to provide the data on which an acceptable management programme can be based.

Indian wild ass *Equus hemionus khur*

Once common in north-western India, West Pakistan and south-eastern Iran, the wild ass now occurs mainly in the Little Rann of Kutch—a salt-encrusted desert region about 1000 sq. miles in extent, and situated along the Gujarat/Pakistan border. The population declined from a conservative total of 2000-5000 in 1947 to about 870 in 1962 (Gee, 1963b). A small herd of 20-30 was also reported in the Great Rann near Nagar Parkar. Although Spillett (1968) was unable to carry out a census, he was inclined to believe that the present status of the Indian Wild Ass is similar to what was reported in 1962. However, Mountford and Poore (1968) reported that a number were shot during the India/Pakistan war and that the total in the Little Rann was not more than about 300. In an aerial census conducted by Dharmakumarsinhji (pers. comm.) in October, 1969, a total of 362 ass were counted, and he felt that the total population numbered about 400 animals.

One threat to the wild ass arises from its susceptibility to disease—notably surra *Trypanosoma evansi* and African horse sickness—transmitted from domestic livestock. A government-financed vaccination programme has been in operation annually since 1961 but has not been wholly successful because a few owners refuse to allow their horses to be treated on the ground that they cannot afford to have their animals idle for the 8-14 days of rest which the treatment requires. Unless vaccination is made compulsory and strictly enforced this constructive programme cannot hope to achieve its purpose.

Most villagers living close to the Rann are sympathetically disposed toward the wild ass; however, there is substantial competition from livestock for the limited grazing.

The wild ass is not yet protected in a legally constituted sanctuary, and it is important that a reserve should be established while the land is still available. There is also a great need for a comprehensive ecological study of the wild ass.

Great Indian rhinoceros *Rhinoceros unicornis*

Once distributed widely in the basins of the Indus, Ganges and Brahmaputra rivers, this rhinoceros is now confined to eight reserves in Nepal, West Bengal and Assam. A few other small, isolated populations still exist as, for example, in the Tirup Frontier Tract in Assam.

Of the 700 or so animals still in existence, by far the largest concentration of about 400 occurs in the 167 sq. mile Kaziranga Sanctuary in Assam (Spillett, 1966). A major shortcoming of this sanctuary is that domestic livestock is permitted to graze within its boundaries. In theory the area available for such use is small, only about three sq. miles, but in practice little attempt is made to adhere to the regulations.

The largest stock in Nepal is to be found in the Chitawan Rhinoceros Sanctuary in the Rapti Valley where 80-100 of the animals survive. Chitawan is of exceptional importance to the future of the rhinoceros, as well as being an unusual example of applied conservation. In the early 1950's several thousand squatters settled illegally in the reserve, destroying the habitat and forcing the rhinoceroses into the swamps south of the Rapti River and on to the islands in the Narayani River. Poachers took advantage of the confused situation to kill a large number of the animals. The result of these activities was that the rhinoceros population declined from an estimated 800 in the early 1950's to about 165 by 1961. Following strong representation by the Forest Department, the Nepalese Government acted decisively. The entire Chitawan Sanctuary was cleared of

settlement and—provided that poaching can be controlled—the outlook for the rhinoceros is now brighter than at any time during the last decade. By its vigorous and timely intervention the Government of Nepal has set a fine example of what drive and determination can do to safeguard an endangered species.

A thorough ecological study of this species is urgently needed.

Pygmy hog *Sus salvanius*

The current status of this diminutive representative of the Suidae has not been determined. Until a few years ago it was thought to be probably extinct, but more recently there has been an increasing number of reports, which, although categorized as 'unconfirmed', suffice to indicate that the animal still survives in several parts of the *terai* of Assam, Nepal and Bhutan. The pygmy hog's apparent scarcity may be attributable to the difficulty of observing it. Not only is it small—a full-grown boar is no larger than a hare—and strictly nocturnal, but it is also exceedingly shy, disappearing rapidly at the first hint of danger. Furthermore, the nature of its marshy habitat renders observation difficult, even under favourable circumstances.

Swamp deer *Cervus duvaucelii duvaucelii* and *C. d. branderi*

Once abundant on the marshy grasslands in the Indo-Gangetic basin, the north Indian race of the swamp deer has declined drastically. With most of its habitat under cultivation, it is doubtful if more than 3500 survive in Nepal, Uttar Pradesh, West Bengal, and Assam (Schaller, 1967). Numbers continue to decline, particularly in Uttar Pradesh where the government has been ineffectual in protecting it from poachers, even in the sanctuaries. The main viable Indian populations occur in the Kaziranga Sanctuary of Assam where the herd of 250 seems to be reasonably well protected, and in the Kheri area of Uttar Pradesh where several hundred individuals receive protection on a private farm.

A few scattered groups of a distinctive subspecies (*C. d. branderi*) still exist in the forests of Central India, but only those in Kanha National Park have much prospect of survival. Even there the chances look slim when viewed against the decline that has occurred in that park during the last 30 years: the combination of disease and poaching reduced the Kanha population from 3000 in 1938 to fewer than 100 today, and there is every indication that the downward trend is continuing. An up-to-date ecological study of the Kanha population is required to identify the causes of decline and to make recommendations for ensuring the animal's survival.

The decline of the swamp deer has been so drastic and so continuous in recent years that its perpetuation in the wild state in India is not assured under prevailing conditions, except in the Kaziranga Sanctuary. Only in western Nepal does there appear to be any cause for optimism. There the population totals perhaps 1000 animals, the majority inhabiting the Sukla Phanta area of Kanchanpur District, an area that is in the process of being established as a sanctuary.

Manipur brow-antlered deer *Cervus eldi eldi*

Only about 100 of these deer survive in the 11 sq. miles Keibul Lamjao Sanctuary in the south-western part of Logtak Lake in Manipur State. Gee (1936a) conjectured that the animal once ranged over a wider area, but was driven to taking refuge in the swamps of the lake by the increasing human population and extensive agricultural development. So long as it remains in its restricted habitat the animal is reasonably secure, but during the rains it moves away from the flooded lake to drier areas, at which time it becomes vulnerable to poaching.

The deer is protected primarily by the impenetrability of its habitat and by the fact that most of the human inhabitants are vegetarians. Moreover, the Manipur Administration has shown commendable interest in safeguarding the animal.

On the other hand, the villagers along the western and southern boundaries of Keibul Lamjao, in addition to extending the area under rice cultivation into the sanctuary, own large herds of livestock. Although cattle cannot enter the swamps, domesticated buffalo graze over a quarter of the sanctuary. About 1000 canoes are also engaged in fishing throughout the area wherever the vegetation is thin enough to permit their passage.

The immediate requirement is the imposition of restrictions on grazing and cultivation within the sanctuary. There is also need for a biological study on which a sound management programme can be based.

Kashmir stag *Cervus elaphus hanglu*

The Kashmir stag, a subspecies of the European red deer, is now largely confined to the 55 sq. mile Dachigam Sanctuary of Kashmir, spending the summer months on the alpine meadows and wintering in the valleys. Possibly as many as 2000 deer still survived in 1947, but ten years later the population had been reduced to about 400 (Gee, 1966). It is doubtful if more than 180 remain in existence today (Schaller, 1969). Although overgrazing by livestock is a problem on the deer's summer range, poaching has been and continues to be the main cause for the decline. Responsibility for the suppression of poaching rests with the Kashmir Forest Department and unless it is prepared to make a more determined effort to bring the situation under control, the deer is certain to become extinct.

Asiatic buffalo *Bubalus bubalis*

The wild buffalo was once abundant in the Indo-Gangetic basin, as well as from Bengal southwards to the Godavari River. It has been eliminated from the greater part of its former range and is now uncommon, the population totalling no more than 2000. Three-quarters of this total occurs in Assam, of which about 550 are in the Kaziranga and perhaps 400 in the Manas Sanctuary, with others scattered along the Brahmaputra Valley. Herds along the Godavari River total no more than 150 (Daniel and Grubb, 1966), while the Nepalese remnant on the Kosi River numbers about 35.

The wild buffalo's favoured habitat comprised the extensive well-watered grass plains. These conditions were also the most attractive from the human standpoint, and the decline of the animal inevitably stemmed from this situation. Not only was the habitat taken over by man but, as cultivation became more extensive, increasing numbers of buffalo were killed in the interests of crop protection. The practice of herding cattle in areas used by wild buffalo was responsible for heavy losses from disease, notably rinderpest. The survival of this species is not assured, and a comprehensive study of it is needed.

Nilgiri tahr *Hemitragus hylocrius*

One of us (G.B.S.) checked on the status of the tahr in October, 1969, by visiting the major remaining areas in South India where it still exists. About 300 animals survive along the western escarpment of the Nilgiri plateau in Madras, protected largely by the Nilgiri Wild Life Association and by the rugged cliffs at an altitude of 7000 feet to which they retreat in times of danger. Unfortunately the forest department has in recent years built roads into tahr habitat and established extensive wattle plantations, thereby creating considerable disturbance and providing easy access to motorized poachers.

About 500 tahr, the largest existing population, are found in the Eravikolam area of the High Range in Kerala, a private shooting reserve maintained by the High Range Game Preservation Association for nearly 75 years. The tahr in this area have survived solely because of the efforts of the local sportsmen. In neighbouring areas, such as in the Palni Hills, where tahr come under government rather than private jurisdiction, poachers have either wiped them out or reduced them to a few small herds. The total number of Nilgiri tahr in existence is probably about 900-1000.

RELATIVELY COMMON FORMS

Included in this category are those animals which, although numerically reduced, are still fairly widespread in the forests and mountains and which, given proper protection and management, could once again become abundant in their respective habitats. If present trends are permitted to continue, however, certain species in this category, too, will ultimately be confined only to sanctuaries.

Animals such as the Himalayan tahr *Hemitragus jemlahicus* and blue sheep *Pseudois nayaur* have for long been protected by the remoteness and inaccessibility of their habitat. The recent increase in military activities and road construction in the mountainous

regions, however, is exposing the Himalayan fauna to intensive persecution. Some species have managed to survive because of their retiring dispositions and solitary habits. These include such animals as the serow, sloth bear, and four-horned antelope *Tetracerus quadricornis*. A few species, particularly the gaur, nilgai, langurs *Presbytis spp.* and rhesus monkey *Macaca mulatto*, have been to some extent protected by religious considerations. But such attitudes are changing. The nilgai, once tolerated because of its resemblance to the cow, is now shot, and the state of Uttar Pradesh even pays a reward for each specimen. Rhesus monkeys are extensively trapped for export to medical laboratories. In 1958-59 between 200, 000 and 250, 000 primates were exported annually from India; by 1965 the figure had dropped to 39, 000. Over 10 million rhesus monkeys were said to have once roamed Uttar Pradesh. Southwick *et al* (1965) estimated that only 800, 000 survived, and that the downward trend was continuing.

The blackbuck, once the most abundant large ungulate in India and Pakistan, is disappearing at an alarming rate, being now rare in most states including Gujarat, Orissa, Bihar, Madras, Uttar Pradesh and Punjab. It is a sardonic fact that the species exists now in larger herds in Texas and Argentina, where it has been introduced, than in its native lands. Because it is so easily shot in its preferred open habitat, there is little likelihood that this animal can survive outside well-protected preserves. Although small populations occur in a few sanctuaries, the perpetuation of this splendid antelope—as well as the similarly threatened Indian gazelle—calls for the creation of a large desert national park in Rajasthan, where possibly the cheetah could be reintroduced some day.

Elephants still occur in fair numbers in northern, southern and western India. No sanctuary is large enough to contain them, and they often enter cultivations where they may cause extensive damage. Because they have no natural enemies and are not heavily poached by man, elephants may become too abundant in some areas for the limited available habitat.

The two predominant South Asian species of deer—sambar and axis deer—are still widespread, though seldom abundant, wherever suitable forest exists. The axis deer in particular could become an economically important species, in the same way as the ecologically similar North American deer of the genus *Odocoileus*. The economic potential of wildlife is well exemplified in the United States where 2, 020, 885 deer were shot by licensed hunters in 1966, bringing a great deal of money to the states concerned. This is in marked contrast to the situation in India where no serious attempt has been made to realize the potential inherent in wildlife. In 1961-62 only 88 axis deer were legally shot in the large state of Uttar Pradesh. Most deer are taken by illegal and unselective methods, which not only reduce or eradicate the basic stock but in the process effectively destroy any prospect of the state governments acquiring revenue from the resource.

The large cats present special problems. Not only are their skins sought by the fur trade, but, because most indigenous prey species have been wiped out, they are obliged to subsist on domestic livestock. The secretive leopard is in no immediate danger of extinction: it manages to survive even in quite densely populated areas by preying on dogs and goats. On the other hand, the status of the tiger is becoming critical in India; in Pakistan it has already been largely eradicated except for a few in the eastern part of the country.

The nominate race, which is the tiger of South Asia, has thus far avoided being placed in the *Red Data Book*, but its status is deteriorating so rapidly that the time is not far distant when it will have to be added to the endangered list. Recent estimates by Gee (1964) and others placed the number of tigers in India at about 2500 to 4000 animals and in Nepal at about 250 animals.

Although the tiger is a highly adaptable animal, its range has been greatly reduced. It still occurs in most of the larger forests, except in the states of Punjab and Kashmir, but only sparsely. Even in the forested Himalayan foothills, once renowned for the number of tigers, the remnant is widely dispersed. The species is represented in only a few sanctuaries, such as Kanha, Kaziranga and Corbett.

An estimated 400-500 tigers are killed each year in India. One taxidermist alone is known to have handled over 100 skins in 1968. Since 1955 there has been increasingly widespread destruction of carnivores by pesticides—notably endrin and folidol issued by the Indian Department of Agriculture—a system that kills indiscriminately. Control over the use of such poisons is essential.

A further important cause of scarcity of tigers has been uncontrolled hunting, not least

by government officials, military personnel and others who frequently resort to reprehensible practices such as shooting from jeeps at night with the aid of spotlights.

The governments of both India and Pakistan have wisely prohibited the commercial export of tiger and leopard skins. However, the authorities do not have the fur trade within the country under control and tourists are still allowed to take skins out of the country. Most fur shops have tiger skins for sale—even in Kashmir where the animal does not occur. Laws are needed which require each skin to be stamped by the government, thus simplifying the detection of illegal skins, and which prevent all trade in endangered species or products made from them.

RESERVES AND SANCTUARIES

It is gratifying to see that most of South Asia's endangered species are represented in areas which have been designated as sanctuaries or national parks. These reserves are doubly important, since they preserve a broad spectrum of the countries' fauna and flora as well as provide a haven for the rare species. Kaziranga Sanctuary in Assam, for example, is a principal remaining stronghold of the Indian rhinoceros, Asiatic buffalo and swamp deer. In addition, it typifies a marsh habitat that once covered several thousand square miles along the Brahmaputra and Ganges rivers. Hog deer, elephant, tiger and other species frequent the area together with the less common animals. Unfortunately, most Indian sanctuaries are small—few exceed 200 sq. miles, and most are smaller—not large enough to retain within their boundaries such wide-ranging creatures as wild dog *Cuon alpinus* and gaur.

Furthermore, the establishment of a sanctuary is not in itself enough: it must be properly maintained. Some sanctuaries contain villages, and virtually all permit the grazing of livestock, sometimes controlled but more usually not. Many sanctuaries, particularly in Rajasthan and other arid areas, are usually so overgrazed that the habitat has degenerated. This factor, together with constant disturbance by herdsmen, the danger of transmission of disease from livestock to wildlife, and the loss of aesthetic value to the visitor, combine to make the grazing of livestock within a sanctuary a highly undesirable practice. It is realized that in some areas, such as the Gir Sanctuary, it would not be feasible to eliminate all villages and livestock. But it should be possible for the government to set a realistic limit—based on the optimum carrying capacity of the land—to the number of animals that may use an area. This would be a distinct advance on the prevailing practice of overstocking, exemplified by the 11 sq. mile Keoladeo Ghana Sanctuary in Rajasthan which is obliged to support some 5500 cattle and buffalo (Schaller *et al.* 1966), a gross misuse of a superlative area.

Many sanctuaries are also subjected to timber extraction programmes. In some states with limited land under forest a certain amount of lumbering may be necessary. If done in a controlled fashion the elimination of some tall trees may actually be beneficial to wildlife, because most species prefer secondary to primary growth. However, the recent trend in south India of cutting out the indigenous forest and planting the exotic *Eucalyptus* is to be strongly deprecated.

A serious danger to wildlife in most sanctuaries is from poaching. The amount of illegal hunting, whether for meat, for certain parts of the animal (such as rhinoceros horn), or for sport, is so extensive in some sanctuaries that the future of the species they are designed to protect is problematical. In several of the Uttar Pradesh sanctuaries, for example, swamp deer have been virtually wiped out, even though the reserves were established for the particular purpose of preserving them. Evidence of poaching is abundant away from the main roads, as the following experiences by one of us (GBS) show:

- (a) On the first morning of a visit to the Dachigam Sanctuary a site was found where a Kashmir stag has been butchered the previous day.
- (b) On the first day in the Keoladeo Ghana Sanctuary a muzzle loader was confiscated from a poaching villager.
- (c) During the first few days in the Kanha National Park dozens of snares set to catch deer were collected.

The institution of a system of daily foot patrols by a small number of dedicated forest rangers would speedily bring poaching under control. Although the forest departments

responsible for the sanctuaries have substantial staffs at their disposal, virtually no sustained attempt is made to curtail poaching.

Because of apathy and political expediency, the wildlife in the few sanctuaries of South Asia is threatened. The surface area of India alone is 1.26 million sq. miles. According to the United Nations list, 14 areas in India qualify for the status of National Parks and Equivalent Reserves, totalling 1974 sq. miles (Appendix B.) Other Indian reserves of varying status raise the overall figure by about 4,120 sq. miles. Expressed in terms of percentage of the total land surface area, and in comparison with most other countries, the figure is low. This insufficiency enhances the significance of each sanctuary out of all proportion to its size and serves to underline the need for those few areas to be administered in a way that will measure up to the aspirations on which they were established—as inviolate sanctuaries for the perpetuation of a selection of the country's indigenous fauna and flora under natural conditions.

One of the fundamental problems in India is that the central government has no administrative control over the preservation of wildlife and the management of reserves. All sanctuaries and so-called national parks come within the absolute jurisdiction of the respective state governments—which can establish, modify or even abolish them according to whim. A uniform policy for all states, co-ordinated at the federal level, is urgently needed if this national heritage is to be preserved.

THE FOREST ESTATE

In the South Asian countries most forest land belongs to the central or state government, rather than to private persons. This is advantageous in the sense that there is thus reasonable assurance that much of the habitat will not be brought under immediate cultivation. However, excessive livestock grazing in the forests, as in the sanctuaries, is causing deterioration through erosion and lack of regeneration. The forest departments are not politically powerful enough to curtail this grazing in most areas, even though some of the livestock consists of useless animals, old, diseased or unproductive.

In another respect, however, the forest departments' responsibility for wildlife is less fortunate. Most departments do not recognize wild animals as a valuable natural resource, and, with a few notable exceptions, foresters show no concern for or interest in the wild fauna under their jurisdiction: the emphasis is almost exclusively on producing the largest number of board feet of timber. Little effort is made to prevent poaching, which is practised not only by villagers but also by government officials, including some in the forest departments. Culprits, although known to the local forestry staff, are seldom apprehended and still more rarely prosecuted. Fines, when they are levied by the judiciary, are so low that they do not deter poaching. As a result, wildlife has become sparse in most forests.

In many countries there is now a growing realization that the maintenance of well-managed wildlife is not incompatible with the interests of forestry. This broader concept has yet to be accepted in South Asia, but in the countries' long-term interests it is important that wildlife management should become an integral part of forest department policy. In addition there is an urgent need for the governments to initiate conservation practices in the forests to prevent further habitat deterioration. The ultimate goal should be a land use policy satisfactory to man, to his livestock and to wildlife; one in which forest products, both plant and animal, are harvested on a sustained yield basis without further harming the land.

TOURISM

Attention has already been drawn to the loss of valuable potential revenue from hunting. Similarly, the South Asian governments have failed to appreciate the even greater unrealized potential inherent in wildlife as a tourist attraction. In Kenya, for example, tourism—which is based almost exclusively on the attractions of wildlife—has progressed during the last two decades to a position of the country's second most lucrative revenue-earner: if present trends continue it will soon top the list.

The need to encourage tourism has been officially recognized in South Asia, but efforts have been concentrated on historic and religious edifices and other cultural attractions, almost to the total exclusion of the wildlife. For example, in India one of the main tourist circuits, between the cities of Delhi, Jaipur, and Agra, touches on both the Sariska and Keoladeo Ghana sanctuaries yet most visitors remain unaware that in them they can view such uniquely Indian species as axis deer, nilgai and blackbuck, as well as many birds. The natural heritage of South Asia is as important and interesting as the cultural one, and visitors to that part of the world should be helped to become aware of it.

It would not be in the least difficult for tours to become as successful and as remunerative in South Asia as elsewhere in the world, but only if the basic amenities are available. A few national parks and sanctuaries have established rest houses, but in most of them the accommodation and particularly the food are of an inadequate standard.

RESEARCH

Sound solutions to any country's conservation problems are dependent upon adequate research and efficient management. It is impossible to establish a viable reserve unless one knows the requirements of the species it is designed to protect, and in any conservation programme the need for an accurate inventory is basic and self-evident. What does the animal eat? How far does it roam? Accurate and regular censuses are essential to find out if the animal is increasing or decreasing. What is the optimum carrying capacity of the forest lands in terms of livestock and wildlife? Virtually no research is being done on this crucial subject in South Asia, and little or nothing is known about most species inhabiting the sub-continent including the entire Himalayan complex. In India, the forest departments and the Zoological Survey of India, the two organizations which could be expected to undertake wildlife research, do not have an ecologist on their staffs. Intensive investigations on particular species have been limited to several primates (Simonds, 1965; Jay, 1965; Sugiyama, 1967; Ripley, 1967), and to the current studies of the Ceylon elephant and the lion, done mostly by foreign researchers.

Each forest department, whether state or federal, requires a separate wildlife branch with a small staff trained in wildlife techniques whose principal function would be field research. Such persons would of necessity have to be trained in Europe or North America, since most South Asian universities neglect to teach even a course in basic ecology, although a start has been made at Benaras Hindu University which holds a diploma course in ecology. Furthermore, each forest officer should be exposed to an intensive field course in wildlife management, which could best be held at the Dehra Dun Forest Research Institute. This course should be taught each year by an experienced authority on the subject, seconded from an overseas university through one of the technical assistance programmes.

It is important that the central governments, particularly in India, should take a more positive role in conservation, both with grants to establish and maintain sanctuaries, as well as by sponsoring research projects.

The time has also come for the world's conservationists to show more active interest in South Asian wildlife problems. A simple example will suffice to illustrate the imbalance: 15 foreign scientists are currently working on wildlife and habitat problems in the Serengeti National Park of Tanzania—more than in the whole of South Asia.

South Asia is presented with an urgent choice. Either poaching, over-stocking by domestic animals, and environmental degradation can continue as at present, with ultimate loss of some of the most valuable natural resources, or, through introduction and implementation of scientifically sound conservation programmes, the forests and wildlife can be retained for the benefit of this and ensuing generations.

RECOMMENDATIONS

Adoption of the following basic proposals would help to remedy the situation in India outlined in this paper. Broadly similar measures require to be taken in the other South Asian countries.

(1) *At the federal level:* The introduction, implementation and sustention of a dynamic conservation policy requires a legally constituted framework within which executive action can be taken. In the United States, for example, the Department of the Interior provides the broad umbrella under which conservation measures can be advanced. In the absence of an equivalent Ministry of Conservation in India, the appropriate agency at the centre is the Ministry of Agriculture, and, more specifically, the Department of Forestry.

A meeting of representatives of the Planning Commission, the Ministry of Agriculture and the Indian Board for Wildlife, held in April 1965, recommended the creation of a wildlife wing within the Department of Forestry, both at the centre and in each state. In August 1968, it was announced that an Assistant Inspector-General of Forests (Wildlife) had been appointed. This represents a highly significant advance.

The imperative need for centralized co-ordination of conservation policy could be further assisted by broadening and strengthening the authority and the effectiveness of the Indian Board for Wildlife by the appointment of a full-time Executive Officer, having the rank of at least Joint Secretary. This appointment would enable the Board to take its rightful place as a major driving force in matters pertaining to wildlife conservation in India. The Board itself should also appoint a small Executive Committee from among its members, which would meet more frequently than the full Board. At the same time arrangements should be made for the Board to submit an Annual Report to Parliament.

Without some such organization there is little prospect of introducing and implementing a dynamic country-wide conservation policy. Such an arrangement would also greatly strengthen the links between the Federal Government and the State Authorities.

(2) *At the state level:* The detailed work of implementing the policy agreed at the federal level will devolve on the states. Within the broad guidelines mentioned in the preceding Recommendation, the task of each state should be to make an assessment of its own wildlife resources and conservation problems, with federal aid in the form of funds and technical assistance where necessary. This would involve undertaking detailed surveys of all forests to evaluate their status and potential; drawing up a comprehensive wildlife management and conservation programme (a) for all forest areas in the state as a whole and (b) for each reserve; investigating the prospects of establishing additional reserves to ensure that a sample of each state's fauna and flora is protected; introducing any new laws that are desirable in furthering this objective; and ensuring that the agreed policy is vigorously enforced.

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APPENDIX A

Mammals of South Asia Occurring on the International List of Rare and Endangered Species as at January 1969

* Status discussed in detail in text

<i>Rhinopithecus roxellanae</i>	Snub-nosed monkey
<i>Caprolagus hispidus</i>	Hispid hare
* <i>Selenarctos thibetanus gedrosianus</i>	Baluchistan bear
<i>Viverra megaspila civettina</i>	Malabar civet
* <i>Panthera leo persica</i>	Asiatic lion
<i>Panthera uncia</i>	Snow leopard
<i>Acinonyx jubatus venaticus</i>	Asiatic cheetah
* <i>Elephas maximus maximus</i>	Ceylon elephant
<i>Dugong dugon</i>	Dugong
* <i>Equus hemionus khur</i>	Indian wild ass
<i>Equus hemionus kiang</i>	Tibetan wild ass
* <i>Rhinoceros unicornis</i>	Great Indian rhinoceros
<i>Rhinoceros sondaicus</i>	Javan rhinoceros
<i>Didermoceros sumatrensis</i>	Sumatran rhinoceros
* <i>Sus salvanius</i>	Pygmy hog
* <i>Cervus duvauceli</i>	Swamp deer
* <i>Cervus eldi eldi</i>	Manipur brow-antlered deer
<i>Cervus elaphus wallichi</i>	Shou (or Sikkim stag)
* <i>Cervus elaphus hanglu</i>	Hangul (or Kashmir stag)
* <i>Bubalus bubalis</i>	Asiatic buffalo
<i>Box grunniens mutus</i>	Wild yak
* <i>Hemitragus hylocrius</i>	Nilgiri tahr
<i>Capra falconeri jerdoni</i>	Straight-horned markhor

APPENDIX B

South Asian Sanctuaries Recognized by the United Nations List as National Parks or Equivalent Reserves

INDIA

		<u>sq. miles</u>
Assam	Manas Sanctuary	106
	Kaziranga Sanctuary	167
Bihar	Hazaribagh N. P.	73
Gujerat	Gir Sanctuary	489
Kerala	Periyar Sanctuary	301
Maharashtra	Taroba N. P.	46
Madhya Pradesh	Kanha N. P.	124
	Shivpuri N. P.	62
Mysore	Bandipur Sanctuary	22
Rajasthan	Sariska Sanctuary	192
	Jaisamand Sanctuary	21
Tamilnadu (Madras)	Mudumalai Sanctuary	125
Uttar Pradesh	Corbett N. P.	205
W. Bengal	Jaldapara Sanctuary	41
		1974
	Total	1974

PAKISTAN

Chittagong Hill Tracts N. P.	101
Madhupur N. P.	40
	141
Total	141

CEYLON

Wilpattu N. P.	254
Ruhunu N. P.	90
Wasgomuwa Nature Reserve	109
Yala Nature Reserve	107
Ritigala Nature Reserve	6
Hakgala Nature Reserve	4
Gal Oya N. P.	98
	668
Total	668

NEPAL

Chitawan Rhinoceros Sanctuary	313
Sukha Phanta Sanctuary	49
	362
Total	362

BHUTAN*

Manas Wildlife Sanctuary	162
Laya Wildlife Sanctuary	500
	662
Total	662

* (Note: Bhutan's two sanctuaries were recently established and have not as yet been included in the U. N. List).

Conserving the Asiatic Lion

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INTRODUCTION

The only remaining population of Asiatic lions (*Panthera leo persica*) is in the Gir Forest in Gujarat State in India. Estimates have been made of their numbers with five counts between 1936 and 1968. These range between 290 in 1955 and 177 in 1968. The problem is whether these figures represent a real decline, and if so, to find why it has occurred and recommend how it can be stopped. This paper gives preliminary results of a current research programme.

Study area

The Gir Sanctuary covers 1265 km². It encompasses the Gir hills which rise above the flat, arid agricultural lands of western Gujarat State. These hills are covered predominantly with a dry mixed deciduous forest, most of which is teak (*Tectona grandis*) and *Acacia* spp.

The climate is strongly monsoonal, with winds off the Arabian Sea bringing wet weather, usually from June or July through September or October. The rainfall during this period is low, with approximately 64 cm typical for the Gir as a whole. A dry cool season follows extending to February or March, and this is followed by a hot season with desiccating winds from the north.

Most valley floors along the periphery of the sanctuary are under cultivation, extending in some cases deep into the sanctuary. Agriculture is a continuous threat to the forest. Encroachment of cultivation has been particularly apparent within recent years with the advent of cash crops, namely sugar cane and ground-nut. Such encroachment limits the distribution of wild and domestic herbivores, especially in the critical dry part of the year when the natural forage is in least supply.

As well as cultivators who live along the periphery of the sanctuary, there are also graziers or 'maldhari', who live on both sides of the boundary, with about 5000 within the sanctuary. These 'buffalo breeders' are believed to have settled before the turn of the century, and now, having established themselves, they are opposed to any threats of moving them elsewhere.

With cattle (cows, bullocks and buffalos) densities varying from 0.2 to more than 0.4/ha and the intense competition for forage which has resulted, it is not surprising that wildlife has suffered. All wild ungulates in the Gir, namely chital *Axis axis*, sambar *Cervus unicolor*, nilgai *Boselaphus tragocamelus*, chinkara *Gazella gazella*, four-horned antelope *Tetracerus quadricornis* and wild boar *Sus scrofa*, are rare.

The dominant financial interest within the Gir is forestry, providing a net return in the order of five or six lakh rupees (approx. £28,000-£33,000) annually. The principal species harvested is teak which is intensively managed on a 40-year rotation. This interest conflicts with the cattle graziers because domestic stock damage the regeneration of trees.

Tourism is a recent development within the sanctuary. At the moment lions are the only attraction and specially conducted tours are arranged for the tourists. During the last five fiscal years (April to March) the number of visitors per year has increased from

4378 to 8443. Despite this remarkable increase, however, tourism to the area still results in a financial loss.

Administration

The protection and management of wildlife and the management of tourist facilities within the sanctuary are handled by the Gujarat State Forest Department. Within the sanctuary, the man carrying this responsibility is the Sanctuary Superintendent. Among his 42 subordinates are one wildlife inspector and 12 game keepers in the western part of the forest (Anon, 1969). Wildlife management is embryonic, and almost the entire staff effort goes to locating lions within 16 km of Sasan and showing them to the public.

The administration of the forest within the Gir is handled by two complementary divisions of the Gujarat State Forest Department. One division is responsible for research, inventories and the preparation of a new forest 'working plan' every ten years. The second division is concerned with the protection of the forest, and the application of the recommendations laid down in the working plan. The latter division employs approximately 155 men and includes about 30 officers who reside in various parts of the sanctuary. Both divisions have a Divisional Forest Officer at their head who is equivalent in rank to the Sanctuary Superintendent.

History

Within historic time the range of the lion outside Africa extended from northern Greece, across the semi-arid latitudes of Syria, Mesopotamia, Persia and eastward as far as central India. Available evidence suggests that it was a recent migrant to India, for it had not reached the most southern or eastern parts of the subcontinent. While it ceased to exist in eastern Europe by approximately 100 A.D. and in Palestine at about the time of the Crusades, it was widespread over the remainder of its range until the middle of the 19th century when the widespread use of firearms brought about a dramatic reduction in its numbers (Talbot, 1959).

By 1834 it had vanished from Bihar and from the Punjab, by 1842 from the Sind, and by 1872 from central India (Daniel, 1956). By 1891 it had disappeared from Asia minor and by 1907 from Mesopotamia (Kinnear, 1920). By 1884, the last surviving intact population of Asiatic lions was to be found in the Gir hills (Talbot, 1959). The credit for this was due to the Nawab ruler of Junagadh on whose private land they existed, and who tenaciously refused to allow them to be shot out. Here they remained until the present day, protected by the generations of conservation-minded Nawab rulers who followed, until the time of Independence when the importance of preserving lions was beginning to be generally recognized. Interest was further spurred when in 1955 Jawaharlal Nehru visited the area, and thereafter advocated that steps be taken to develop a tourist industry around the lion. This was begun in 1956. In 1965 the area was upgraded from a game reserve to a wildlife sanctuary, and at the sixth meeting of the State Wildlife Advisory Board held in November, 1968, it was recommended by the State Minister of Forests that the Gir Sanctuary be further upgraded to a National Park.

RESULTS

Counts of lions

Various attempts have been made to count the lions since 1936. All of these involved counting the number of fresh lion tracks representing individuals the day after the roads within the sanctuary and surrounding lands had been 'swept clean' of tracks. In this method it is assumed that lions move to water once a day and that tracks can be recognized individually by differences in length and breadth. In addition, in 1968, buffalo calves were staked out as baits over the sanctuary for a period of days, so that a direct count of the number of individual lions appearing at the baits could be made.

Numbers were rather similar from 1936-1963, with a decrease later (Table 1). The apparent decrease in 1950 was due to counting over a smaller area (Wynter-Blyth, 1956). About 50 per cent of the lions were found outside the sanctuary in 1955 (Wynter-Blyth, 1956) and about 17 per cent in 1968 (Dalvi in litt.).

TABLE 1 COUNTS OF LIONS
IN THE GIR FOREST

<u>Year</u>	<u>Count</u>
1968	177
1963	285
1955	290
1950	240
1936	287

Availability of prey

This depends on the seasonal distribution and vulnerability of prey animals, and also on the amount eaten from each prey killed. This amount determines not only whether the animals get sufficient to eat at any one feed but also how soon the lions need to kill again. Available prey are partly wild animals, but also domestic stock which are enclosed within thorn hedges at night and (mostly) vulnerable to lions when grazing in the forest by day. The density of stock varies since the animals kept permanently in the forest are supplemented by others brought in seasonally from outside. Prey vulnerability depends on age, size and species. The amount eaten is greatly affected by human interference, since Harijans, called untouchables in pre-independence times, rob the lions of their kills whenever they can. These people eat the meat and sell hides and bones.

(a) *Ungulates permanently within the sanctuary*

(i) Domestic stock

About 21,000 'cattle' live permanently in the sanctuary. Table 2 analyses their numbers and composition in 1968-69. These data were kindly made available by the Gujarat State Forest Department, but the figure for goats is based on my counts.

TABLE 2 DOMESTIC LIVESTOCK PERMANENTLY WITHIN THE SANCTUARY 1968-69

	Adult	Sub-adult*	All ages
Cow	605	644	Camel 227
Bullock	813	644	Horse 215
Buffalo	9747	8919	Goat† No official figure
TOTAL	11165	9663	442

* Less than approximately three years of age

† My estimate is approximately 2000

(ii) Wild ungulates

Data on the relative densities of wild ungulates were obtained from night counts using a 12-volt spot-light. Most roads in the sanctuary were surveyed, mainly in the western half, covering 1025 km altogether. Normal speed was 10-20 km per hour with an observer standing at the back of a jeep with canvas sides removed for better viewing. Observations (Table 3) were made on both sides, giving a field of view about 75 m wide.

TABLE 3 WILD ANIMALS SEEN ON NIGHT TRANSECTS IN APRIL-MAY 1969
(1025 km)

(a) Ungulates:		(b) Predators:	
Cheetal	249	Lion	14
Sambar	39	Leopard (<i>Panthera pardus</i>)	8
Nilgai	23	Jungle cat (<i>Felis chaus</i>)	62
Wild boar	18	Desert cat (<i>Felis libyca</i>)	1?
Four-horned antelope	5	Hyaena (<i>Hyaena hyaena</i>)	7
Chinkara	4	Jackal (<i>Canis aureus</i>)	1
	<hr/>	Fox (<i>Vulpes bengalensis</i>)	7
	<hr/>	Ratel (<i>Mellivora capensis</i>)	1
	<hr/>	Mongoose (<i>Herpestes edwardsi</i>)	4+
(c) Other:		Civet (<i>Viverricula indica</i>)	6
Porcupine (<i>Hystrix indica</i>)	12		
Hare (<i>Lepus nigricollis</i>)			
approx.	174		
Common langur (<i>Presbytis enrellus</i>)	not counted		

(b) Domestic stock temporarily in the sanctuary

At least since 1884 additional 'cattle' have been brought into the sanctuary each year for several months, in the dry season as well as in the wet season (Watson, 1884). About 24,677 non-resident 'cattle' entered the Gir Forest in 1968-69, and this number is fairly typical of other years. Table 4 shows the probable herd structure, assuming it to have been similar to the herd structure of the total 'cattle' population outside of the sanctuary.

TABLE 4 ESTIMATED NUMBERS OF NON-RESIDENT 'CATTLE' ENTERING THE SANCTUARY IN THE FISCAL YEAR 1968-69 (24,677)

	Adult	Sub-adult	Total
Cows	6198	2101*	8299
Bullocks	8529	2846*	11375
Buffalo	3852	1151	5003†

* Yearlings are excluded since they are not normally brought into the Sanctuary.

† Figure supplied by the Gir Divisional Forest Officer, 7/10/69.

(c) Ungulates outside the sanctuary

The domestic livestock population in all districts or 'Talukas' adjoining the sanctuary totalled 456,486 in 1966-67 (Anon, 1967a and b). The 'cattle' densities alone averaged 0.8/ha and when donkeys, sheep, goat, camel and horses are added to this figure the density of free ranging stock amounted to 1.0/ha or roughly 2.5 times the highest densities reached within the sanctuary.

Although the numbers of wild ungulates were not estimated in the areas adjoining the sanctuary they were probably negligible because conditions were unsuitable for them.

Food habits

(a) Faecal analysis

So far, approximately 1000 droppings of predator faecal material have been collected. 211 were sufficiently large (bore diameters of 4 cm or larger) to be considered as 'lion only' defecations, while the remainder contained leopard and hyaena faeces in unknown proportions. Within the 'lion only' category 6.9 per cent have been identified by preliminary non-microscopic analysis as containing hair of wild prey, while the rest were regarded as containing probably domestic stock.

(b) Carcass analysis

Two surveys have been carried out to find which classes of the domestic stock are killed by lions. The first survey was done in the dry season over several months in 1968 in conjunction with other studies. It involved visiting a number of villages in various parts of the Gir, and to some extent along the periphery, inquiring about information regarding lion kills. I was told about many of the carcasses, but did not see them

The second, more refined survey was done between 21 August-21 September 1969, in the latter part of the wet season. The area studied was limited to the western half of the sanctuary, and an area equal in size surrounding the western half of the sanctuary boundary. Ninety-eight villages, about half of them outside the sanctuary, were offered a reward for reports of any lion kills within 24 hours of the event. As a further check, two to three men were hired to visit each of the villages at least once every 14 days to ask the whereabouts of kills. As each case was reported, I visited the kill sites, examined the carcass remains and interviewed the grazier who saw the killing. Table 5 shows that cows, bullocks and buffalos were more often killed than goats, horses or camels, as might be expected from their relative abundance. Secondly, more cows were killed during the wet season, when more were brought into the sanctuary. Thirdly, relatively few bullocks were killed although they were abundant (Table 2, 6). During the wet season, most cows killed were adults, while more sub-adult than adult bullocks were killed (Table 6). The implication is that lions found adult bullocks too large, but not adult cows. I noticed that lions had difficulty in killing adult buffaloes when these were tied up as bait.

TABLE 5 REPORTS OF DOMESTIC STOCK KILLED BY LIONS

Time of year	Cow	Bullock	Buffalo	Other	Total
Dry season	14	8	23	3	48
Wet season	23	10	15	2	50

TABLE 6 AGE CLASSIFICATION OF LION KILLS RECORDED DURING THE WET SEASON

	Adult	Sub-adult
Cow	19	4
Bullock	2	8
Buffalo	8	7

Prey utilization and competition with Harijans

During the August-September survey I recorded the degree that lions utilised carcasses (Table 7).

TABLE 7 PREY UTILIZATION BY LIONS

Extent of utilization	No. of carcasses
None	13
Up to 10 kg	11
More than 10 kg	4
Not known, probably some	29

TABLE 8 NUMBER OF KILLS MADE BY LIONS APPROPRIATED BY HARIJANS.

	Carcasses appropriated	Not appropriated
Inside sanctuary	25	17
Outside sanctuary	11	2
Total	36	19

TABLE 9 DISTRIBUTION OF HARIJANS

Villages (Nesses)	Inside Sanctuary	Outside Sanctuary
Harijans resident	2	34
Harijans not resident	30	2
Visited by Harijans	29	2
Total villages interviewed	32	36

Clearly lions did not make full use of their kills. At least 23 per cent of all carcasses examined had no meat eaten from them, and fewer than 20 per cent of cases had as much as 10 kg of meat utilized (visual estimate). The primary reason for this would appear to be competition with Harijans. As soon as these people learned of a kill they went to the site and drove away the lions. In many cases (83 per cent of those examined, the graziers reported that it was they who drove the lions away, but Harijans still appropriated the carcass. Table 8 shows that 64 per cent of 55 kills examined had been claimed or were about to be claimed by the Harijans. Their activity was particularly dominant outside the sanctuary. The only carcasses which they did not claim outside the sanctuary were two goats, considered too small to be worth taking.

In the western part of the sanctuary, Harijans lived in or visited all villages but one of those interviewed. However, few Harijans actually lived inside the sanctuary (Table 9). Consequently, fewer lion kills inside the sanctuary were appropriated.

Baiting Lions

Most lions which came within 16 km of Sasan were accustomed to participating in 'lion shows'. When found, lions were conditioned to remain where they were by means of a live bait, usually a sub-adult male buffalo. After tourists had seen the lions and left, the buffalo were offered to the lions. 172, 217 and 252 baits were offered in the dry seasons (tourist seasons) of 1965-66, 66-67 and 67-68 respectively. None of these baits was taken by Harijans, and in most cases (40 examined) more than 10 kg was eaten by the lions.

Additional factors affecting lion numbers and their distribution:

(a) Forest removal

The Trigonometrical Survey of 1871-72 gave the area of the Gir forest as a little

over 3110 km². Today it covers 1196 km², all but 121 km² of which is within the sanctuary. The area which was once forest has been replaced by a treeless landscape, with more domestic stock but less suitable for lions.

(b) *Cultivation*

In 1963, approximately 59 per cent of the lands contiguous with the sanctuary were under cultivation (Anon 1967c). In 1969, most valley floors extending within the sanctuary were under cultivation, with further expansion in progress. The composite map of the sanctuary prepared by the Divisional Forest Surveyor in April 1968, showed some cultivation deep within the sanctuary, especially in the Devalia block in the south-west which was all but isolated from the rest of the sanctuary by a strip of cultivation.

Formerly, these lands provided additional space for lions and supported a sizeable population of domestic if not wild herbivores, which in turn benefited the lion. Because the soils were rich and had a high water table, it is reasonable to assume that their capability for supporting herbivores was among the highest in the Gir. Apparently agricultural encroachment has accelerated recently with the advent of cash crops, such as groundnuts and sugar cane, which provide no benefit for lions or their prey.

(c) *Fodder removal*

According to the 1969-70 advertisement by the Gujarat State Government to fodder contractors, approximately 1684 ha of grass cover (estimated at 840, 000 kg of fodder) were scheduled for cutting within the sanctuary during the current fiscal year. A further area of 2016 ha (1, 100, 000 kg) contiguous with the sanctuary boundary was also to be cut, the fodder in both cases to be removed, stored and utilized in other parts of the state during scarcity years. In addition to these areas, a further 2609 ha would be contracted out for use as fodder for the villages surrounding the Gir. As with cultivation, this annual practice constituted a substantial loss of vegetative energy from the indigenous ecosystem, which otherwise could ultimately have benefited the lion.

DISCUSSION

1. Numbers of lions

The apparent decline in the lion population of nearly 40% from 1963-1968 could be due to an over-estimate in the earlier years. This has been suggested by the late Mr. E. P. Gee (in litt. to the I.U.C.N.). Mr. S. K. Sinha (unpublished) reviewed the 1963 count, and found possible errors. Apparently, some 130 lions were counted in 10, 360 ha of the sanctuary in 1963 and this was presumably an over-estimate.

Dalvi (1969) reviews the 1968 count, for which he was responsible. This count was the most intensive ever, involving the new baiting method as well as counting fresh tracks, and employed 200 men, many more than in previous counts. Although Dalvi's count differed from the four earlier ones, the close agreement between his two different methods suggests that his result was reliable.

Other important factors are firstly the change in lion distribution since 1955, when 50 per cent were outside the sanctuary compared with only 17 per cent now, and secondly the disappearance of lions from the Girnar range to the north and the Mithiala range to the east. This must mean either that the lions are now more concentrated within the sanctuary than formerly or that the decrease recorded by the counts is likely to be genuine. For conservation purposes it is wise to conclude that a decrease has in fact occurred, and to examine those parts of the former range where lions are now absent, for possible reasons. The reliability of the earlier counts cannot now be assessed, and it is not profitable to conjecture about the extent of the decline. The important point is to ensure that the decrease is halted.

2. Possible conservation measures

(a) Removal of the indigenous cattle

No one likes to see cattle in a wildlife sanctuary. They compete with wild herbivores, and presumably contribute to their present rarity. Yet looking at the sanctuary entirely from the standpoint of the lion's conservation, there is no reason to suppose that lions cannot live on cattle just as well as on wildlife, and possibly better. If all the cattle were removed suddenly, with the objective of allowing the wild herbivores to recover, the lions might starve or emigrate. The presence of some cattle may take the pressure of predators off the wild herbivores. Moreover, Hodd (1969) has shown that the Gir habitat when fenced against domestic graziers, can regenerate its plant cover comparatively quickly. In short the effect on lions of reduced grazing pressure cannot be predicted without experiment, and the situation is obviously complex.

Following the recommendations of the State Minister of Forests for the establishment of a National Park within the Gir sanctuary, reports have been submitted for two alternative sites, each of which would cover about 12,500 ha. It is likely and important that one of these proposed sites will be established as a National Park within the next two years, and cleared of all its domestic stock. This should benefit the wild herbivore population and the tourist industry, and will also provide an experimental area for research of tremendous value for wildlife conservation in India.

(b) Removal of immigrant cattle

In December 1968, a State government committee recommended that the 'influx of outside cattle for grazing into the Gir forest during the wet season should be totally stopped.' The grounds were that the outside cattle competed for food with the wild ungulates, and reduced their numbers and hence the number of lions. This recommendation, did not consider the importance of non-resident cattle, and in particular cows, in the lion's diet. Approximately 65 per cent of wet-season lion kills were shown by the survey to involve immigrant stock. In the short term, the logical component to prohibit first is adult bullocks, since they are the least preferred by the lions. In the long term, further research is needed to show whether prohibition of cows as well will or will not affect the lion's survival.

(c) Development of the tourist industry

The tourist industry is playing an important role in improving the availability of prey for lions in the western part of the Gir forest. The certainty of seeing lions is the only reason that most tourists visit the area, and 'lion shows' can only be guaranteed if baits are used. During the 1968/69 season the baits attracted at one time or another approximately 20 per cent of the total lion population. During the 1968 census the density of lions within a 16 km radius of Sasan was significantly higher than anywhere else in the sanctuary.

During the last four years the number of visitors coming to the Gir specifically to see lions has doubled and now exceeds 8000 per annum, although in 1968/69 the number of visitors was five per cent less than in 1967/68. However, the tourist industry is running at a considerable loss, apparently because of the rather high price of accommodation (Rs. 80/- per party of one to eight) and hence the fact that few people use the Guesthouse overnight. Seeing lions is really quite inexpensive and could be advertised as such (8443 visitors to the Gir in 1968/69 spent an average of only Rs. 7/30 each). Diversifying the tourist interest and developing a programme of activities for the visitors beyond the lion shows would provide an incentive for visitors to spend at least a night at the Guesthouse.

3. Social and legal aspects

At the present time the Gujarat State Government compensates graziers who lose stock to lions within the sanctuary. This practice was initiated in order both to lessen the hardships of the graziers and also to discourage them from taking reprisals. From 1963-69, nine cases of unnatural deaths involving 13 lions have been recorded which identify some form of malpractice, mostly poisoning, as the cause.

The success of the compensation system at this stage is questionable. During the wet season survey of lion kills in 1969, only 33 per cent (14) of the graziers suffering losses said that they were intending to apply for compensation, and of these it can be expected that a smaller percentage actually did so. Three of the nine cases involving lion deaths due to malpractice occurred during the year.

The primary cause for the poor response by the graziers would appear to be the restrictions governing the conditions under which they are eligible to apply for compensation. These restrictions are that:

- (1) No grazier who loses stock outside the sanctuary shall be compensated. The wet-season survey showed that 20 per cent (9) had lost stock outside the sanctuary.
- (2) No grazier who loses stock more than an arbitrary distance of two furlongs (400 m) from his village shall be compensated. During the wet-season survey, 60 per cent (27) lost stock at distances greater than two furlongs from their villages, and in 42 percent (19) of the cases the distances exceeded 2 km.
- (3) No grazier, if he is a cultivator from outside the Gir and loses his stock more than two furlongs inside the sanctuary boundary, shall be compensated. During the wet-season survey, 76 percent (16) of the non-indigenous graziers inside the sanctuary lost stock at distances greater than 2 furlongs from the sanctuary border, and 43 per cent (9) at distances greater than 2 km.
- (4) No grazier shall receive compensation if he owns more than about 20 head of stock. Thirteen per cent of the 153 applications filed during 1968-69 were rejected because the farmers who made the requests were considered to be too prosperous.

Obviously much could be done to improve and expand the present system of compensation. Moreover much of the needless loss of the lion's food to Harijans could be controlled by simply letting it be known that graziers would lose their right to compensation if they allowed Harijans to take the meat. Not only would this benefit the lions but it would profit both the government and the graziers because the lions would need to make fewer kills in order to sustain themselves, which ultimately would result in fewer requests for compensation. However the extent of hardship that this would create for the Harijans and how this could be lessened should also be investigated.

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SUMMARY

Once distributed over most of India, all of Persia, and the Middle East the Asiatic lion is now confined in the free living state to a 500 square mile reserve in the northwestern part of India, known as the Gir Forest Wildlife Sanctuary. In June of 1968 the government of Gujarat undertook a census of the lion population, and found it to number about 180 or drastically less than the population estimate made in 1963. At about this time The Royal Society sponsored a one year study of the lion's ecology and the reason for decline. This paper summarizes the results of these investigations up to September 1969.

The lion population appears to have undergone a significant reduction in recent years; the greatest reduction has probably occurred outside the Sanctuary.

Lions both inside and outside the sanctuary are living almost entirely on domestic stock. Appropriation of lion kills by Harijans is a major factor in limiting the utilization of this prey.

Significant reductions have also occurred both in the size of the Gir ecosystem and in the available sources of energy in the lion's food chain.

RÉSUMÉ

Il fut un temps où l'aire de distribution du lion d'Asie couvrait la majeure partie de l'Inde, toute la Perse et le Moyen Orient, mais de nos jours cette aire se trouve réduite à une réserve de 129. 500 hectares située au nord ouest de l'Inde et connue sous le nom de 'sanctuaire de la Forêt de Gir', où le lion vit à l'état sauvage. En juin 1968, le gouvernement de Gujarat effectua un recensement de la population des lions et put constater que ses effectifs avaient diminué de 180 individus sinon plus par rapport à l'estimation faite en 1963. Environ à cette époque, la Société Royale finança un programme de recherches d'un an sur l'écologie du lion et les causes de la diminution de ses populations. Le présent article résume les résultats de ces recherches jusqu'd septembre 1969.

La population du lion d'Asie semble avoir subi une diminution significative au cours des dernières années. Il semble que la diminution la plus importante ait eu lieu en dehors des limites du Sanctuaire.

A l'intérieur et à l'extérieur du sanctuaire, les lions se nourrissent presqu'exclusivement de bétail domestique. Mais les intouchables (Harijans) s'approprient fréquemment les proies tuées par les lions, ce qui limite de façon importante leur consommation par les fauves.

Il y a également eu des réductions importantes du point de vue de la grandeur de l'écosystème du Gir et des sources d'énergie disponibles dans la chaîne alimentaire du lion.

The Vanishing Indian Tiger

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INTRODUCTION

The tiger, *Panthera tigris* Linnaeus, a rare combination of magnanimity, colour, ferocity and awe, has been a subject of interest in the hunting history of India for ages. Even today, when emphasis has shifted from killing to conservation, he still remains the centre of attraction in the Indian jungles. There is hardly any other animal which has attracted so much attention from hunters, conservationists, wild life enthusiasts and photographers. For foreign as well as local tourists, the tiger in the centre of their view-finder, is the ambition of their Indian sojourn. An encounter with a tiger is an exciting moment in life and every time this is repeated, it provides, without doubt, a new experience and an added thrill.

This paper is a preliminary report of the distribution and status of the Indian tiger and is a part of the main project 'The Controversial Tiger—A Study of Ecology, Behaviour and Status' which is being undertaken under a Jawaharlal Nehru Fellowship.

HABITAT OF THE TIGER

Fifty years ago, the Indian tiger was found almost all over the Indian sub-continent except in the alpine snow-clad mountains of the Himalayan dry region and the extreme tropical thorn forests of the western desert of Rajasthan. In the north-western part of the country, the dry Sal (*Shorea robusta*) sub-montane forests of Kalashar, the tropical bamboo (*Dendrocalamus strictus*) forests of the Morni hills of Haryana and the sub-montane Sal forests of Nahan in Himachal Pradesh were tiger hunting blocks in the past. The tigers also strayed out of the forests in open lands when standing crops provided cover. Now there are no tigers in these forests.

Uttar Pradesh

English (1888), Champion (1927, 1933), Hewett (1938), Corbett (1943), Srivastava (1954) and Smythies (1956) have described the tiger habitat of the State, while narrating their experiences of tiger shikars. In the dry deciduous sal and sain (*Terminalia tomentosa*) forests of Dehra Dun and Saharanpur districts of Uttar Pradesh, tigers were found in abundance in the undergrowth of Rohini (*Mallotus philippensis*) and *Chlorodendron infortunatum* and in ravines where *Moraea koenigi* grows in thickets. Motichur, Phanduwala, Timli, Dholkhand, Beribara, Mohand, Shahjahanpur were some of the blocks where tiger shooting was a certainty. The tiger population was also high in the tropical savannah habitat of Gola Tapper, where they used to hunt deer, hog deer *Hyelaphus porcinus*, barking deer *Muntiacus muntjac* and wild boar *Sus scrofa* in the tall elephant grass during night and retire during day to the nearby fresh water swamps under thickets of *Diospyros emoryi*. The population pressure of tigers forced them to live in adjoining sugar-cane fields and tea-garden bushes. These forest hunting blocks have been over-hunted and now there are only 40 tigers left in Dehra Dun and Saharanpur forest divisions. Some of the blocks have been closed to shooting and a few like Motichur, Mohand and Kansroo have been declared sanctuaries where the tiger is protected.

Tigers are still found in the tropical dry deciduous sal and mixed miscellaneous forests of Siris (*Albizia procera*) and Papri (*Holoptelea integrifolia*), with heavy under-growth of Rohini, *Chlorodendron infortunatum*, *Acacia laevis* and *Holarhena antidiacrenica*, in the forest divisions of Kalagarh, Lansdown, Ram Nagar, Bijnor, Haldwani, Pilibhit, Kheri, Bairaich, Gonda, Gorakhpur and Terai Bhabar.

The 'happy' hunting grounds of Jim Corbett are situated in tropical sub-montane forests in the foot-hills of the Himalayas. The elevation of these foot-hills ranges from 500 to 1,000 meters above sea level. The main species of the forest is Sal, with Sain, *Bauhinia* spp. and *Kydia calycina* in the foot-hills, and Oak (*Quercus incana*) and Chir (*Pinus longifolia*) in the temperate region and at higher elevations. There are few patches of open land which are ideal for wild life, such as chital *Axis axis*, barking deer, elephant *Elephas maximus*, wild boar and sambhar *Cervus unicolor*. The broken topography of these grass-lands provides a habitat for predators—tigers and panthers *Panthera pardus*—where they can hide and can stalk their prey.

Tigers have also been recorded in the northern sub-montane hills, occasionally ascending to Mussorie (2, 833 metres a.s.l.) in the temperate region, which remains under snow from November to April and has broad-leaved and coniferous forests. They mainly live on hogs and Himalayan black bears (*Selenarctos thibetanus*) (Burton, 1933). A man-eating tigress was shot by Mr. B. B. Osmaston in 1889 near Mundali Forest Rest House.

The forest divisions of southern Uttar Pradesh (Band, Jhansi, Mirzapur) present a different topography climate and vegetation. The region is characterized by very high temperatures and low rainfall. The forests consist of tropical dry deciduous species, such as Dhawari (*Anogeissus latifolia*), Dhok (*Anogeissus pendula*), Tendu (*Diospyros melanoxylon*), Arjun (*Terminalia arjuna*), Khair (*Acacia catechu*), Salai (*Boswellia serrata*), Mohuwa (*Madhuca indica*) and scattered trees of Kusum (*Schleichera trijuga*). All along the base of the Vindhya plateau, there runs a bamboo belt about 50 metres wide. These bamboo thickets and the spaces between sandstone blocks, which remain shaded for the greater part of the day, are ideal habitats of tigers. The forest blocks of Mirzapur, which were once considered to be an inexhaustible source of tigers, support hardly ten tigers now. Tigers were also found outside forests in ravines and other broken country and in cultivated agricultural fields. In the whole of the Southern Forest Circle, of Uttar Pradesh, there are now only 40 tigers.

The tropical Terai and Bhabar lands, with their edaphic sub-climax of swamps, tall elephant grass and scattered trees of Simal (*Salmalia malabarica*) and Siris (*Albizia procera*), were the best areas for tigers. Large areas of these lands have been brought under sugar-cane cultivation, which has developed a new habitat ideal for tigers to litter and raise cubs without much interference.

Almost all these habitats of Uttar Pradesh became the hunting grounds of Governors, Generals, Governors, High Officers of the British Army, Imperial and Indian Civil Service, Maharajas, Rajas, Nawabs and even District Officers. By the end of the 18th century, the slaughter of tigers began in the Terai. One Anglo-Indian judge shot 360 tigers with his own rifle by the end of the year 1800 (Perry, 1964). Hunting of a tiger became a status symbol. Even in the last 30 years there have been quite a few officers who have shot a tiger a year in their 30 years' service. Others also, who booked hunting blocks for a fortnight, had reasonable success in bagging tigers, leopards, spotted deer, hog deer and sambhar. All these they could shoot easily and for Rs. 20/- (less than than U.S. \$3.00). Champion (1934) made an interesting observation about the tiger population. He recorded that while the tiger population had increased in the 25 years 1907-1934, the population of other game had dwindled by 25%. He did not estimate the total population of tigers nor indicate any percentage increase.

No scientific studies have been made to assess the total U.P. population of tigers, but accounts of hunting success and 'encounters' with tigers suggest a fall in the tiger populations during the last few years. My discussions with forest officers and calculations of the tiger population show only 400 tigers. The official figure is 500. Out of these, 80 are in various National Parks and Sanctuaries. The State authorities have become conscious of this falling population of tigers. The whole of the western Dehra Dun Forest Division, Maidan, Lachiwala and Thano blocks of eastern Dehra Dun division and a few others have been closed. In other forest blocks only 50 tigers per year can be shot. Some good forest areas like Dholkhand, Motchur, Jaulasal, Maldhan, Tanda, Sonaripur, Bankatawa have been established as sanctuaries and some parts of Ram Nagar and Kalagarh forest divisions have been constituted as the Corbett National Park where tigers have been strictly protected.

Bihar

Once the vast State of Rajas and wealthy Zimandars, Bihar, particularly the districts of Purnea, Sarhsa, Dharbhanga and Muzaffarpur, was the ideal habitat of tigers. Here too, they have been over-hunted. Tigers are now found only in the tropical dry deciduous sal forests of Tabo, Bonuabura, Lat, Kerk, Koderma, Kaimus, Hazaribagh and Betla. Chital, barking deer, sambhar, gaur *Bos gaurus*, wild boar, sloth bear *Melursus ursinus*, tiger and leopard have been declared protected in these blocks. Hazaribagh and Betla forest areas have been designated National Parks.

In 1930 Mr J. W. Nicholson, a forest officer, carried out a census of tigers by counting pug marks near water-holes over an area of 117 sq. miles and estimated 32 tigers in Bihar. The recent estimate of the same area shows a fall in tiger population of 75%. Only 8 tigers are reported to be in the above areas (Wright 1969). In all, there are not more than 90 tigers in the whole of the State.

West Bengal

The Royal Bengal tiger is famous in natural history, travel and fiction books on India. In the foothills of the Eastern Himalayas, tigers occur in the wet tropical evergreen forests with extensive patches of savannah (Jaldapara), in the tall grass in the stable bed of the Tista river and in the tropical mixed forests of Sukana, Corumara, Jalpaiguri, Buxa, Cooch Behar and Chapramari forests, where the main species are Sal, *Mesua ferrea*, *Schima wallichii*, *Michelia spp.*, *Albizia procera*, *Litsaea spp.*, *Chiorodendron infortunatum*, *Melilomis*, *Typha*, elephant grass etc. They feed on sambhar, chital, wild boar and even rhinoceros calves (*Rhinoceros unicornis*).

The Lower Bengal swamps of the southern Sunderbans, supporting mangrove forests of *Rhizophora*, *Bruguiera spp.*, *Sonneratia spp.*, *Ceriops*, *Kandelia*, *Heritiera minor*, *Thespesia populnea* and heavy grass jungles, have been the known habitats of the tigers. The usual food of tigers in these forests consists of chital, hog deer, wild boar. The tigers in this area have a difficult life. They live in salt water, in swamps infested with pneumatophores.

The former population of tigers in Bengal can be estimated from the fact that George Udnye Yule in 25 years (1856) had shot 400 tigers in Bengal and continued slaying afterwards, but he did not care to count them, (Fawcett 1943). Jerdon (1874) records an abundance of tigers in southern Bengal. They are still found in Sunderbans living a semi-aquatic life and are said to be larger and more ferocious and savage than those found in other parts of India. The number of tigers has fallen considerably (only 140 in the whole of the State). To protect the tiger, some of the blocks—Jaldapara, Gorumeria, Mahanadi, Chapramari and Lothian Island—have been constituted Sanctuaries where tigers are protected. Hunting of all herbivores, which are the food of tigers, has been prohibited all over the West Bengal reserved forests.

Assam

Assam, the north-eastern region of India is the junction of Indo-Chinese Indo-Malayan, Peninsular and European fauna. The Indo-Chinese element is represented by raccoon-dog *Nyctereutes procyonoides*, hog-badgers *Arctonyx collaris* and *A. taxoides*, crestless porcupine *Hystrix hodgsoni* and tragopans. The Indo-Malayan element comprises the tiger, wild buffalo *Bubalus bubalis*, elephant, rhinoceros, gibbon *Hylobates hoolock*, sun bear *Helarctos malayanus binturong*, *Arctictis binturong*, clouded leopard *Neofelis nebulosa*, flying squirrel *Petaurista coniceps* and the Great Indian Hornbill *Buceros bicornis*. The gaur, sloth bear, common langur *Presbytis entellus*, chital, barking deer and a variety of cats are the peninsular representatives. The European element is represented by the Himalayan black bear, swamp deer *Cervus duvauceli* and a variety of birds. Nearly 70% of the mammals living in the Himalayas are found in the valleys of Assam.

Assam is known for black leopards, the marbled cat *Felis marmorata*, and its large variety of monkeys: common langur, capped langur *Presbytis pileatus*, golden langur *Presbytis geei* and *Macaca assamensis*. Tigers are found in a variety of habitats in Assam. Their usual haunts are in tall elephant grasses, Ekra (*Erianthus sp.*), Tora (*Alpinia sp.*) and *Saccharum spp.* along the river banks, in the humid and luxuriously growing tropical moist dry deciduous forests of *Schima wallichii*, *Albizia lebbeck*, *Hymenodictyon excelsa*, *Sapium buccatum*, *Wrightia tomentosa*, *Mallotus philippensis*, with glades of evergreen species (*Trewia nudiflora*, *Ficus glomerata*, *Ficus cuneata*, *Gmelina arborea*, *Alstonia scholaris*) in cooler aspects, and even in tea bushes of the extensive tea-gardens.

The population of tigers shows a decline even in inaccessible parts of Assam, but they have been protected in the Kaziranga, Manas, Sonairupa, Garampani and Orang Sanctuaries. It is estimated that there are 500 tigers in the State. Tigers are also found in Nagaland and Manipur. The estimated population in both these areas is not more than 100 tigers. In the forests of Manipur, the tiger feeds on the Manipur brow-antlered deer *Cervus eldi*. Tigers occur in Bhutan also.

Orissa

The tropical dry deciduous sal forests of Orissa are still inhabited by tigers. The forest blocks of Chandake, Dibrigarh, Khulasari in Sambhalpur and Angul, Simlipal and Maurbhanj, Ranipather in Bhulbani, and the swamps of Raigoda and Mahanadi, are noted for tigers. They feed on sambhar, chital barking deer, four-horned antelope, gaur, mouse deer *Tragulus meminna*, nilgai, elephant calves, and cattle. Some of the above areas have been declared sanctuaries for protection of tigers.

Recent estimates of the population of tigers in Orissa are 326 (1968). Considering this low figure of tigers in the State, the Government of Orissa has banned shooting of tigers throughout the State.

Madhya Pradesh

Forsyth (1889), Sanderson (1912), Hicks (1911), Burton (1931, 1933), Brander (1933) and Schaller (1967) have given an interesting account of the tiger habitat of Madhya Pradesh. The tropical dry deciduous sal, teak and mixed forests of Madhya Pradesh have been the tiger-hunting grounds of the past.

Even today, tigers are found in the ravines forested with Dhok (*Anogeissus pendula*) and Khair (*Acacia catechu*), and in thick patches of Arjun (*Terminalia arjuna*) and bamboo forests, of Shivpuri, Sheopur and along the banks of the Kuno river in Gwalior. The other areas where tigers are still found in fair numbers are Nimach, Jalsinghal, Devas and Umaria, Sohagpur, Basidogri, Manpur, Shikarganj in Rewa and Chhatarpur, Sidri in Panna, the eastern Balaghat, north-western Bilaspur, Sarguja and Sadol and south of Mandla, where forests of tropical mixed and dry deciduous sal with heavy undergrowth and tropical dry deciduous mixed forests of teak, *Terminalia tomentosa* and *Anogeissus latifolia* occur; these are some of the best habitats of tigers in the country. Tigers are also found in the tropical dry deciduous sal forests, dry deciduous teak and moist deciduous forests of Bastar and Jagdalpur, dry deciduous forests of teak, with a 20% mixture of such species as *Anogeissus latifolia*, *Terminalia tomentosa*, *Terminalia arjuna*, *Butea monosperma*, *Lagerstroemia parviflora*, *Lannea grandis* and *Boswellia serrata*, in Damoh, Narsinghgarh, Jubalpur and Betul, Bori in Hoshangabad and Raipur. They feed on sambhar, barking deer, chital, nilgai, gaur, four-horned antelope and swamp deer (Kanha) at night, and retire during daytime into rocky crevices or the heavy undergrowth of Jamun (*Syzygium*) and *Vitex nigundo* along streams.

The forests of Kheoni, Shikarganj, Manjhar, Blocks I, II and III of Naurhiya (Rewa), Panna, Siri, Dubri, Shivpuri, Kanha, Bandogarh where tigers are found have been constituted wild life sanctuaries and National Parks. Kanha has become famous for photographing tigers during daytime.

The late 19th century and early 20th century records of Gordon Cumming (1872) show that he shot 73 tigers in one district (Narbada forests) in two years (1863-64)—at times two tigers a day for five days. The hunting areas of Maharaja of Rewa record shooting of 24 tigers in 1951, 9 in 1952, 5 in 1953 and 13 in 1954. Tiger shooting was a routine affair from January to May. The only occasions specially mentioned were those when white tigers were shot.

For the Maharaja Scindia (Gwalior), as for other rulers, tiger hunting was the favourite pastime. The late Maharaja Scindia shot 700 to 800 tigers with his own rifle. H.R.H. Prince of Wales during his short visit of four days in February, 1922 shot three tigers in one block of Bilwara and four tigers in Bamora block. Ellison (1925) estimated nearly 400 to 500 tigers in the erstwhile state of Gwalior. At the time of this estimate, Ellison's remarks were that the number was going up. Once His Highness Gwalior shot 33 tigers in one year in Bhuj, Besla forests, near Gandhi Sagar. Now there are 3 or 4 tigers in the same reserve. There are hardly 40 to 50 tigers in the forests of Sheopur, Shivpuri and parts of Guna, Gwalior State.

Brander (1933) mentions Madhya Pradesh as having the finest shooting blocks in the east. He also records the wild life situation in Banjar valley (now Kanha) of 1900, as being as good as that in any tract in Africa. In an evening stroll, he saw 1,500 head of 11 different species. But when he revisited India in 1928, the situation had changed. Still, he recorded *tigers to be commonly found in Banjar valley. But today the tiger population is hardly* 20% of what it was 30 years ago. The tiger population has been reduced in all the forest areas of Balaghat, Betul and Mandla. The total estimated population of tigers in Madhya Pradesh is about 600.

The tropical dry deciduous teak forests of Amraoti, Nagpur, Chanda and Dang forests of Maharashtra are other areas where tigers still struggle for existence. Nearly 42 square miles of Taroba forests have been declared a National Park. There are hardly 320 tigers in the State. Tigers have also been reported in the Dangs areas of Gujarat. Their number is not more than five in the whole State.

Andhra Pradesh

The erstwhile Princely State of Hyderabad had preserved its wild life, and tigers were commonly found there. Jerdon (1874) records an abundance of tigers in the South Indian forests. In the old Hyderabad State, Colonel Nightingale shot nearly 300 tigers during his lifetime (by 1868). Around Secunderabad, there were excellent tiger shooting areas. Up to the year 1897, there were no restrictions for tiger hunting and tigers were as numerous as ever; Burton in 1899 considered Jangaon (Asifabad) a breeding place of tigers.

Tigers were comparatively numerous in the forests of eastern and western circles till 1935. Prince Azam Jah Bahadur shot 35 tigers in 33 days (Ali, 1935). But today, they are confined to the tropical dry deciduous forests of Pakhal and Elurnagaram in Warrangal district, Paloncha in Khammam district, Qawal in Adilabad district and in tropical open dry and in thorny forests of Pocharam in Medak district, subsisting on cattle and a few wild animals like sambhar, nilgai, chital and four-horned antelope. The present estimate is that there are only 20 pairs of tigers in the whole State. The Andhra Pradesh Government has declared Pakha, Elurnagaram and Qawal areas as wild life sanctuaries and tigers have been protected.

Mysore

Tigers are now found only in the open dry deciduous forests of Bandipur, Muthodi or Jagar Valley and Magarhole. They are also found in the districts of Mysore, Coorg, South Kanara, Chitradurga, Shimoga, Kinara, Dharwar, Belgaum, Gulbarga, Hassan divisions and Chickmagalur.

The first three areas have been declared sanctuaries and tigers, along with elephants, gaur, sambhar, chital, nilgai, barking deer, four-horned antelope, sloth bear, wild boar, chinkara, blackbuck and leopards are protected. Sanderson (1912), Morris (1910), Anderson (1914), Phythian-Adams (1935) and Krishnan (1969) have given interesting accounts of the tiger habitat of Mysore.

Mysore contained some famous tiger grounds and their number was as numerous as anywhere in Shimoga and Bandipur. Sanderson (1912) described tiger netting and shooting as a common practice in Mysore forests. He also refers to the experiments on poisoning tigers as part of a tiger eradication campaign organized by him. Tigers were declared game and came under management only in 1931 with an annual bag limit of two for each licence (Major E.G. Phythian-Adams, 1935). This system has reduced the tiger population to approximately 114.

Tamil Nadu

The forests adjoining Bandipur are situated in Madumalai (Tamil Nadu) on the slopes of the Nilgiris and support tropical moist mixed deciduous forests with belts of tropical wet evergreen species along rivers, patches of swamp and grass lands where gaur, sambhar, chital, four-horned antelope, barking deer, mouse deer, sloth bear, wild dog (*Cuon alpinus*), leopards and tigers live. Tigers were commonly found in the upper plateau of the Nilgiri hills, in temperate wet evergreen patches called 'Sholas'. These tigers were accused of killing a great number of cattle and were notorious man-eaters (Richmond, 1935). Now only a few tigers are left in these forests and they are hardly ever seen.

Kerala

It is worth mentioning Periyar sanctuary, although it is mainly noted for herds of elephants and gaurs. Sometimes one may come across a sambhar and barking deer, but a tiger or a leopard is a rare sight. The other forests of Kerala where tigers are reported are Wynad bordering Mysore and Sungan Anaimalai bordering Tamil Nadu. The population may not be more than 10 pairs.

The tiger population in the southern Peninsula has gone down considerably. It is estimated that there are hardly 40 tigers in Andhra Pradesh, 5 in Tamil Nadu and 20 in Kerala. These States together with Mysore have declared the tiger habitat as sanctuaries and complete protection has been given to the tigers throughout the States.

Rajasthan

The tiger is an animal of cold regions; the way it has selected Rajasthan as its home is very interesting. This dry region of north-western India supports open dry deciduous pure and mixed forests with thorny bushes and acacia trees, open grasslands and broken country, including the deep ravines of the Chambal. These have been the habitats of the tiger.

There is hardly any published description of the tiger's habitat in the State. Rice (1857), who shot nearly 98 tigers in Rajasthan and Central India, makes only a casual reference to it. Khan (1935), Tulsinath (1956) and Singh (1959) have written about their hunting adventures in Rajasthan: their attempts at describing the habitat tend to be rather peculiar as when Singh (1959) described the moist glades of Sawai Madhopur forests as evergreen forests. Similarly others have mentioned rocks, bushes, trees and streams but without a scientific description. Sen and Sankhala (1962) have tried to classify various wild life zones in Rajasthan, including the tiger domain, but their account too is generalised and does not describe the tiger land in detail.

Rajasthan marks the extreme western limit of distribution of the nominate race of the tiger. The State has two physio-biotic complexes. One in the north-west comprises the Indian than desert—the vegetation is scanty, water is scarce and the tiger which depends considerably on water is conspicuously absent. The domain is held by lower predators like foxes, jackals, hyaena and wolves who prey on rodents and domestic stock.

The second physio-biotic complex of Rajasthan is the south and the south-eastern part, which covers the districts of Banswara, Dungarpur, Udaipur, Madhopur, parts of Alwar and Jaipur and presents a contrast to the first complex. The topography changes from flat lands to the continuous hill ranges of the Aravalli and the rolling Vindhyan hills of southern Rajasthan. The rainfall varies from 600 to 1100 mm, falling during 30 to 40 days in July and August. The remaining period is dry. Summers are very hot. This climate supports tropical dry deciduous forests of teak, mixed with dhok, *Anogeissus pendula*. Tigers, however, also occur in the mixed forests of *Anogeissus latiflora*, *Diospyros melanoxylon*, *Boswellia serrata* etc. In Chittorgarh, Kotah and Bundi districts, riverine islands are their ideal homes. Jalwara, Balopur, Dilod, Kuakhera and Bansrodgarh are still the best blocks. Darrah has been declared a wild life sanctuary. Tigers are also found in the dry teak forests of Laxmipura, Gugor, Lalwara, Nargath, Motapur, Uchawad in Kotah, Asnawara, Bund bhimla, Dehlanpur, Amet, Kalapatra, Kotra and Chamergarh in Jhalawar district. But the real home of tigers in Rajasthan are the *Anogeissus pendula* forests of Bundi, Sawai Madhopur, parts of Chittorgarh, Bharatpur, Alwar and Jaipur where they live near dry steams, rocky outcrops, old forts and ruins during the day, and hunt sambhar, nilgai, wild boar, chital, four-horned antelope and chinkara during the night. Examples of the best habitats of tigers are Balwan, Ramgarh, Bherupura in Bundi; Khandar, Naldeshwar, Kachida, Kasturi-ki-masjid in Sawai Madhopur; Bhadurpur, Cheen Sapota, Karampur, Keladevi and Mandaral in Karauli forest and Van Vihar, Ram Sagar, Gurja, Narbhata and Raikho in Dholpur forest.

Two wild life sanctuaries have been created—one in Dholpur and the other in Sawai Madhopur. The famous tiger blocks of Alwar districts are Akbarpur, Sirawas, Rampur, Ajabgarh and Sariska. The last two have been declared a reserved area for the protection of tigers. The ravines of the Chambal, parts of Sawai Madhopur, Karauli and Dholpur are known habitats of tigers. Their staple food in these habitats are chital, sambhar, wild boar, nilgai, chinkara, four-horned antelope and cattle.

In between the two main geographic sections of Rajasthan is a zone of poor and sparse vegetation, with a few artificial water-holes. Earthen dams have been constructed at a number of places to hold every available drop of water. The seepage from these dams on the leeward side has developed fresh water swamps with tall reeds and grasses. Tigers, though not normally found in the region, very much like these edaphic micro-climates and settle down to raise litters. They feed on nilgai, chinkara, blackbuck, cattle and even camels and goats. The best examples are at Bundbuchera and Ramgarh.

In recent years, biotic interference by man and his animals has considerably reduced the tiger's domain and population in the State. I have conducted no census of the tigers of Rajasthan, but my present study indicates that the population of tigers and the area of tiger-land in Rajasthan have shrunk during the last few decades and there is a downward trend in the tiger population in the State.

I would say that the tiger-land in Rajasthan has shrunk from 25, 900 sq. kilometres (10,000 sq. miles) to only 12, 950 sq. kilometres (5,000 sq. miles) and the number of tigers has also been reduced by 50% in Bundi, 90% in Baran and Kotah and 85 to 100% in other areas.

Based on these trends, studies and some personal information, my rough estimate of the tiger population in the State is 90, made up of Alwar 16, Bundi 8, Chittorgarh 10, Jaipur 6, Jhalawar 6, Kotah (Baran) 20, Mount Abu 2, Sawai Madhopur 12 and about 10 in other areas like Jhajhpur, Mandal in Bhilwara and Baretha in Bharatpur etc.

PRESENT STATUS OF THE TIGER

The correct population of tigers in India has been a subject of controversy. Gee (1964) states that at the close of the last century there were 40, 000 tigers in India. According to Corbett (1955) the tiger population in 1953 was only 2, 000. Gee's (1964) estimates suggested a rise of tiger population to 4, 000. Seshadri (1968) estimates the population of tigers to be 2, 500. None of these estimates gives the method of calculation except Gee who says that some personal estimate is better than no estimate! The absence of any systematic census and conflicting figures ranging between 40, 000 and 2,000 in 50 years and again raising by 100% from 2,000 to 4,000 in about 10 years, particularly when we know that more tigers have been shot during these ten years, is very confusing.

According to Jim Corbett's letter published in the London Times of May 10, 1955, tigers were likely to be wiped out from India within ten years except from a few sanctuaries and one or two ex-Princely States. More than ten years have passed but still tigers are holding their own. We are still receiving reports of successful bags from many shooting blocks of Madhya Pradesh, Uttar Pradesh, Rajasthan, Maharashtra, Orissa and Bihar. Dr. S. Dillon Ripley, Secretary of the Smithsonian Institution, recently made a statement (Futehally, 1967) that there would be no tiger left in the Indian wilds in 50 years. Perry (1964) is also of the opinion that by the end of the twentieth century, we may see the last of the great mammals in their wild state and the tiger is included among them. If it has taken 50 years to reduce the number of tigers from 40, 000 to 2, 000, should it take another half a century to reduce the number from 4,000 to a zero, particularly when their habitats are dwindling, when there are more guns and a greater craze for tiger hunting? It is a fact that the tiger population has dwindled in recent years. Naturally, one would like to know the cause of the devastation. I would say that unfortunately it is the result of many factors operating simultaneously.

Some 15 years ago, one of the common complaints of villages in the tiger area was against cattle stealers; permits to destroy the beasts were freely issued without any charge. The discretion of declaring a tiger a cattle stealer was a privilege enjoyed at the district level. Even in genuine cases of cattle stealing, the tigers which fell victim were often not the real culprits. If there were any success, it was only after killing at least four normal tigers to one cattle lifter.

Permits were issued more or less arbitrarily for harvesting our tiger resources, often without knowing the capital and its recuperating power, or, at times, on the basis of visual estimates. To start with, there were no laws to control tiger shooting. Once, when I caught an influential shikari stealing two tiger cubs from Berupura forests of Bundi in 1953, I had a few sleepless nights because of the confusing legal position. In some States,

there were no 'close seasons' until 1958 (in other States, even now, there is no close season for tigers). Tiger hunting went on all the year round, day in and day out, all 24 hours, on water-holes, with search lights, from 'Machan' and jeeps.

Tiger eradication campaigns were also launched by villagers and the latest technique used by them is poisoning the kill with pesticides. Even during the early 'twenties and 'thirties, naturalists like Sanderson (1912) Stebbing (1920), Glasford (1928) and Burton (1933) raised their voices for protection of Indian wild life. But practically no attention was paid and the voices were lost in the turmoil of World War II. After the war, the jeeps and the dazzling lights took toll of what was left, at an accelerated rate.

I remember an address by the late Shri M. D. Chaturvedi to the Forest Officers and Rangers in 1951, 'Tell your father-in-law to give you a pair of guns in place of a pair of ear-rings for your wife'. In 1965 when I met him in Delhi, and reminded him of his advice, he virtually wept and tried to rectify the mistake by advocating replacement of guns by cameras. It was too late.

Inglish (1888) describes the tiger as an embodiment of cruelty, of hate and savagery incarnate. Jim Corbett (1944) and his famous book 'Man-eaters of Kumaon', inspite of the explanation given by him for a tiger becoming man-eater, has horrible tales and descriptions of the barbaric man-eating tiger, a wretched, dreadful beast, killing and mutilating men, women and children, girls in particular, who were held by the throat and dragged by the man-eaters, dismembering a hand, a leg or head. Such tales leave an impression on the minds of the reader of weeping widows, screams of children and cries of mothers. The vivid description of the chopping up every bit of a dead tiger by villagers makes matters worse. These descriptions have paved the way for the easy issue of licences for shooting of tigers all over the country. Every tiger is considered a man-eater unless the contrary is proved, which nobody bothers to prove. The result is that the word 'man-eater' has become a synonym for tigers. The reaction to a tiger is to shoot it at first sight.

Then came foreign trade. Before 1947, there was hardly any Shikar Company conducting organised tiger hunts. Today, there are 26 Companies spread all over the country. The terms offered are even now much cheaper than those for a lion hunt in Africa. The hunting safari started a roaring business, the striped beauty attracted the eye of the foreign markets and tiger skins or trophies came into fashion. This was the last nail in the tiger's coffin, as bale after bale of tiger skins started moving out by sea and air. Records of these are also not available as there was no restriction or duty on the export of tiger skins. The only figures available are of the tiger and leopard skins (2354) exported after a ban was imposed.

The above figures do not include the skins carried out by tourists, business people and diplomats returning home. The increasing demand raised the prices of tiger skins from Rs. 300/- in the 1950's to Rs. 3, 000/- in the 1960's. This offered an incentive to poachers to use poison baits to kill tigers without the risk of noise. They sold the skins to a variety of customers including curio shops, jewellers, art emporiums and furriers. The estimated number of tiger skins in these shops in Delhi alone is not less than 500. Their ownership cannot be questioned as the tiger is neither a protected animal nor is its sale controlled. Legally, the position of the tiger is worse than that of a log of wood. A piece of wood whether brought from a forest or not is forest produce. It is for the party possessing the piece to prove that it has been legally obtained. But in case of a tiger or its parts, once the boundaries of the forest are crossed, one is the rightful owner to possess or sell. Recently a total ban has been imposed on the export of tiger and leopard skins. This is a step in right direction. But still there is no restriction on export in the accompanied baggage of passengers. The Indian Board for Wild Life, at their last meeting held in New Delhi on 8th and 9th July, 1969, recommended a total ban on the export of all cat skins.

Meanwhile, a new and revised estimate has been made of the tiger population. The estimates are based on information supplied by the Chief Conservators of Forests of the respective States and observations of the different authorities who have intimate local knowledge of tiger-land in India, but not on any systematic census of the tigers. Some State Forest Departments have conducted pug mark counts at waterholes during the hottest part of the year (May-June); others have collected information about 'encounters' of local people with tigers, to assess the population. A few estimates are still purely guess work.

The results are as follows:

Andhra Pradesh	40	Mysore	114
Assam	500	NEFA, Nagaland & Manipur	100
Bihar	90	Orissa	326
Gujarat	5	Punjab	0
Haryana	0	Rajasthan	90
Himachal Pradesh	0	Tamil Nadu	5- 81
Jammu & Kashmir	0	Uttar Pradesh	400-500
Kerala	20	West Bengal	100
Madhya Pradesh	600-1400		
Maharashtra	329	TOTAL	2, 724-3, 700

A conservative estimate of total numbers would be 2, 500.

Many hunters and writers have inadvertently painted a 'black' picture of tigers. They never thought that by giving a vivid description of some tigers killing men, they were painting an erroneous image of tigers as a whole. Quite probably they might have done so out of enthusiasm to make their stories thrilling. Certainly, who would feel sympathy for the tiger who took away a sleeping young lady from her husband (Ganwari) or the tigress which killed the brother and carried away the sister (Banskho-Singh, 1959)? But they were individuals. How many such instances are on record? Very few! If tigers could air their grievances, they would blame the whole human race for robbing them of their food, for baby-snatching and cold-blooded murder of innocent cubs and even of pregnant mothers. Many more tigers have been killed by man than men by tigers, in the last decade. If we read newspapers, we find most heinous crimes committed every day by man. But we do not raise our voice against the whole of mankind. We bring the individuals to book. The same should hold true for tigers. It is not proper to exterminate the entire race of tigers. If the tiger is lost to the forest, the forest will just be a storehouse for timber and pulp and not the thrilling jungle to inspire nature-lovers.

How long can a species stand such an onslaught? If care is not taken, we may have to wait less than 50 years to record the total disappearance of tigers, exposed as they are to easy shooting due to dependence on water-holes, open forests and almost all areas being approachable by jeeps.

The tiger continues to be shot. Only a few dedicated naturalists of the country have been raising their voices, whenever they get an opportunity, to save this colourful life of our jungle from further slaughter. But a few interested parties with vested interests have long managed to shelve proposals for protection. Thanks to the authorities who listened to the naturalists, the tiger has been declared protected since 1968 throughout the State of Rajasthan. Other states like Orissa, Gujarat, Andhra Pradesh, Tamil Nadu, Mysore and Kerala have also protected the tiger. There is some hope.

Still there is a long way to go. Luckily the species is very co-operative due to its adaptability to varying habitats, short gestation period of 102 days, 2. 8 cubs per litter every alternate year, breeding almost all the year round with one major peak period, sex ratio with feminine dominance (Sankhala 1967), fast rate of growth during first three months, deep concern of mothers in rearing and schooling their cubs, maturity at the age of four years, unfixed nature of pairs, individualistic behaviour of living alone and a fairly long span of life (20 years), all of which have helped it to withstand persecution by trigger-happy shikaris and unscrupulous traders. The tiger is still found, but now he needs protection.

The Indian tiger, the world's most magnificent animal, deserves to be in the Red Data Book of the International Union for Conservation of Nature Resources, and a complete ban on tiger shooting and trade in the tiger and its products should be imposed. The member countries of the I.U.C.N. and the members of all conservation bodies should organize campaigns to save the tiger for our children and their children's children.

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SUMMARY

The Indian tiger was once distributed all over the Indian sub-continent except snow-clad mountains of the Himalayas and the extreme western desert of Rajasthan. Its western limits were the Sal forests of Kalashar in Haryana, tropical dry thorn forests of Sikar Khetri, Kumbhalgarh in Rajasthan; Banaskanta, Panchmahal in Gujarat; dangs and West Coast forests of Maharashtra. In the South, tigers were quite common in Mysore, Hyderabad and parts of Madras. The dry deciduous sal forests of Uttar Pradesh, Bihar, Bengal, Orissa and the dry deciduous teak and mixed forests of Orissa and Madhya Pradesh were its haunts. The Sunderbans of south Bengal were considered an inexhaustible reservoir of tigers. They were rated as pests in high rainfall areas of Assam, Manipur and Nagaland. Even the dry deciduous forests of Gwalior, Dholpur, Sawai Madhopur, Bundi, Alwar and Chittorgarh were famous hunting blocks of the rulers of the Princely States. Tigers are still found in many parts of India; a brief description of their habitats is given.

People have shot as many as 400 tigers and thereafter stopped counting. In the recent past quite a few Maharajas and Rajas claim to have shot over 1,100 tigers. Some forest officers claim to have killed over 30 tigers during their 30 years' service. Our exports claim a boost in foreign exchange earnings from the sale of tiger skins. As many as 2, 354 skins (tigers and leopards) were exported from April to October, 1968 (after imposition of the ban on export of these skins). One can imagine the number of skins exported before the ban. This raised the price of a skin from Rs. 300 to Rs. 3, 000—an effective incentive to the use of poison in the quest for the skins of these magnificent beasts. Crop protection guns wound many animals who die a painful death in obscurity.

The result is not far to seek. The population of the tiger has dwindled to an incredibly low number. There are many estimates. Corbett estimated 2, 000 tigers in India in 1955, Gee raised the figure to 4, 000 in 1964; Seshadri in 1968 returned to Corbett's figure of 2,000. Nobody knows the true population. There has never been a serious attempt to census tigers in the country. But from the shrinking habitat and trends in numbers, one can safely say that under present conditions the Indian tiger is endangered. An estimate of the population, based on the author's own observations and reports from Chief Conservators of forests and other naturalists, is between 2, 000 and 3, 000.

This population in a habitat of 784, 558 sq. kilometres (300, 918 sq. miles) of forests represents one tiger per 259 sq. km (100' sq. miles), as compared to the total population of 177 Indian lions in a habitat of 1, 295 sq. km (500 sq. miles) or one lion per 7. 25 sq. km (2. 8 sq. miles), and they deserve a special programme for their protection.

India is the only country where tigers can still be seen with ease. The diminished population of the world's most magnificent mammal should attract the attention of the International Union for the Conservation of Nature and Natural Resources. The Indian Tiger should be included in the Red Data Book and given complete protection.

RÉSUMÉ

Il fut un temps où le domaine du tigre indien couvrait tout le subcontinent indien à l'exception des montagnes enneigées de l'Himalaya et du désert du Rajasthan. La limite occidentale extrême de ce domaine suivait les forêts de Sal (*Shorea robusta*) du Kalashar, de l'Haryana, les forêts tropicales sèches à épineux du Sikar Khetri, de Kumbhalgarh au Rajasthan; Banaskanta, Panchmahal au Gujarat; les dangs et les forêts de la Côte occidentale du Maharashtra. Dans le Sud, les tigres étaient assez communs dans le Mysore, la province d'Hyderabad et certaines parties du Madras. Les forêts sèches de sal à feuilles caduques de l'Uttar Pradesh, du Bihar, du Bengal, de l'Orissa et les forêts sèches à teck et mixtes de l'Orissa et Madhya Pradesh étaient les lieux de pré-dilection des tigres. Les Sunderbans du Bengal méridional passaient pour être des réserves inépuisables de tigres. Dans les régions à forte pluviosité de l'Assam, de Manipur et des Naga Lands, ils étaient considérés comme des fléaux. Les forêts sèches à feuilles caduques de Gwalior, Dholpur, Sawai, Madhopur, Bundi, Alwar et Chittorgarh constituaient les fameux terrains de chasse des dirigeants des Etats Princiers. On trouve encore des tigres dans de nombreuses régions des Indes; le présent article donne une brève description de leurs habitats.

Certaines personnes ont tué jusqu'à 400 tigres puis ont cessé d'en faire le compte. Dans un passé récent, plusieurs Maharadjas et Rajas se vantent d'avoir abattu plus de 1.100 tigres. Certains fonctionnaires des services forestiers assurent avoir tué plus de 30 tigres au cours de leur 30 années de service. La vente des peaux de tigres à l'étranger se montre extrêmement lucrative. En 1968, entre les mois d'Avril et d'Octobre, on a exporté jusqu'à 2.354 peaux de tigres et de léopards (et ceci après l'entrée en vigueur de l'interdit sur l'exportation de ces peaux). On peut imaginer ce qu'était l'exportation des peaux avant cet interdit. Ceci a fait passer le prix des peaux de tigres de 300 à 3.000 roupies—une incitation puissante à empoisonner ces magnifiques animaux et à les dépouiller de leur fourrure. Les fusils qui protègent les récoltes blessent fréquemment les tigres qui finissent par mourir de leurs blessures dans quelque coin obscur.

Le résultat ne s'est pas fait attendre. La population de tigres a atteint un chiffre dangereusement bas. En 1955, Corbett estimait qu'il y avait environ 2000 tigres en Inde. Gee, en 1964, a donné un chiffre de 4000 tigres tandis que Seshadri (1968) revenait au chiffre de 2000 indiqué par Corbett. Personne ne connaît de façon exacte le nombre de tigres vivant encore en Inde, et il n'y a jamais eu de tentative sérieuse pour en recenser le nombre. Mais compte tenu du rétrécissement de l'habitat et de la diminution inquiétante de la population, on peut affirmer avec certitude que dans la situation actuelle, la vie du tigre indien est menacée.

Les estimations que j'ai pu faire au sujet des populations de tigres en Inde, d'après mes propres observations et des rapports fournis par les conservateurs en chef des Forêts ou par d'autres naturalistes donnent des chiffres de 2.000 à 3.000 fauves.

Cette population de tigres occupe un habitat de 784.558 km² de forêts, ce qui fait un tigre pour 259 km² alors que la population totale de lions indiens (177) occupe un habitat de 1.295 km², c'est à dire un lion pour 7,25 km², et il est donc indispensable d'élaborer pour eux un programme spécial de conservation.

L'Inde est le seul pays où on puisse voir les tigres sans trop de difficultés. Cette population très réduite du plus magnifique fauve du monde devrait être prise en considération par l'Union Internationale de la Conservation de la Nature et de ses Ressources. Le Tigre Indien devrait être inscrit dans le Red Data Book et être complètement protégé.

Philippine Tamaraw: Here to Stay

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The rare *Anoa mindorensis* or tamaraw, prized endemic species of the Philippines and listed as in a critical condition by the Red Data Book of the International Union for Conservation of Nature and Natural Resources (IUCN), may shortly graduate from the endangered category. There are fresh indications that this gem of the Philippine fauna is not vanishing, after all, thanks to the timely awakening of the citizens to the importance of the animal and of the realisation of the need of preserving it. Much is owed to the generous backing and sincere dedication of the government, the private sector and the communications media. In fact, without the combined resources and assistance of these groups, the tamaraw restoration effort would have failed. The protection which the animal now enjoys may be regarded as a major breakthrough in conservation. More so, it is a salute to man's capacity for achievement in an atmosphere of mutual assistance, vigilance and a sense of pride in a natural blessing.

Protection for the tamaraw theoretically dates back to the mid-30's when the original Tamaraw Law was passed, but it was only very recently, after the organisation of a Tamaraw Foundation, that it became a reality. The initial success has blazed a pioneering trail in the Philippines and augurs well for the future of conservation work in the country. People who, ordinarily, would have scoffed at the idea, now voluntarily contribute whatever they can to the restoration effort.

This sudden sense of pride in something truly, solely Filipino, stems to a great extent from the inspiration of two men, General Charles A. Lindbergh and Professor Tom Harrisson, both sponsored by the World Wildlife Fund and IUCN. Both were instrumental in preparing the groundwork for the current Philippine Wildlife Conservation Foundation.

In one of the world conferences held by the IUCN in 1965, one of the subjects of deliberation related to two rare Philippine species on the verge of extinction, the tamaraw and monkey-eating eagle. The conference requested the Philippine government to do whatever it could to save these indigenous species.

The Parks and Wildlife Office immediately responded by posting an officer at Mt. Iglit in Mindoro, where a few tamaraw stragglers were supposed to have been sighted. In addition, it submitted a draft bill to Congress which proposed the Monkey-eating Eagle as the Philippine National Bird. Both steps were ineffective in the face of the depredations being caused to the two species and their habitats. What can one ill-equipped, ill-paid and ill-armed man do against well-armed, fully equipped violators of the law, especially when they also happen to be high-ranking government officials? It is really very unfortunate when law-enforcers themselves, who are supposed to lead the people in keeping the law, are no better than all those who break the law. In such circumstances it was hardly surprising that there was no improvement in the status of the tamaraw and monkey-eating eagle.

THE TAMARAW, SYMBOL OF THE PHILIPPINES

The tamaraw is one of the rarest of animal species. It has come to be regarded as the symbol of the Philippines because of its unique characteristics, being among the finest and strangest of mammals in the world and found only in the hinterland of Mindoro in the southern Philippines. A tamaraw most nearly resembles a carabao, the main distinguishing features being its size and the growth direction of its horns. It is smaller than the carabao, its approximate height from the ground to the shoulder being four feet

and total body length seven feet. The horns, instead of the usual circular shape of the carabao's, thrust straight upward in a 'V'. Sex is indicated by colour, size of horn and the head depression. The bull has a somewhat flattened but definitely broader horn, the body is brownish in hue with a darker band on the back; the female is generally darker in pigmentation, smaller in physical build and with no bands on any part of the body; also its horns are more rounded, and there is a deeper depression on the head.

Reputedly harder to hunt than other animals, because of its super-sensitivity, which enables it to detect hunters and enemies a mile away, and its natural preference for the most inaccessible places during daytime, the tamaraw is generally a nocturnal animal. That a tamaraw starts to move around late in the afternoon and retires into the depths of the forest in the morning may partly be motivated by its instinct for self-preservation, but does not dissuade hunters from going after it. It is known to be nervous of other animals and will leave areas which other animals have invaded. Hunters, however, have become wise to these oddities and have learned to make use of various modern hunting methods, ranging from fast, modern means of transportation, such as helicopters and airplanes, to spotlights, high-powered rifles, telescopes and other such products of human ingenuity.

The summer months, April to July, are the mating season of the tamaraw. During this period it manifests various oestral modes or tendencies, such as general restlessness, a desire to lock horns with other tamaraws and mounting of females. However, the species is monogamous and the bull has never been known to consort with more than one female during any particular breeding season, though it may choose another in a subsequent breeding season. When the mating season is over, tamaraws may congregate in small herds of up to eleven animals, usually including only a single adult bull. The average longevity of a tamaraw is 20 years, but in captivity life expectancy is reduced to an average of three years although four captive tamaraws in Quezon City, Manila and Makati are known to have exceeded this limit.

FEEDING

It has been noted that although the animal often appears to keep to thick cover most of the time, the plants on which it likes to feed, such as cogon, talahib and other related grasses, are characteristic of meadows, fields and other open spaces. This preference for feeding in open areas increases the peril it runs of falling victim to poachers.

LEGAL PROTECTION FOR TAMARAW

The tamaraw is supposed to have been a protected animal since 1936, when the Tamaraw Law was passed, or even before that. However, the Law, which was supposed to be its salvation, proved inimical to its safety. It did provide for the banning of hunting, killing or even hurting of the animal, but it also provided for its own circumvention in a clause which condoned killing in protection of life and property, which has since been frequently invoked by violators.

Before the enactment of the Tamaraw Law (Commonwealth Act 73, 1936, as amended by Republic Act 1086), protection was already supposedly covered by Act 2590, entitled An Act for the Protection of Game and Fish, but better known as the Wildlife Law, which was passed in 1916. In addition, Act 3915, entitled An Act for the Establishment of National Parks, Declaring Such Parks as Game Refuges and Other Purposes, but usually referred to as the National Park Law (confirmed as Republic Act 826 in 1952) authorised the creation of a permanent agency to administer national parks and wildlife and also authorised measures for their conservation. Finally, in 1961, Mt. Iglit was established as a game refuge and animal sanctuary, to protect the tamaraw from possible disturbance or damage in its home range and to allow it to breed and increase in number.

That the species did not benefit from this protective legislation became very apparent from subsequent events and the testimony of eyewitnesses. It was constantly harassed and driven out or deprived of its habitat by hunters, ranchers and 'kaingineros', until there seemed to be very little chance of its survival.

BASIC CITIZEN RESPONSIBILITY FOR CONSERVATION

Many species have disappeared from the face of the earth because of people's neglect. Many examples of this needless disappearance of interesting and important creatures in all parts of the world are deplored by conservationists. The Philippines barely escaped this unfortunate situation in the case of its two most notable species, the tamaraw and monkey-eating eagle, both found only in the Philippines, in Mindoro and Mindanao, respectively.

However, the rarity, great scientific interest and threatened status of these two species aroused international concern. This was voiced in a series of resolutions adopted by IUCN during its conference held in Bangkok in December 1965. One resolution requested the Philippine government to adopt urgent measures to safeguard the remnants of the two species, to set aside areas in which they could be assured absolute and effective protection and to support such measures by a scientific programme of propagation.

Up to early 1969, there was no improvement at all in the situation of the two species; in fact it was very clear that they had dwindled to an even lower number than had been estimated in 1965. This led to visits to the Philippines by two of the foremost exponents of nature conservation, General Lindbergh and Professor Tom Harrisson of Cornell University, the impact of which will be discussed further below.

PRESENT STATUS OF THE TAMARAW

In the early 1950's the tamaraw population was reckoned at a couple of hundred head. By the mid 1960's, the number had dropped by half and was probably reduced even further in subsequent years, with the advent of various modern hunting implements, the growing popularity of the sport, the status symbol attached to shooting one, and the high ornamental value of a mounted tamaraw head.

In fact, however, the major cause of the decline of the tamaraw was civilisation itself. While in former times primitive poachers, who had to depend on crude hunting implements, were the principal enemies of the animal, now hunting safaris of people from the cities began to arrive, armed with superior weapons and with highly efficient means of transportation. The aboriginal natives for their part, as a matter of survival, improved their crude hunting methods to keep pace with their civilised counterparts, who had meanwhile discovered a second more devastating reason for pursuing the tamaraw—to obtain and mount its head as a trophy of prowess and bravery. The original reason for hunting was of course that tamaraw meat is delicious and much sought after by those who have had the chance of tasting it.

A further hazard to the tamaraw's future is frequent encroachment by the 'kaingineros' of its habitat, adversely affecting its habits and depriving it of its feeding grounds. Since the breeding activity of the animal is largely determined by the food factor, it is no wonder that its rate of reproduction was soon estimated to have been reduced to less than a quarter of its rate of mortality. The opening of cattle ranches in its territory is yet another factor which has led to the decimation of the species. It is said that the scent of the domestic cow is greatly abhorred by the tamaraw and drives it into the remotest hinterland, where it would rather die of starvation than partake of grass upon which the cow has trod.

THE RESULTS OF INTERNATIONAL INTEREST IN THE TAMARAW

But for the timely intervention of the World Wildlife Fund and IUCN, there was possibly no chance of the tamaraw's survival. Luckily, General Lindbergh's visit in 1969, and three subsequent follow-up visits by Professor Harrisson, to which reference has been made, came at the right moment for the beleaguered animal. The presence of these conservation experts renewed interest in the conservation of threatened Philippine fauna and led the way to the establishment of a pilot conservation project; the preservation of the tamaraw as a joint effort of government and interested private citizens; and the organization of a Philippine Wildlife Conservation Foundation as the permanent vehicle for promoting and sustaining conservation programmes in the country.

A most important aspect of these developments was that it brought the cause of conservation to the attention of the government and secured the support of no less than President Ferdinand E. Marcos, when the draft of the Tamaraw Conservation Project, an initial project of the Foundation, was presented to him. Sixto K. Roxas, well-known economist and President of Bancom Development Corporation, took over as Project Director. The other two members are Manuel Elizalde, Jr., Secretary to the Presidential Assistant on National Minorities (PANAMIN) Foundation; and the author of this paper, biologist and Officer-in-Charge of Parks and Wildlife, the government agency which administers national parks and wildlife reserves in the Philippines.

The Tamaraw Programme was successful in effecting the immediate mobilization of effort to preserve the remaining herds from further dissipation and to establish a permanent body for continuing and enlarging the scope of the programme. Thus the cause of conservation was brought to the highest levels of government and active participation among responsible citizens was stimulated by bringing them together with the appropriate agencies of the government.

President Ferdinand E. Marcos deserves a special tribute for his active interest in the tamaraw programme, which he immediately endorsed and for which he pledged full support.

Under the coordination of various agencies, the following positive and important signs of the progress of Stage 1 of the programme are to be noted: (1) cancellation of all hunting licences within the tamaraw reservation of Mindoro Occidental; (2) fielding of three special teams at Mt. Iglit, Mt. Calavite and Sablayan, the three tamaraw sanctuary sites, and of a two-man research team from the Parks and Wildlife Office, to undertake a scientific investigation of the habitat requirements of the tamaraw, including food plants and grazing patterns, all of which are of immediate importance to the programme; (3) the setting up of metal notice-boards, 'Special Warning to Hunters', by Parks and Wildlife personnel in strategic places in Mindoro, such as the San Jose, the Mt. Iglit approaches, Sablayan, Mamburao (the provincial capital), Paluan, and at all airports and landing fields; (4) the enlargement of the original 8, 956 hectares of the Mt. Iglit sanctuary by a further 75, 000 hectares: it now includes the Mt. Baco range and provides ample habitat for the tamaraw; one thousand hectares was reserved for the re-settlement of the Batangans, the primitive tribesmen indigenous to the area. The Batangans have long co-existed amicably with the tamaraw. Because of their special interest in the animal, they have been employed to keep an eye on the whereabouts or presence of hunters in the area, a duty in which they are very efficient.

The Department of National Defence has signified its interest, too. It assigned the Provincial Commander of Mindoro Occidental as its liaison officer with the project, while a unit of the Philippine Constabulary Special Forces Team has been deployed in the foothills of the Mt. Calavite Reservation since 18 March 1969, as a support team for Parks and Wildlife personnel stationed there. It also placed a jeep at the disposal of the Project for use in patrol work until the Parks and Wildlife Office procures its own.

The Department of Justice, through the Superintendent of the Sablayan Penal Colony, has offered the facilities of the colony as an operational base for the liaison group assigned to the area and also for the purpose of supporting measures to protect the Mitchell Peaks area. Following upon the mobilization of the government agencies, which initiated the project, 15 affluent private citizens founded what is now the Philippine Wildlife Conservation Foundation. It will be concerned mainly in promoting, assisting and, where necessary, financing projects aimed at the protection, conservation and management of wildlife in the Philippines, but its primary concern is the protection of the two most rare and unique indigenous species, the tamaraw and monkey-eating eagle, in that order of priority.

The Foundation also serves as a coordinating body between government and the private sector and provides policy support to government conservation agencies. It had much to do with the successful rallying of various news media to the conservation cause, which resulted in an excellent response. Thus General Lindbergh's visit and the plight of the tamaraw enjoyed extensive coverage in the papers and radio; news of the project has been broadcast periodically over Manila and provincial stations, including a number of interviews with the present author. The Parks and Wildlife Office also maintains a regular fifteen minute radio programme, called 'It's a Beautiful World', every Wednesday

over Station DZAS. Thus many listeners are introduced to the subject of wildlife conservation.

Communication links between the three field teams in Mindoro and the Manila Central Office has been greatly facilitated by the recent acquisition of three two-way radio sets, purchased by the Philippine Wildlife Conservation Foundation.

The PANAMIN Foundation, a private voluntary agency headed by Manuel Elizalde, Jr., is another organisation which has given generous co-operation. Before the formation of the Philippine Wildlife Conservation Foundation, it provided the institutional support that the programme needed and made available its Aerocommander aircraft for inspection and reconnaissance trips over the project area.

With the preventive phase of the programme thus fairly well and methodically established, on the basis of restriction of hunting, establishment of game reserves, artificial stocking and environmental controls, four problems remain to be dealt with by the Foundation as soon as possible. These are related to the tamaraw breeding programme, to setting up the Foundation's own air transport facilities and a research station, and to seeking permanent membership in the IUCN.

Since there is no record of successful breeding of tamaraw in close captivity, attempts to achieve this are being discouraged; instead, the idea which is more favoured is to establish an enclosure of optimum size on Mt. Iglit where the animal can breed in semi-captive conditions. An added advantage of this alternative is its proximity to the research station. It would be important that the area chosen should be adequately fenced with strong chain-link fence, and due to the considerable expense involved, the programme will look to outside sources, such as the World Wildlife Fund, for assistance.

The second objective of the programme is the acquisition of a light aircraft, to provide easy mobility and also a better chance of checking areas, outside existing reservations, where tamaraw have been sighted. The use of an aircraft would also be of special value in law enforcement, since some would-be poachers who are accustomed to travel around the islands in airplanes or helicopters, could be more easily intercepted. Finally, there are the advantages of being able to use the 'plane to drop supplies at field stations of the different teams and to service the twin-project on Mindanao for the protection of the monkey-eating eagle.

As previously mentioned, the Mt.Iglit reserve is the site of a wildlife research and reconnaissance station, where two biologists from the Parks and Wildlife Office are at present investigating the habitat requirements, food-plants and grazing patterns of the tamaraw. A third objective of the Foundation will therefore be to seek the assistance of international organisations in funding certain additional research equipment and supplies.

Lastly, it is felt that the Foundation, having made such an encouraging start with the tamaraw restoration and conservation work, would definitely benefit from becoming a regular member organisation of IUCN, as well as actively identified with the World Wildlife Fund. A recommendation to this end is expected shortly.

CONCLUSION

During the ground-laying stage of the Tamaraw Foundation Programme, when the prime movers of the programme carried out a reconnaissance of the tamaraw area to try at least to make certain that it still existed, the only sign of the animal that they found consisted of a few footprints. It is therefore specially heartening to note that as of June, 1969, the research team posted to the area sighted 24 tamaraws in eleven groups of varying size. Some of the herds seen suggested that the proportion of sexes is about equal.

It has also been reported by the fieldmen that tamaraw are no longer so shy and can be seen coming out to graze even during broad daylight. The animals seem to realise that they can now safely stay in the open, thanks to the campaign described in this paper, in which every section of government concerned, at national, provincial and local level,

law enforcement agencies, IUCN and the World Wildlife Fund, the private sector and the mass publicity media have all combined.

Indeed, the encouraging cooperative spirit elicited by the tamaraw restoration effort is a clear indication of the triumph of dedication, of purpose and of the sincere desire to alleviate the damage done in the past to the wildlife heritage of the Philippines. Indeed, the tamaraw is here to stay.

The Swamp Deer of North Kheri

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INTRODUCTION

The swamp deer, sometimes called the barasingha, is listed as a species threatened with extinction. I cannot do better than quote from the critical study of the barasingha by George Schaller: 'The barasingha (*Cervus duvauceli*) has declined so drastically in numbers in recent years that the continued existence of the species is not assured under present conditions'. Again: 'Today the barasingha exists only in a few isolated pockets. Its main centre of survival is in the North Kheri Forest Division near the Sarda river in Uttar Pradesh and the adjoining areas of South Western Nepal. Scattered herds also occur in North Bengal and Assam ... The surviving populations in Central India are small and all are on the verge of extinction'. These remarks were made in 1965 and the position has probably further deteriorated. This is an account of an effort to save the remnants of the swamp deer of Uttar Pradesh.

LOCATION

The State of Uttar Pradesh (old United Provinces), lying at the foot of the Himalaya and below Nepal, is one of the biggest and most heavily populated political units of India. A moist deciduous type of forest, with the hardwood sal (*Shorea robusta*) growing in gregarious expanses, is an important component of the forest estate. It stretches along the base of the foothills and for some distance into them, occupying two very distinct types of terrain, the Bhabar and the Terai. The former, is a practically waterless expanse of boulders, gravel and coarse sand of great depth, beneath which the perennial streams of the Himalaya disappear during the dry season to emerge in the Terai belt. The latter is formed by the extremities of the detritus that pours out of the friable Himalaya with its many streams, and consists of the finer sediments. Here the rivers are sluggish and meandering and their banks and beds are covered by coarse grasses. This is the home of the tiger, the wild pig and of several deer, including the swamp deer. The latter favour the more marshy areas, while the hog deer prefer the drier terrain and the sambar and the barking deer or muntjac prefer the forested belts.

SITE

The swamps and grasslands of the reaches of the Sarda River have always been famous as the habitat of the swamp deer. It is here that they attained their optimum in numbers. This river, from the point where it debouches into plains out of the gorge just above Tanakpur, flows in a south easterly direction between the district of Pilibhit in Uttar Pradesh and Nepal. Thereafter, for the rest of its passage until its confluence with the Ghagra, it flows in the adjacent district of Kheri within the boundary of India. The Ghagra river is formed by the meeting of the Karnali, the Kauriala and the Girua, which emerge at Chisa Pani in Nepal about a hundred miles east of the Sarda gorge and flow in a southerly direction. It is in the triangle formed by this river system with Nepal, comprising nearly fifteen hundred square miles, that this species now exists in isolated forest pockets, which are not its natural habitat but where it has been driven by the reclamation of swamp and grasslands.

Swamp deer used to congregate in herds of upwards of a thousand. The species came into trophy condition during the cool winter months and its habitat could be beaten by a line of elephants from where they would emerge in spectacular numbers. They suffered

much during the years of British occupation. Warrantable heads were shot in large numbers by V.I.P.s, the trophies removed and the carcasses left to nature and her scavengers. However, even these orgies did not affect the numbers to any devastating extent and during the early fifties herds of five hundred could be found in the growths of tamarisk which lined the river banks.

Decimation has come with the advance of cultivation to the edge of the Reserved Forest, in which the marshland habitat of swamp and savannah has been reclaimed. The deer have been crowded out of existence, and their reproduction has been affected. The operation has been hastened by the massive issue of licences for crop protection firearms, as political patronage, which have been used for exterminating this confiding species. The swamp deer retreated steadily from its erstwhile range and by 1964 Ghola was their last refuge. This area was a peripheral marsh of about 3,000 acres surrounded by cultivable land, which was leased by large land-holding farmers. It was not cultivated to any extent because of a bill before the State Legislature, which sought to impose a ceiling on land holdings and thereby secure distribution to landless labour. This area contained about fifteen hundred swamp deer, the last outpost of the mighty herds in their retreat before the relentless advance of India's exploding population.

In July 1964, at the first meeting of the State Wildlife Board, I strongly urged that Ghola (which was due to be vested in Government as surplus land in any case) should be acquired by the Forest Department and maintained as a sanctuary together with a contiguous area of Reserved Forest. I continued to press this project at the biennial meetings of the Board, and also with the Forest Department, but the Government did not accept this view till 1966, by which time more and more land was being reclaimed by squatters. A survey by Dr. Schaller in 1965 revealed six hundred swamp deer, and by July 1966 just before the outbreak of the rains, the few remaining pools were littered with the carcasses of swamp deer which had been wounded and had staggered to the nearest water to die. It was too late. Soon after, the Marxists (Naxalites) moved in and had to be ejected by the armed constabulary.

In 1965 I had already realised that the swamp deer of Ghola were doomed and set about ploughing areas of land in the Reserved Forest and close to my farm, sowing fodder grasses and constructing salt licks of a mixture of salt and clay. These were frequented originally by chital and hogdeer. I then organised a drive in Ghola, which was about eight miles away with elephants and firecrackers and a herd of about two hundred swamp deer moved to where I could afford them a modicum of protection. The first phase in rehabilitation had begun. The danger however was not past. The area had cultivation on two sides and the cultivators had firearms. In addition large herds of scrub cattle competed for fodder grasses and poised the ever present threat of an epidemic which could wipe out the deer. Moreover, it formed a part of a shooting block, though theoretically the swamp deer was a protected species.

For two years I battled to get the area declared a sanctuary, and remove the menace of cattle grazing. I took pictures and lobbied in official and legislative circles, but political pressures were great and the animals were depicted as competitors with domestic stock. Why keep them? Where were the cattle to graze? The vested interest in shikar too stood out against the claim for protection for a vanishing species. The powers-that-be still clung to the tattered memories of mammoth game bags when the wherewithal had vanished.

In 1967 Shri Charan Singh, an exceedingly sympathetic Forest Minister, declared the Dudwa Sanctuary of 82.2 square miles and ordered the exclusion of cattle as far as possible. Something has been done and it is hoped that this sanctuary may be extended. There are now over a thousand swamp deer in a range of about ten square miles, where originally a battered remnant had come to rest. The threat is not past however and it is hoped that with a change in concept, which the meeting of this august body will presage, our wild life will take its rightful place as a foil to the stresses of present day existence and not as a sop to some pseudo-atavistic trait in man.

The future is sombre. The public, when it lives on the verge of insufficiency, will not give its moral support to the continued existence of the swamp deer which grazes their crops, nor will they forego a square meal for the doubtful edification of posterity. The rescue of wildlife in an undeveloped and overpopulated country must come from the dedicated forums of world opinion.

It is my opinion that a research station for the study of the swamp deer, its future protection, and its reaction to changes in habitat should be set up under the auspices of I.U.C.N. Studies might also be undertaken on causes of the decline of the central Indian subspecies *Cervus duvauceli branderi*, whose reproduction seems affected. Perhaps the species can be revitalized by the import of stock from other isolated pockets.

The Tiger of the Terai with special reference to the Kheri Forests of Uttar Pradesh, India

ARJAN SINGH

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Much has been written of the future of the tiger (*Panthera tigris*) but this magnificent predator has been studied chiefly over the sights of a rifle and a deal of wishful thinking has been mixed with false sentiment for his survival. The fact remains that this flamboyant cat which has made India famous, is on the way out due to many and increasing pressures unless drastic and realistic measures are taken.

Before I proceed to particularize I give figures from the IUCN's Red Data Book. We start with Persia, the westerly limit of the tiger; there are less than 20 left. From Persia we look north east to Afghanistan: there are no figures but there are probably close to a dozen, no more. East again to West Pakistan: a very depleted number. North to southern Russia, to the shores of the Caspian where once the tiger roamed in great numbers: present numbers 60 to 70, and no more than this in North Korea and north eastern China, with the figures of southern Korea close to 50. For the rest of China no figures are available, and there are none for East Pakistan or India, both countries where the numbers are considerably reduced. To the south east down through the east Asian peninsula: no numbers available for Burma or Malaysia or for Thailand, Cambodia or North and South Vietnam. In Sumatra all that is known is that the situation has seriously deteriorated. In Java 20 to 25 animals are left in the entire island, and in Bali wholesale destruction of the Balinese tiger has reduced the population to the present pathetic figure of four.

The tiger, unlike the lion which is partly diurnal, is completely nocturnal. The tiger has learnt to tolerate man due to force of circumstance, but not to live with him. Man-eaters are a local aberration, but the average tiger of which I write avoids man and his proximity if possible. It hunts during the hours of darkness and lies up during the day.

The terai forests of the sub-montane tracts of Uttar Pradesh, bordering Nepal, have always provided the ideal habitat for the tiger: towering sal trees (*Shorea robusta*), with dense secondary undergrowth in the winter, and heavy stands of narkul and elephant grass bordering marshy pools in the summer, for the tiger is extraordinarily intolerant of the sun and heat.

During the years of British occupation, into the 1920's and '30's, tiger shooting was the sport of a privileged few. The rules protecting them were adequate and strictly enforced. The tigers were largely game killers, and the occasional head of cattle which was taken from among those which grazed permissively in the Reserved Forests was part of an occupational risk for which no penalty was exacted. Licences for firearms were issued with circumspection, and crops did not impinge to any large extent on the boundaries of the forest. It was in the forest that the tiger lived. His habitat consisted of dense forests and grasses, well in the interior, and every block had its resident tiger. No sooner was one killed than another took its place. The source of supply was the Kingdom of Nepal where the natural home of the tiger was the forest clad foothills of the Churia Range, the second rampart of the Himalaya, with a rainfall of a hundred inches, where towering trees and creeper-clad undergrowth, interspersed with swamp and marsh, shaded the ultimate and selective breeding grounds of the tiger. A seemingly inexhaustible supply could produce 41 in a three-week shoot by the Maharajah in 1933, and 120 in three months in 1939 in Chitawan. This was the situation up to the close of the second world war.

The last two decades have been a revolution which is frightening in the magnitude of its impact. Man is on the march and whole species are threatened to be swept away by his lengthening stride. Nepal has exploited its great virgin forests. Colonization has also taken place on a large scale, and Chitawan was able to produce only one tigress for the

Duke of Edinburgh in the early 'sixties. With the abolition of feudal privileges the pressure on wildlife has increased greatly. The tiger has responded to this decrease in habitat and food supplies by migrating to the adjacent forests of India and this accounted for the vaunted surplus of the middle 'fifties and 'sixties, which the Indian Forest Department claimed as a success of its wildlife policies. Incidentally, the surplus had also been gleaned in the Western Circle of Uttar Pradesh, once the favourite hunting grounds of the dollar-avid shikar companies who have now been moved to the new and more lucrative pastures. Though no census figures for Nepal are available it is unlikely that the tiger exists to any large extent except in Kanchanpur-Kailali in western Nepal and Chitawan in central Nepal.

Jim Corbett, though better known as a hunter of man-eaters, was our original conservationist. Writing in the 'fifties, he gave the tiger another ten years of existence in India. Facts have belied his gloomy prognostications, but an extension of this decade as from now might well be an accurate forecast of the end. The pressures are simply too severe.

The forests of Uttar Pradesh comprise 13% of its land mass, in place of the recommended 33%, an ideal which cannot be attained due to the pressure on land. The chief timber of these forests is the sal, a magnificent tree which reaches a height of 100 to 150 feet and a girth of 8 to 12 feet. Not being as broad leaved as the teak it encourages secondary growth and shelters a variety of wildlife. But because it takes 150 years to attain maturity its replacement is sought by exotic species like the eucalyptus, which attains maturity in 30 years or less, but which will never offer effective shelter to wildlife owing to cyclic operations inhibiting secondary growth, to early maturity and no shade capacity. These replanted areas will forever be denied to the tiger.

The most insidious effect on the tiger population has been the extension of cultivation to the edge of the forest. Licences for crop protection firearms have been issued on a massive scale and these weapons have been used for poaching inside the forest. The decimation of his natural prey and shrinkage of his habitat has caused the tiger to follow into the fields the bony scrub cattle that infest the forest for grazing. It finds temporary shelter in the fields of sugarcane, where it subsists on the deer, which are attracted by the young crops, and on cattle. The creature of the deep woods who shunned the proximity of man has come to terms with his destroyer. That this is a transitional state of affairs is obvious, as the crop grazing deer are shot for meat and the skins of the cattle-stealing tigers find their way to foreign markets through devious means.

A large percentage of tigresses seem to favour sugarcane fields for dropping their April litters. In the current year, five tigers were shot, eight cubs captured and three cubs burnt in sugarcane fields in the area of Pallia in Kheri District. There must be many more examples of these losses in the long border which the field now has with the forest. Shikaries roam the fields at all hours on tractors, scouring the sugarcane fields for the marauders they have created. It is all in the interest of crop protection, food production and the many shibboleths which makes man the dominant race.

There are no rules for shooting outside forest areas, and though a draft bill is ready to be presented to the legislature, this measure has been held up for the last three and a half years. Rules inside the Reserved Forests are adequate if implemented properly but there is no census governing the quotas and the cumulative impact on the surviving tiger population could be disastrous.

The international forums of public opinion must now endeavour to halt this tragic race of the tiger, both India's and the world's heritage, to extinction. The Taj Mahal can be rebuilt marble upon marble, but to destroy an evolution of 200 million years will be among the major crimes committed by mankind in the fulfilment of his destiny.

**XIth Technical Meeting of IUCN
Third Session: Part 1, Mammals**

SUMMARY OF DISCUSSION

Mr Arjan Singh supported the contention that certain State Forest Services needed to adopt a more forceful approach to the elimination of poaching, if the status of numerous threatened species was to be improved. He quoted the example of Dudhwa Sanctuary, in Uttar Pradesh, where the control of poaching had been principally responsible for a substantial increase in the swamp deer population within the space of a few years. He felt that, ultimately, the formation of a separate Wildlife Service within India was essential to the long term future of the country's wildlife resources.

Mr Srivastava reminded the delegates that poaching was not the only cause of depletion; for example, reduction of habitat and of natural prey might represent significant factors in the decline of the tiger. He suggested that strictly controlled hunting of tigers in selected areas would be a more effective conservation measure than a total ban. A number of delegates endorsed this view and drew attention to the necessity of permitting the elimination of confirmed cattle lifters and man-eaters. Dr Spurway suggested that if responsibility for the shooting of man-eating tigers could be delegated officially to a small cadre of selected hunters, it would eliminate the possibilities of so-called 'man-eaters' being killed for private pleasure and profit, under the pretext of performing a public service. Mrs Almitra Patel wondered if compensation could not be paid for cattle killed by tigers, as was done for domesticated stock killed by lions. She joined other delegates in condemning the poisoning of tigers by villagers, and expressed the hope that agricultural pesticides, which had been used for this purpose, could be replaced by less harmful alternatives. Dr Schaller subsequently expressed doubt as to whether habitat destruction and the depletion of natural prey were major factors in the tiger's decline. Madhya Pradesh, for example, had few tigers, although it retained vast tracts of forest. Most Indian forests had ample prey in the form of livestock. Many tigers preyed on cattle to some degree and any suggestion that all cattle lifters should be shot could result in the tiger's annihilation.

Mr Soni stated that he favoured a scientific solution to the numerous questions concerning the future conservation of the tiger in India. He considered that an accurate census and further studies on the tiger's natural history were required to determine whether or not hunting should be continued and, if it should, what proportion of the population could be culled. Professor Dillon Ripley welcomed the Inspector-General of Forests' initiative and, on behalf of the Smithsonian Institution, pledged financial support, in its research work under the foreign currency programme, to aid the proposed tiger survey.

Both Dr Severinghaus and Mr Stracey expressed the view that the absence of a comprehensive policy on the management of domesticated livestock represented a serious obstacle to effective wildlife management in India.

Mr Mountfort stated that in Pakistan there were probably only about a hundred tigers left (all in East Pakistan). A large reserve had been created for them in the Sunderbans and a total ban had been imposed on the export of tigers and tiger skins.

In reply to a question from Dr Odend'hal, on the status of the Gir forest lions that had been translocated to Chandraprabha forest several years ago, Mr Joslin stated that their numbers had increased from three to eleven but, subsequently, all trace of them had been lost. They had probably been killed by poachers. He referred to the articles on this subject in the issue of Cheetal (Vol.XII No. 1) and the Indian Forester (Vol. 95 No. 11) that had been circulated at the Assembly.

The Great Indian Bustard

Choriotis nigriceps (Vigors)

SALIM ALI

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The Great Indian Bustard *Choriotis nigriceps* is an endemic Indian species with its nearest relatives in Australia (*C. australis*) and Africa (*C. kori*). It is a large terrestrial bird, somewhat larger than a vulture in body size, with stout bare legs, cursorial feet and horizontal carriage. A large male may stand over a metre high to the top of his head and weigh between 8 and 14 kg; females are smaller, weighing about 4 to 8 kg. It is this great lump of palatable meat that makes the bird so vulnerable to sophisticated poachers! The species has now become an object of serious concern to conservationists because of its rapidly deteriorating status under the changing conditions, mostly man-made, which pose an increasing threat to its survival. Unless tackled with vigour and determination these trends bid fair to render the species extinct within a generation or less; the position is as critical as that.

The Great Indian Bustard is normally met with singly or in scattered pairs or small parties of 5 or 6, though droves of up to 25 or 30 have been mentioned in the past, the largest of such containing 34 individuals. It is a resident species wherever occurring, but subject to considerable nomadism. The pattern of its local movements have not been studied; apparently they are governed chiefly by the monsoon rainfall with the seasonal transformation of barren areas into scanty grassland. The bird affects wide open spaces of grassland in more or less stony semi-desert country, interspersed with scattered scrub of *Zizyphus*, *Butea*, *Leptadenia*, *Capparis*, *Euphorbia* and suchlike bushes, and with fields of various foodcrops, mustard and cotton. It is largely omnivorous. Grain (often entire panicles of cereals etc.) and tender shoots of crop plants figure in its dietary, mustard being a special favourite. Drupes and berries such as *Carissa* and *Zizyphus* are also largely eaten. Among animal food, locusts, grasshoppers, beetles (Cantharidae, Scarabidae and Buprestidae), and other large insects figure commonly; at certain seasons the green blister beetle (*Cantharis tenuicollis*) forms a major food item and is said to taint the flavour of the bird's flesh during this period. Lizards, centipedes and snakes, even poisonous ones, e.g. Sawscaled Viper (*Echis carinata*), are also taken. Pebbles up to an inch and a half have been found amongst the stomach contents, and in one case a complete quail's egg!

The principal breeding season is between March and September chiefly the monsoon period, but locally it may extend into November. A single egg is normally produced, very rarely two. It is laid on the ground in a shallow scrape or depression (sometimes sparsely lined with grass) in the shelter of a bush in open grass-and-scrub country, often in the environs of cultivation where it is exposed to accidental trampling by grazing village cattle. In colour the egg is drab or pale olive-brown faintly blotched with a deeper shade of brown; it measures about 80 x 60 mm. The female alone incubates; the incubation period is undetermined, and other particulars of the breeding biology are poorly known. The bird is believed not to breed till about 4 years old, but this needs confirmation.

It is a polygynous species, each cock having 3 to 5 hens. In the breeding season he gives a bizarre nuptial display from the top of some eminence in undulating grassland. It consists of strutting and posturing in the presence of the females (or even without them) with the special gular pouch inflated to grotesque proportions so that it stretches all down the throat protruding below between the legs like a wobbling feathered bag. The expanded tail is fully erected between the drooping wings—like a turkeycock's—and tilted forward until it touches the nape of the backwardly arched neck. It is flapped up and down, often to the accompaniment of a deep booming moan audible over 300 metres away. (A detailed account of this extravagant display will be found in Hume & Marshall, 1879, and R.S. Dharmakumarsinhji, 1962).

The territory of each cock appears to be very extensive, but how this or the bevy of females are acquired is not known. No rivalry or fighting between cocks has ever been observed or reported.

A scientific census of the Bustard has never been attempted and its population dynamics are totally unknown. In the context of this regrettable lack of all precise data and the rapidly deteriorating status of the bird, support of the WWF to the project outlined by Mr Dharmakumarsinhji for an ecological survey of the Great Indian Bustard is of particular relevance.

The bird is excessively wary at all times and difficult to approach within shotgun range except by subterfuge such as in a bullock cart or on camelback, or by stalking from behind a village buffalo, to which the birds have become accustomed in the countryside.

Curiously enough, however, they remain surprisingly unsuspicious of and unperturbed by jeeps in spite of all the noise and rattle they produce, and permit absurdly close approach. There is no doubt that this post-war universal menace—the jeep—is the most culpable and potent single factor in bringing about the present sorry plight of the bustard (and other forms of wildlife) in India. In reality it is the unholy combination of the jeep with the unscrupulous poaching 'sportsman'—often in the shape of irresponsible, ignorant and vandalistic military personnel—that has above all else led the way to the near-extinction of this magnificent bird. It seems to have no serious natural enemy besides man.

Crows sometimes destroy its eggs, whilst wild cats and jackals may occasionally prey on a chick or brooding female, but cases have not been reported. Apart from human predation perhaps the most important factor in the decimation of its numbers is the direct consequence of the unprecedented population explosion in the country, further aggravated by influx of hordes of refugees from Pakistan and repatriates from Burma, Malaya, Ceylon and Africa. This has necessitated vast encroachment on the erstwhile natural habitats of the bustard for agricultural and rehabilitation purposes. Between these two fires—the expropriation of its breeding ground and direct harassment even in its once remote desert fastnesses—there seems to be no alternative to the inevitable extinction of the bustard.

My efforts to obtain some dependable estimate of the bird's current numerical status have proved disappointing. No actual counts are available from anywhere—not even reasonably approximate ones—and much of the other information is also of a diffuse and subjective character. I give it here if merely to stress the unsatisfactoriness of the situation and to impress the need for a more organized scientific investigation by modern censusing techniques. The main difficulty in the making of reliable counts is the very widely scattered and sparse occurrences of the birds. Their nomadic habits and the unfeasibility of ringing them on a sufficiently large scale further inhibit a study of the seasonal movements, breeding and mortality rates, and population dynamics. In the absence of a network of reliable local observers, most of this basic information would need to be self collected by mobile teams of investigators. The vastness of the areas to be covered, and the time required to do so would render the project difficult if not impracticable without the necessary organization and resources.

The range of the Great Indian Bustard as given by Ali & Ripley, 1969, is: formerly (i.e. c. 100 years ago) Sind, Punjab (now W. Pakistan) eastward to Bengal and Orissa; southward through peninsular India to southern Madras Presidency (now Tamil Nadu). Presently rare or absent over much of this range though still not uncommon in remote areas of W. Rajasthan, e.g. Jaisalmer. Southernmost authenticated record Tiruchirapalli, Tamil Nadu c. 10°30'N (1924). Casually or regularly seen, and also breeding in small numbers, in parts of Gujarat (Banaskantha, Kutch, Saurashtra) and Deccan (Ahmadnagar dist.); sporadically south to Mysore.

A very incomplete and rather haphazard estimate of numbers observed by reliable bird-watchers in recent years is given below for what it is worth.

WEST PAKISTAN

Cholistan (Bahawalpur, Punjab). Two flocks of 17 and 22 birds-winter 1968-69 (C.W.D. Savage).

RAJASTHAN

Random sightings within the last 3 or 4 years mostly of one or two sporadic birds each, reported by Mr Mahendra Prakash, Conservator of Forests, from the districts of Bikaner, Jodhpur, Nagaur, Pali, Jalore, Barmer and Jaisalmer. The information merely serves to pinpoint the areas where the bird still exists, but gives no indication of the size of the populations concerned, especially as compared with the recent past (see below). He states that the birds have definitely suffered from the prevailing drought (1968-69) which has indirectly inhibited their breeding. He confirms that partly due to insufficient publicity of the fact that the Great Indian Bustard population is declining rapidly and partly to ignorance of the statutory ban on its killing, the bird is still shot by 'new' shikaris. But, military and police personnel (Border Security Force and Armed Constabulary) who should be better informed and more law-abiding, are usually the chief culprits. There being no special wildlife protective staff available with the Rajasthan Forest Department it is not possible to enforce the ban, with the result that these 'motorized' poachers go scot free.

Information furnished by the scientists of Central Arid Zone Research Institute, Jodhpur in 1962 and 1963 was of a more optimistic character. They then reported seeing parties of 8-15 birds from time to time and considered the species as 'not very uncommon' or even as 'quite common' in the desert areas of the Pokaran-Chandan region. They had suggested this area as suitable for a bustard sanctuary.

KUTCH

There is heartening word from Maharao Madansinhji (the ex-ruler of Kutch State and a knowledgeable sportsman) that in the past year or two he has noticed fair numbers of Great Indian Bustard in Kutch district which used to be one of the bird's regular habitats before the area was merged with Gujarat some 20 years ago. Lakhpat, Abdasa and Mandvi talukas or tehsils (sub-districts) are mentioned in this connection. In recent years Mr Himmatsinhji (the Maharao's brother, also a competent ornithologist) reports coming across 7 birds in Bhuj taluka, 5 or 6 near Mandvi, and 2 in Lakhpat taluka—in all about 15 birds between 1962 and 1967. None were seen in some of the other localities formerly noted for the birds. The periodical droughts in Kutch (recurring every second or third year) inhibit breeding in some years owing to non-availability of suitable grassland, and possibly tempt the birds away elsewhere. This observer puts the present bustard population in Kutch at between 25 and 30 individuals. As elsewhere in the bird's northwestern range, border military personnel in jeeps continue to be its most ruthless predators, in spite of orders and warnings of punitive action from Army Headquarters.

SAURASHTRA AND GUJARAT

Bustard are reported to occur in small numbers between Dhrangadhra and Wankaner, and a few birds possibly in the Banaskantha district of N. Gujarat, west of Palanpur. According to Yuvraj Shivrajkumar of Jasdan there are at present some 4 or 5 birds in the Jasdan and Babra areas of Saurashtra, and perhaps the same number in the neighbouring Amreli district.

R. S. Dharmakumarsinhji, who is our most knowledgeable authority on the Great Indian Bustard, has kindly given me his estimates of the birds in the different parts of its range. The figures are based partly on his own field observations while Wild Life Preservation Officer of Maharashtra State in 1955 or thereabouts and Regional Secretary, Western Region, Indian Board for Wild Life, and partly on the testimony of reliable sportsmen.

They may now be much out of date since the position has undoubtedly deteriorated very considerably in the intervening years. Unfortunately no recent figures are available for comparison.

R. S. Dharmakumarsinhji estimated the population as follows:

	birds
Gujarat State . . .	100
Maharashtra . . .	100
Rajasthan . . .	500
Madhya Pradesh . . .	400
Haryana . . .	30
Punjab (India) . . .	30
Mysore . . .	60
U.P. . . .	15
Orissa . . .	15
Andhra Pradesh . . .	10
	Total in India . . .
	1260

An indication of the bird's former abundance in Maharashtra is provided by a note in the defunct *Oriental Sporting Magazine* by an anonymous writer signing himself 'Lover of all Sports', that during the 20 years between 1809 and 1829 he himself shot no less than 961 Great Indian Bustards in the neighbourhood of Ahmadnagar!

The figures for Madhya Pradesh and Mysore certainly seem much too high, even for the time to which they relate. I am inclined to consider the figure for Orissa also as an overestimate.

In reply to my query about the present status of the Great Indian Bustard in Madhya Pradesh, the Chief Conservator of Forests simply said 'It is not seen!' Nevertheless it is possible that a few fugitive birds *may* still survive in the Gwalior area (Esagarh, Shivpuri, Morena), where I had found them scarce and much harassed even 30 years ago (1938).

As regards Mysore, the Chief Conservator of Forests replied that the bird is rare and on the verge of extinction, but occasionally seen in Tumkur district.

Although the data on the present position, such as it has been possible to collect, are vague and haphazard, the reports all point to, and emphasize, the parlous state in which the Great Indian Bustard stands today. It needs no crystal-gazing to realize that the day is not distant when this magnificent bird will have joined the Dodo. The tempo of the downward trend is so alarming, that unless vigorous and effective action is launched without delay to stay the rot, the disappearance of the bird from the face of the earth may come even sooner than we have cause to fear.

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SUMMARY

The Great Indian Bustard *Choriotis nigriceps* (Vigors) (Gruiformes: Otididae) is an endemic Indian species with its nearest relatives in Australia (*C. australis*) and Africa (*C. kori*). An adult male may weigh between 8 and 14kg; a female 4 to 8 kg. Its flesh is considered to be very palatable: thus quantity and quality combine to render the bird vulnerable to pot-hunting poachers.

The species was fairly plentiful and widespread in peninsular India till some 40 years ago, but has since been vanishing at an alarming rate. The decline has been accelerated

since the Second World War, and particularly after India became independent in 1947. The basic reason for this is the tremendous explosion in the human population, vastly augmented by refugees from Pakistan, and Indian repatriates from SE. Asian and African countries. Their rehabilitation, and the need to grow more crops for feeding them, necessitated enormous encroachments on the Bustard's natural habitats—open grassy plains and semi-desert areas now rendered cultivable by dams, reservoirs and canal irrigation. However, the deadliest single factor in the Bustard's annihilation has been the Jeep which has enabled poachers to penetrate deep into erstwhile inaccessible bustard country with ease. Add to this the relaxation of the Arms Act and its provisions, the general laxity in the observance and administration of the game laws, and the rising cost of meat of any description, and it is not difficult to account for the catastrophic deterioration in the status of the bustard. At the present rate the bird will probably become extinct within a generation, if not earlier.

No proper censusing of the Great Indian Bustard has ever been attempted in the past; neither are any dependable figures available for its surviving populations. A rather conjectural estimate some years ago put the total population in Indian territory at 1260 birds (the present author considers this an overestimate). In spite of being totally protected by law, the Great Indian Bustard continues to decline: to stop this there is a proposal to create a Bustard sanctuary in the extensive grasslands of Gujarat where a few birds still survive, but the practicability of this project will need a thorough ecological investigation.

RÉSUMÉ

La grande outarde indienne, *Choriotis nigriceps* (Vigors) (Gruiformes: Otididae) est une espèce indienne endémique dont les parents les plus proches se trouvent en Australie (*C. australis*) et en Afrique (*C. Kori*). Un mâle adulte peut peser de 8 à 14 kg et une femelle de 4 à 8 kg. Sa chair passe pour être très fine, ce qui en fait une proie de choix pour les braconniers.

Jusqu'à il y a environ 40 ans, cette espèce était relativement abondante et répandue en Inde Péninsulaire, mais depuis lors, elle disparaît à une vitesse inquiétante. Cette diminution s'est accentuée depuis la Seconde Guerre Mondiale et surtout depuis l'Indépendance l'Inde. La raison majeure en est la poussée démographique très importante due à l'arrivée des réfugiés du Pakistan et des rapatriés indiens du Sud Est asiatique et d'Afrique. Leur réinstallation et la nécessité d'étendre les cultures afin de les nourrir a obligé à empiéter très largement sur les territoires naturels de l'outarde—plaines herbeuses découvertes et zones semi-arides, rendues exploitables grâce à la construction de barrages et de canaux d'irrigation. Toutefois, le facteur le plus meurtrier pour l'outarde a été l'introduction de la Jeep, qui a permis aux braconniers de pénétrer avec facilité très avant dans le territoire autrefois inaccessible de l'outarde. Il convient d'ajouter à cela l'adoucissement du décret sur la chasse (Arms Act) et de ses clauses, le relâchement général dans l'observance et l'application des lois sur la chasse et l'augmentation du prix des viandes de toutes espèces. On comprend ainsi pourquoi l'outarde s'éteint si rapidement. Dans l'état actuel des choses, cet oiseau disparaîtra probablement en l'espace d'une génération, si ce n'est plus tôt.

Dans le passé, on n'a jamais tenté de recenser avec exactitude les effectifs de l'outarde indienne et on ne dispose pas non plus actuellement de données sûres concernant les populations survivantes. Une estimation approximative faite il y a quelques années indiquait pour l'ensemble du territoire indien une population totale de 1260 oiseaux (l'auteur pense que ce chiffre est supérieur au chiffre réel). Bien que totalement protégée par la loi, l'outarde continue de disparaître. Pour mettre fin à cette diminution, il est question de créer une réserve d'outardes dans les grandes zones herbeuses du Gujarat où quelques oiseaux survivent encore. Mais il faudra effectuer des études écologiques très approfondies pour savoir si ce projet peut être réalisé.

The Great Indian Bustard, *Choriotis nigriceps* (Vigors), a vanishing species in India, and some suggestions for its preservation

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The Great Indian Bustard *Choriotis nigriceps* (Vigors) is one of the most magnificent game birds found in India. The dwindling population and the gradual reduction of its distribution has been engaging the attention of those concerned with Indian Wild Life. Dharmakumarsinhji (1957, '62, '66) has contributed vivid accounts of its habitat, habits, seasonal movements, food, courtship, etc. He (1957) has also suggested certain measures for protection of this species. In the present article an effort has been made to give the present position of this bird and a few suggestions for its preservation.

FIELD CHARACTERS

Choriotis nigriceps is a large, turkey-sized, bird weighing up to 18 kgs. Its height is about 90 cm. to the top of head. Sexes are alike except that the females are slightly smaller in size. It has a distinctive black crest on the head and white markings on the breast and underparts. A large whitish patch near the tip of the wings is also prominent.

BREEDING

It is polygamous. Breeding commences after the break of rains in June-July. The breeding season has been variously stated to extend from May to November but the majority of the authors have quoted June to October. The breeding areas have low bushes. Dharamkumarsinhji (1957) says that eggs are laid mostly in the months of August to October when cover and food are at their best. Eggs are laid singly.

HABITAT

The Great Indian Bustard lives in semi-desert grasslands with plenty of low bushes. It prefers well drained and hilly terrain. Occasionally it may visit cultivated areas. This bird can live on different types of soil, e.g. desert (Rajasthan), black soil (Nalsarovar in Gujarat and Ahmadnagar in Maharashtra), red and yellow soils (Dhrangadhra in Gujarat) and alluvial soil (Balrampur in Gujarat). Its habitat lies in the 5 to 30 inches (12.5 cm. to 75 cm.) zone of annual rainfall.

DISTRIBUTION

Baker (1929) gives its distribution as Punjab, Sind, east of the Jamuna (=Yamuna) and south of Rajputana (Rajasthan), Gujarat and the Bombay Decan. Stragglers occur in the United Provinces (Uttar Pradesh), Behar (Bihar), Bengal and Orissa in the east, on the Malabar Coast in the south, and even in Ceylon.

Dealing with nesting of this bird Baker mentioned its occurrence in Gwalior (now a part of northern Madhya Pradesh). Subsequently it was reported from Saugor (Deeks 1935), Afghanistan (Whistler 1945) and Kutch (Vijayrajji 1943).

Recent sightings on the basis of reports received from different sources (including the Chief Conservators of Forests of the various States and from Nepal), and of the author's own experience, are given below.

Maharashtra: Gangapur 80 km from Aurangabad (Ahmadnagar District).

Uttar Pradesh: Jhansi (about a decade ago).

Gujarat: Kathiawar and Saurashtra.

Rajasthan: Three, Nagaur District (Jan. 1969); pair, Korna village c. 42km from Jodhpur (Jan. 1969); pair between Kansaur and Bhinyad village, Barmer district; 17 birds and one chick between Pokaran and Chacha village, Jaisalmer District; seven between Ramdeora and Mawa village, District Jaisalmer; one on Chandan to Jaisalmer Road; one between Kholla and Pali, District Pali; and three, Hatamta Jor Bhinmal Tehsil, District Jalore.

Nepal: near Champaran District of Bihar.

Thus, this species is now mainly restricted to western Rajasthan and to parts of Gujarat and Maharashtra. Although in a personal communication Dr. B. Biswas of the Zoological Survey of India, Calcutta, expressed doubts about the identification, the reported occurrence in Nepal is worth noting. Only once has the species previously been reported from Nepal (Gray & Gray, 1846).

POPULATION

Dharmakursinhji (1957) mentions that droves of 30 to 40 individuals could be observed during most of the year in certain suitable habitats in Kathiawar. Tyabji (1952) recorded having seen 200 to 300 of these birds on one occasion in 1923, and 400 on another occasion in 1926, in Manmad area in Maharashtra. Dr. Ishwar Prakash of the Central Arid Zone Research Institute, Jodhpur, informed me (personal communication) of a group of 17 birds and one chick between Pokaran and Chacha village in the Jaisalmer District of Rajasthan. Many authors have drawn attention to the dwindling population of the species in areas investigated by them, e.g. Dharmakumarsinhji (1953, Saurashtra), Shivrajkumar (1962, the whole range), Sen & Sankhala (1962, Rajasthan), Spillett (1968, Gujarat), Yuvraj of Jasdan (1947, Kathiawar), the Editors of the Journal Bombay Natural History Society (1952, p. 277; Ahmadnagar).

CAUSES OF THE DECLINE

(1) Spread of cultivation and increasing population pressure

The natural habitat of the species is grasslands with scattered bushes, which is constantly being reduced by cultivation. As the bird is wary of humans, it withdraws to comparatively undisturbed areas. Also the removal of bushes deprives it of protection.

(2) Sportsmen or shikaries

This bird is regarded as a delicacy and is much sought after for the table. Nomadic tribes, the Dafers in Saurashtra and others in Rajasthan, have contributed much to bringing the bustard to its present condition. In addition to persecution by the local people, it has had to face hunting by more active and better-equipped army personnel. During the Second World War (1939-45) and later, due to abolition of Shikar Departments of the erstwhile princely States, people have had more opportunities for indiscriminate shooting. The introduction of jeeps and modern guns has aggravated the situation.

(3) Egg collectors

Dharamkumarsinhji (1957) mentioned egg-collectors as one of the menaces to this species. In view of the fact that the females lay only one egg and maturity is attained at the age of 4 years in hens and 5 or 6 years in cocks (Spillett 1968, p. 43), the breeding rate is very slow even without such egg predation.

PROTECTIVE MEASURES

In the past, the rulers of many States strictly forbade bustard shooting: according to Spillett (1968), when Dhrangadhra was a princely state, a fine of Rs. 1,000/- and/or imprisonment for a period of up to six years was imposed on any one found killing this bird. As long ago as 1948 Dharamakumarsinhji submitted to the State Government a memorandum on the need for protection of wild life in Saurashtra, and in 1950 he submitted a report on the wild life and game surveys to the Government of India. In both these reports he emphasized the need for protecting the bustard.

A number of States have enacted Acts, listed below, and framed rules thereunder, declaring bustard completely protected and shooting, catching, trapping, or collecting of its eggs as illegal.

The Rajasthan Wild Animals and Birds Protection Act, 1951.

The Bombay Wild Birds and Wild animals Protection Act, 1951.

The Saurashtra Wild Animals and Wild Birds protection Act (1952) and Rules 1965 (based on the Bombay Act, 1951).

But it is clear from various reports that legislation has not proved effective in protecting the species.

Dharmakumarsinhji (1957), The Editor (Journal Bombay Natural History Society, 1952, p. 277) and Shivrajkumar (1962) have suggested establishing sanctuaries for the protection of the bustard. Recently in a Symposium on Natural Resources of Rajasthan (Jodhpur University, October, 1968) a resolution was adopted urging the Government of Rajasthan to create a sanctuary for this bird.

PROBLEMS OF PRESERVATION

The practical difficulties in protecting the bustard fall broadly under three categories: Biological, Economical and Administrative.

(1) *Biological:* Bustards fly quite readily for distances of several miles at a stretch. This factor serves as the greatest deterrent to the creation of sanctuaries, because once on the wing and out of the sanctuary area the bird is easy shooting as it flies slowly at low heights. Secondly, the eggs or chicks have to be protected from predators like crows, eagles and wolves. On the other hand, the Great Indian Bustard does not seem to suffer from much competition for food in its present habitat.

(2) *Economical:* Many economical considerations have probably prevented establishment of a sanctuary, foremost among them being the stringent budgetary position of the department concerned. Although the estimates of Dharmakumarsinhji (1957) for establishing and running a sanctuary require revision, it is felt that the State Government concerned should not find it difficult to provide roughly Rs. 20,000/- per year, especially if expenditure could be partly met from funds received from or through the Government of India or Indian Board for Wild Life.

An incidental economic problem is that of the withdrawal of crop protection guns in the vicinity of Sanctuaries.

(3) *Administrative:* Merely framing rules is not enough: there has to be effective machinery to enforce them. Here a problem arises concerning the competence of persons who can report a person for committing an offence. Generally, Forest Officers of the rank of Divisional Forest Officer or Assistant Conservator of Forest are vested with the powers to lodge such reports, but these officers are seldom likely to be on the spot when offences are committed. Secondly, there is the problem of control outside forest areas: these areas are under the jurisdiction of police, who are also not generally available on the spot.

In order to check poaching, therefore, it would be necessary not only for crop protection guns to be withdrawn, but also for some arrangement to be made with the military and the police department to prevent their armed personnel from entering sanctuary areas except to meet urgent situations when arms are needed.

Suggestions: The idea of establishing a sanctuary for this bird is generally agreed, but no one has proposed any particular area. In now recommending for consideration the four sites detailed in an appendix, due consideration has been given to soil, rainfall, type of forest and vegetation, and past and present distribution of the species. The general conclusion reached is that it would be most useful to rehabilitate the bustard in existing Bird Sanctuaries or National parks, as far as possible in or near the areas of its past and present distribution, with second preference for areas in which some reserved forest exists.

Of the four proposed areas, Shivpuri (Madhya Pradesh) is a National Park, Nalsarovar (Gujarat) is a Bird Sanctuary and Gajner (Rajasthan) is a reserve forest; the fourth area at Ahmadnagar is suggested only to explore the possibility of finding, a suitable refuge in an area where the bird probably still survives but there is at present no suitable kind of reservation.

Other measures which need to be taken, include the maintenance of a proper watch on the bustard's population, with regular censuses, if feasible. Perhaps, also, a few birds should be kept in the country's leading zoos to acquaint the public with the species and its serious danger of extinction. Finally, tourist departments and the forest departments of Central and State Governments should jointly issue pamphlets with appeals to visitors as well as to the general public to help the Government in the task of ensuring its protection.

SUMMARY

The past and present status of the Great Indian Bustard *Choriotis nigriceps* (Vigors) is reviewed. The characteristics of its habitat are described and the causes of its decline considered. Suggestions are made regarding possible sites for sanctuaries, especially areas already protected into which it might be reintroduced. Attention is also drawn to the need for public co-operation.

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APPENDIX

Ecological and other details of proposed sites for Great Indian Bustard Sanctuaries.

- (1) Shivpuri (Gwalior District, Madhya Pradesh)—Area 158 Sq. Km (61 sq. miles). Approach: 115 km S. of Gwalior on Agra to Bombay road and 90 km from Jhansi; there is a railway branch line from Gwalior. Shivpuri was declared as National Park in 1955. In the past the Great Indian Bustard has been reported in this general area from Saugor, Gwalior and Dihala (c. 80 km west of Jhansi, very close to Shivpuri). Vegetation:—*Prosopis spicigera*, *Azadirachta indica*, *Balanites aegyptiaca* (=*B. roxburghii*), *Zizyphus mauritiana*, *Salvadora oleoides* *Acacia leucophloea*, *A. arabica*, *Adhatoda vasica*, *Clerodendron phlomoides*, *Ehretia aspera*, *Capparis aphylla*, etc. Soil: black/alluvial. Rainfall 50-75 cm.
- (2) Nalsarovar (Ahmedabad District, Gujarat)—This area was declared as a Bird Sanctuary in April, 1969. Comprises a lake which at high water level in July/August may exceed 260 sq. km (100 sq. miles) in area, but by December is reduced to 208 sq. km (80 sq. miles). Much of the lake is surrounded by barren shores or flats, and along the higher fringes are found desert scrub and trees like *Salvadora* spp. and *Prosopis* sp. There is an all season road and daily bus service from Ahmedabad. Nalsarovar lies c. 80 km S.E. of Dhrangadhra where the bustard was numerous until 15-20 years ago. Vegetation: *Acacia arabica* *A. leucophloea*, *Capparis aphylla*, *Zizyphus mauritiana*, *Azadirachta indica*, *Salvadora persica*, *S. oleoides* etc. Soil black. Rainfall 50-75 cm.
- (3) Gajner (Bikaner District, Rajasthan). Situated c. 30 km S.W. of Bikaner to which there are both rail and road connections, contains a lake about half a kilometre long by a quarter of a kilometre broad. Part of the area is forest reserve. Vegetation *Prosopis spicigera* ('Khejri'), *Salvadora oleoides* ('jhal' or 'pilu'), *Acacia arabica* ('babul'), *Zizyphus jujuba* Ober), *Azadirachta indica* ('nim') *Capparis aphylla* ('Karil'), *Euphorbia nerifolia* ('thor') and *E. roigleana*, *Cenchrus catharticus* ('blerut') *Eleusine flagellifera*, ('sawan') *Pennisetum cenchroides* ('dhaman'), etc. Soil desert. Rainfall 25-50 cm.
- (4) Ahmadnagar (Maharashtra). Vegetation: *Acacia* spp. *Zizyphus mauritiana*, *Albizia amara*, *Randia dumetorum*, *Cassia auriculata*. Soil black. Rainfall 60 cm. There is no existing wildlife sanctuary in the vicinity, but the abundance of the Great Indian Bustard in the past and its occurrence even today in this area shows it to be a natural habitat—an opinion also expressed by the Editors of the Bombay Natural History Society's Journal in 1952, when commenting on an article by Tayabji. Although Ahmadnagar has been a great centre for Defence department activities, the present situation suggests that there is a good possibility that an area which would make a very suitable Great Indian Bustard sanctuary could be made available.

A Report on the 1969 Status of the Monkey-eating Eagle of the Philippines

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Pithecophaga jefferyi, commonly known as the Monkey-eating Eagle, is one of the most outstanding species in the Philippine fauna facing a serious threat of extinction. It ranks second in the order of endangered endemic species of the Philippines, after the tamaraw *Anoa mindorensis*.

DESCRIPTION

The Monkey-eating Eagle is the largest eagle in the world. Its huge size (length over 3 feet, wingspan over 8 feet), powerful bill, peculiar habits and food preferences, and majestic stance all combine to give it a remarkable and awe-inspiring appearance. The depth of the bill is greater than that of any other bird of prey, except Steller's Sea Eagle (*Haliaeetus pelagicus*). The high vaulted nasal opening, set almost vertically, is another character. The naked tarsi and feet approach those of the Harpy Eagle (*Harpia harpyja*) in size and strength, and the scaling of the tarsi is remarkably similar. Its lancelike talons, which are very strong and powerful, are used to grip its prey securely until it bleeds to death.

Physical characteristics which distinguish the female from the male are as follows: rather larger size, general colour especially forehead a shade darker, breast much whiter, underparts more buffy and bill broader and more powerful.

HABITAT AND DISTRIBUTION

The Monkey-eating Eagle has a restricted distribution having been recorded only on four of the 7,100 islands of the Philippines, namely Luzon, Samar, Leyte and Mindanao. According to latest reports, this bird is already extinct in Samar and Leyte but still exists although in much depleted numbers on Mindanao and Luzon.

Its habitat preference is for lowland and medium elevation primary forests from 500 up to a maximum of 4,000 feet in altitude. A breeding pair stays in a definite territory of about 40-50 sq. km, preferably containing a mixture of virgin forest and cleared areas.

STATUS

There are now only about 40 Monkey-eating Eagles waging a desperate bid for survival in the mountains of Mindanao. When the Philippine scientists Dioscoro S. Rabor and Rodolfo B. Gonzales made preliminary studies on the Ecology, Biology, Habits and Life History of the Monkey-eating Eagle in 1963/64, about 100 were thought to be still present in the country (as reported by Professor Rabor to the IUCN conference in Bangkok in 1965).

In 1969, Professor Gonzales estimated that the number had fallen to about 36. The preliminary survey conducted by the Parks and Wildlife Office in September and October in the same year reported 29 living eagles in the areas investigated. Putting together the two 1969 reports gives the following distribution in Mindanao, province by province: -

1. Bukidnon	3
2. Surigao del Sur	3
3. Davao del Norte	2
4. Davao del Sur	9
5. Davao Oriental	2
6. North Cotabato	11
7. South Cotabato	4
8. Zamboanga del Sur	2
9. Misamis Occidental	2
10. Lanao del Norte	2
	40

The present distribution of the surviving eagles suggests that they were formerly more or less evenly distributed and were apparently common on Mindanao. Of the problem of estimating the population size at that time, a practical, although arithmetical, solution was devised by Professor Gonzales on the basis of knowledge of the bird's habits, particularly its total hunting range. Using this formula, he estimated an average population decrease of 1.61% a year for 60 years or roughly a loss of 19.3 birds each year. Obviously at this rate, as Professor Gonzales observed, not a single *Pithecopaga* would be left on Mindanao in two or three years' time. There is no doubt from these investigations, that it is on the verge of extinction.

STUDIES

Notwithstanding the attention that it has attracted since first known to science, little is known of the bird's biology, life history, ecology and habits. Reference has already been made to the first studies carried out in 1963/64 by Professors Rabor and Gonzales. Another study was conducted by Professor Gonzales in 1967 and 1968, and an investigation of the present status of the eagle in thirteen selected mountainous areas in Mindanao in April-June 1969. Plans for this last investigation were evolved in the course of conferences with Professor Tom Harrisson of Cornell University when he visited Silliman University, Dumaguete City, in recognition of the fact that such an investigation was essential to the formulation of sound conservation plans. Through the good offices of Professor Harrisson, the World Wildlife Fund provided funds for the project.

In September and October 1969, the Parks and Wildlife Office conducted its first preliminary survey, carried out by a staff biologist and supporting team, in which special attention was paid to nesting sites and any possible concentration of the eagle in the mountainous areas and hinterland of Mindanao. The survey also aimed to determine the feasibility of establishing research centres on Mindanao Island, which would work on formulating effective management programmes for the Protection and conservation of the bird.

The Parks and Wildlife Office now proposes a research project on the Monkey-eating Eagle, designed to take 5 years and start in January 1970. This will be the first scientific research project on the eagle to be undertaken jointly by the Office, the Government of the Philippines and the private sector. The conservation and scientific aspects of the project have received support from the World Wildlife Fund, the National Research Council of the Philippines, and the Philippine Wildlife Conservation Foundation. Assistance may also be extended by the National Science Development Board of the Philippines.

LIFE HISTORY OF THE MONKEY-EATING EAGLE

It may be of interest at this point to summarize some of the salient features which have emerged from the study made by Professor Gonzales of a breeding pair of the eagles in the forest of Kibawalan, Malalag, Davao del Sur Province, in 1963/64.

1. Food and feeding habits

At least for this particular pair of eagles, perhaps 'Lemur-eating Eagle' would be a better name than the customary 'Monkey-eating Eagle', since the majority of the carcasses brought to the nest consisted of flying lemurs, *Cynocephalus volans*. Of the 48 carcasses seen in or brought to the nest, 43 were flying lemurs, 3 were monkeys, *Macaca philippinensis*, one was a flying squirrel, *Petinomys* spp., and one a tree squirrel, *Callosciurus philippinensis*.

Flying lemurs formed a major portion in the eagles' diet, not because they were the most abundant suitable prey in the region, for monkeys were even more so, but because of the ease with which they were captured. A clearer picture of this statement may be conveyed by considering the following facts concerning the habits of prey species, which presumably influence the eagle's hunting success. As is generally known, flying lemurs are nocturnal animals which hide or sleep during the day-time in natural hollows or trees. Sometimes, however, the first light of dawn catches them away from such cavities and they, therefore, have to conceal themselves among thick foliage near to or at the very top of tall trees. At other times, one can find them only 5 or 6 feet above the ground clinging to tree-trunks. In either case, spotting them is not too difficult for the eagle. Another feature perhaps prejudicial to the flying lemurs is their habit of travelling or staying on their own or in pairs while outside their hollows. Since there is supposed to be 'greater safety in numbers', this particular aspect of their behaviour is likely to render them more vulnerable to attacks of eagles.

Monkeys, however, almost always travel in troops with a leader, usually a large male, who assumes the dual role of a scout and defender of the group. At the approach of the giant birds, the leader shouts a warning cry and all his followers, especially the young ones instantly run for cover either to the ground or to the nearest foliage. But the leader usually stays behind and even exposes himself rather conspicuously to the enemy. In one such incident, a female eagle was seen soaring over an area and, presumably, the monkeys must have seen it too for they were all excited and running for cover. The leader of the pack, however, not only stayed behind but in fact climbed to a higher branch from which point he and the eagle could see each other clearly. The latter however, did not make any attempt to attack and even if it had, the monkey might have proved himself a fair match for the eagle.

Similar incidents were also noted by the same observer during the incubation period, when the sitting bird purposely left the nest to swoop down on monkeys which ventured closely to the nest-tree. But in none of her attempts was she seen to be successful: the intended prey was too agile for her. As far as hunting for monkeys is concerned the birds fared better if and when they hunted together. Only occasionally an adult eagle hunting alone succeeded in catching a monkey, but perhaps the victim was a stray.

As regards to the other two food items mentioned, the flying and tree squirrels, they were relatively too uncommon in the Kibawalan area to have been of much significance in the eagle's diet. The eagle was also reported to have been seen feeding on hornbills, either *Buceros hydrocorax* or *Aceros leucocephalus*. This has not, however, yet been observed by any of the other research teams.

2. Breeding habits

That the Monkey-eating Eagle has never been known to breed in captivity may be partly due to the fact that courtship and even mating take place in the air when the pair is flying at considerable altitudes. When egg-laying time approaches, the couple builds its nest, which is a hundred feet or more above the ground. It often uses its old nest, which it refurbishes with dried twigs before each egg-laying. The eagle breeds annually and lays only one egg, which is pure white and slightly larger than a goose's.

It takes 60-61 days to hatch this egg, while the fledging period is 104-105 days, or a good 15 weeks, after which the young bird can live by itself. Sexual maturity is attained in three years, and the life span has been estimated at forty years.

Parental care is very strong. Incubation and brooding are shared by both sexes, but there is a very unequal division of duties. The male's share of the total incubation and brooding period is comparatively small, but he does most of the work of procuring food for his mate and, later, for the offspring too. Moreover, he considers the security of the family

very seriously, becoming very wary of predators, especially the Crow *Corvus macrorhynchos*, the Rufous Hornbill *Buceros hydrocorax* and the Wreathed Hornbill *Aceros leucocephalus*, which might endanger the lives of the eaglet. He never leaves the vicinity of the nest-tree, except when in search of food, constantly assuring his mate of his presence by hovering over the eyrie, uttering strange sounds in tones distinctly heavier and thicker than his usual call; the female responds with a mellow, ascending note.

In the case of the pair observed by Gonzales, the male was seen bringing food to the nest five times during the incubation period, and twenty-nine times during the fledging period. The female probably also hunted, but she was seen bringing food only three times during the whole nestling stage, and never during the incubation period. However, the female did most of the actual feeding of the chick during its first three weeks of life (16 times against 1 by the male). The reverse was true from the fourth week onwards (23 times by the male against 9 by the female). The parents, especially the male, appeared to be oversolicitous of their offspring to the extent of feeding it even on the day prior to its leaving the nest, when it was fifteen weeks old.

3. Voice

The usual call of the Monkey-eating Eagle can be characterized as being weak, lacking in volume and carrying power. It is a long, somewhat mellow whistle that steadily increases in pitch and ends with an upward inflection. Alternatively, it ends with an accented, downward inflection. The voice of the male is slightly heavier or thicker than that of the female.

Among the circumstances eliciting the normal call are those during the change-overs at the nest. The intimate calls heard at certain times are of the second form.

There is another call that the eagles are heard to utter when they are excited. It consists of short somewhat intense high-pitched notes. Contentions over food and attacks by bird enemies are the main situations which elicit this kind of call.

The eaglet's voice, faint and hardly audible during its first week in the nest, becomes louder by the time it is 7 or 8 weeks old. It is during this time that alternate gorging and fasting begins. The eaglet reacts to the fasts by calling plaintively and incessantly for several minutes, after which it will quieten down. The arrival of a parent, especially with food, evokes another noisy response from the nestling. Interruption of its meals by the female bird also produces the same reaction.

Except for its being softer in quality, the voice of the young eagle, a month after it has left the nest, is like that of the parents.

CAUSE OF DECLINE

All over the world raptorial birds are persistently threatened with destruction by people who are ignorant of the intrinsic values and benefits that these birds confer. The Monkey-eating Eagle is an example of a bird severely menaced by the widespread destruction of its natural habitats and the indifference of the average Philippine citizen to conservation of any wildlife—both offshoots of ignorance of the importance of the eagle. Because of this there is excessive collection and hunting both by legal and illegal hunters for varying reasons: the great demand for the bird abroad and within the country for the zoo trade, for pets and/or exhibits in private residences, for public exhibitions, for stuffing and mounting as parlour trophies or monuments to a person's hunting prowess, and for the high price it commands. There are also attempts at evasion of the laws controlling the exportation of the species.

Ignorance is the underlying factor and applies to the conservation of all other forms of wildlife in the country, accounting, for example, for the dwindling number of the native Tamaraw (*Anoa mindorensis*). If people were conscious of the value of these species there would be no problem of apathy and indifference and no appalling destruction of indigenous vegetal cover, particularly forests, without any consideration being given to the disastrous long term results—the loss of irreplaceable and valuable wildlife.

MEASURES TO REHABILITATE THE EAGLE

In appealing strongly to and trying to rally the interest of the Filipino people, the Parks and Wildlife Office is always emphasizing the importance, value and significance of the Monkey-eating Eagle in the world avifauna. PWÖ's intensified information and educational campaign is slowly gaining impact and momentum. Today, there is a marked increase in the understanding of and response to the conservation drive for the Tamaraw and the eagle and other wildlife species.

Behind the success of the campaign is a massive, concerted effort by both government and private sector. Early in 1969, following visits by General Charles Lindbergh and Professor Tom Harrisson, conservation was given new impetus; there is now a more intensified information drive with the aid of the press, radio, and other media; tighter conservation measures; increased citizen participation; and the formation of conservation teams which are fielded in different areas in Mindanao.

A bill which, if approved, would provide for the protection and conservation of the Monkey-eating Eagle, and declare it as the Philippine National Bird, has been prepared by the Office in co-ordination with the legislative committee of the Department of Agriculture and Natural Resources, where it is undergoing the final revision.

One of the most important moves made by the Office is the five-year research project already mentioned, which will be among the priority projects to be undertaken by its Biological Research Division.

BASIC CONSERVATION LEGISLATION:

Finally, it is worth recalling that there are already certain laws and regulations designed to safeguard the wildlife and wildlife reserves of the country, which would be effective in maintaining wildlife resources if only they were enforced and observed. Examples of these are: Act 2590, as amended, which prohibits the hunting, wounding, taking, killing or the mere possession, living or dead of any protected bird or mammal, also the taking or wilful destruction of the nests or eggs of a protected species; Parks and Wildlife Administrative Order No. 5, an amended version of Forestry Administrative Order No. 17, which regulates the taking, possessing, exchanging or exporting of certain protected game and other wildlife, and fixes licence fees; Forestry Administrative Order No. 18, which establishes 'closed' and 'open' seasons for certain game and wildlife, and stipulates what birds and animals, and how many of each, may be hunted and in what period of the year; and lastly Act No. 2590, otherwise known as the Wildlife Law, which automatically sets aside as game refuges all national parks and equivalent reservations and applies similar prohibitions and penalties as the other laws.

CONCLUSION

The Monkey-eating Eagle is a priceless heritage, which every Philippine citizen should take pride in sharing. Helping in any capacity in the general effort to prevent the extirpation of this bird, even if only through the implementation of conservation laws or obeying them, is an individual's supreme expression of appreciation of his natural patrimony.

With a little more effort and continued support, reawakened interest in wildlife can surely halt the catastrophic decline in the population of one of the world's most magnificent birds.

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XIth Technical Meeting of IUCN Third Session: Part 2, Birds

SUMMARY OF DISCUSSION

Mr Gupta summarized the results of his investigations in Rajasthan into the status of the Great Indian Bustard. He considered that the bustard was commonest in the western districts of Rajasthan and Bikaner. Cultivation, hunting and egg collecting were the main causes of the Bird's decline. He recommended that consideration be given to re-introducing the bustard into established sanctuaries or reserved areas, and suggested Shivpuri (Madhya Pradesh), Nalsarovar (Gujarat), Gajner (Rajasthan) and Admadnagar (Maharashtra) as suitable locations. He stressed the needs for publicity for the plight of the bustard, for the establishment of breeding nuclei in zoos, and for more accurate assessments of the bird's populations.

Mr Dharmakumarsinhji endorsed the view that the Great Indian Bustard was the most threatened bird in India at the present time. In addition to hunting and destruction of its habitat by cultivation, he believed cattle grazing to be a significant factor in the bird's decline. Eggs were trampled and few chicks survived. It was essential to protect the birds breeding areas, but it was equally essential that State Governments enforce the bustard's legal protection. He supported the plea for the establishment of captive breeding nuclei and further sanctuaries, but he reminded delegates that land reservation alone was not entirely satisfactory, as the bustard moved around extensively. He endorsed the content of Dr Salim Ali's paper, but commented that he had observed definite rivalry among male birds, although he too had never witnessed actual fighting.

Mr Savage stated that one or two flocks of bustards occurred in Pakistan every year from April to about mid-July, or later, depending on the rainfall. The Pakistan Government had taken active steps to protect these birds during the past three years. The whole of Bahawalpur Division, bordering Rajasthan and Bikaner, was now a wildlife reserve, and a sanctuary had been established near Fort Abbas. Bustards were sometimes shot by senior officials and army officers, who did not appreciate the bird's rarity. To overcome this problem, the Pakistan National Appeal of the World Wildlife Fund was arranging to have conservation posters printed and distributed to schools, government offices and officer's messes. Finally, he considered that the Pakistan Government would welcome the proposal to establish a reserve or National Park adjacent to India, not only for the protection of the bustard, but also for the protection of blackbuck, chinkara and other species.

Mr Scott stated that the Survival Service Commission had recommended the ICBP to form a specialist group to investigate the status and conservation of bustards. As President of the ICBP, Professor Dillon Ripley endorsed this proposal.

A Review of the Present Status and Position of Endangered Species of Indian Reptiles

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India's reptiles include 3 species of crocodiles, about 171 species of lizards, 203 species of snakes, almost all known forms of marine turtles and 25 tortoises and terrapins. An assessment, at the present state of our knowledge, of the status of any Indian reptile is likely to be unsatisfactory. For example in 1968 the Bombay Natural History Society circulated among fisheries personnel in India and Pakistan a questionnaire on the status of the Long-snouted Crocodile or Gharial (*Gavialis gangeticus*) for the IUCN's Red Data book on reptiles. The data that we obtained did not add much to our knowledge of the status of the animal in the sub-continent. The lack of precise information on any species of Indian reptile is largely due to the fact that reptiles are not aesthetically of interest as for instance are the birds, and except for a few species known to sportsmen or known for their poison, the majority are inconspicuous. However, a fairly reliable opinion of the status of the commercially exploited species can be formed on the basis of trade data. It is also possible to form a reasonable conjecture on the status of highly specialized forms on the basis of the destruction of the habitats of which they are typical.

The commercial exploitation of crocodiles during the last few decades has seen the extermination of the species in most areas of its range. The scale of destruction can be gauged from the fact that in 1948 and 1949, 16,000 and 30,000 skins respectively were exported through Calcutta port alone and the estimated production of crocodile skins was 40,000 to 50,000 per annum. Though three species are involved, the major portion of this number was made up by the widely distributed Marsh Crocodile (*Crocodylus palustris*). The Estuarine Crocodile (*Crocodylus porosus*) and the Gharial (*Gavialis gangeticus*), being restricted in distribution, are apparently less affected, but the recent status survey indicates that the Gharial has also suffered considerable commercial exploitation. An idea of the steep decline in the population of crocodiles can be had from the fall in the export of crocodile skins after 1958, when 5,000 kg were exported. The animal did not appear again in export figures until 1964, when 223 kg of skins were exported. The export of crocodile skins was banned in 1967, but it would be difficult to enforce this ban as surreptitious export under other names cannot be prevented unless all three species are specifically and simultaneously placed on the protected list. There have been thoughts of starting crocodile farms but considering the fact that it takes 10 to 14 years for the animals to reach commercially exploitable size, it would be infinitely more economical to enforce an absolute ban on their killing for a similar period of time and let nature take its course.

Definite data are not available on the status of the marine turtles. The Leathery Turtle (*Dermochelys coriacea*) was known to nest along Kerala Coast and about 40 used to be caught annually in nets. They are now reported to be seen only occasionally. The Green Turtle (*Chelonia mydas*), as in other areas of its range, is commercially exploited, 800 to 1000 being landed from Palk Bay. Whether this turtle nests along the coasts of India is not clear, though it does so in the Irrawaddy divisions of Burma, where in the early years of this century over a million eggs used to be removed annually.

Among lizards, the Monitor lizards of the genus *Varanus* are heavily exploited. During the last ten years an average of 100 tonnes per annum of lizard skins, mainly *Varanus*, have been exported from the country. The rise in the export of lizard skins shows a significant relation to the fall off in the export of crocodile skins, rising from 3 tonnes in 1958 to 209 tonnes in 1968, with a peak of 314 tonnes in 1966 valued in excess of 4 million rupees.

The effect of this enormous and continuous drain on the *Varanus* population is already evident in the scarcity of this once common lizard and it seems unlikely that exploitation at the current rate can be sustained; the time may not be far off when monitor lizards

would cease to be of commercial interest. Whether the population of the animal once it has reached this dangerously low level would recover in strength is conjectural. The water monitor (*Varanus salvator*) is already on the protected list and other species of *Varanus*, all economically useful as vermin destroyers, need to be similarly protected if they are to be saved.

Apart from the monitor the only lizards which may form part of commercial catches are some of the Agamids of the Himalayas and the Spiny-tailed lizards of the genus *Uromastix* of the Indian deserts. There are however no data on these.

The larger snakes, particularly the python are heavily exploited for skins. During the past decade on an average, 46 tons of snake skins have been exported from India every year, the maximum during the period being 133 tons in 1962 valued at 2 million rupees.

Enquiries at a tannery in the south showed that formerly 9,000 skins of snakes used to be handled daily, the number has now come down to 3,000 a day. Tanned skins examined were of the species, *Elaphe helena*, *Natrix piscator*, *Oligodon taeniatus*, *Coluber fasciolatus*, *Ptyas mucosus*, *Boiga trigonata*, *Ahaetulla ahaetulla*, *Python molurus*, *Naja naja*, *Eryx conicus*, *Eryx johni* and *Vipera russelli*. On an average the skins of the smaller snakes a metre or less in length weigh about 10 gm. and give an idea of the enormous numbers necessary to make up the tons that are exported. It appears that snake skins are also reaching the point of no commercial interest, exports having come down during the last three years to an average 1.6 tons per annum. The population of snakes, as of *Varanus* lizards and crocodiles before them, have been brought down to dangerously low levels. This is unfortunate considering the importance of snakes in the control of vermin affecting agriculture.

We are at least more or less aware of the position of the larger reptiles, from the statistics of commercial exploitation, but the position of the small and obscure reptiles is difficult to determine. Reptiles which are cause for concern are the highly specialised species restricted to certain habitats. Among snakes 31 per cent of species in India, and among lizards 30 per cent of the skinks (Family Scincidae) and 19 per cent of the Agamids (Family Agamidae), are restricted to the hill forests of the Western Ghats south of latitude 14°. Similarly 32 per cent of the snakes and 13 per cent of the lizards occur only in the Eastern Himalayas in the Indian region. A large number of the lizards and snakes endemic to the Western Ghats occur only in evergreen forests in high precipitation areas. These specialised reptiles will certainly disappear through habitat destruction by man in the form of removal of the original cover for replacement with exotics. This is a process that is happening at an accelerated pace in the hills of south India where the original vegetation is being replaced with Eucalyptus and wattle. This drastic change in the environment and the consequent change in the insect and other reptile food-sources of these forests is bound to spell doom to the specialized reptiles found only in these areas. To save not only these reptiles but also other forms of animal and plant life restricted to these forests, it is essential to select and retain as sanctuaries areas of primary forest with the particular ecological conditions which hold specialized animal and plant life.

It is also necessary to institute as early as possible status surveys of all the larger reptiles and of such rare forms as the Indian egg eating snake (*Elachistodon westermanni*).

SUMMARY

Lack of precise information makes assessment of the status of Indian reptiles difficult. However, on the basis of data available on commercial exploitation of reptiles it appears that the crocodiles, marine turtles, lizards of the genus *Varanus* and many species of snakes need protection. Endemic reptiles restricted to certain habitats are also in danger of extinction.

RÉSUMÉ

Par manque de renseignements précis, il est difficile d'apprécier la situation des reptiles en Inde. Toutefois certaines données portant sur l'exploitation commerciale des reptiles montrent que les crocodiles, les tortues marines, les lézards du genre *Varanus* et de nombreuses espèces de serpents auraient besoin d'être protégées. Des reptiles endémiques cantonnés dans certains habitats sont également menacés d'extinction.

The Endangered Crocodiles of India

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Four decades of observation and contact with the wildlife of India have given the author ample opportunity to observe closely and regularly Crocodiles in Northern India, the land of the Ganges and its tributaries, where waters once teemed with crocodiles and it was usual to sight several groups basking in the sun if one travelled for a few hours on a bullock cart along the bank of a river. Localities previously visited have been revisited in the last two years and the experience gained forms the basis of this paper.

Wildlife outside the Government Forests has been sadly neglected and endangered mainly because of commercial exploitation for meat, skin, fur and feather. Crocodiles used to be found mainly outside Government forests, in rivers and ponds. In all such areas there was and is hardly any enforcement of well-intentioned legal measures. Diminishing food resources and destruction of habitat are other important causes of declining numbers.

Of the twenty-three species of crocodiles, the author has seen three in India and has closely observed two of them. The three species found in India are, *Crocodylus porosus*, the estuarine crocodile abounding in Sunderbans of Bengal, *C. palustris*, commonly known as the Muggar or Naka, and *Gavialis gangeticus* or the Gharial.

Little has been written and less is known about the Indian crocodiles because they live under water and surface only when feeding or because of their immense liking for heat when they come ashore to bask in the sun or when the air is warmer than the water. When floating they look like logs of wood, often remaining submerged with only their eyes showing out of the water. If it is a Gharial (*Gavialis gangeticus*) the lump on the snout also shows up. They are extremely shy and, on the slightest suspicion of close approach or sight of a man, slide into the water from the bank where they may be basking.

C. porosus has acquired the reputation of being a man eater, frequenting the estuarine waters of the Bay of Bengal, and as such few champion its protection.

DESCRIPTION

C. palustris—the common Muggar or Naka—has dark olive brown upper parts and the lower parts are pale yellow. The young ones are pale with some black spots. The average length is ten to twelve feet but specimens of eighteen feet or more may be obtained. The snout is short and broad and the conformation barely suggests a triangular outline. It has also been described as the snub-nosed crocodile. The top of the head is rough with ridges. It can walk and run on all fours. The fingers are webbed at the base, and the outer toe is broadly webbed and the outer edge of the hind limb is turned into a serrated fringe. They may be seen at some places even now, basking on sandy river banks in groups of twenty or more. Males and females cannot be distinguished as they lie basking.

Gavialis gangeticus—the Gharial—is also dark olive brown above and pale below. The young ones are pale brown and grow darker with age. The snout is long and slender, extending from the head like the handle of a frying pan. It is known as the Gharial because of the round pitcher like protuberance forming the nose at the end of the snout. It is far more pronounced in the case of the male, so the sex can be determined from a distance. The nose which is very much swollen, can be inflated like a bag when the nostrils are closed. The female is known as 'Goh' and outnumbers the male. They are often found basking on river banks in company with *C. palustris* or Muggar. Larger males are seen as solitary monsters basking on river islands with deep waters all round, where the current is slower and where man is unable to approach too closely.

The hide of both the Muggar and the Gharial is highly prized because of the pattern of squares on it. The squares on the Gharial are smaller even though the specimen may achieve above the average length. The hide is used for making strong fancy articles from cabin trunks to ladies' bags and shoes.

HABITAT

C. palustris or the Muggar is found all over India in rivers, lakes, tanks, ponds and marshes, sometimes even a few miles from the nearest river or large tank. During the monsoon floods, rivers, lakes and ponds all become one continuous sheet of muddy water in most low lying areas, where the width of water may even be twenty or more miles. It is then that the muggars in the rivers reach tanks and ponds and the receding waters often leave them there. When the smaller tanks and ponds dry up in winter and summer, muggars are often found buried in mud or making overland journeys to rivers or bigger tanks, usually when it is dark. It is also found in waters in the forests where it lies basking or waiting for its prey to come near enough for an attack. They may be seen on the exposed roots of trees on stream banks subject to erosion, living in the deep river pools where currents are sluggish and entering holes and caves under water or just above water level on the steep banks. They multiply to large numbers in sacred lakes and ponds like Pushkar in Rajasthan, until they become a nuisance and need removal to ensure safety of bathers in the sacred waters.

Gavialis gangeticus or the Gharial is mainly found in the Ganges and its tributaries in north India but a few specimens have been recorded from Mahanadi in 'Septikoshi' area of Orissa and, according to a knowledgeable person, in the river Sutlej also. They are usually found in the deeper pools of rivers and not in shallow tanks and village ponds.

SIZE

C. palustris attains a length of more than eighteen feet but the average now found is only about twelve feet. The length of a crocodile is often reputed to be five or six times its head but in larger specimens, the length calculated according to this formula would be more than thirty feet which has never been recorded. When hatched they are small but grow fast, approximately a foot a year for the first five or six years, after which growth is slow and said to be only an inch a year, which means that a twenty foot crocodile would be more than two hundred years old. This needs careful checking under controlled conditions. *Gavialis gangeticus* attains a length of more than thirty feet but the largest the author measured was only twenty-two feet and two inches.

HABITS

Little is known about the breeding habits of the Muggar and the Gharial. Both lay eggs in sand pits not far from the water's edge and cover them with sand with the help of their tails. The female remains in the pool nearby but the eggs hatch by the heat of the sun. Twenty to forty eggs are laid at a time and it is not difficult to find them because of the tracks left by the crocodile. The eggs are hard, white and elongated and are laid after the monsoon rains are over. The young ones can be observed on the shallow banks from February to May. They also bask in the sun in company of the adults. The male Gharial or *Gavialis gangeticus* is sometimes seen chasing the female in the water which causes much splashing.

FOOD & FEEDING

The Muggar or *C. palustris* feeds on almost any living or dead creature it can find in the water or on the ground near by. The young start feeding on insects and small fish and take to bigger fish as they grow up. It can run at considerable speed on all fours with the great body raised well above the ground to catch its prey in the jaws and drag it quickly in to the water. It can walk leisurely also, as, for instance, during its travels in search of rivers or bigger tanks when the smaller ones start drying up. This is done mainly in the

dark. How they find their way is a mystery, as none have been recorded as going in the wrong direction or being found in daytime on the ground far from water, though they are sometimes found buried in the mud of drying and dried up tanks and ponds.

The Author has on several occasions seen goats and sheep grazing near the bank attacked all of a sudden by an apparently sleeping crocodile, which had failed to notice the presence of men on the opposite bank. They take to attacking domestic animals and sometimes even drag cows into the river. Hindu mythology has a story of a crocodile dragging an elephant, drinking water on the river bank, by the fore foot into the water until only the tip of the trunk was left, when supernatural powers intervened to save the elephant. Sometimes deer swimming across are caught and dragged under water. Driven by hunger a crocodile starts frequenting fording places to catch domestic live-stock and sometimes men, when they are walking or swimming across. It is then that terror spreads round the countryside as the crocodile ranges for miles up and down the river frequenting many fords. At threatened fords groups of men thrash the water with sticks to frighten and drive away the lurking crocodile before they cross the river. None of the species are man-eaters in the sense tigers and panthers are, because they do not stalk men to kill them and because a man-eating tiger or panther often refrains from killing any other animals unless driven to do so by hunger. The crocodiles lie in wait at crossing places for their prey and surface the water to have a better view of animals crossing the river. The view outside the water is better than from inside the water. They do not show any preference for men, although they can start by taking dead bodies floating down the rivers. Crocodiles usually feed in the morning and evenings.

The Gharial is reputed to be a fish-eater but like the Muggar it also eats anything dead or alive. The author has examined the stomach contents of scores of dead crocodiles and often found pebbles and stones weighing from two ounces to two pounds. Bones, animal and human, were also found. Sometimes metal and silver ornaments worn by village women were found proving that they had swallowed human bodies. A Gharial is feared more than the Muggar probably because of its size.

HUNTING

The crocodiles appear to take floating baits and not those that sink. An attempt to hook a crocodile with a strong hook and metal fishing line failed when a piece of meat was attached, because it sank. The same experiment was repeated with goat lungs attached, which kept floating and attracted the crocodile in no time.

Crocodiles can be netted also but the bigger ones tear the net and escape. Ingenious are the ways of crocodile hunters. One method used is to stuff the wet skin of a freshly killed goat with quick lime and sew it up. When a crocodile is noticed surfacing, the skin is floated down the river and the hungry crocodile swallows it. On mixing with water the quicklime reacts and the crocodile dies a painful death. In shooting crocodiles with rifles the brain and neck shots are fatal, but the animal has to be 'anchored' by breaking the spine at two places otherwise it enters water and may sink to the bottom to die and float up after a few days and be retrieved far down the river. Sometimes when a wounded crocodile enters the water, it attracts fish and turtles: they nibble at the open wound and the crocodile rushes out of the water, only to be followed by the turtles at whom he snaps and sometimes succeeds in cracking the shell of one of them. The crocodile then goes back to the river, only to be attacked afresh by fishes and turtles and so on till death.

Professional crocodile catchers scour the rivers in small boats and when they reach pools frequented by crocodiles, the boat is anchored. One end of a strong rope is securely tied to a peg driven on the ground and the hunter dives into the pool with the other end of the rope in his hand. He reaches the crocodile at the bottom and ties a noose round the belly and then the crocodile is dragged ashore. Why the crocodile does not attack the man with the rope remains a mystery. These hunters eat the meat of the crocodile.

Crocodiles can be shot at night from a boat by the aid of a flashlight beam thrown on the surface of the water. The eyes of the crocodiles reflect light and shine a dull red and it is not difficult to take a brain shot. The eyes of a Ghariyal reflect light only from certain angles and so they are not shot at night.

Crocodiles are normally shy and inquisitive and in waters where boats are unfamiliar

they may follow a boat, on either side, to the fright of the occupants. But they will not try to overturn the boat.

PRESENT STATUS

In North India large groups of 30 to 60 crocodiles basking on sandy banks and rocks have become a rare sight and now groups of 10 to 20 may be seen at favourite spots, which often change with every monsoon flood when new deep pools may be formed. In South India the position is said to be far worse. In Orissa the position is desperate. On the Indo-Nepal border the rivers and streams still hold considerable numbers of crocodiles because of better enforcement of laws.

Man is the main predator of crocodiles though the very young ones have many enemies and survival may be as few as six per 20-30 eggs laid. Trade, especially foreign trade with the big return offered in foreign exchange, resulting in a wavering export policy, is the main cause of declining numbers. Diversion of river waters into canals also reduces the habitat and affects the status of *Gavialis gangeticus*. Intensive fishing in the rivers and the favourite pools of the crocodiles also reduces the food supply, resulting in diminished numbers.

SUGGESTION FOR CONSERVATION

Export of crocodile skin in any form should be prohibited or drastically reduced. The general procedure is that orders already registered and skins in stock are allowed to be exported and this results in skins being added to the stock. Shooting of crocodiles except those that endanger human life should be prohibited for the next ten years. Special care should be taken to enforce game laws specially in areas outside the forests where crocodiles are found. Netting and catching should be prohibited. A survey of the present numbers, especially of *Gavialis gangeticus* should be undertaken to judge its present status. The breeding stock of mature crocodiles must not be destroyed otherwise there is no hope of their survival and India and the World would be the poorer by the extinction of the unique Gharial.

The Indian Board for Wildlife is taking an interest in preserving crocodiles and the animal features regularly on the agenda of the Board meetings. The possibility of starting crocodile farms has to be investigated.

SUMMARY

The author observed and studied crocodiles in North India. The two species studied i.e. *Crocodylus palustris* or Muggar and *Gavialis gangeticus* or Gharial face extinction because of poor enforcement of hunting rules, highly profitable foreign trade in skins, loss of habitat and food resources etc. The two species of crocodiles studied are similar in colour and habits but vary in size, habitat and anatomy. Their breeding and feeding habits are similar but the Gharial or *Gavialis gangeticus* prefers deep waters and lonely places.

Both feed on almost any living or dead creature by swallowing it entire. When they take to attacking domestic animals and human beings they start frequenting fords and lie in wait for the quarry.

A number of methods are utilised for hunting crocodiles. They may be netted in strong nets, hooked with metal lines and strong fishing hooks, shot with a rifle, noosed and dragged out of the river, poisoned and burnt when they are tempted to swallow a goat skin stuffed with quick lime or shot at night by the aid of a flashlight. Their existence is endangered and immediate steps need to be taken to preserve them.

The measures recommended for their conservation are:

- (a) prohibition of export of skin or any other part of a crocodile.
- (b) hunting and shooting to be prohibited for ten years.

- (c) game laws to be more rigorously enforced in areas outside the Government forests, by some appropriate agency.
- (d) a survey to be undertaken of the present status of *Gavialis gangeticus*.
- (e) preservation of breeding stock and establishment of crocodile farms to be encouraged.

RÉSUMÉ

L'auteur a observé et étudié dans le nord de l'Inde, deux espèces de crocodiles: *Crocodylus palustris* ou Muggar et *Gavialis gangeticus* ou Gharial. Ces deux espèces sont menacées d'extinction par divers facteurs—non observation des règlements sur la chasse, vente très lucrative des peaux à l'étranger, disparition des habitats, des ressources alimentaires, etc. Les deux espèces sont de même couleur et ont des habitudes semblables mais diffèrent par leur taille, leur anatomie et leur habitat. Elles se reproduisent et s'alimentent de la même façon, mais le Gharial préfère les eaux profondes et les endroits isolés.

Tous deux se nourrissent de chair vivante ou morte et avalent leur proie toute entière. Quand ils ont pris l'habitude de s'attaquer aux animaux domestiques ou à l'homme, ils se mettent à fréquenter les gués des rivières et attendent tapis le passage de leur proie.

Il existe de nombreuses façons de chasser le crocodile. Ils peuvent être capturés à l'aide de filets très résistants, de lignes métalliques et de forts hameçons, abattus à la carabine, attrapés au lasso et tirés à terre, empoisonnés et brûlés par des appâts en peau de chèvre bourrés de chaux vive ou encore abattus de nuit à l'aide de lanternes puissantes.

Leur existence est actuellement menacée et il convient de prendre immédiatement des mesures destinées à les protéger.

Voici quelles sont les mesures de protection recommandées:

- (a) Interdire l'exportation de peaux ou de tout autre produit du crocodile.
- (b) Interdire toute forme de chasse au crocodiles pendant dix ans.
- (c) Faire appliquer de façon plus énergique les règlements sur la chasse par un organisme quelconque en dehors des forêts d'Etat.
- (d) Entreprendre des études sur la situation actuelle de *Gavialis gangeticus*.
- (e) Encourager la constitution d'unités de reproduction et créer des fermes d'élevage de crocodiles.

**XIth Technical Meeting of IUCN
Third Session: Part 3, Reptiles**

SUMMARY OF DISCUSSION

Mr Biswas referred to his recent survey of distribution and movement of the gharial along the Ganges and Kosi rivers, the results of which had been plotted on a map. In the rains, gharial in the Ganges migrated as far as Allahabad. The marsh crocodile was once common in West Bengal, but now was quite rare; its numbers had also declined in Uttar Pradesh and Madhya Pradesh. Its populations were still relatively secure in Ajmer and Pushkar, and it was still fairly common in Muthura. In many areas, however, it was being killed by fishermen because of its depredations among fish. Laws to protect the crocodiles were not being enforced. He recommended that all States that still had crocodiles should establish sanctuaries to which animals that were proving a nuisance could be translocated.

Dr McClure noted that numerous references in the discussions had been made to poaching, and he wondered what control was exercised on the possession of firearms in India. He was informed that nobody could obtain or possess a firearm without a licence from the authorities.

Mr Vijai Singh suggested that breeding farms for gharials should be set up, to compensate for losses to poachers and fishermen. Mr Arjan Singh favoured tighter controls on river fishermen and on the auctioning of fishing rights.

Dr Tiwari stated that the Kosi river, in North Bihar, still had sizeable populations of gharial. The animals commonly basked on the islands between the various river channels and, at least in the past, they could be readily observed from boats. He recommended that the Kosi river and its tributaries be considered as an area for the study and conservation of the gharial. He also stated that the Andaman and Nicobar Islands had provided an undisturbed natural environment for the estuarine crocodile until quite recently. The rehabilitation of displaced persons from the mainland on the Andamans, however, had resulted in the virtual eradication of the crocodile from the main islands in this group. He recommended that action be taken now to prevent a similar situation arising in the Nicobar Islands.

Mr Prakash informed the delegates that crocodiles were completely protected in Rajasthan. The Jaipur Zoo had a successful crocodile breeding programme and young crocodiles were regularly exchanged for other animals.

Professor Behura suggested that the limbless lizard (*Barkudia insularis*) which had been described from specimens collected on Barkuda Island, on Chilka Lake, Orissa, might merit inclusion in the Red Data Book. Several recent expeditions to the island had failed to find a single animal. Their numbers on the Andhra University campus also appeared to be in decline. He had seen numbers of water monitors killed, and he doubted if local people, or even those responsible for enforcement of the law, appreciated that the monitor was a protected species.

A number of delegates gave examples of harmless lizards that were commonly killed because they were thought to be poisonous. They stressed the need for a crash programme of conservation education and publicity in rural areas, if these situations were to be remedied.

Dr Tiwari recommended further investigations on the very rare egg eating snake *Elachistodon westermanni*, which is apparently known only from its original description based on four museum specimens.

Dr Glasgow, the Assistant Secretary of the U.S. Department of the Interior, referred to his country's new Endangered Species Act, which would restrict the importation of threatened species from other parts of the world into the United States. The Act would also aid the elimination of alligator poaching, through the control of interstate shipment of alligator skins.

Endangered Plant Species and Their Habitats

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Deforestation is of common occurrence all over the world, but in many areas in India it has assumed catastrophic proportions. Any forest that lies near human dwellings is open to constant depredation: timber is removed for firewood and other uses; the foliage of trees and the ground grass cover are collected for fodder. India is suffering under the so-called 'Population Explosion', and so more and more forest produce is required to supply the normal needs of the people.

But in addition India keeps about the largest number of cattle of any country in the world. In a sense, therefore, all plant species that supply the needs of humans or of various domestic animals, are to be considered in the danger list and must be carefully protected. Deforestation not only removes all useful plants from the surface of India, but it also exposes the soil to the effects of crippling erosion.

Shifting cultivation, to a greater or lesser degree, is practised all over India, particularly in areas obtained from the various forest departments. As such forest lands are given to the people for a very nominal price, they are not duly appreciated and, in consequence, little care is taken to preserve the soil and its fertility. In my experience during my tours of various parts of India I have noted many instances of this treatment of the former forest lands. Perhaps one of the more striking instances I noted is the cultivation of potatoes in Assam; to prevent water-logging of the soil and consequent rotting of potato tubers, potato beds are set up on steep hill slopes, the beds being steeply tilted downwards. The heavy rains of Assam wash away all soil between beds, and in a short while such slopes become useless for any cultivation. The dark brown colour of the water of the streams and rivers in Assam is proof of the enormous quantities of good soil that are being constantly washed away from the hill sides.

However, it is not my purpose to discuss the very important problem of soil erosion or of deforestation; my aim is to speak of some plant species that are in danger of extinction in India.

MEDICINAL PLANTS IN THE DANGER LIST

Among the plants exposed to greater depredations are those possessing or reputed to possess medicinal value. No sooner does a plant come into the public eye, either because of its known curative properties, or because of possibilities for research, than an intense hunt is organized all over the country for such plant or plants.

Before 1952 *Rauvolfia serpentina* Benth. was used in the indigenous systems of medicine, but the demand was not great; the plant was common and abundant in forest areas all over peninsular India. Then after the publication of the various papers extolling the medicinal powers of the plant, a ruthless search was started all over the country, a search that only came to a stop when *Rauvolfia* was found to have disappeared from forest areas.

Of late the more important species of *Dioscorea*, in particular *D. deltoidea* Wall, have captured the attention of plant chemists, especially as sources of steroid hormones. *Dioscorea* has been and still is ceaselessly removed from the soil of India, except perhaps in the more inaccessible areas of the Himalayas.

There are many other plants of known medicinal virtues that could be mentioned. However, precisely because of the great value of such plants, their cultivation is being taken up by individual firms or government concerns, so that in spite of the threatened extermination, to which they are exposed, truly and correctly speaking such plants cannot be classed as endangered species: artificial propagation does insure their survival.

ENDANGERED ORNAMENTAL PLANTS

Orchids are popularly classed among the more beautiful and attractive flowering plants; they are certainly colourful, and often highly sweetly scented, and show the most bizarre shapes; we have orchids that look like giant spiders (*Arachnis*), or like colourful insects (*Cottonia*), or like miniature fiddles (*Porpax*). Then, as many orchids grow epiphytically, that is to say on tree branches, often dead ones, they present a great temptation to the on-looker to remove them from the forest and take them home or send them to the market; in India there is a thriving business that knows no limits of time or country.

It may be worth noting that in India in the neighbourhood of hill stations most orchids are coming close to extinction; the authorities of some of these hill stations have imposed an embargo on the removal of orchids from their forests, but the rule is not enforced with sufficient energy, and in consequence orchids are becoming rare plants, where once they were the show pieces of the area.

In my own experience, I have noted that along the Western Ghats, by the sides of roads or paths, orchids are now rare, even though in out-of-way spots they are still very abundant. In Assam relatively few orchids, I mean wild ones, can be seen e.g. near Shillong, yet at Cherapunji, a short distance away, every tree is loaded with orchids. In Darjeeling I have heard from some of the older residents that once upon a time, within living memory of many people, orchids were numerous; after intensive collecting for many years, orchids are now rare in the area. The Mizo Hills of Assam are still one of the richest areas of India for showy orchids; there are hopes that this beauty may be preserved, as the district authorities have imposed a tax of one Rupee for every single orchid plant collected for export out of the area.

The following is a sketchy list of some of the more attractive orchids, which are being removed from the Sikkim and Assam Himalayas and other parts of Assam for commercial exploitation.

<i>Aërides multiflorum</i> Roxb.	<i>Dendrobium formosum</i> Roxb.
<i>Aërides odoratum</i> Lour.	<i>Dendrobium infundibulum</i> Lindl.
<i>Aërides taeniale</i> Lindl.	<i>Dendrobium lituiflorum</i> Lindl.
<i>Agrostophyllum khasianum</i> Griff.	<i>Dendrobium nobile</i> Lindl.
<i>Arundina</i> sps. Said by Hooker to be among the finest orchids of the Eastern Himalayas.	<i>Dendrobium ochreatum</i> Lindl.
<i>Coelogyne maculata</i> Lindl.	<i>Dendrobium pierardii</i> Roxb.
<i>Coelogyne nitida</i> Lindl.	<i>Dendrobium pulchellum</i> Roxb.
<i>Coelogyne praecox</i> Lindl.	<i>Dendrobium wardianum</i> War.
<i>Cymbidium eburneum</i> Lindl.	<i>Eria convallarioides</i> Lindl.
<i>Dendrobium amplum</i> Lindl.	<i>Eria dasypylla</i> Par. & Reichb. f.
<i>Dendrobium chrysanthum</i> Wall.	<i>Eria ferruginea</i> Lindl.
<i>Dendrobium crepidatum</i> Lindl.	<i>Eulophia virens</i> Br.
<i>Dendrobium cretaceum</i> Lindl.	<i>Paphiopedilum hirsutissimum</i> Pfitz.
<i>Dendrobium crystallinum</i> Reichb. f.	<i>Phaius maculatus</i> Lindl.
<i>Dendrobium densiflorum</i> Wall.	<i>Phaius wallichii</i> Lindl.
<i>Dendrobium devonianum</i> Paxt.	<i>Pholidota articulata</i> Lindl.
<i>Dendrobium falconeri</i> Hook. f.	<i>Pholidota imbricata</i> Lindl.
<i>Dendrobium fimbriatum</i> Hook. var. <i>dentatum</i> Hook.	<i>Pholidota undulata</i> Lind.
	<i>Phreatia elegans</i> Lindl.
	<i>Sarcochilus suaveolens</i> Hook. f.

SOME ORCHIDS NEEDING SPECIAL PROTECTION

Aërides crispum Lindl: An epiphyte with bright rose-coloured flowers and a strong and refined perfume. Originally found all over the Western and Eastern Ghats of India, probably also in Ceylon and Burma. The plant is rare by now, so that in over 30 years of exploration I have found it in the field but on three occasions.

Platanthera susannae Lindl: This ground orchid has been reported from India, Burma, Java, China and throughout Malaysia. In India it is found in humus-rich soil in the under-growth of thin forest, usually on sloping ground. The flowers are striking for their size

and shape, and for a strong and most refined perfume. Wild pigs are said to be attracted to the underground tubers and thus help humans in the extermination of this most beautiful of monsoon orchids.

Rhynchostylis retusa Blume: An epiphyte with long pendulous racemes of white or pinkish flowers, growing on trees in thin forest; often a number of plants grow together, and then, when in full bloom, are a very pleasant sight. Spread from tropical Himalaya through India and eastwards through Assam and Burma to Java and the Philippines. It is a favourite among orchid growers, and this is why perhaps it is becoming rare in the wild parts of the country.

Eria reticosa Wight: Monsoon orchid growing on trees or rocks, with white, highly scented flowers, which are 3 cm or more across; often growing gregariously in good numbers at a spot. It is found on the Western Ghats, and southwards to the Nilgiris, always in exposed situations. It is by now a rare species.

Cymbidium aloifolium Sw: Robust epiphytes, often growing in dense masses on the supporting tree; flowers appear in long pendulous racemes, the flowers being 4-5 cm across, yellowish with a deep purple centre. Widely scattered in hilly tracts of India, southwards and eastwards through Burma to Java. Because of the supposed medicinal value of the plant, it is being hunted down in the western parts of India nearly to the point of extinction.

Porpax reticulata Lindl. & *P. jerdoniana* Rolfe: Endemic species in the Western Ghats, extending southwards to Malabar and Travancore. Both species are of rare occurrence and inconspicuous, on tree trunks; both are among the smaller orchids of India.

Eria exilis Hook. f: Minute epiphytes from a creeping rhizome. This is not only one of the smallest among orchids, but also among flowering plants of India. It is found on tree trunks on the Western Ghats, and extends to Travancore; it has also been reported from Thailand.

Dendrobium mabelae Gammie: Perennial erect epiphytes, from small pseudobulbs; flowers white. Endemic in the Western Ghats of India, a very elegant plant; as most *Dendrobium* spp. of India, this species suffers from ruthless persecution.

Tropidia angulosa Bl.: Ground orchid with a stem up to 30 cm long, occasionally branched, with numerous small white flowers. A rare orchid, but reported from Sikkim Himalaya, through the Western Ghats down to Travancore, and eastwards through Burma to Java.

Apostasia wallichii R. Br. ex Wall: In general appearance this ground orchid looks like a grass, with inconspicuous yellow flowers; in India it seems to be restricted to the Sibsagar district of Assam, but it is found far southwards in Ceylon, and eastwards in New Guinea. When forest grasses are cut, this orchid is also removed from the ground, and this may account for the rarity of the plant which is not allowed to reach the fruiting stage.

Anoectochilus sikkimensis King & Pantl: A ground orchid originally reported from the Sikkim Himalayas; it has also been reported from Kohima in the Naga Hills, where it is a rare species. Clearing of the forest floor removes this plant and prevents its fruiting.

Paphiopedilum fairrieanum Pfitz: This is a ground orchid found in good humus in forest areas'. It was introduced into Europe from Bhutan a long time ago, and held in high esteem. Somehow or other the plant was lost, and came to be known in the popular literature as 'The Long Lost Orchid'. It is only recently that the plant has been rediscovered in the Eastern Himalayas. In the Kameng Frontier Division of NEFA it is fairly abundant at one small spot, but due to recent developments in road and building construction, the plant may be wiped out again in this out-of-the-way corner.

Paphiopedilum villosum Pfitz: A ground orchid from the Mizo district in Assam. Flowers are attractive on account of their colour, shape and size. There is much demand for export to other parts of India and abroad, and in consequence collection of these plants goes unchecked.

OTHER INTERESTING PLANTS NEEDING PROTECTION

Nepenthes khasiana Hook.f.: At first this plant grows erect, then gradually it becomes a climber, and may grow to over 6 m high in secondary forest. The flowers are inconspicuous, but the 'pitchers' formed by the leaf tips, are showy; each has a lid which is movable; young 'pitchers' are but about 3 cm long, 1 cm across; in time 'pitchers' grow to over 25 cm long, 5 cm across. Very restricted in distribution to the Khasia and Jaintia Hills of Assam, on grass slopes or under secondary forest.

Dischidia bengalensis Colebr: Climbing plant; the leaves produce 'pitchers' which harbour much debris and insects. The surface of the 'pitchers' cannot absorb liquids. Very rare plants, from Eastern Nepal and Sikkim.

Aldrovanda vesiculosa Linn: Very widely distributed from Central Europe, through East and Southeast Asia to Timor and Queensland. A rootless swimming plant with whorls of leaves; each leaf can close like a book and thus capture insects, which are digested. Rare in most parts of India; reported from salt-pans south of Calcutta.

Drosera ssp.: Small insectivorous plants inhabiting very moist areas, and of various forms. *D. burmanni* Vahl has a rosette of leaves flat on the ground, and an erect flower stem; insects are captured by the glutinous substance that covers the leaves, very much in the way of the common European *Pinguicula*. *D. indica* Linn. grows among low grasses in the monsoon in most parts of India; the leaves are elongated and narrow, and provided with glandular hairs that trap and digest the insects. *D. peltata* Sm. is more restricted in distribution than *D. indica*; its leaves are orbicular, and provided with glandular hairs; it is an elegant herb. Until recently these *Drosera* ssp. were in no way endangered by occasional collection; lately the leaves and fruits of the three species and the small tubers of *D. indica* have been extensively collected for medical research.

ENDEMIC GENERA OF INDIAN PLANTS

In the following list, only herbaceous plants are included; they are usually of little or no economic importance, though they may be of great scientific interest. Unless the contrary is stated, they are monotypic genera, i.e. with but a single species.

Adenoon Dalz: A composite of the monsoon period, restricted to the higher parts of western India.

Caesulia Roxb: Composite of cultivated fields, common in peninsular India in rice fields.

Calacanthus Anders: Acanthaceous monsoon large herb or undershrub, with showy large blue flowers; higher hills of western India.

Catamixis Thorns: A composite, large herb of the western Himalayas.

Dicaelospermum C. B. Clarke: A cucurbit, slender herb, of the monsoon; it is a climber, in most respects similar to *Melothria maderaspatana* Cogn. but quite typical in its fruits. Very restricted in distribution; Western Ghats of Bombay.

Frerea Dalz: Asclepiad with showy flowers, growing on inaccessible scarps of higher hills of Bombay.

Glossocardia Cass: Composite; diffuse herbs of drier ground in peninsular India; flowers inconspicuous. 2 species.

Goniocaulon Cass: A composite, erect showy plant of grass fields, flowering in the second half of the monsoon. Peninsular India.

Griffithella Warm: Podostemaceae. Grows in swift flowing streams in the Western Ghats during the monsoon and post-monsoon periods.

Haplanthus Nees: Acanthaceous herbs, 3 species, armed with rough cladodes; at edges of forest in higher parts of peninsular India.

Helicanthes Danser: Loranthaceous tree-parasite, rather rare; on the Western Ghats above 600 m.

Jerdonia Wight: Gesneriaceae. Perennial herbs creeping in lower parts erect above. Scientifically interesting, but not a showy plant.

Lamprachaenium Benth: Composite. Tall herbs with small purplish heads, restricted to the higher parts of Bombay.

Nanothamnus Thorns: Composite, diffuse or prostrate herb, rather similar to some species of *Blumea*. Restricted to about 600-800 m alt. on the Western Ghats.

Oianthus Benth: Asclepiad, 4 species. Large herbs or undershrubs, climbing; rare, endemic in western parts of India.

Platystemma Wall: Gesneriaceae; from western temperate Himalaya; slender herbs, very rare.

Polyzygus Dalz: An umbelliferous soft erect herb of the monsoon, with white flowers; restricted to the western parts of India.

Roylea Wall: A labiate, an elegant tall herb of subtropical western Himalaya, with small white or pink flowers.

Willisia Warm: Podostemaceae. A very small herb, growing in dense masses in swift flowing monsoon streams on the Western Ghats.

To this list might be added a large number of endemic species, and other species recently discovered as new in India; many of the new findings are far from common, and this is why they have not been discovered previously.

CONCLUSION

In general one might summarize and say that there are two types of plants that are in need of protection:

- Plants with very showy flowers, that attract the attention of the general public; these are collected for home or personal decoration, or for commercial exploitation.
- Plants of little attraction for the general public, often because their flowers are inconspicuous and not attractive, but often of great scientific interest. Because of this it is the scientists who are often responsible for the near extinction of these very valuable plants.

A concerted effort is needed by the general public, local authorities and scientists for the preservation of some of the beautiful or interesting plants of India. In the case of orchids we should make efforts to reproduce them from seed, as has been done and is being done in many parts of the world. Orchids possess an astonishingly large number of seeds per pod, so that if orchid reproduction by seed is developed in India, there is no orchid that need be placed in the list of endangered plants. It is only through seed cultivation that India can develop orchid export on a national or international commercial scale.

SUMMARY

Forests near villages are constantly being cut down for various purposes, and many forests are threatened. The more important medicinal plants suffer from uncontrolled collection; but their economic importance has compelled users to cultivate such plants extensively. On the other hand ornamental plants in general, and orchids in particular, are regularly collected from the forests, without any effort being made for the perpetuation of the species. The exploitation of orchids from the Eastern Himalayas is discussed, and lists are given of the orchids more commonly exported to national and international markets. Further, a number of individual species or genera are mentioned as needing special protection; among these are some orchids of Peninsular India or of the Himalayas; also some of the more striking insectivorous plants; among the genera only those of herbaceous habit are listed. The paper ends with a plea for the cultivation of orchids on a large scale, which is only possible through seed reproduction.

RÉSUMÉ

Les forêts situées près des villages sont constamment exploitées à des fins variées et de ce fait, nombre d'entre elles se trouvent menacées. Les plantes médicinales les plus importantes sont récoltées sans restrictions; toutefois étant donné l'intérêt économique de ces plantes, les exploitants ont été amenés à les cultiver de façon très extensive. D'autre part, les plantes d'ornement en général et les orchidées en particulier sont récoltées systématiquement dans les forêts, sans qu'il ne soit rien entrepris pour conserver et perpétuer les espèces. Le présent article traite de l'exploitation des orchidées dans l'est de la chaîne de l'Himalaya et donne une liste des orchidées qui sont les plus communément vendues sur les marchés nationaux et internationaux. On indique en outre un certain nombre d'espèces ou de genres isolés qui requièrent des mesures de protection particulières; parmi ceux-ci se trouvent certaines orchidées de l'Inde Péninsulaire ou des Himalayas ainsi que certaines des plantes Insectivores les plus remarquables et des plantes herbacées appartenant à des genres endémiques. En conclusion, l'auteur demande que les orchidées soient cultivées de façon extensive à partir d'une reproduction par graines.

The need for Conservation of Flora and Floral Provinces in South East Asia

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Southeast Asia is one of the richest and the most varied botanical regions in the world. It is also among the earliest domestication centres of plants and animals in the palaeotropics. The most ancient complex of domesticated plants were Himalayan and Malayan bananas, Indian taro, yams from Bengal to Indo-China, sago, screw-pine, bamboos, sugar-cane, *Derris* and *Cordyline*. The first planters were sedentary fisher folk; and among the first plants from which they selected clones were not only edible forms but sources of fish poison, dyes and fibres for matting, cordage and nets (Sauer, 1952). Shifting cultivation has been practised in the region for several centuries and is a major problem in the hilly areas of Assam, Manipur, Tripura, N.E.F.A., the Naga Hills, Orissa, etc. This is a system of impermanent land husbandry and consists of clearing a patch of forest after cutting and burning the vegetation, and abandoning it again after some decades. Fire has played havoc with the natural vegetation and is the cause of mono-dominant types of forests in the region. Fire is still the cheapest way to suppress invasion of leafy monsoon forest trees into the teak forest. Thus, in many places in Southeast Asia (Thailand, Burma) commercial teak forest is still cleaned with ground fires. During the last five millennia, advanced agriculture, forestry and husbandry have replaced the nomadic and hunting way of life. Thus, in many parts of the world forests have been degraded to shrubbery or savanna and grasslands by the activities of man and animals, especially in areas which were the major sites of ancient civilization and birthplaces of staple foods. It has been recognized that Southeast Asia was the home of mango, banana, breadfruit, peach, oranges, lemon, rice, soybean, sugarcane, yams, taro, jute, kenaf, roselle, tree cotton, pepper, and certain millets, vegetables and pulses (Maheshwari, 1961). In the present century, medical and agricultural improvements led to a serious population explosion in the region. Besides the economic and political problems facing the region, population growth has set in its wake a considerable change in the terrestrial biosphere. It is realized that this will inevitably result in the transformation of various natural ecosystems into man-made plantations, lakes, etc. and consequent extinction of the indigenous flora and fauna of the regions. In recent years, the development of powerful techniques for digging, road-making, drainage, setting up of power stations, industries, suburbs, etc. have posed a serious threat to the plant and animal life of the regions. In this connection, the Bangkok Conference on Conservation of Nature and Natural Resources in Tropical Southeast Asia held in 1965 called attention to the fact that fourteen species of mammals, twenty-four species of birds and a number of species of plants are listed as approaching extinction (IUCN, 1968).

FLORAL PROVINCES

On the basis of climatic, physiographic and Phytogeographical analysis, India and adjoining parts of Southeast Asia have been divided into various floristic regions, e.g. Eastern Himalayas (Mishmi, Abor, Bhutan, Sikkim); Assam (Garo, Khasi, Jaintia, Nowgong, Naga, Manipur, Lushai Hills, etc); Central Himalayas (Nepal); Western Himalayas (Kumaon, Garhwal, Simla, Kulu, Chamba, Lahul, Kashmir, Murree, Ladakh, etc); Ganga Plain (Rajasthan east of the Aravalli Hills to Bengal, Sunderbans, Orissa north of the Mahanadi river); Malabar (Khandesh, Konkan, Kanara, Coorg, Malabar proper, Kerala); Deccan (Malwa, Bihar, Berar, Madhya Pradesh, Chota Nagpur, Deccan proper, Mysore, Coromandel Coast, etc); Ceylon; Burma (Upper Burma, Lower Burma); Andaman and Nicobar Islands; Thailand and Indo-China; Malay Peninsula; etc. Each floristic province or domain is characterized by a special floristic assemblage which constitutes the floral element of a particular province. These provinces are also inhabited by endemic species of which two

kinds are generally recognized, viz. the palaeo-endemics or epibiotics (i.e. surviving remnants of ancient but widely distributed taxa, also called relict types), and the neo-endemics (i.e. new species and recent forms which are still in the process of extending their distribution). Thus, plants like *Ginkgo biloba*, *Melasequoia glyptostroboides* and tree ferns (e.g. *Cyathea khaysana*) may be cited as examples of the first group, while species of Himalayan *Gentiana*, *Impatiens* and *Primula* may be mentioned as examples of the second category.

It has been estimated that about 25,000 species of flowering plants are found in Asia, south of the Himalayas (Dewolf, 1964). Hooker (1909) estimated some 17,000 species of angiosperms and 600 species of ferns and fern-allies in the flora of modern India, Burma, Ceylon, Pakistan and Malaya. The largest genera comprising a hundred or more species are: *Bulbophyllum*, *Dendrobium*, *Eria*, *Habenaria*, *Carex*, *Eugenia* (*sensu lato*), *Ficus*, *Impatiens*, *Pedicularis*, *Strobilanthes* (*sensu lato*), *Primula* and *Rhododendron*. The Flora of Eastern Himalayas contains over 4000 species of flowering plants and 250 species of ferns and fern-allies, distributed in three altitudinal zones, a tropical, a temperate and an alpine zone. There are 600 species of orchids, largely in the subtropical zone up to 2000 m; the best known are *Cymbidium*, *Coelogyne*, *Paphiopedilum*, *Dendrobium*, *Vanda*, *Phaius*, *Eria*, *A'rides*, and *Anoectochilus*. In the temperate zone, from 2130-3550 m. we find *Magnolia*, oak and chestnut, with *Osmanthus*, *Trachelospermum*, *Aralia*, *Aucuba*, *Hydrangea*, *Bergenia*, and *Camellia*. At higher elevations is the region of *Rhododendron* represented by over 40 species in Sikkim, which grow here in forests of giant trees, up to 5180 m. Beyond the treeline stretches a great alpine flora with *Leontopodium*, *Primula*, *Saxifraga*, and *Pedicularis*, up to the bare granite walls and the everlasting snows of the world's mightiest mountains. Some of the rare species and novelties available here are: *Psilotum nudum*, *Dipteris wallichii*, *Cyathea gigantea* (Tree Fern), *Gnetum montanum*, *G. gnemon*, *Drosera peltata* (Sundew), *Xylanche himalaica*, *Monotropa uniflora*, *Monotropastrum macrocarpum*, *Taxillus vestitus*, *Balanophora dioica*, *Coptis teeta*, *Podophyllum hexandrum*, *Paroxygraphis sikkimensis*, *Magnolia campbellii*, *Meconopsis betonicifolia* (Blue Poppy), *Helwingia himalaica*, *Fritillaria cirrhosa*, *Vanda caerulea* (Blue Orchid of Asia), *Phaius mishmensis*, *Arisaema griffithii* and *Sapria himalayana*. The hill forests of the Assam region resemble those of the Eastern Himalayan region, except that there is no alpine zone. The Malabar region and the Western Ghats are among the richest botanical areas in India. These regions contain representatives of such families as the Dipterocarpaceae, Guttiferae, Palmae, Sterculiaceae, Myrtaceae, and Anacardiaceae. Several palms like *Bentinckia cuddapana*, *Pinanga dicksonii*, *Calamus rheedei* and species of *Strobilanthes*, *Impatiens*, *Arisaema* and of bamboos are endemic in this region. In the Shola forests some of the most conspicuous trees are: *Michelia nilagirica*, *Ternstroemia japonica*, *Gordonia obtusa* and species of *Ilex*, *Photinia*, *Viburnum*, *Eugenia*, *Glochidion*, etc. In recent times, rubber, cashewnut and *Eucalyptus* spp. have been introduced successfully in suitable areas of this region. The coconut forms a major element in the economy of the Kerala State and is found all along the lagoons and canals of the coastline. The Deccan province is largely dominated by deciduous forests and contains representatives of dry, hot countries. The Ganga Plain province is so densely inhabited by man that much of its original vegetation is already lost. It is agriculturally the richest part of India. The sal forests of Oudh are probably mere remnants of the great sub-Himalayan sal belt which at one time covered a much larger area. The flora of Andaman and Nicobar Islands is related with that of Burma and Malaya. The main types of forests in this region are mangrove and coastal forests, evergreen, semi-evergreen and deciduous forests and diluvial forests. The flora of Ceylon shows affinities with those of Indian and Malaysian types, but constitutes a separate region. There are about 2800 species of flowering plants, of which 780 species belonging to the families Orchidaceae, Rubiaceae, Euphorbiaceae, Melastomataceae, Myrtaceae and to the genera, *Strobilanthes*, *Eugenia*, *Memecylon*, *Phyllanthus*, *Impatiens*, *Hedyotis*, *Cchlandra*, etc. which are endemic in this region.

Burma is botanically the richest region in Southeast Asia, but its flora is inadequately known. This is due to its complicated systems of inaccessible and steep mountain ranges which occupy a much greater area than that of the plains. The forests are one of its greatest natural resources because they cover large areas and many of the trees and other plants have been used for timber, firewood and other products (Davis, 1960).

Indo-China is situated in the heart of the monsoon area. It has given us some interesting plants like *Musa coccinea*, *Pilea*, *Serissa*, *Tetragastigma*, *Torenia* and orchids like *A'rides*,

Coelogyne, *Cymbidium*, *Saccolabium*, etc. The main types of forests in this region are tropical evergreen forests, hill evergreen forests, coniferous forests, Dipterocarp deciduous forests, mixed deciduous forests and mangrove forests. Approximately 40% of the country is forested in Indo-China proper, whereas in Thailand it reaches 60%. However, one must take into consideration that except in inaccessible parts and in sacred areas surrounding temples and monasteries, little of the original vegetation remains. This is partly due to age-old exploitation and to the devastating habit of shifting cultivation (*ray*), burning the original vegetation to grow crops (Raymond 1959). In a recent report on 'The Flora of Thailand Project' it has been emphasized that the natural vegetation of Thailand is now rapidly disappearing. The rice fields and the lalang grasslands are quickly spreading. The wild plant and animal life is confined to the remotest parts of the country, in the national parks and certain high mountains (Larsen & Warncke, 1966).

The Malayan province contains more than 4500 species belonging to the dominant families like Orchidaceae, Leguminosae, Gramineae, Rubiaceae, Euphorbiaceae, Annonaceae and Melastomataceae. The region is particularly rich in palms, gingers, orchids (*Arachnis*, *Bulbophyllum*, *Haemaria*, *Paphiopedilum*, *Phalaenopsis*, *Spathoglottis*), bamboo (*Dendrocalamus*), aroids (*Aglaonema*, *Alocasia*, *Typhonium*) and gesneriads (e.g. *Chirita*, *Didymocarpus*), besides interesting plants like *Dischidia*, *Nepenthes*, *Platycerium*, *Tacca*, *Orchidantha*, etc.

CONSERVATION OF THE FLORA

The present status of the flora as it emerges from this study shows that the region is suffering floristic disturbances which are caused by man and his associated agents as follows:

1. By destruction of forests and herbage to clear the land for cultivation, industrialization, mechanization and urbanization;
2. By the introduction and colonization of foreign weeds and pests (e.g. *Lantana*, *Eichhornia*, *Opuntia*, *Croton*, *Mikania*) with consequent changes in the facies of the vegetation. The distinctive character of the original flora disappears in closely settled portions of the country and a 'cosmopolitan flora' comprising a few hundred or thousand species inhabits these areas (Maheshwari, 1963b). The alien flora of India and adjoining regions shows a marked number of tropical American species (Maheshwari, 1962).
3. By raising monoculture crops or creation of pure plantations (of teak, rubber, *Cinchona*, *Eucalyptus*, etc.) and simplification or reduction of species in mixed forests. This is usually achieved by felling and poisoning of the so-called weed species in the forest crop;
4. By the introduction of new fauna brought to control the flora (e.g. in the biological control of *Opuntia*);
5. By the multiplication and rehabilitation of herbivores and carnivores for the sake of protection and game reserves. The introduction of wildlife preservation in these forests upsets the normal development of the flora, as a high animal population already inhabits these areas.

It thus appears from the above analysis that except in the inaccessible parts of hilly regions like Burma, Assam and N.E.F.A., and in the reserved forests, little of the original vegetation remains. Exploitation of timber, wood and other useful products obtained from plants like *Madhuca*, *Emblica*, *Terminalia*, *Mallotus*, *Juglans*, *Diospyros*, *Shorea*, *Sterculia*, etc. depleted the forests in the earlier days. Later, in order to meet the growing needs of the population and in particular its food requirements, large areas of forests were converted into arable lands for the cultivation of food crops and cash crops like tea, coffee, rubber, jute, tobacco, cardamom, etc. There are references that during the Mahabharata, the Khandava forest situated between the Ganges and the Jumna Rivers was destroyed by fire to extend agricultural and grazing lands. In recent times, the survival of several plants has been threatened in their original habitats on account of heavy exploitation to meet the needs of pharmaceutical, horticultural and agro-industrial enterprises, e.g. *Rauvolfia serpentina* ('Sarpagandha'); *Saussurea lappa* (Kuth Roots); *Vanda caerulea* (Blue Orchid of Asia); *Podophyllum hexandrum* (Indian Podophyllum); Himalayan Aconites;

Allium strackeyi ('Jamboo'); *Angelica glauca* ('Gandrayan'); *Nelumbo nucifera* (Lotus); *Atropa acuminata* (Indian belladonna); *Asrides odoratum*; *A. maculosum*; *Nepenthes khasiana* (Pitcher Plant); *Dischidia rafflesiana*; *Copis teeta* (Mishmi teeta of commerce); *Meconopsis aculeata* (Blue Poppy of Western Himalayas); *Helminthostachys zeylanica*; *Schizaea dichotoma*; *Acorus calamus* (Sweet Flag); *Alpinia galanga*; *Ceropegia fantastica*; *Frerea indica* and many others. Thus, it would appear that the economic, utilizable and commercial aspects of the flora have so far received enough attention at the hands of governments and the public. The scientific, ethical and bio-cultural aspects of the flora seem to have received less recognition and attention. The first step towards the profitable exploitation of the forest areas in the region is their conservation. In this connection, the following means and measures will be needed to save the flora from further devastation and to utilize the floral wealth of the region.

1. The need for a regional flora of Southeast Continental Asia is evident. This is a multi-national project which requires a great deal of negotiation with various governments before a good organizational and financial basis can be realized. A permanent staff of trained and devoted collaborators and a working centre with large reference collections and an adequate library are other minimum necessities. Such collections and libraries are extremely scarce in Southeast Asia and hence a close collaboration, including also exchange and liaison of personnel with the large British and European herbaria will be necessary. Hooker's Flora of British India (which includes modern India, Burma, Ceylon, Pakistan and Malaysia) is out-dated and needs a critical modern revision along the lines of *Flora Europaea*, *Flora Malesiana*, etc. Thus, plant collecting in the region should not be stopped, but continued on a still larger scale during the coming years (Santapau, 1956; Smitinand & Raymond, 1959).
2. The conservation of natural areas and gene-centres of wild plants for scientific research, for the teaching of conservation and for the preservation of rare or valuable plants and animals and whole communities is an urgent problem. A chain of representative scientific areas and nature reserves should be set aside in all the regions, provinces and districts, and permanently protected or managed in order to preserve native plant and animal communities, habitats and rare or valuable individual species, forms and local races of such areas. These areas should serve as a record of the past, as a conservatory of plant and animal life or gene reservoirs, and as scientific control areas for the future (Burkill, 1959).
3. An intensified botanical survey of our national parks, wildlife sanctuaries, and reserved or protected forests should be carried out with a view to preparing an inventory of the flora and to preserving such rare species that have been driven to the verge of extinction. Some time ago, the author prepared a floristic list of the flowering plants and ferns inhabiting the Kanha National Park in Madhya Pradesh, India. Among the rare, interesting and economic plants found in the Park, mention may be made of *Ceratopteris thalictroides*, *Drosera burmannii*, *Youngia acaulis*, *Rotala tenuis*, *Rotula aquatica*, *Mallotus philippensis*, *Dioscorea alata*, *D. Bulbifera*, *Shorea robusta*, *Sterculia urens*, *Pterocarpus marsupium*, *Diospyros melanoxylon*, *Boswellia serrata*, etc. (Maheshwari, 1963a).
4. The preservation of living types of species and other taxa found in their original habitat and the relict areas representing past floras would be of great scientific value to botanists, phytogeographers, taxonomists and biosystematists. It would be difficult to explain the distributional patterns and disjunct distribution of plants, if these species become extinct or disappear due to biotic interferences.
5. A living collection of endangered, economic and unique plants should be laid out in one or more botanic gardens, arboreta, national parks, sanctuaries, nature reserves, etc. for conservation purposes (e.g. in the case of *Metasequoia*—the living relic of an extinct genus). These gardens and parks should also contain documented collections of authentically named living plants.

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SUMMARY

Southeast Asia is one of the richest and the most varied botanical regions in the world, containing about 25, 000 species of flowering plants. This region was the birthplace of several economic plants like mango, banana, breadfruit, peach, oranges, lemon, rice, sugar-cane, yams, taro, jute, kenaf, roselle, tree cotton, pepper, certain millets, vegetables and pulses. Among the most ancient complex of domesticated plants in this region were Himalayan and Malayan bananas, Indian taro, yams from Bengal to Indo-China, sago, screw-pine, bamboos, sugarcane, *Derris* and *Cordyline*. An age-old exploitation of natural resources coupled with shifting cultivation, fire, population, war, industrialization, mechanization and urbanization has led to the rapid disappearance of the natural vegetation. Thus, in closely settled portions of the region, a 'cosmopolitan flora' colonizes the area which was formerly occupied by a flora of greater variety.

The region is divided into several floral provinces, each characterized by its special floristic assemblage and inhabited by local, endemic species and forms. The latter may represent either the surviving remnants of ancient, widely distributed taxa (e.g. tree ferns) or new species and forms of recent origin (e.g. Himalayan *Gentiana*, *Impatiens* and *Primula*). In recent times several plants have been driven to the verge of extinction in their original habitats by indiscriminate exploitation to meet the needs of pharmaceutical, horticultural and agro-industrial enterprises, e.g. *Rauvolfia serpentina* ('Sarpagandha'); *Saussurea lappa* (Kuth Roots); *Vanda caerulea* (Blue Orchid of Asia); *Nelumbo nucifera* (Lotus); *Atropa acuminata* (Indian belladonna); *Meconopsis betonicifolia* (Blue Poppy); *Allium stracheyi* ('Jamboo'); Himalayan Aconites; *Helminthostachys zeylanica*, and many others. It would appear that the economic, utilizable and commercial aspects of the flora have received enough attention at the hands of governments and the public. It is high time that the scientific, ethical and bio-cultural aspects of the flora also received adequate recognition and attention. In conclusion, the following means and measures to save the flora from further devastation and to utilize the dwindling floral wealth of the region are listed and discussed.

1. Preparation of a regional flora of Southeast Continental Asia along the lines of *Flora Europaea*, *Flora Malesiana*, etc;
2. Conservation of natural areas and gene-centres of wild plants in different regions and provinces for scientific research, for teaching of conservation and for preservation of rare or valuable plants and plant communities;

3. Intensified botanical survey of national parks, wild life sanctuaries and reserved or protected areas;
4. Preservation of relict areas and of 'living types' of species and other taxa in original habitats;
5. Recognition of the role of botanic gardens as plant sanctuaries for endangered, economic and unique plants and for conservation of 'gene pools' of wild plants.

RÉSUMÉ

L'Asie du Sud Est possède une des flores les plus riches et les plus variées du monde; celle-ci compte en effet près de 25.000 espèces de plantes à fleurs. De nombreux végétaux d'intérêt économique sont originaires de cette partie du monde, ainsi le manioc, le bananier, l'arbre à pain, le pêcher, l'oranger, le citronnier, le riz, la canne à sucre, l'igname, le taro, le jute, le kénaf, la roselle, le cotonnier, le poivrier, certaines espèces de millet, de légumes et de légumineuses. Parmi les plantes 'domestiquées' les plus anciennement cultivées dans cette région, on trouve les bananiers de l'Himalaya et de Malaisie, le taro des Indes, l'igname depuis le Bengal jusqu'en Indochine, le sagou, le pandanus, les bambous, la canne à sucre, le *Derris* et la *Cordyline*. L'exploitation ancestrale des ressources naturelles jointe aux effets désastreux des cultures sur brûlis, du feu, de l'explosion démographique, de la guerre, de l'industrialisation, de la mécanisation et de l'urbanisation ont rapidement entraîné la disparition de la végétation naturelle. Ainsi, dans les régions très peuplées, une flore 'cosmopolite' s'est installée là où autrefois prospérait une flore infiniment plus variée.

La région du Sud Est Asiatique se divise en plusieurs provinces floristiques qui sont chacune caractérisées par un complexe floristique (élément floral) particulier et occupées par des espèces et des formes locales et endémiques. Ces dernières représentent soit des vestiges vivants de taxons anciens et distribués sur un territoire étendu (types-vestiges, par exemple les fougères arborescentes) soit des espèces et formes nouvelles d'origine récente (néo-endémiques, par exemple *Gentiana*, *Impatiens* et *Primula* de l'Himalaya). A l'époque moderne, plusieurs espèces ont été presqu'entièrement éliminées de leurs habitats d'origine à la suite d'une exploitation indiscriminée conduite pour les besoins d'entreprises pharmaceutiques, horticoles ou agricoles, par exemple *Rauvolfia serpentina* (le 'Sarpagandha'), *Saussurea lappa* (racines de Kuth), *Vanda caerulea* (Orchidée bleue d'Asie), *Nelumbo nucifera* (lotus), *Atropa acuminata* (Belladonne des Indes), *Mecconopsis betonicifolia* (Pavot bleu de l'Himalaya), *Allium stracheyi* ('Jamboo'), aconites de l'Himalaya, *Helminthostachys zeylanica* et d'autres encore. Il semblerait donc que les aspects utilitaires et l'intérêt économique de cette flore soient bien connus du gouvernement et du public, et il est grand temps maintenant de considérer les valeurs scientifiques, éthiques et bioculturelles de celle-ci. En conclusion, il faudra adopter les mesures suivantes si l'on veut empêcher que ne se poursuive le pillage de la flore et si on veut utiliser les richesses florales déclinantes de cette partie du monde.

1. Préparation d'une flore régionale de l'Asie Continentale du Sud Est sur le modèle de la *Flora Europaea*, *Flora Malesiana*, etc.
2. Conservation de régions naturelles et de 'banques naturelles de gènes' de plantes sauvages dans différentes régions et provinces à des fins de recherche scientifique, d'éducation et de protection de plantes et de communautés végétales rares ou intéressantes.
3. Etude botanique approfondie de nos parcs nationaux, de nos réserves d'animaux sauvages et des régions protégées en vue d'établir un inventaire de la flore.
4. Protection de spécimens vivants d'espèces et d'autres taxons dans leurs habitats d'origine et des zones reliquées représentant des flores anciennes et disparues.
5. Reconnaissance du rôle des jardins botaniques en tant que réserves de plantes menacées, rares ou d'intérêt économique et comme 'banques de gènes' des espèces sauvages.

Protection of Rare and Endangered Plants in the Indian Flora

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INTRODUCTION

During the last decade, in particular, sufficient emphasis has been laid by eminent naturalists, biologists and foresters on the urgency to preserve for posterity our vanishing wild animal life and, as a result, numerous wild life sanctuaries and national parks are now to be seen in representative areas in India.

Surprisingly not much has been said or done to protect our equally valuable heritage, the wild plant life of India, which is unique in the context of world flora for its richness. It ranks second to Brazil in the world as far as number of species is concerned. It is true millions of saplings are planted during our annual tree festival but the choice of species is limited to valuable species of forestry importance and ornamentals. The richness of the Indian flora is due to the vastness of the country and its range of climates and topography. There is every type of climate and habitat, from deserts (hot deserts of Rajasthan and cold deserts of Ladakh at 3650m-5180m) and the dry scrub of the Punjab to tropical evergreen rainforests of Assam, W. Ghats, Andamans and Nicobars and the coniferous and broadleaved forests of the Himalayas, with areas of alpine flora in the upper temperate regions and above the timber line.

The Indian flora has been enriched by the immigration of plants from widely different bordering regions, notably the Chinese and Malayan to the east and south, the European and African to north-west and west, and the Tibetan and Siberian to the north (Hooker and Thomson 1855, Chatterjee 1939).

The deliberations of this important assembly organised by the IUCN are sure to leave an impact in this country, will focus attention on the urgent need to prevent species extinction in the Indian flora and encourage a realization that some plants are becoming very rare. Special efforts must be made by Indian botanists to preserve urgently the rich genetic resources that have evolved over millions of years, which if lost can never be recovered.

In view of the urgency of the problem, the FAO of the United Nations convened a Technical Conference in Rome in 1967, on Exploration, Utilization and Conservation of Plant Gene Resources. The recommendations included:

- (1) A programme of plant exploration and collection.
- (2) Surveys of threatened or essential plant materials.
- (3) Existing institutes to serve as centres for training and for the programme of plant exploration and collection.

As a first step in the achievement these objectives, it is essential to have an up-to-date inventory of the Indian flora by extensive and intensive surveys. Happily this is now being done in this country due to the revival of the Botanical Survey of India and the formation of the National Botanic Gardens, at Lucknow, and there is a move to strengthen the Taxonomic Forest Botany Department at the Forest Research Institute, Dehra Dun, whose main function is the study of the forest flora of India. The surveys and monographic studies carried out by these three organizations will no doubt reveal data on species that are rare or are endangered. Measures regarding their protection are discussed further below.

AFFINITIES

According to Hooker & Thomson (1855) 'India contains representatives of almost every natural family on the globe, a very few small S.American, Australian and S.African orders being the chief exceptions; and it contains a more general and complete illustration of the

genera of other parts of the world than any other country whatsoever of equal or even considerably larger extent'.

The major elements of the Indian flora extend to surrounding countries and this point is considered one of the remarkable botanical features of the Indian region considering its great size. There are only a limited number of families that are peculiar to it.

The Australian type of flora in India is represented by genera such as *Casuarina*, *Scaevola*, *Pittosporum* etc.

The Malayan Archipelago and the Sino-Japanese type of flora in India has been worked on by the author (Sahni 1969).

Malayan: *Altingia excelsa*, *Daubanga grandiflora*, *Exbucklandia populnea*, *Mesua ferrea* etc. *Gaultheria nummularoides*, a prostrate herb with striking dark-blue berries, occurs from N. W. Himalayas to the Javanese mountains 4800 km away.

Sino-Japanese: *Bischofia javanica*, *Corus macrophylla*, *Dillenia indica*, *Leycesteria formosa*, *Loropetalum chinense*, *Magnolia campbellii*, *Quercus lamellosa* etc. Sahni (1962) recently identified *Picea brachytyla*, a Chinese spruce, from the NEFA.

Siberian: Represented in the upper temperate and alpine regions of the Himalayas by species of *Potentilla*, *Pedicularis* and *Lonicera*. *Corydalis sibirica*, according to Hooker & Thomson, occurs as far away as Khasia.

European: These species and genera abound in the Himalayas and are too well known to merit mention. Hooker (loc. cit.) has listed 222 British plants in the Indian flora.

Egyptian, S.Arabian and Persian: *Peganum harmala*, *Salvadora persica*, *Acacia nilotica*, *Populus euphratica* etc.

Tropical African: *Capparis*, *Grewia* and columnar *Euphorbia* etc.

Delphinium dasycaulon of Ethiopia also occurs in the Deccan. The absence of pines and oak is a point of strong resemblance between the flora of peninsular India and tropical Africa.

American: *Podophyllum*, *Meconopsis*, *Rhodedendron*, *Magnolia*, etc. *Mitreola paniculata* occurs in India and Brazil.

Good (1947) has given estimates of the number of species in various floras. It is significant to note that India ranks second in the world, the first position being given to the Brazilian flora:—

Brazil	c. 40,000 species
India	c. 21,000
China	c. 20,000
Malaya as a whole including the peninsula	c. 20,000
Tropical Africa as a whole	c. 13,000
Central America	c. 12,000
Australia as a whole	c. 12,000
Borneo	c. 11,000
Philippines	c. 10,000
Malayan Peninsula	c. 7,000
New Guinea	6,862
Japan	c. 5,800
Java	c. 5,000
Taiwan	c. 3,700
Ceylon	c. 3,100
Korea	2,165
Egypt	c. 1,500
Tibetan Plateau	741

RARE OR ENDANGERED PLANTS

In the course of this paper, plants that are becoming rare and need to be protected are highlighted. Examples cited are very largely from personal experience as a result of the author's extensive botanical travels in the Himalayas from Kashmir to NEFA (except Nepal & Bhutan) and from north to south from close to Dras, across the famous Zoji La

in Kashmir, to the tip of Ceylon; and from east to west from the Gt. Nicobar Island close to Sumatra in the Bay of Bengal to Karachi on the Arabian Sea. The area thus covered includes the major part of the botanical regions of India as described by Hooker (1906). Some examples are also included from other South Asian countries.

In the course of his travels the author has been able to collect and observe the flora in the following areas: Kasmir (Zoji La, Amarnath, Apharwat, Liddar valley, Kolohoi glacier etc.); Kulu Valley, Tehri Garhwal (Tons, Jamuna, Uttarkashi, Chakrata and Tehri Divisions); Kumaon (Panchulhi) (Sahni 1955); N. Bengal (Darjeeling, Kalimpong); Upper Assam (Lakhimpur); Sikkim (Donkia La 5791m, Llonakh, Nathu La, Jongri) (Sahni 1960); NEFA (Kameng and Subansiri Districts) (Sahni 1969); Andamans and Nicobars, particularly the Gt. Nicobar Island (Sahni 1953, 1958); Maharashtra, Goa, Nilgiris, Kerala and Ceylon.

Plants which are spectacular, rare and need protection are enumerated as follows:

Himalayan Region

Balanophora involucrata, a glabrous, fleshy, fungus-like herb parasitic on the roots of trees, first collected by T. Thomson in 1847 between Narkanda and Kotgarh. This was collected after 96 years in 1943 by the author and Professor P. N. Mehra from the Kulu valley and incorporated in the herbarium of the Government College, Lahore. Its rarity can be judged by the fact that no specimen is incorporated in the F. R. I. Herbarium which has one of the richest collections in Asia. The genus however is not so rare in the E. Himalayas. *B. dioca* was collected by the author from W. Sikkim in 1960 (Sahni 632 in Herb. DD).

Rhododendron edgeworthii a very ornamental epiphyte with creamish white flowers, collected by the author in Kameng Dist., NEFA (Sahni 5115) has only about thrice been collected since Lister's found it in 1875 in Dafla hills; in recent years it has been collected by Rolla Rao and Srinivasan of the Botanical Survey of India from Kameng District.

Cypripedium cordigerum a highly ornamental terrestrial orchid reported by Coventry (1923) as abundant at Gulmarg from 2438-3048 m. Its distribution is from Kashmir to Kumaon. This is no longer abundant in this area and has only once been sighted by the author in Gulmarg (in the course of about five visits) and collected in Tehri Garhwal in 1956 at 2745m (Sahni 24945).

Populus gamblei: a large poplar collected by the author for the first time in NEFA (Sahni 1969; Sahni 5024, previously collected by Haines 997 from Kalimpong and Haines 998 from Bhutan).

Picea brachytyla a handsome Chinese spruce not previously recorded from India was discovered in Kameng, NEFA (Sahni 1962). It was collected at an altitude of 3, 500 m. In China it occurs over an extensive area in Western Hupeh, W. Szechwan and W. Yunnan.

Abies delavayi a Chinese fir reported from NEFA.

Sapria himalayana a near ally of the well known *Rafflesia arnoldii* was collected by Griffith, in the Mishmi Hills in 1836. This discovery added the family Cyttinaceae to the Indian Flora. Bor (1953) over a century later found this plant in the Balipara Frontier Tract in NEFA and reported 'The fact that it flowers at a time when the forests are unlikely to be visited by a botanist no doubt accounts for its supposed rarity'. This remarkable parasitic species is found on the roots of a giant vine *Cissus elongata*. The flower buds, about the size of a grapefruit are rosy-pink in colour and are found on the surface of the soil towards the end of the rains. The diameter of the opened flower is c. 35cm. The colour of the reflexed lobes is a deep crimson and their upper surface is covered with yellowish papillae.

Phyllostachys bambusoides an economically important bamboo of China and Japan collected by the author from Ziro, NEFA (Sahni 1969, 5028 in Herb. DD).

Syndiclis paradoxa, a small Lauraceous tree collected only once in Bhutan (Bor 1953).

Meconopsis betonicifolia, a. blue poppy of the E. Himalayas, S. E. Tibet, Upper Burma and Yunnan. Introduced into cultivation in 1924 and now widely grown in Europe. It has been collected by Hari Dang, Secy., Wild Life Preservation Society, Dehra Dun, from Kameng, NEFA in recent years.

Spectacular uncommon Himalayan plants

Rhododendron dalhousiae, epiphyte on branches of *Magnolia campbellii* in the E. Himalayas; *R. thomsoni* of Sikkim a favourite of Joseph Hooker and depicted in a tablet to his memory; *R. argenteum*, tree 12 m high with magnificent long leaves, silvery beneath; and the tiny *R. nivale* of Sikkim at 5180 m, the most alpine of woody plants and barely 5 cm tall.

Ferns: *Cyathea gigantea*, the giant tree fern of the E. Himalayas, and *Osmunda regalis*. Magnoliaceae: *Magnolia griffithii* of Upper Assam and *Illicium griffithii* of the E. Himalayas. Conifers: *Larix griffithiana*, the only deciduous conifer in India, occurring in the Himalayas from E. Nepal to NEFA; *Pinus gerardiana* which has a very restricted distribution. Poplars: *Populus euphratica*, the Sindh Poplar, rare in the plains of the Punjab and occurring again in Ladakh up to 3962 m, where it is fairly common.

Orchids: *Arundina graminifolia*, an attractive terrestrial orchid 2 m tall with pinkish flowers and foliage similar to that of bamboos; *Pleione humilis*, a highly attractive terrestrial orchid in NEFA. Shrubs and undershrubs: *Agapetes buxifolia*, with reddish flowers, *Loropetalum chinense*, with curious white flowers, both from NEFA, and *Lavatera kashmeriana*, a hollyhock-like undershrub, which does not occur outside Kashmir. Alpines: *Primula sikkimensis*, *P. minutissima*, *P. involucrata*, *Corydalis cashmeriana*, *Megacarpaea polyandra* and *Campanula ramulosa*; *Rheum nobile* the gigantic rhubarb of Sikkim up to 1m tall (its dried leaves are used as a substitute for tobacco and therefore its existence is threatened); *Paraguilegia grandiflora*, a. most handsome alpine with sky blue flowers growing at 4570m.

Thylacospermum repufragrum on Donkia La, Sikkim, at 5790 m, which forms large, hard hemispheric cushions 30 m across, taking centuries to grow. *Arenaria musciformis*, also forming cushion like growths, in the W. and E. Himalayas: collected at 5210 m at Cholomo N. Sikkim (Sahni 82). *Ermania himalayensis*, which sets a world altitude record for flowering plants: it was collected by the famous mountaineer Padmashri Gurdial Singh on Kamet, W. Himalayas at 6,400 m (21,000 ft) and is incorporated in the F. R. I. Herbarium: it has also been collected from Mt. Everest at 5791 m. *Saussurea gossypiphora*, a striking woolly herb collected in Kashmir, Harkidun (Tehri Garhwal) and further east in Sikkim at 4876 m (Sahni 24070, 80). *S. obvollata*, the famous 'Brahma Kamal' of the Himalayas, growing at 4,000 m.

In the temperate E. Himalayas in NEFA is the curious *Coptis teeta* a stemless herb supposed to cure all sorts of diseases from sore eyes and toothache to a sluggish brain or liver!

Indus Plain Region (of Hooker 1906, modified)

In this paper only the Indian section is covered, which includes the E. Punjab, the old Rajputana west of the Aravalli range and Jamuna River, Kutch and Northern Gujarat.

Rosa lyellii (Mt. Abu 1722 m), *Tecomella undulata*, *Commiphora wightii* (*Balsamodendron mukul*).

Gangetic Plain of Hooker (1906)

Tecomella undulata, *Commiphora wightii* (rare); Bengal proper: *Aldrovanda vesiculosa* (Droseraceae), with leaves like those of Venus's Fly-trap, a S. European plant, perhaps hitherto found nowhere in India except in salt-pans near Calcutta. It is a floating fly-trap.

W. Peninsula (Deccan and Malabar Regions)

Podocarpus wallichianus, the only conifer in peninsular India, *Bentinckia coddapanna*, a reed-like palm endemic in Kerala on precipitous cliffs.

Entada pursaetha, a liana with gigantic pods up to 1.5 m. recently collected by the author from Goa. *E. phascoloides* does not occur in India (Santapau 1959). *Gnetum ula*, a. gymnospermous liana in rain forests.

Phlebophyllum kunthianum (*Strobilanthes kunthianus*), not rare but endangered by the fact that it blooms only once in 12 years. 1969 is the year of blooming in Kodaikanal hills, the

first flush in August.¹ It last flowered in 1957, 1958. After simultaneous flowering, it seeds profusely and then dies; seeds get embedded in the soil and take 10 years to resurface and germinate. Its Nilgiri habitat has a maximum altitude of 2669 m, rising precipitously from the west to extensive grassy downs seamed with densely wooded gorges. The other most outstanding plants of this area which need protection are *Rhododendron nilagiricum*, *Lilium neilgherrense* and the tall *Lobelia leschenaultiana*. Peat bogs are of the rarest occurrence in India (Hooker 1906) and ought to be preserved as nature reserves. They occur in depressions in the Nilgiris at c. 2130 m. The most interesting feature of the Nilgiri flora is its affinity with the flora of Khasi, Naga Hills and Manipur. *Ternstroemia japonica*, *Gaultheria fragrantissima*, etc. are common to both.

Deccan Region (Peninsula south of the Ganga valley and east of Malabar)

Chloroxylon swietenia (Satinwood) of fairly common occurrence; *Pterocarpus santalinus* (Red Sanders) which yields wavy-grained ornamental timber; *Santalum album* (threatened by spike disease); and *Cycas beddomei*, endemic in Cuddapah district.

Andamans

Diospyros marmorata (Andamans marble wood), a highly ornamental timber, and *D. Kurzii*. *Podocarpus nerifolius* is the only conifer of the Andamans, a very high class timber, which needs to be protected and extensively cultivated.

Nicobars

Podocarpus wallichianus (recorded from the Nicobars for the first time, Sahni 1953, 22992 Gt Nicobar); *Symplocos chengapae* Raiz et Sahni, an ornamental tree with fragrant flowers and a new species, discovered by the author from Gt. Nicobar Island (Sahni 1959); *Bentinckia nicobarica*, an endemic palm the only congener of which occurs in Kerala. The flora is characterized by the absence of Dipterocarpaceae.

Ceylon: The flora is characterized by a high degree of endemism. *Helminthostachys zeylanica*, *Ochlandra stridula*, *Diospyros ebenum*, *D. quaesita*, *Hortonia angustifolia* and *Schmacheria castaneifolia* merit mention.

Burma: *Osteomeles anthyllidifolia*, a rosaceous shrub previously known from China and Pacific islands: its congeners are in the Andes; *Rosa gigantea* and *Lonicera hildebrandiana*, both characterized by flowers of extraordinary size; *Amherstia nobilis*, is one of the most beautiful trees in the world, which needs to be preserved in its original habitat.

Malayan Peninsula Region: The very singular *Impatiens mirabilis*, with a stem as thick as a man's leg and 1. 2m high; *Brugmansia lowi* and *Rafflesia* spp., stemless and leafless root-parasites of the Cytinaceae; *Primula imperialis*, *Dendrobium superbum* and *Vanda tricolor*, which have been removed on a large scale from their natural habitat by horticultural collectors.

Indonesia: *Eucalyptus deglupla*, a rain forest species of Celebes and Timor Islands, and one of the two or three eucalypts which are not native to Australia: the bark is ornamental, having a range of shades of green, grey and salmon pink, hence the name 'Rainbow Eucalyptus'; protection in its original habitat is needed.

Rhododendron vanderbiltianum, with pale yellow corolla, grows in association with pines and oaks at 2,100-3, 000 m and *R. taxoides*, with red corolla, grows on serpentine rocks at 3, 250 m (Sleumer, 1966). *Dryobalanops*, a camphor yielding tree, is a relic in C. Sumatra: in the late tertiary it thrived in the adjoining S. Sumatra where silicified wood of unquestioned identity testifies to its former frequent occurrence, where it is now extinct (Steenis, 1948). *Rafflesia arnoldii* of Sumatra, the most outstanding plant in the plant kingdom, has flowers c. 90 cm across.

Nature Reserves

During the last 50 years, several plants have been driven to the verge of extinction in their original habitat on account of large scale exploitation to meet horticultural and

¹ It was found to be fairly commonly flowering in the area in December—Ed.

pharmaceutical demands. Well known examples are the Blue orchid *Vanda caerulea* of Khasi Hills, 'Kuth' *Saussurea lappa* of Kashmir, which was exported to China, and *Rauvolfia serpentina*. According to Purseglove (1959) 'Inevitably with the spread of the rapidly increasing population, plants and animals, which were known to have occurred in Singapore, have disappeared completely'. As an initial step in the selection of nature reserves, type areas of fauna and flora, with remnants that are left, should be gazetted. Hari Dang (1969), Secretary, Wild Life Preservation Society of India, Dehra Dun, has supplied the names of the following main wild life sanctuaries in the Himalayas that have been gazetted, though in a very few cases this is awaiting official implementation: Kashmir (Dachigam 1828-3962 m); Himachal Pradesh (Diankund 1633-3352 m; Kufri 1329-3048 m); Uttar Pradesh (Harkidun, Tehri Garhwal 2437-6400 m, Nanda Devi Sanctuary 3352-6400 m); Nepal, (Rapti Valley, Mahendra National Park 609-1828 m, Thyangbochi Buddhist Sanctuary in the vicinity of Mt. Everest 3650-6096 m); Bhutan (Laya-Lingh-shi N. W. Bhutan); NEFA (Sela-Rupa, Tirap National Park).

The ban on shooting of wild life in the sanctuaries should be extended to removal of uncommon plant communities before they are lost for all time. Exceptions should, of course, be made for sample collections by botanists from recognized herbaria of international standing who are collecting authentic data on distribution for monographic or floristic studies. It is desirable to establish two botanical gardens in the Himalayas one at Kufri, for the W. Himalayas, and another further east in E. Kumaon, as, barring the botanic garden at Darjeeling in the E. Himalayas, there is no other botanical garden of repute in the Himalayas. One of the functions of these gardens should be to protect and increase Himalayan plants facing extinction. It is also desirable to have a botanical garden at Mahabelshwar to represent the vegetation of the W. Ghats.

In conclusion, it is emphasized that vigorous efforts are required to protect remnant populations of the rare and endangered species of plants enumerated in the foregoing account. Efforts should be made to maintain representative collections of spectacular species of plants that are at present in undisturbed habitats. Encouragement should be given to the establishment of national parks and sanctuaries where, in addition to animals, threatened plants can multiply. Indigenous species of wild animals and plants should be preserved in maximum variety and reasonable abundance. Concentrated efforts should be made to establish natural areas for the preservation of species, their habitats and representative samples of ecosystems.

As Commelin said in 1701 (de Wit, 1949) 'It is certain, however, that this Science, like all Sciences, flourishes sometimes more and sometimes less all in accord with the inclination of Rulers and the Favour of Government'. The present trend, the world over, is happily in favour of nature conservation and preservation of nature's precious heritage of flora and fauna therefore has better prospects.

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SUMMARY

The flora of India is unique in the context of world flora. It ranks second in the world to Brazil in total number of species and contains representatives of almost every family on the globe. The richness of the Indian flora is due to the vastness of territory embracing a range of climates and as Hooker and Thomson said in 1855 '... it contains a more general and complete illustration of the genera of other parts of the world than any other country whatsoever of equal or even considerably larger extent'. Affinities of the flora are discussed. Rare and endangered plants observed from personal experience in the Himalayas from Kashmir to NEFA are enumerated. Examples are cited from other areas visited such as Andamans, Nicobars, Kerala, Goa, Ceylon etc. The most outstanding rare or endangered plants in India are considered to be *Balanophora involucrata*, a fleshy fungus-like parasite, *Sapria himalayana* a remarkable parasitic plant with deep crimson flowers 35 cm across, *Rhododendron edgeworthii*, an ornamental epiphyte in the E. Himalayas, *Symplocos chengapae* (a handsome ornamental tree discovered by the author from the Nicobars) and *Entada pursaetha* of Malabar, Assam etc. It is desirable to establish three botanical gardens one in the W. Himalayas at Kufri (H.P.), the second in E.Kumaon and a third at Mahabaleshwar. In conclusion it is emphasized that vigorous efforts are required to protect remnant populations, maintain representative collections of spectacular species that are at present in undisturbed habitats and encourage the establishment of sanctuaries.

RÉSUMÉ

La flore de l'Inde est unique au monde. Elle vient après le Brésil pour le nombre total d'espèces et contient des représentants de presque toutes les familles végétales du globe. La richesse de la flore indienne vient en partie de l'étendue du pays qui comporte une gamme très variée de climats et, comme l'ont dit Hooker et Thomson en 1855 '... elle constitue une illustration des genres des différentes parties du monde de façon plus générale et plus complète qu'aucun autre pays d'étendue égale ou même largement supérieure'. L'auteur cite un certain nombre de plantes étrangères qui se retrouvent à l'état spontané en Inde. Il enumère ensuite des plantes rares ou menacées qu'il a observées dans la chaîne de l'Himalaya, du Cachemire à la Circonscription Frontalière du Nord Est ainsi que dans d'autres régions telles que les îles Andaman, les Nicobars, le Kerala, Goa, Ceylon, etc. Les plantes rares ou menacées les plus remarquables de l'Inde sont *Balanophora involucrata*, un parasite charnu à l'aspect de champignon, *Sapria himalayana*, une plante parasite étonnante dont les fleurs sont d'un pourpre intense et mesurent 35 cm de diamètre, *Rhododendron edgeworthii*, une plante épiphyte ornementale de l'Himalaya oriental, *Symplocos chengapae* (un bel arbre ornemental découvert par

l'auteur dans les fles Nicobar) et *Entada pursaetha* de Malabar, de l'Assam, etc. Il serait très souhaitable de créer trois jardins botaniques, le premier dans le massif de l'Himalaya occidental à Kufri (H.P.), le second dans le Kumaon oriental et le troisième à Mahabaleshwar. En conclusion, l'auteur souligne la nécessité d'une action énergique pour protéger les populations restantes, entretenir des collections représentatives d'espèces remarquables qui vivent actuellement dans des habitats intacts et, enfin, encourager la création de réserves.

Endangered Plants and Conservation in the Islands of the Indian Ocean

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The Indian Ocean is a region of the greatest biological interest. Scattered across its broad surface are a number of high islands that have been isolated for such long periods of time that they have developed unique floras and faunas. In general, the low-lying groups of coral islands such as the Maldives and Laccadives are of little botanical interest, as they are clothed almost entirely by widespread tropical species that are dispersed by ocean currents. They provide no problem for plant conservationists and need not be considered further. The two largest islands Madagascar and Ceylon are both very rich in endemic species and genera. They pose special problems of their own and will be discussed here only in relation to the other islands. There remain in the eastern sector the Andamans, Nicobars and Christmas Island and in the western sector, the three Mascarene islands—Mauritius, Reunion and Rodriguez, the Seychelles with Aldabra and the Socotra group.

The Andaman and Nicobar islands consist mainly of Tertiary deposits, with some igneous rocks and lie parallel with the coast of Burma and Malaya at a distance of about 350 miles. The islands may have been joined to the mainland in the mid-Tertiary and their floras bear a close resemblance to that of the neighbouring mainland and, to a lesser degree, to India. There are no endemic genera, but there are 87 endemic species recorded for the Andamans, a few of which are shared with the Nicobars. On the Nicobars themselves, a further 36 endemics occur. Although a few species collected in earlier times were not seen by Parkinson in 1923, there is no reason to think that the flora has been seriously depleted. No recent collections have been made and further field work is needed to enlarge our knowledge of the flora and to enable a decision to be made on the most suitable sites for nature reserves.

The Christmas Island of the Indian Ocean is about 43 square miles in area and lies about 190 miles to the south-west of Java. The island was visited in 1904 by H. N. Ridley who published a list of the flowering plants he found there. This included 28 endemic species among which were six orchids. There are no endemic genera on the island and general relationships of the flora are with Malaysia. Although phosphate rock has been mined on the island since 1897, a considerable area of natural forest still remains. For the time being the majority of the endemic species may be safe but the possibility of establishing a nature reserve on the island should be explored.

Turning now to the Western Indian Ocean, the three islands of the Mascarene group are all mountainous and of igneous origin. They have long been famous as the home of the extinct birds, the Dodo and the Solitaire. Their floras have been far less publicised, but they include many plants of great interest in the study of evolution and phytogeography. The floras of the three islands are related to one another and also have many links with Madagascar.

Mauritius lies 500 miles S. E. of Madagascar and has an area of 720 square miles. It was originally clothed completely by forests, but nothing remains of the lowland forests which have been cleared for cultivation and only remnants survive of the upland forests. Fortunately Vaughan and Wiehe made an ecological survey of the remaining vegetation in 1937 and on the basis of their recommendations 10 nature reserves were created in 1944. Most of the land belonged to the Crown Forest Estate and the reserves are managed by the Forests Department. None of the reserves are in their original condition and the invasion by aggressive alien weed species is a cause for grave concern. Among these a privet (*Ligustrum walkeri*), a guava (*Psidium cattleyanum*) and *Rubus* and *Ardisia* species are the most abundant, producing dense stands which prevent the regeneration of indigenous species. The Forestry Department has been attempting to weed out alien species but is severely handicapped by lack of funds.

The only flora of Mauritius on which an assessment of the present position can be based is that of Baker, published in 1877. This was never complete, as by that date the lowland forest had been almost entirely destroyed and Baker did not study the collections of Commerson made in 1768-1772. Baker recorded 182 endemic angiosperms among which were 10 species of *Eugenia* (Myrtaceae), and 11 of *Pandanus* (Pandanaceae). Families well represented by endemics are Rubiaceae (15), Compositae (9), Euphorbiaceae (12) and Orchidaceae (20). The orchids are probably under-estimated as Baker would have had a few from the lowlands, many already being extinct. How many more endemics have died out since Baker's day it is impossible to estimate without a thorough revision of the flora.

Among the plants that rank high in scientific importance in Mauritius are four monotypic endemic genera: *Astiria*: (Stereuliaceae), *Hornea* (Sapindaceae), *Tetralaxis* (Lythraceae) and *Cylindrocline* (Compositae). *Cylindrocline commersonii* Cass. is a shrub now restricted to a small area in the Pouce Mountain Reserve where it is hoped that it will survive. In another small reserve, the Petrin Reserve, is an example of an upland *Pandanus* marsh containing 5 of the endemic species of *Pandanus*. Macabe Reserve, comprising 1200 acres, contains a relatively undisturbed sample of the upland rainforest in which 30%-35% of the indigenous local flora is endemic. The figure increases to about 80% for Mascarene endemics as a whole, an important point in view of the fact that many species formerly widespread in the group are now everywhere on the decline. Very few Mascarene species have yet received other than superficial study. Some may prove to be of the highest scientific importance in providing links in a chain of evidence. The genus *Foetidia* (Lecythidaceae) is a case in point. The Mascarene species *F. mauritiana* is the most advanced in its leaf venation pattern, while the other three species of the genus in Madagascar show different stages in the evolution of angiosperm leaves from the fossil *Glossopteris* type to modern forms.

Although the nature reserves of Mauritius were selected after a full ecological survey, this unfortunately, is no guarantee that they will continue to perform indefinitely their purpose of conserving samples of the indigenous flora. The reserves were not in their primaevial condition when selected and with the expanding human population of the island, political, social and economic factors are joining with alien plants and animals to cause degradation of their ecosystems. It does not seem likely that they will retain their present condition for long unless international interest and some financial assistance is forthcoming to maintain them.

Rodriguez situated 360 miles east of Mauritius and with an area of 42 square miles is the smallest and most isolated of the Mascarenes. When the first abortive attempt at colonization was made in 1691, Francois Leguat, the leader of the expedition, described the island as 'an earthly paradise', 'richly spread with great tall trees'. By the time of I.B. Balfour's visit with the Royal Society Transit of Venus expedition in 1875, no natural plant communities remained. Balfour recorded enormous numbers of goats, several thousand head of cattle and the land eroded with deep gullies and covered with alien weeds. Only individual plants of indigenous species remained and scattered groups in inaccessible places. He found 175 indigenous species of which 35 were endemic. Some of these have since become extinct. The endemics included 3 monotypic genera *Mathurina* (Turneraceae), *Scyphochlamys* (Rubiaceae) and *Tanulepis* (Asclepiadaceae). In addition to the dominant relationships of the flora with the other Mascarene islands and Madagascar, a few genera such as *Abrotanella*, *Myoporum* and *Nesogenes* suggest a link with the subantarctic islands and Australasia.

No natural plant communities have survived on Rodriguez, but the question remains of the best means of preserving the remnants of the indigenous flora. The species might be kept alive individually in botanic gardens and this should in any event be done. A more satisfactory alternative would be to recreate in a reserve made for the purpose in Rodriguez a viable plant community in which the plants could survive. It will not be possible to reproduce exactly any of the former ecosystems as too many species, both plant and animal, have been lost already.

Reunion with an area of 1000 square miles is the largest of the Mascarenes and lies about 95 miles S.W. of Mauritius. The vegetation is least altered of the three islands. Even so, most of the forest below 2000 ft. has been destroyed mainly for cultivation of sugar cane. The surviving flora is extremely rich and varied. Apart from orchids, it contains over 200 species that are endemic to Reunion or are Mascarene endemics.

According to Rivals there were 160 species of orchids including about 90 endemics, but about three-quarters of these are already extinct. Most of them would have been in the former lowland forest and they give a hint of the unrecorded riches that must have been lost in Mauritius and Rodriguez. Further evidence of the diversity of the flora is the presence of four endemic genera and four other genera shared with Mauritius. The genus *Dombeya* (Sterculiaceae) confined to Madagascar and the Mascarenes, except for one African species, has 15 endemic species in Reunion. At present there are no reserves or national parks on the island, though the forest of *Acacia heterophylla*, a Mascarene endemic, is controlled by the forestry service. Rivals states that the flora above 6000 ft. is still untouched. In the context of the history of the other Mascarene islands it is obviously desirable that reserves should be selected without further delay. I would strongly recommend this.

The Seychelles group lies about 1000 miles to the north of Madagascar and consists of five mountainous islands of igneous origin and a large number of small islands. The larger islands were originally forested, but have been much altered by human occupation. The low lying parts are under cultivation for coconuts, cinnamon and vanilla and only remnants of the forests remain in the higher more rugged parts. An enumeration of the flowering plants was published by Summerhayes in 1931, based upon earlier collections. This indicated a surviving indigenous flora of 233 species of which 90 were endemic. Summerhayes recognised 11 endemic genera, but two of these have since been merged with more widespread genera. The remarkable monotypic genus *Medusagyne* represents an endemic family. Unfortunately, *Medusagyne* has not been seen for many years and is presumed extinct. The relationships of the flora, according to Summerhayes, are almost equally with India and the East and with Madagascar and the Mascarenes. There is a much smaller African element. The endemic *Vateriopsis seychellarum* Heim is of particular interest as the only member of the Dipterocarpaceae in the Western Indian Ocean. It is now reduced to 3 trees and is a critically endangered species. As a result of discussion with C.Jeffrey, Botanist on the Seychelles Botanical Survey 1961-62, I have been able to assess the present status of the endemics. Three are probably extinct, 10 are endangered, 67 are rare and only 3 are common enough not to be the cause of immediate concern.

There are no reserves on the Seychelles at present, but Jeffrey in his Report on the Botany of the Seychelles made recommendations for the conservation of selected areas. The question of national parks in the Seychelles is at present under discussion, though it appears that finance may be a limiting factor.

Aldabra is a raised coral atoll situated about 260 miles N.W. of Madagascar with a land surface of about 60 square miles. The proposal to build an airport on Aldabra aroused considerable opposition and prompted the Royal Society Expedition of 1967. Thanks to the co-operation of Mr S. A. Renvoize, botanist to the expedition, I am able to give an up-to-date assessment of the flora. A total of 31 endemic angiosperms were found, of which 9 were recorded for the first time and await description. One species, *Cassipourea thomassetii* Alston (Rhizophoraceae), previously recorded, was not seen, but it is possible that it still survives in the dissected terrain of the atoll. Six species were seen either once or a few times and may be on the verge of extinction from natural causes. The remaining 24 species are probably safe so long as no major change in the environment is made by human interference.

Socotra and the adjacent island of Abd al Kuri lie about 140 miles off the Horn of Africa (Cape Guardafui). Unlike other islands discussed here Socotra is a continental rather than an oceanic island. Recent geophysical evidence indicates that it has been isolated since the Miocene, about 15 million years. This has allowed time for considerable divergence of the flora from those of Africa and Arabia with which it is most closely allied. The island has been known since classical times and man and his goats have wreaked considerable damage on the flora, especially during the last century. The first comprehensive collection of the flora was made in 1880 by Balfour who recorded 565 indigenous species of which 212 are endemic (37%). Further collections were made by Smith and Lavranos on the Middle East Command Expedition of 1967 and I am indebted to Mr. A. R. Smith for up-to-date information on the status of the flora. Of the endemic species 32 recorded by Balfour were not seen despite search in the localities he indicated. These must be presumed extinct. Of the remainder, 61 are now so rare and localised that their continued existence is endangered and a further 33 are scarce enough to cause concern.

The residual endemics, numbering 86, are common enough to be safe for the time being. The chief culprit in this deplorable situation is the goat, which destroys everything except a few species unpalatable to it. Among the endangered species is *Dirachma socotrana* Schweinf., sole representative of the Dirachmaceae, now reduced to 30 mature trees on a single mountain pass. No regeneration was seen and of a number of plump seeds brought back to Kew, only one germinated. It is hoped to propagate this plant and distribute the species to other botanic gardens.

There are no nature reserves on Socotra at present and some steps to protect the flora are urgently needed. As a result of the 1967 expedition the areas where concentrations of rare species occur are known. There are three areas in the mountains which together contain nearly all of the surviving endemics. The possibility of converting these into national parks should be considered. Since 1967 Socotra has been administered by the Peoples' Republic of South Yemen.

The fact that information on many of the islands is incomplete makes a general summary of the situation in Indian Ocean region as a whole difficult. The data are most complete for Socotra, Seychelles and Aldabra. Grouping these, gives a total of 326 endemic species of which 36% or 11% have probably become extinct during the last century; 77 or 24% are more or less critically endangered; 124 or 38%, are sufficiently depleted to cause concern and only the balance of 89 or 27% can be regarded as reasonably safe at present. The Mascarenes may justifiably be considered as a group, but the data are less complete and less reliable. Most of the extinctions occurred earlier than the last century but the number can only be guessed. Having regard to the composition of Mascarene floras as a whole, earlier losses on Rodriguez may well have been 70 species and they must also have been considerable on Mauritius. Botanic gardens could play a valuable part in ensuring the survival of the endangered species. Pamplemousse Botanic Garden in Mauritius has a fine collection of Mascarene palms as well as a selection of other endemics. This kind of work needs to be extended not only to spread the burden, but also to give a greater chance of survival for endangered species. Indian botanic gardens are favourably placed to help in the preservation of the dwindling floras of the Indian Ocean islands.

SUMMARY

A survey has been made of the floras of the islands of the Indian Ocean, excluding Ceylon and Madagascar which provide special conservation problems. Tentative lists of the endemic species have been prepared, but these cannot be finalised in the present state of knowledge. Nevertheless, there is sufficient evidence to show that considerable loss by extinction has been sustained by the floras of the Western Indian Ocean.

The floras of the Andaman and Nicobar Islands together include about 123 endemic species. Probably few of these are endangered, but more field work is needed to assess their status. Christmas Island has about 28 endemics most of which are not in immediate danger. A nature reserve is needed for their conservation in view of the phosphate mining on the island.

The Mascarene Islands, Mauritius, Rodriguez and Reunion were all originally clothed in forest and were extremely rich in endemic species. Baker's estimate of 182 endemics for Mauritius in 1877 is probably too low. A number of species were already extinct and others have died out later. Among the plants of the highest scientific importance are four monotypic genera. The remnants of the flora are preserved in a series of Reserves, but social economic and political factors render their future problematical. Rodriguez was derelict when the first systematic collection of plants was made in 1875. No natural plant communities remain. Among 35 endemic species recorded are 3 monotypic genera. Probably at least 70 other species have been lost. Reunion is now the least changed and richest of the Mascarenes with about 290 endemics recorded. Even so, a recent estimate states that three quarters of the 160 indigenous orchids are now lost. There are no national parks or reserves and suitable areas should be selected before further deterioration takes place.

Thanks to recent expeditions the present status of the floras of Aldabra, the Seychelles and Socotra is better known. For the three groups together, 326 endemic species are recorded, but 11% of these are believed to have become extinct during the last century. The

extinctions on the Seychelles include the monotypic family Medusagynaceae. Of the remainder 24% are endangered, 38% are depleted and only 27% can be considered safe at present. Floral reserves have been proposed for these island groups.

Attention is drawn to the need for cultivation of endangered species of the Indian Ocean region in tropical botanic gardens.

RÉSUMÉ

Des études floristiques ont été effectuées dans les îles de l'Océan Indien à l'exception de Ceylon et de Madagascar qui suscitent des problèmes de conservation particuliers. Des listes provisoires des espèces endémiques ont été préparées, mais elles ne peuvent être dressées de façon définitive dans l'état actuel de nos connaissances sur ces flores. Malgré cela, on possède de nombreuses preuves révélant qu'un nombre considérable d'espèces appartenant à ces flores se sont éteintes.

Les flores des îles Andaman et Nicobar comprennent ensemble près de 123 espèces endémiques. Il est probable que peu de ces espèces sont menacées, mais il faudrait poursuivre les recherches sur place afin de déterminer leur situation. L'île Christmas a environ 28 espèces endémiques dont la plupart ne sont pas immédiatement menacées. Il conviendrait de créer une réserve naturelle afin de les sauvegarder, car l'île est exploitée pour ses phosphates.

Les îles Mascareignes, Maurice, Rodriguez et de la Réunion étaient toutes à l'origine recouvertes de forêts et possédaient une flore riche en espèces endémiques. Baker estimait en 1877 qu'il y avait 182 espèces endémiques à l'île Maurice, ce qui était probablement inférieur à la réalité. Un certain nombre d'espèces avaient déjà disparu et d'autres se sont éteintes par la suite. Parmi les plantes qui présentent un très grand intérêt du point de vue scientifique on trouve quatre genres monotypiques. Ce qui reste de la flore est conservé dans un certain nombre de réserves, mais les facteurs politiques, économiques et sociaux rendent son avenir assez aléatoire. L'île Rodriguez était à l'abandon quand on y fit pour la première fois en 1875 un recensement systématique des plantes. Il ne restait aucune association végétale naturelle. Parmi les 35 espèces endémiques découvertes se trouvaient 3 genres monotypiques. Il est probable qu'au moins 70 autres espèces se sont perdues. La Réunion est actuellement l'île la moins modifiée et celle qui a la flore la plus riche de toutes les Mascareignes avec environ 290 espèces endémiques. Mais en dépit de cela, une estimation récente révèle que les trois quarts des 160 espèces indigènes d'orchidées ont déjà disparu. Il n'existe ni parcs nationaux ni réserves et il conviendrait donc de délimiter des zones à protéger avant que ne se poursuive la dégradation de la flore.

Des missions récentes ont permis de mieux connaître l'état actuel de la flore de l'île Aldabra, des Seychelles et de Sokotra. Dans ces trois groupes d'îles on a trouvé un total de 326 espèces endémiques, mais il semble que 11% de ces espèces aient disparu au cours du siècle dernier. Dans les Seychelles, une famille monotypique—les Medusagynaceae—a disparu. De plus, 24% de ces espèces sont menacées, 38% sont extrêmement rares et 27% seulement d'entre elles ne sont pas menacées au moment présent. Il a été proposé de créer des réserves floristiques dans les îles appartenant à ces trois groupes.

L'auteur souligne la nécessité de cultiver les espèces menacées de la région de l'Océan Indien dans les jardins botaniques tropicaux.

Endangered Plant Species and Their Habitats—A Review of the Indian Situation

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INTRODUCTION

Increasing human populations and development have brought about sudden, irreversible and often far-reaching disturbances of natural conditions essential for the survival of vast numbers of plant and animal species. A recent International Conference (UNESCO 1968) made several recommendations urging the IBP, IUCN and other international and national organizations to initiate studies into these problems, in addition to the establishment of natural areas for the preservation of plant and animal life, their habitats and representative samples of ecosystems. At this Tenth General Assembly of the International Union for Conservation of Nature and Natural Resources, the Survival Service Commission is to review the status of endangered species and their habitats. This paper presents a preliminary report on the extinct and endangered taxa of Indian plants with particular reference to their habitats.

METHODS OF STUDY

Excluding stray remarks on the danger of extinction to certain well known orchids and reports of extensive modification of habitats as a result of development, we had no earlier work to guide our study. Srinivasan (1959) had also encountered this problem as is evident from his remarks (p. 86): 'To say merely that rare plants have to be protected would be meaningless, unless it is precisely defined as to what would constitute such rare plants, and by what authentic standards their rarity is actually evaluated'. He goes on to consider the status of economically important species (which appear to have sufficient legal safeguards), endemic or apparently endemic species (he lists 48), mono-specific Indian representatives of genera enjoying a wider distribution elsewhere (*Iberidella andersonii* Hk.f.& Th.), Indian type species, species that are indiscriminately exploited or destroyed, and scientific curiosities (*Nepenthes khasiana* Hk. f.). He includes some rare species or species with limited distribution, also, and makes another significant observation (p. 89): 'The term "rare" has to be used with some reserve only, especially in the context of our present day knowledge of the flora of the entire peninsula'. The Botanical Survey of India was reorganized in 1954 and has among its objectives the revision of Hooker's 'Flora of British India', preceded by extensive and intensive exploration of the various parts of the country that had not been sufficiently explored. During the last 15 years we have accumulated considerable data on the plant wealth of the country; but our work is far from complete. Recognizing the importance of Ecology, a separate unit was started in the Headquarters of the Botanical Survey of India and special efforts were made to study those areas which were in imminent danger of undergoing sudden and irreversible changes; e.g. the submergible areas adjoining major hydro-electric schemes (Thothathri, 1964; Raju, 1965; Sebastine and Ramamurthy, 1966). Based on data from our recent explorations, we have been able to compare the flora of certain areas which had been previously botanized and for which published or at least manuscript accounts exist. Unfortunately the earlier workers had not been thorough, as they themselves admit. Neither do we claim perfection for our work as a result of many handicaps. Nevertheless, we believe that it can be shown by comparing the floristic accounts that a large number of plants cannot be found in places where they have previously been recorded.

COMPARISON OF FLORISTIC ACCOUNTS

Khandala in the Western Ghats of India

The district of Khandala covered by the studies of Santapau (1967) had been earlier explored by Graham (1839). During 1917-19, Blatter, Hallberg and McCann made extensive collections from Khandala. Apart from these collections McCann made special collections of the Gramineaceae, Cyperaceae and Orchidaceae from 1919-1931. In addition to these, stray collections had been made by A. Gibson, J. S. Law, J. E. Stocks, and others. Santapau who took up the study of the flora of Khandala worked for nearly 10 years in the area between 1940-1949. His work was intensive and he reported over 1, 235 taxa of angiosperms and gymnosperms. This list contains, in addition to his own collections, plants reported by Blatter, Hallberg, McCann, Graham and others. Santapau could not collect specimens of some 224 taxa even though many of them are represented by specimens in the Blatter Herbarium. Considering the intensive nature of Santapau's study it is not likely that he could have overlooked such a large number of plants. In many instances he remarks that he made a special search for over 10 years for some plants reported by Blatter and others, but they could not be found: *Balanophora indica* Wall., *Ceropegia lawii* Hk. F., *Erythrina indica* Lamk., *Leea setaligera* Clarke, *Salacca prinoides* DC, *Tylophora indica* (Burm.) Merr. and *Wagatea spicata* Dalz. All the four taxa of Podostemaceae, *Terniola zeylanica* Tul. var. *konkanica* (Willis) Sant., *Tfoliosa* Wedd., *Zeylanidium lichenoides* (Kurz) Engl. var. *khandalense* (Willis) Sant., *Z. Uchenoides* (Kurz) Engl. var. *bhorensis* (Willis) Sant., were listed on the authority of earlier workers. Santapau had not seen them in Khandala. Of the 49 taxa of Cyperaceae, 13 were listed on the authority of earlier reports and 39 taxa out of 121 Gramineae were neither seen nor collected by Santapau.

Indore district in Central India

Indore, a district of Madhya Pradesh comprises part of the Malwa Plateau and lies approximately within Latitude 22°22' and 23°10' N and Longitude 75°15' and 75°35' E. Biscoe (1910), a former Conservator of Forests, published a list of 166 species of shrubs and trees. After a lapse of over 50 years, Rao and Sastry (1964) studied the vegetation of the same area and reported 566 species *including a large number of herbaceous plants*. A comparison of the two studies reveals an interesting fact; some 40 species of trees and shrubs reported by Biscoe are missing from the collections made by Rao and Sastry. It is possible that they could have overlooked some of them but it is most unlikely that they could have missed all the 40 species of *trees and shrubs*. It is our opinion that these plants have become exceedingly rare or even disappeared from the area under study, mainly: due to the influence of man. The more striking examples are the following: *Acacia eburnea* Willd., *Acacia jacquemontii* Benth., *Bauhinia variegata* L., *Capparis grandis*, *Careya arborea* Roxb., *Carvia callosa* (Wall.) Brem., *Casearia tomentosa* Roxb., *Eriolaena hookariana* Wt. & Arn., *Gmelina arborea* Roxb., *Grewia damine* Gaertn., *Oroxylum indicum* (L) Vent., *Pilostigma malabaricum* (Roxb.) Benth., *Salvadora persica* L., *Santalum album* L., *Semecarpus anacardium* L.f., *Soymida febrifuga* A. Juss. and *Strychnos potatorum*.

Biligirirangan Hills in Mysore State

Biligirirangan Hills form a discontinuous north to south range of hills located in the south east corner of Mysore State and lie between 11°5'-13°5' N and 77°-78°E. Barnes (1944) studied this area and published a paper recording 468 species. Recently Kammathy, Rao and Rao (1967) explored the same area and published a list of 825 taxa. This list includes 267 taxa reported by Barnes (and one by Fischer) which were not collected by them. Special mention must be made of the Orchidaceae. Of the 68 taxa of this family 48 are given on the authority of Barnes. No representative of the following genera could be found: *Anoectochilus* Bl., *Calanthe* R. Br., *Chiloschista* Lindl., *Chrysoglossum* Bl., *Coelogyne* Lindl., *Cymbidium* Sw., *Disperis* Sw., *Epipogium* R. Br., *Geodorum* Jacks., *Liparis* Rich., *Malaxis* Soland. ex Sw., *Peristylus* Bl., *Platanthera* L. C. Rich., *Polystachya* Hk., *Rhynchostylis* Bl., *Satyrium* Sw., and *Zeuxine* Lindl. Some other taxa of importance that have disappeared from this area include *Aganosma cymosa* G. Don., *Buettneria herbacea* Roxb., *Cephalostigma flexuosum* Hook.f. & Th., *Dillenia retusa* Thunb., *Dioscorea bulbifera* Roxb.

fera Linn., *Eriolaena Hookeriana* Wt. & Arn., *Heracleum candolleanum* Gamble, *Hoya wightii* Hk.f., *Linum mysorense* Heyne ex Benth., *Lobelia heyniana* Roem. & Schult., *Lonicera leschenaultii* Wall., *Mallotus beddomei* Hk., *Myriophyllum intermedium* DC, *Olea glandulifera* Wall., *Osbeckia cupulaxis* Don, *Parnassia mysorensis* Heyne, *Pedicularis zeylanica* Benth., *Phaseolus angularis* (Willd.) W.F.Wight, *Pycnospora lutescans* (Poir.) Schind., *Ranunculus wallichianus* Wt. & Arn., *Rauvolfia densiflora* (Wall.) Benth. ex. Hk.f., *Rubus fulvus* Focke, *Ruellia beddomei* Clarke, *Syzygium ruscifolium* (Willd.) Sant. & Wagh. and *Thalictrum dalzellii* Hk.

Andaman and Nicobar Islands

The Andaman and Nicobar Islands lie in the Bay of Bengal. An account on the flora of the Andamans was published by Gamble (1903). Parkinson (1923) studied these islands 20 years later and published another account. The Botanical Survey conducted three major expeditions in recent times (Thothathri 1962). Thothathri, who was in charge of these explorations and is continuing his studies, informs us (personal communication) that forests in the North Andamans on the way to Thilait Bay were cleared to rehabilitate refugees in 1959. Similarly, in 1964, Middle Andaman evergreen forests were cleared at Betapur for similar purposes. However, Great Nicobar Island is full of virgin forests largely untouched by man. The only inhabitants of this island are the aborigines (Jaravas). This island, according to Thothathri may be considered for conservation of habitat. Though the study of the flora of these islands is not quite complete, the following plants reported by earlier workers from these islands may be considered to be extinct or very rare (Thothathri could not find them): *Aegialitis rotundifolia* Roxb., *Calophyllum amoenum* Wall. ex Choisy, *Gomphia hookeri* Planch., *Kadsura roxburghiana* Arnott, *Kayea manii* King, *Leptonychia glabra* Turcz., *Mischocarpus sundaicus* Bl., *Podocarpus nerii-folia* Don, *Polyosma integrifolia* Bl., *Prunus martabanica* King. The following plants are endemic to these islands: *Ailanthus kurzii* Prain, *Ardisia andamanica* Clarke, *Blachia andamanica* Hk.f. *Canarium manii* Kurz, *Chailletia andamanica* King, *Dillenia andamanica* Parkinson, *Dipterocarpus kerrii* King, *Drypetes andamanica* (Kurz) Pax & Hoffm., *Dysosylon andamanicum* King, *Glochidion andamanicum* Kurz, *Gouania andamanica* King, *Hippocratea andamanica* King, *Hopea andamanica* King ex Parkinson, *Lagerstroemia hypoleuca* Kurz, *Lasianthus andamanicus* Hk.f., *Linociera parkinsonii* Hutch., *Linostoma andamanicum* Hutch. ex Parkinson, *Macaranga andamanica* Kury, *Mallotus andamanicum* Hk.f., *Maesa andamanica* Kurz, *Mangifera andamanica* King, *Memecylon andamanicum* King, *Mezoneurum andamanicum* Prain, *Miliusa tectona* Hutch. ex Parkinson, *Myristica andamanica* Hk. f. *Orophea hexandra* Bl., *Peristrophe andamanica* Clarke, *Planchonia andamanica* King, *Polyalthia dubia* Kurz, *P. parkinsonii* Hutch., *Strobilanthes glandulosus* Kurz, *Xanthophyllum andamanicum* King. Plants that are known only from the Nicobars are: *Aporusa glabrifolia* Kurz, *Bentinckia nicobarica* Becc., *Crateva macrocarpa* Kurz, *Hippocratea nicobarica* Kurz, *Garcinia jelinekii* Kurz ex King, *Mussaenda jelinekii* Kurz, *Orophea kaischalica* Kurz emend Thoth., *Trichoglossis quadricornuta* Kurz. *Symplocos chengapae* Raiz. et Sahni.

Lucknow city and its environs

A comparison of the floristic studies on Lucknow and its environs gives us a very good idea of the effect of urbanization on the flora of the area. Anderson (1859) published notes on the flora of Lucknow with a list of 536 taxa including 156 cultivated ones. He considered the list far from complete. More than a century later, Patil (1963) who studied the very same area collected only 330 taxa including cultivated ones. Sharma (1964) has added another 13 species bringing the total to 343.

The disappearance of 193 taxa from such a small area, even if some of them could have been overlooked by Patil, emphasizes the effects of expanding cities on floristic composition.

ENDANGERED PLANTS

The following list consists of various taxa considered to be rare and probably facing extinction at least in India. It is drawn up on the basis of extensive explorations conducted by the staff of the Botanical Survey of India and experience gained therefrom. Recent collections have been compared with existing plant specimens in various herbaria and recent monographs and revisions have also been consulted. The plants listed by Sriniv-

vasan (1959) have also been included: *Aconitum kashmircum* Stapf. ex Coventry, *A. moschatum* (Bruhl ex Duthie) Stapf, *Allardia vestita* Hk. f & Th., *Allium clarkei* Hk.f., *A. consanguineum* Kunth, *A. loratum* Baker, *A. thomsonii* Baker, *Anemone tomentosa* Sw., *Anemone tetrapala* Royle, *Aquilegia nivalis* Falc. ex Baker, *Artemisia amygdalina* DCne., *Astragalus bicuspis* Fisch., *A. falconeri* Bunge, *A. gracilipes* Benth. ex Bunge, *A. bakeri* Ali, *A. oxyodon* Baker, *A. malacophyllum* Benth. ex Bunge, *Belosynapsis kewensis* Hasek., *Calophyllum kunstleri* King, *Carduus nutans* Linn., *Carrallia (?) lucida* Roxb., *Catamixis baccharoides* T. Thorns., *Chilocarpus malabaricus* Bedd., *Dianthus cachemiricus* Edgew., *D. jacquemontii* Edgew., *Doritis taenialis* (Lindl.) Benth., *Dischidia rafflesiana* Wall., *Epipogium tuberosum* Duthie, *Eremostachys superba* Royle ex Benth., *Erysimum melicentra* Dunn, *Falconeria himalaica* Hk.f., *Gentiana cachemirica* DCne., *G. kurro* Royle, *Hedysarum cachemirianum* Benth., *Helichrysum cuthicum* (Cl.) Rolla Rao et Deshpande, *Iris aurea* Lindl., *I. gilgitensis* Baker, *Lavatera kashmiriana* Camb., *Lespedeza elegans* Camb., *Mertensia maltzoides* Clarke, *Nepenthes khasiana* Hk.f., *Pleurospurum stylosum* Clarke, *Potentilla clarkei* Hk.f., *P. kashmirica* Hk.f., *P. curviseta* Hk.f., *Primula reptana* Hk.f., *Rhododendron inaequala* Hutch., *Salvia hians* Royle, *Saussurea clarkei* Hk. f., *S. elliptica* Clarke, *S. glandulifera* Schultz, *S. lappa* Clarke, *S. schultzei* Hk.f., *Senecio jacquemontianus* Benth., *S. thomsonii* Clarke, *Stylophorum lacturoides* Baill., *Swertia thomsonii* Clarke, *Tanacetum artemisoides* Schultz, *T. falconeri* Hk.f., *Tetragastris sinense* Oliv. var. *himalense* Hara et Kanai, *Trisetum hirsutum* Wall., *Vaccinium nuttalii* (Cl.) Sleumer, *Valeriana elegans* Clarke, *Viola falconeri* Hk.f. & h.

The following plants are included on the authority of Rao (1969): *Adinandra griffithii* Dyer, *Aglaia perryi* Hiern., *Anacolosa ilioioides* Mast., *Camellia caduca* Brandis, *Elaeocarpus prunifolius* (C. Muell) Mast., *Impatiens acuminata* Benth., *I. bella* Hk.f. & Th., *I. fimbriata* Hk.f., *I. paludosa* Hk.f., *I. rudicana* Benth., *I. porrecta* Hk.f. & Th., *Ilex ambeloides* Hk.f., *Zanthoxylum khasianum* Hk.f.

Dr. A. S. Rao writes on the disappearing plants of Assam (personal communication): 'The efforts of the Botanical Survey of India in the last twelve years to obtain fresh collections of many of the rarities collected by classical collectors, have not yet yielded any satisfaction, notwithstanding repeated visits and in different seasons and close careful searches. The only conclusion to be drawn is that these rarities (represented in the herbaria very often by a single collection) have become extinct in their original sites. Future intensive exploration may result in discovery of new locations, but the fact that they are no more in their original localities is very sad and is to be deeply deplored. The several species listed are mostly of academic interest but any time they may assume an economic importance. The few species of orchids listed may convey a more meaningful impression to the lay public. These precious slow growing ornamentals have been systematically gathered from the wild to supply to the public, thus progressively threatening their multiplication or even existence in the natural habitat. Conservation of these and any other threatened species is very necessary. This can be done by publicity, education and altering of agricultural practice'. He concludes these remarks with the following list:

Acanthephippium sylhetense Lindl., *Amblyanthus multiflorus* Maz., *Anneslea fragrans* Wall., *Aphyllorchis montana* Reichb.f., *A. vaginata* Hk. f.*Apodytes benthamiana* Wt., *Apostasia wallichii* Br., *A. nuda* Br., *Ardisia quinquangularis* A. DC, *A. rhynchophylla* Clarke, *Coelogyne viscosa* Reichb.f., *Dicentra roylei* Hk.f. & Th., *Distylium indicum* Benth., *Epipogium roseum* (D.Don) Lindl., *Eria barbata* Reichb.f., *E. crassicaulis* Hk.f., *Euonymus echinatus* Wall., *Galeola lindleyana* Reichb.f., *Gastrodia exilis* Hk.f., *Homalium schleichii* Kurz, *Ilex ombelioides* Hk.f., *Iodes hookeriana* Baill., *Magnolia gustavii* King, *M. pealiana* King, *Michelia lanuginosa* Wall., *Nymphaea pygmaea* Ait., *Orophea polycarpa* A. DC, *Palauium polyanthum* Benth., *Paphiopedilum fairieanum* (Lindl.) Pfitz., *P. hirsutissimum* (Lindl.) Pfitz., *P. insigne* (Lindl.) Pfitz., *P. spicerianum* (Reichb.) Pfitz., *P. venustum* (Wall.) Pfitz., *Popowia kurzii* King, *Pachylarnax pleiocarpa* Dandy, *Saurauja griffithii* Dyer, *Satyrium nepalense* Don, *Uvaria lurida* Hk.f. & Th., *Vanda caerulea* Griff. Six species of ornamental orchids belonging to *Paphiopedilum*, *Satyrium* and *Vanda* are greatly sought in their natural habitat. The National Orchidarium (at Shillong) has a good number of these under cultivation forming a 'bank' of species that are rare or nearly extinct in the wild state.

THE MAIN THREAT

The main threat is of course from Man, who is bringing about drastic and irreversible changes in the habitats. These changes are the by-products of his desperate attempts to support the fantastic growth in human populations. One estimate puts the size of the world population at 50 billion by the turn of the next century (Brown, 1956). In order to feed them cultivated farm lands will have to be increased considerably. It is estimated that we cultivate today 1.45 billion hectares out of a total of the 13.60 billion hectares of the earth's surface. According to K. M. Malin (quoted by Ohlin, 1967), with capital expenditure the farm land area could be increased to 5.49 billion hectares and with new farming methods and large capital expenditure it could reach 9.33 billion hectares (Ohlin, 1967). If we bear in mind that deserts and unsuitable land and structures constitute about 5.42 billion hectares it is not difficult to visualize the nature of land that will fall prey to the nuclear age agriculturists; the meadows and pastures (2.58 billion hectares) and the forests (4.10 billion hectares). When we finally reach that point envisaged by Malin, we could be reasonably certain that most of the plants and animals not directly useful to man will be extinct unless some of them were lucky enough to find a place in the limited number of National Parks, Game Sanctuaries or Zoological and Botanical Gardens. In addition to increasing the agricultural farm land area, man is speeding the extinction of many species of plants and animals by polluting the environment. A recent WHO report (1968) reviews the problem and calls for additional research and control measures. Ehrlich (1968) mentions Lake Erie as an example and comments (p. 62): 'The once beautiful lake is now a septic tank—a stinking mess. In 1955, the lake supported commercial fishing. In that year 75 million pounds of fish were taken. No one in his right mind would eat a Lake Erie fish today if one could be found'.

Another example may be found in the actions of the U.S. Government in using defoliation as a warfare technique. Among the many criticisms against this practice a recent resolution passed by the Ecological Society of Japan states (Ito, 1968 p. 513-514): 'From the ecological point of view, we fear that such wide-scale application of herbicides will deal a deadly blow to tropical forest ecosystems and cause serious damage to human beings and property. ... the large scale destruction of the vegetation in the high temperature and humidity of tropical forests may cause rapid erosion of organic matter in the soil and may turn the forest areas with the richest biological productivity into semipermanent lateritic barrens'. The society expressed the hope that ecologists everywhere would support their stand. We do.

WHAT COULD BE DONE

We support Ehrlich when he says (1968, p. 65-66): 'In spite of all the efforts of conservationists, all the propaganda, all the beautiful pictures, the conservation battle is presently being lost'. The reason for this is very simple. There are too many people on this earth today. A good percentage of them live at starvation level and are least interested in questions which do not directly relate to providing them with food. Most members of the remaining affluent minority do not care enough. 'They (Americans) have never heard of the California condor and would shed no tears if it became extinct. Indeed, many Americans would compete for the privilege of shooting the last one'. (Ehrlich, 1968, p. 66). Conservationists, to the best of our knowledge, have never come out boldly against the real threat to wildlife, the unprecedented growth in human populations. If this problem is not tackled successfully, it is unlikely that our efforts to preserve wildlife will bear fruit. A rational integrated plan of action to check the rise in human populations should be evolved and enforced all over the world through international co-operation. Following this, a scheme could be embarked upon to determine with some degree of accuracy the actual number of plant and animal species facing extinction. It is fairly easy to determine the extent of the threat to the plant wealth of those countries that have been thoroughly studied botanically. In countries whose floristic composition is imperfectly known and where extensive development is taking place, extensive and intensive explorations should be conducted without further delay. For this we urge the Governments of the various countries whose representatives are present here today to provide sufficient funds and wherever necessary inter-governmental collaboration.

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SUMMARY

This is a preliminary report on the extinct or endangered plants of India with special reference to their habitats. From the considerable experience gained by the Botanical

Survey of India it has been possible to show, by comparing floristic accounts, that a large number of plants cannot be found now in places where they had been previously recorded. Among the rare and threatened taxa should be included 40 species endemic to Andaman and Nicobar Islands. A further list of 118 taxa of extinct or endangered species is included on the basis of earlier published accounts on the subject, comparison of recently collected plant specimens with existing older collections in various herbaria, and a study of recent monographs and revisions. Though many of the species listed are of academic interest only at present, they could assume economic importance at any time. Many of the rare ornamental orchids are being extensively removed from their natural habitats. The National Orchidarium at Shillong has many of them under cultivation.

The increase in human populations is the main threat to wild plants and animals alike. In addition to extending agriculture to all available cultivable and even marginal land, Man is accelerating the extinction of many plant and animal species by polluting the biosphere. It is strongly recommended that as a first step measures should be taken to check the rise in human populations all over the world. If this could be done successfully, further steps could then be taken to determine the extent of the threat to plant wealth and the remedial measures required.

RÉSUMÉ

Le présent article constitue un rapport provisoire sur les plantes disparues ou menacées en Inde, avec référence particulière à leurs habitats. Grâce aux données abondantes rassemblées par le Centre d'Etudes Floristiques de l'Inde, on a pu montrer, en comparant des rapports sur la flore, qu'un grand nombre de plantes n'apparaissent plus dans des sites où on les avait observées auparavant. Parmi les groupes rares et menacés, il faut inclure 40 espèces endémiques aux îles Andaman et Nicobar. Une seconde liste comprenant 118 ordres de plantes éteintes ou menacées a été constituée sur la base de rapports publiés antérieurement, de la confrontation de spécimens de plantes récoltées récemment avec des collections déjà existantes conservées dans divers herbariums, et enfin de l'étude de monographies et rapports récents. Bien que plusieurs des espèces citées ne présentent qu'un intérêt purement académique, elles pourraient à tout instant prendre une importance économique. Un grand nombre d'orchidées rares et belles sont récoltées sans aucune mesure dans leurs habitats originaux. L'Orchidarium National de Shillong en cultive de nombreuses espèces.

La grande menace qui pèse sur les plantes et les animaux sauvages est l'augmentation des populations humaines. Outre l'extension de l'agriculture à toutes les terres cultivables et même aux marginales, l'Homme accélère le processus d'extinction d'un grand nombre d'espèces animales et végétales en polluant la biosphère. Il est très fortement recommandé de prendre d'abord des mesures pour freiner l'accroissement des populations humaines dans le monde. Si on y parvenait, il faudrait alors étudier l'importance des menaces qui présentent sur le monde végétal et les remèdes à y apporter.

Some Endangered Plants and Threatened Habitats in South East Asia

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INTRODUCTION

Ever since the dawn of civilisation, man has altered to varying degrees his environmental ingredients as he started using the natural resources of the earth's ecosystems. In this process man's influence on vegetation has been in one way or other rather destructive and he has been changing the ecosystem of the whole world though not wholly to the detriment of his ultimate welfare. Though this was inevitable to some extent in the earlier stages of human settlement when man cleared vegetation for agriculture, the stage has now been reached when further destruction of ecosystems will spell disaster to man's very existence.

From the earliest times, unrestricted felling, fire, grazing and shifting cultivation have been responsible for threatening many habitats and for the extinction or near extinction of many plant species. This has been the story everywhere, more so in the tropics and sub-tropics which carry about two-thirds of the world's population. While much of these processes applied to times long past, the accelerated developments that are now taking place have produced new kinds of interactions with the environment that were not previously evident. Economic development and industrialisation have caused man's activities to extend increasingly to many natural habitats which were hitherto relatively safe from biotic influences of an aggressive nature. This is particularly relevant in the developing countries of Asia and Africa where both the pace and impact of developmental activities are more pronounced.

The rapid development of ever greater areas of land and modern technology have caused various tropical biotic communities to undergo radical changes. Deforestation, irrigation, unplanned and extensive introduction of exotics, large scale use of weedicides and fertilisers, etc., have drastically transformed the landscape or caused considerable damage to both fauna and flora. Despite temporary economic advantages, this alteration of the tropical ecosystem has sometimes resulted in a sudden change of balance between man and his environment giving rise to innumerable difficulties (Darling 1968).

This paper considers some endangered plants and threatened habitats in various South East Asian countries, which call for immediate attention to make the public conscious of the great dangers involved if the processes which have brought about the present situation are left unchecked.

COUNTRY BY COUNTRY REVIEW

Malaysia

The natural vegetation of the Malay Peninsula is Tropical Rain Forest and within this three important types, namely (i) Lowland Dipterocarp Forest, (ii) Montane Forest, and (iii) Limestone Forest, are distinguished. The Lowland Dipterocarp Forest covers the greater part of the Malay Peninsula and the greatest threat comes from development programmes which involve large-scale felling of these species-rich forests for agriculture or industrial purposes. The prized Malayan hardwoods— dipterocarps such as *Balanocarpus heimii* and *Shorea* spp.—are characteristic of the richest soils in the region.

These species, once existing over hundreds of square miles, may soon succumb to large scale habitat destruction. An unknown but certainly a large number of associated species will also be lost for ever (Editorial 1967; Lek 1968; Steenis 1969; Wycherley 1969).

Steenis (1969), while stressing the destruction of the biocoenosis of the Lowland Dipterocarp Forest, mentions the elimination of rare trees like *Dactylocladus*, only just discovered in Malaysia. As a result of more intensive botanical explorations, other rare species like *Trigonobalanus*, in the hills, and *Allantospermum (A. borneense)* have been discovered. The latter unique tree genus was located for the first time in Malaysian Borneo (Sabah) only a decade ago and has since been detected in Malaya proper in Larut/Bubu Forest Reserve, one of the very few easily accessible reserves of primary lowland forest on the west coast. There is great concern about the preservation of this reserve, which has a long history of scientific exploration. Logging activities are making deep inroads into the area and, unless positive steps are taken to halt these, it is feared that the last remaining tract of rich luxuriant forest on the west coast will be lost and with it a major part of the scientific heritage of Malaysia (Ng 1968; Steenis 1969, 1969a).

The other threat to Lowland Dipterocarp Forest lies in selective fellings in forest reserves to encourage more economic species. This disturbs the microclimate of the forest stands which is detrimental to the numerous uneconomic but botanically interesting species. It may be emphasised here that these and various other operations designed to improve the economic value of forest reserves are unavoidable in a developing economy, but it is at the same time essential that special efforts are made to preserve selected areas in their original condition (Editorial 1967; Lek 1968; Steenis 1969).

The Montane Forest Type of the Malay Peninsula (Lek 1968) differs greatly from the Lowland Dipterocarp Type. Oaks and laurels predominate and the forest floor is much richer in herbs and monocotyledons. While species with a wide range, from sea level to about 1670 m, such as *Garcinia*, *Calophyllum*, *Urena lobata*, etc., are not in any great danger of extinction, the species that cannot tolerate the high temperatures of the lowlands are threatened. Examples are *Illicium* spp., *Viola serpens*, species of hill *Impatiens*, numerous herbaceous Sonerilas and Medinillas, most montane Begonias and numerous orchids. Most of these species are not only endemic to the Malay Peninsula, but also are extremely rare and often very localized in their distribution.

These species are threatened for two reasons. First, there is hill cultivation: much formerly accessible montane forest has already been cut down for agriculture and whatever remains is being destroyed by the native inhabitants. Secondly, many of these plants, particularly those with showy flowers, are being collected in large quantities. This is particularly true of the orchids which are in great danger of extinction. Conservation of this montane vegetation is urgently needed not only for preserving the natural flora, but to stop serious erosion from the mountains which is an obvious danger to the lands below.

The limestone flora of the Malay Peninsula (Lek 1968; Johnson 1968) occurs mainly in the northern half of the Peninsula (north of Kuala Lumpur). Most of the plants of this forest type are 'rockery plants', the majority of which are calcicole. Many are endemic and very rare, e.g. *Miltusa parviflora*, *Orophea cuneiformis*, *O. hirsuta*, and *Popowia velutina*. Of the eight species of *Impatiens* enumerated from these hills seven are confined to limestones. Again, of the nine species of *Boea* listed as endemic to Malaya, six are rare and confined entirely to calcareous habitats. These hills are being subjected to heavy mining and quarrying for limestone and iron ore. Thus a rather limited habitat is likely to be destroyed or modified and the threat is to the whole biocoenosis rather than to individual plant species.

Many orchids in accessible areas are subject to overcollection and are doomed if there are not enough inaccessible reserves free from risk of habitat destruction. *Paphio-pedilum niveum*, a slipper orchid of the limestone hills, is still taken in large quantities from Langkawi Island, the only Malaysian locality, despite legal protection. This orchid is very attractive but difficult to cultivate and there is a constant demand to replenish stocks from the wild (Wycherley 1969).

The limestone Batu caves on the northern outskirts of Kuala Lumpur (Wycherley 1965, 1967, 1968, 1969) have been a cause of considerable concern, because of their religious and scientific interest. They are threatened by quarrying which may completely destroy their value for researchers and tourists. The caves have a very interesting and special-

ized flora including many endemics and rarities (e.g. *Livistona rupicola*—a rare palm) which will be lost if the whole hill is blasted down or even if too many of the high valleys are opened up to drying winds. Some species like *Echinodorus ridleyi* (regarded as a primitive survivor from the division of flowering plants into Monocotyledons and Dicotyledons) are already lost as far as Malay is concerned. The importance of such areas as reserves of genetic material has long been recognized.

The other types of forest which need attention in the Malay Peninsula are: peat and freshwater swamp forests, beach forests, mangrove forests, etc. These forests may well contain species new to science (Lek 1968).

The opening up of large areas in Sarawak and Sabah by development programmes presents similar problems (Anderson 1968; Steenis 1969, 1969a). The principal plants threatened with extinction occur on limestone hills and many are endemic to particular hills. Several orchids have a localised distribution and are much sought after by collectors (Anderson 1968a). Threatened species in Sabah include palms, such as *Orania* (near Kudat) and *Corypha* (near Kudat and Bandau), lowland dipterocarps, such as *Shorea gratissima* (only found at sea level), and near endemics, e.g., *Potentilla leuconota* (Carson 1968).

Ferns as a group have attracted little attention in Malaysia and in fact throughout South East Asia. None the less some are so rare to have been located only once while others are restricted in their distribution. Ferns once found in habitats throughout South East Asia have disappeared with the clearing of natural forest and road making through hitherto undisturbed areas. A list showing the status of some Malayan ferns has been made by Johnson (1968)

Singapore

In Singapore a sandstone ridge Gunong Panti which lies in South East Johore is causing concern. *Paphiopedilum bullenianum* (Malayan slipper orchid) as also many liverworts and mosses are endemic to this area, while other plants are of a most unusual kind for such a low altitude. Though the area is a forest reserve, plans are in operation to clear the lower slopes leaving only the upper ridge. Forestry operations have extended up the hill and caused a risk of exposure and habitat modification which could hasten the loss of some species combined with other pressures. Whether the rich and unusual flora of the sandstone ridge will be able to survive when the slopes have been denuded is doubtful (Johnson 1968; Wycherley 1969).

The Lowland Dipterocarp Forest on Bukit Timah Hill in Singapore is a glaring example of habitat modification. Occupying an area of about 184 acres in the centre of Singapore Island the forest is completely surrounded by cleared land and housing colonies. Being on a hill the forest is at the mercy of lateral wind movement. Much of the ground vegetation has 'dried' out of existence, while secondary community species are slowly migrating into the forest (Lek 1968).

Thailand

It is reported that plants and their habitats in Thailand are very much endangered by human activities directly or indirectly. Intensive agriculture and economic development to meet the needs of an evergrowing population have opened up certain forest lands to farming, resulting in some species becoming rare or threatened with extinction (Smitinand, 1968, 1969).

Among the species in danger are the terrestrial parasites, which seem to have rather specific hosts and may not survive once their host plants are removed by shifting cultivation or new land settlements. *Sapria himalayana*, a native of hill evergreen or lower montane forests feeding only on roots of a liana of the genus *Tetrastigma*, and *Rafflesia patina* are examples. Other parasites living on bamboos, such as *Aeginetia indica*, *A. pedunculata*, *Christisonia siamensis*, as well as some members of the genus *Balanophora*, are equally easily destroyed by disturbance of the host species.

Again in Thailand, vegetation existing on limestone formations is in great danger, because limestone is currently being exploited for building material and other construction work, and some of the plants are endemic to the habitat. Rare plants of limestone hills include: *Buddleia macrostachys*, *Delphinium stapheliosmum*, *Dichiloboea acaulis*, *Eria ornata*,

Gentiana australis, *Habenaria carnea*, *Hemipilia calophylla*, *Impatiens psittachina*, *Luculia gratissima*; *Pandanus obovatus*, *P. calcis*; *Paphiopedilum bellalulum*, *P. godefroyae*, *P. niveum*, *Phyllanthodendron mirabilis*. Destructive fires caused by careless shifting cultivation in the valleys and foothills have been responsible for extermination of other species.

True endemic species are often rare as they tend to be confined to specific areas, whence removal will terminate their existence. Most of these endemics though attractive are of no commercial value and hence comparatively safe, but *Afgekia sericea* (a climber of dry deciduous forest), which produces hardly any seed outside its habitat, and *Paphiopedilum sukhakulii* (a very recently discovered species of hill evergreen forests) which is subject to heavy exploitation, are in danger of becoming rare or even extinct.

Plants of commercial value in Thailand protected by law are divided into two categories, namely, timber and minor forest products. Though timber exploitation is under control, several orchid species which have been exported for decades, such as *Paphiopedilum* spp. and *Vanda coerulea*, the most wanted orchids in international trade, are getting fast depleted. Yet they (and other orchid species) have been declared protected species under forest law and something more must be done urgently to save them from extinction.

Philippines.

The activities of man have drastically affected the natural vegetation of the Philippines, endangering many habitats and bringing many endemic and indigenous species to the verge of extinction.

The factors responsible for the extinction of species according to Quisumbing (1967) are shifting cultivation, deforestation and reforestation, illegal cutting, squatting, fire, grazing, landgrabbing, land reform, shore and offshore reclamation projects, depletion of water-sheds, neglect of national parks and reserves, and collection of wild flowers and other plants.

Quisumbing (1967) has made a lucid survey of the Philippine species of plants facing extinction and some of the species from his list may be mentioned: the commercially important trees are mostly the dipterocarps, like *Anisoptera thurifera*, *Dipterocarpus grandiflorus*, *Parashorea malaanonan*, *Pentacme contorta*, *Shorea astylosa* and *S. polystylerma*. Other species of importance in danger are *Alseodaphne malabonga*, *Litsea* spp., *Cinnamomum mindanaense*, *Albizia acle*, *Intzia bijuga*, *Pterocarpus* spp., *Toona calantas*, *Endospermum peltatum*, *Dracontomelum dao*, *Pistacia chinensis*, *Palaquium* spp., *Diospyros philippinensis*, *Wrightia laniti* and *Vitex parviflora*. The last mentioned is one of the saddest cases.

Summer fires attributed to the nomadic habits of some of the tribal people has done tremendous damage to *Pinus insularis* forests. These fires invariably kill other trees mixed with the pines, particularly the ground flora, *Nepenthes* spp. and *Lilium philippinense* are among those threatened with extinction. The various agricultural development programmes have also seriously affected the virgin vegetation. The huge pineapple plantations of Del Monte in Bukidnon and the extensive estates of the Dole corporation in a mountain in Cotabato; the large plantations of *Musa textilis* of the Japanese in Davao; are reported to be responsible for the loss of numerous virgin forest species.

Some mangrove species, like *Bruguiera* spp., *Ceriops* spp., *Rhizophora* spp., are used for fuel and are also facing extinction due to conversion of mangrove swamps into fish ponds. Some orchids particularly the giant orchid *Grammatophyllum speciosum*, *Renanthera* spp., etc. have also disappeared as a result of such shore and offshore reclamation. Reclamations of inland swamps has caused the extinction of many indigenous endemic species of the genera *Erythrina*, *Pandanus*, *Premna*, *Nauclea* and others.

Extensive and intensive collection of orchids for export has stripped the Philippine forests of orchids, and caused the extinction of many species, most of them endemic.

Orchids like the Renantheras, *Phalaenopsis* spp., *Dendrobium* spp., and *Vanda* spp. are exported by thousands and very soon these species may become extinct. Some other species of orchids that are facing extinction or have vanished are: *Paphiopedilum philippinense* (very rare), *Vanilla Calopogon* (very rare), *Coelogyne merrillii* (many other species are extinct), *Dendrochilum glumaceum* (many species are extinct), *Eria* spp.,

Aerides quinquevulnerum (very rare), etc. The example of *Lilium philippinense*, an endemic species in the grassland under pine forests, has already been quoted.

Another group under threat are the medicinal plants. They include: *Phaeanthus ebracteolatus*, *Agathis philippinensis*, *Smilax china*, *Cassia alata*, *Hydnocarpus alcalae* and *Cordia dichotoma*. Of the food plants *Hedyachras philippinensis* and *Diplodiscus paniculatus* may be mentioned. Ornamental plants facing extinction include many species of ferns and tree ferns, such as *Phoenix hanceana* var. *philippinensis* and *Alocasia* spp. (very rare, great quantities exported in past years); *Bauhinia cumingiana*, *Derris scandens*, *Salmalia malabarica*, *Dillenia philippinensis*, *Barringtonia asiatica*, *Rhododendron quadrasianum* var. *intermedium*, *Palaquium philippinense*, *Clerodendron quadriloculare* and *Gardenia longiflora*. Others deserving mention are: *Cycas* spp., *Podocarpus costalis*, *Freycinetia* spp. (killed with tree felling), *Oryza* spp. (disappearing because of reclamation of offshore land), *Livistona* spp. (disappearing due to overlogging), *Zalacca clemensiiana* (endemic, very rare), *Calamus* spp. and *Daemonorops* spp. (over collection and many killed during felling of trees) and *Pinanga* spp. (endemic, eliminated by forest destruction).

Ceylon

Though there is no recent record of endangered plants and threatened habitats in Ceylon, the situation with respect to rare species is no better than elsewhere. Species known to have become very rare are: *Dendrobium macarthiae*, *Adansonia digitata*, *Rhynchosystylis retusa* and *Sphagnum zeylanicum*. There must be a number of others and a list of these is being prepared in the course of revision of 'Trimen Flora', which was started about a year ago (Abeywickrama 1969).

Burma

Some of the examples of rare or endangered plants from Burma reported by Sahni (1969) are: *Osteomeles anthyllidifolia* (rosaceous shrub), *Rosa gigantea* and *Lonicera hildebrandiana* (both characterised by flowers of extra-ordinary size) and *Amherstia nobilis* (one of the most beautiful trees in the world).

Indonesia

Examples of threatened species from Indonesia reported by Basjarudin (1968) are: *Rafflesia* (Sumatra, Kalimantan and Java), *Amorphophallus titanum* and *Rauvolfia* spp. (Sumatra and Java), many orchids like *Vanda*, *Dendrobium* and *Renanthera* and the flora of lowland forest of Udjung Kulon. Others reported by Sahni (1969) include: *Eucalyptus deglupta* (Rainbow Eucalyptus) a rain forest species which is one of the two or three *Eucalyptus* species not native to Australia and needs to be protected in its original habitat; *Rhododendron vanderbiltianum* (growing in association with pines and oaks at 2,000 to 3,000 m) and *R. taxoides*; *Dryobalanops* (a camphor yielding tree, a relic in Central Sumatra). There is also steadily increasing concern about the rapidity with which forests are disappearing in Borneo, especially in the limestone habitats (Richard 1969).

India

India presents widely varying climatic and edaphic conditions with equally wide variations in vegetation in different parts of the country, from stunted and scattered scrub in arid and semi-arid regions to luxuriant and multi-tiered vegetation in high rainfall zones. The forest types, therefore, range from dry deciduous and moist deciduous to giant tropical evergreen rain forests and lofty coniferous vegetation, with a number of intermediate and overlapping forms amongst them. Broad-leaved forests form the bulk of vegetation (94%) and represent about 41% of those of South-east Asia, while coniferous forests (6%) are about 7% of those of South-east Asia.

Forests in India occupy 75.3 million ha or about 23 per cent of the total land area. They have been under scientific management for over a century, being mostly State-owned; private forests represent hardly 1.7 per cent of the total. As much as 10 million ha or 13.3. per cent of the forests are located in hilly and mountainous regions where they are managed primarily for their protective role, thus ensuring preservation of indigenous flora without disturbance by commercial exploitation. The productive forests cover 65.3 million ha or 86.7 per cent of the forest area, of which 59.2 million ha or 78.6 per cent are merchantable.

The exploitation of merchantable forests is governed by silvicultural systems adapted to each forest type and the species constituting them, but in all cases the emphasis is on the maintenance and improvement of the productivity of the site and the locality factors. With due regard to climatic and geophysical features the silvicultural systems vary from selection to clear-felling and planting, the latter category being very much restricted (1.4 million ha or 1.7 per cent of the total forest area). Thus, the bulk of the forest continues to be managed as natural forest with due safeguards to preservation of indigenous flora.

Although nearly half of the varied and complex flora of India is endemic (endemism in dicotyledons is estimated at 47 per cent), there is still a fairly large non-endemic element (in the dicotyledons reckoned to be 38.5 per cent). This is not only due to the continuity of land which now exists through the middle East to the Mediterranean and European regions on the one hand and through Tibet to China and Japan on the other, but also due to long since vanished connections in previous geological eras when 'Gondwanaland' extended unbroken from Africa, through India to Australia. The flora of the Western Himalayas has a great affinity to that of Western Asia and Europe, and genera and species of China and Japan occur in the Eastern Himalayas; typifying the former are the yew (*Taxus baccata*) and *Juniperus communis*, and an instance of the latter is *Rhododendron formosum*. The tropical flora of North-eastern India is closely allied to that of the Burmese and Malayan region, many instances being found amongst the genera *Dipterocarpus*, *Shorea*, *Gardenia*, *Tectona*, *Elaeocarpus* and *Podocarpus* (a genus of broad-leaved conifers), as well as amongst tree ferns, bamboos, canes and vegetation of the tidal forests. *Casuarina* is representative of the Australian element; and *Tamarix*, *Zizyphus*, *Inula*, *Tecomella*, *Euphorbia*, *Acacia* and *Cenchrus*, of Western India are pointers to African affinities.

With respect to tree species of forestry importance there does not appear to be any species which is threatened to extinction as a result of exploitation. However, there are certain species which by virtue of their restricted or limited occurrence in specialised locations do need some attention to augment their proportion in the forest, both on scientific and economic grounds. Among these may be mentioned the following:

(1) *Ailanthus malabarica* which apart from being a good matchwood and plywood species yields oleo-resin (*Halmaddi dhoop*). It occurs in the tropical evergreen rain forests of the Western Ghats, from Konkan southwards. The resin is used as incense and in native medicine.

(2) *Dysoxylum malabaricum*. A large evergreen tree of the tropical rain forests of Western Ghats from North Kanara southwards. The wood is yellowish or light red, close grained, hard and elastic, and is a good ornamental timber, also used in matchwood and plywood and furniture. Its natural reproduction is not altogether satisfactory (Bourdillon & Tireman, 1921 quoted by Troup 1922).

(3) *Pterocarpus santalinus* (Red Sanders). This is a small to moderate sized deciduous tree with a very restricted natural range and found chiefly in the Cuddapah District (Andhra Pradesh) extending a short distance into the adjoining districts of Kurnool, North Arcot, and Nellore, with an outlier in the Kambakkam and Nagalapuram hills of Chingleput. Its principal home is in the Palkonda or Seshachellam hills of Cuddapah and North Arcot (Troup 1922). Its wood is extremely hard, dark red to almost black, largely used for carving and ornamental work and musical instruments for which it is much in demand as an item of export.

Though the above species, the list of which is only illustrative and not exhaustive, are not threatened with extinction it is essential that their regeneration and stocking is augmented to offset any chances of becoming rare in future.

Amongst the herbaceous and shrubby plants, mention may be made of medicinal plants, particularly those which have come into prominence recently and are much sought after by private agencies as well as pharmaceutical firms. These include *Rauvolfina serpentina* and *Dioscorea* spp. Equal attention needs to be paid to the protection of orchids and ferns which are often subject to intensive collection. According to Sahni (1969), the most outstanding rare or endangered plants in India appear to be *Balanophora involucrata*, a fleshy fungus-like parasite, *Sapria himalayana*, a remarkable parasitic plant with deep crimson flowers, *Rhododendron edgeworthii*, an ornamental epiphyte in the Eastern Himalayas

Symplocos chengapae, a handsome ornamental tree comparatively new to science, and *Entada pursaetha* of Malabar, Assam, etc.

Rau (1969) has also proposed protection of certain important botanical curiosities, plant groups and individuals of purely floristic and scenic interest. In this respect, the importance of the orchid belt of North-eastern India as well as localities of insectivorous plants, *Nepenthes* and *Aldrovanda* and the curious pitcher plant, *Dischidia*, are suggested for special protection. The epiphytic orchids of Western Himalayas, together with the enchanting alpine vegetation, also deserve this.

Pacific Islands

There is great concern for the biocoenosis of the Pacific Islands as these islands harbour a most unusual flora on land specks in an immense expanse of ocean. Fosberg (1949), Hurlmann (1959, 1969) and Steenis (1965) have given short accounts of the threatened species and endangered habitats which fall outside the scope of this paper.

CONSERVATION OF HABITATS AND SPECIES

While what has been mentioned earlier may present a rather pessimistic picture of man's impact on vegetation, and in fact on all our natural resources, it is not wholly so. It has to be appreciated that natural resources were not resources at all until man was both present and able to make use of them. The ability to identify, reach and use natural resources has been a continuous process for man, ever since the beginning of civilization. His impact is not to be thought of as being wholly destructive because certain man-modified habitats definitely represent altered ecosystems of greater production and wealth-building power than the natural conditions. The need of the day, particularly in the developing countries, is for better living and prosperity of their people, provided the continued availability of the resource is ensured in perpetuity. In that case it will be in consonance with the definition of conservation which is 'rational use of earth's resources to achieve the highest quality of living for mankind' (IUCN 1968).

Irrespective of the mistakes that may have been made in the past and the accelerated developments taking place, man has already realised the need for conservation and has tried to solve the problem of habitat deterioration and species extinction. New ways of thinking and changing technology give us the opportunity to build and rebuild an environment which provides aesthetic values and goods and services.

While the developmental programmes in the developing countries have to go on—because the increasing population has to be fed and people have to be prosperous and given a better living after centuries of static and subsistence living—what is really needed is the creation of sizable nature reserves for scientific, scenic, recreational and educational values. The need of the day is not merely the protection of the individual plant species but of ecosystems (both communities and habitats) and nature reserves would serve that purpose.

Survey

It is imperative that an intensive vegetation survey of all the endangered species and threatened habitats is carried out and action initiated for their preservation through the cooperation of the different Departments of the countries concerned and other International organizations interested in the matter. In fact steps need also to be taken for the preservation of those ecosystems which though not threatened at the moment may be so in the near future because of accelerated developmental programmes launched by the developing countries.

Nature Reserves and National Parks

As mentioned above the preservation of natural flora and fauna would be achieved to a large extent with the establishment of sizable and adequate Nature Reserves and National Parks in different vegetation types in each country. The need for nature reserves and national parks has been emphasized time and again by international organizations like the International Union for Conservation of Nature and Natural Resources (IUCN), UNESCO, etc. The Commonwealth Forestry Conference made emphatic recommendations

to this effect (Talbot & Talbot 1968; Anonymous 1968). The organization and the utilization of such nature reserves and parks in the South East Asian tropics was also discussed at some length at IUCN Conference held at Bangkok in 1965 (Brooks 1968).

Such permanently safeguarded sites, in addition to serving the cause of conservation and outdoor recreation, would provide permanent field biological laboratories for future fundamental scientific work as also biotopes for three main applied scientific purposes, namely: (1) study of the processes that take place under natural conditions within such ecosystems for a better understanding to help future natural resources economics and management; (2) preservation of natural flora and fauna as gene pools for future use coming about through technological advances, and as breeding stock for producing the new gene combinations required in the future; and (3) as controls in the study of areas now under management and to sustain and stimulate better conservation education.

It is gratifying to note that almost all the countries in South East Asia have established a number of national parks and nature reserves to serve the above purposes and many more are proposed. The establishment of Virgin Jungle Reserves (VJR) by the Forest Department of Malaysia is also a welcome step in this direction. Undoubtedly the existing reserves are not enough and there is need for more national parks, and nature reserves. The existing reserves also need to be better maintained and put on a permanent legal footing. In this respect the importance attached by IBP (International Biological Programme) to conservation of ecosystems in both disturbed and undisturbed sites is shown by the provision of a special section (CT) on the conservation of terrestrial communities.

Preservation Plots

These are ecological plots laid out in various representative forest types in demarcated forest areas, set aside in perpetuity for the preservation of forest with no human interference beyond what is needed for its maintenance and protection. The sole object of the plots is to preserve and develop the natural vegetation to its climax without human interference. These plots are miniature nature reserves for purposes of scientific study and the preservation of primary vegetation and are of great value as biological banks of germplasm of various indigenous species apart from preserving the identity of original vegetation.

In India, the need for establishing these preservation plots was felt very long ago and the oldest date back to 1914. At present these plots are maintained in almost all the vegetation types of the country, down to the District level. The recommended size of these preservation plots is generally 4 hectares.

Protected Trees

Protected trees are selected specimens maintained in order to preserve (1) outstanding examples of forest trees, and (2) trees of special botanical interest. Here again, in India, protected trees have been maintained in almost all the forest types of the country.

Botanical Gardens and Arboreta

It has been proposed to have living collections of threatened species in one or more Botanic Gardens and to distribute the living material to other botanical gardens in the world for scientific studies (Steenis 1965). It would mean propagating species and keeping them in cultivation, which may not be always easy, though we have species like *Ginkgo biloba* and *Franklinia alatamaha* which owe their present existence to long cultivation (Fosberg 1949).

Role of International Organizations

The role of various International organizations with regard to conservation of habitats and species has been commendable and in this respect mention needs to be made of the International Union for Conservation of Nature and Natural Resources (IUCN), International Biological Programme (IBP), United Nations Educational, Scientific and Cultural Organisation (UNESCO), Food and Agricultural Organisation (FAO), and World Wildlife Fund (WWF).

It is the purpose of the IUCN 'to promote or support action which will ensure the perpetuation of wild nature and natural resources on a world-wide basis, not only for their intrinsic, cultural or scientific values, but also for the long term economic and social welfare of mankind'. For this purpose the IUCN has been organizing active programmes in cooperation with other international agencies. These are too well-known to be listed here. The South East Asia Project on Wildlife Resources and Parks was organised in 1963 involving about ten countries of the region and various aspects of the project have been carried out in close coordination with FAO, UNESCO, UNTAB and the IBP. The first stage of the project—field missions—has been completed with creditable achievements. The first Regional Conference on Conservation of Nature and Natural Resources on Tropical South East Asia was held at Bangkok in 1965. This Conference keynoted the problems and importance of conservation in South East Asia and the special relationship and concern of their respective organizations in the region.

With regard to the conservation of terrestrial communities (CT) the International Biological Programme (IBP) has an important role to play in providing a scientific basis for conservation activities. We still require a great deal of basic information on ecosystems for action-oriented programmes in forestry, agriculture, fisheries, outdoor recreation and land-and-water use capabilities.

A world network of research reserves, representing the major ecosystems of the world, which IBP aims to set up, would serve as check areas or yardsticks for use and management of comparable areas under intensive use. These protected areas would also serve as reservoirs of genetic materials which may be of scientific and economic value in the future.

Reports from South East Asian countries on the status of IBP show that a number of countries in the region (Philippines, Thailand, Indonesia, Malaysia, India, etc.) have set up National Committees for the IBP and started undertaking different projects (Editorial 1967; Kadarsan 1968; Steenis 1969). This is a welcome step for the conservation of habitats and species.

Ever since its early days, UNESCO's science programme (Anonymous 1968b; Mills 1968) has been concerned with problems relating to the natural environment and natural resources. One of the first landmarks in these activities was the establishment of IUCN in 1948 under UNESCO's auspices. The arid zone research programme which has been probably the most spectacular, was launched towards the end of 1948, while the humid tropics research programme was started in 1954. Almost since the establishment of UNESCO's Regional Centres for Science and Technology for South Asia and Southeast Asia, Conservation, in its broadest sense, has been a very important aspect of the work in these regions. UNESCO's humid tropics programme has included a series of symposia on problems relating to humid tropics vegetation and ecology, with principal emphasis on rational use and conservation of natural resources. In addition a series of Botanical Training Expeditions devoted to the study and collection of humid tropics vegetation have been organized, with the active cooperation of Southeast Asian countries.

FAO's interest in Conservation of Nature and Natural Resources in Asia-Pacific region has been equally great, with about 240 field projects operating in 1965-66 in 14 countries in the region. In view of the urgency of the problem, FAO convened a Technical Conference on Exploration, Utilization and Conservation of Plant gene Resources in 1967. The Conference recommended, *inter-alia*, (1) programme of plant exploration and collection (2) surveys of threatened or essential plant materials and (3) existing institutes to serve as centres for training and actual programme of plant exploration and collection. FAO is also collaborating in various projects being executed by the IBP.

The World Wildlife Fund (WWF) aims at supporting conservation of nature in all its forms (landscape, soil, water, flora and fauna) by raising funds and allocating them to projects, by publicity and education of general public and younger generations in particular. Among WWF projects, financial support for IUCN and International Council for Bird Preservation (ICBP) have the highest priority, in order to enable these bodies to build up vital scientific and technical basis for world conservation and specific projects. Other projects cover a very wide range of subjects from education, ecological studies and surveys, to the establishment and management of areas as national parks and reserves and emergency programmes for safeguarding of animal and plant species threatened with extinction. The WWF is particularly interested in these aspects of natural

resources which are threatened in South East Asia. During the period 1961-1965 the Fund has supported 127 projects and quite a number of these have been operating in South East Asia. It is expected that many more projects will be supported in this region in future (Scott 1968).

Role of Forest Services

The Forest Services of the various countries have successfully played a positive role in the conservation of floral and faunal habitats and species. This is reflected not only in their policies, laws and management, but also in the fact that the very foundation of management of forest lands is conservation. In India, the Forest Service of the country, which is now over a century old, has been a pioneer in conservation of habitats and species and has been constantly alive to this problem; this has been the case in other countries too. The Forest Services in most countries in the region have been responsible for the establishment of nature reserves and national parks, preservation plots and protected trees, botanical gardens and sanctuaries. They have also been responsible for enactment of suitable legislation for the regulation and management of forest lands and wildlife and the preservation of threatened habitats and rare flora and fauna. It is in fact encouraging to note that in almost all the countries covered in this paper suitable legislation exists, though it often needs to be better enforced.

The Indian Board for Wildlife and the Central Board of Forestry have contributed effectively towards wildlife and nature conservation and public consciousness about natural resources. Nature conservation education now finds a proper emphasis at all stages of schooling so that a student can learn to understand the nature conservation concept and practice it in later life. It is realised that conservation of resources has to become a part of thinking in the people and the movement has to begin with school children. The Central Board of Forestry, which is the highest forest policy making body in the country has very successfully played a positive role in this field.

Role of Other National Agencies

The role of various other organizations in different countries is of equal importance to the attainment of the present status of conservation of habitats and species. In India the Bombay Natural History Society, Friends of Trees, Birds Watchers Field Club of India, Wildlife Preservation Society of India, Wildlife Club of the Forest Research Institute, Dehra Dun, Nilgiri Wildlife Association and Society of Indian Foresters and other bodies have maintained a sustained effort through various publicity media to achieve this goal. The Malayan Nature Society (Malaya and Singapore) has been aiming for many years to conserve representative samples of each habitat and type of vegetation (Medway & Balasingam 1968; Wycherley 1969). The Batu Caves Protection Association (Malaysia) has been seeking the dedication of Batu Caves as a nature reserve and a national monument (Wycherley 1967). The various private conservation organisations in the Philippines like Society of Filipino Foresters, Philippine Chamber of Agriculture and Resources, Conservation Committee of the Philippine Constitutional Society, Philippine Hunters' Club etc. are all aiming at conservation of habitats and species. The boy scout movement in the Philippines is very effective and its objectives include conservation (Anonymous 1968a).

CONCLUSION

Preservation of all types of flora and fauna, in fact of all natural resources, is imperative not only for the progress and prosperity of man but also for his very existence. On the other hand, the pressing needs of a diversified economic development make the human manipulation of natural ecosystems equally inescapable. It is, therefore, essential that a judicious integration and harmonious blending of the various objectives and national requirements is achieved through a careful study and understanding of biogeocenotic relations of flora and fauna. Undue emphasis on any one aspect is bound to adversely affect the others. Therefore, a combination of objectives, as advocated in the concept of multiple use of forest and related lands, appears to be the most practical and workable proposition. In any case, the strict preservation of representative samples of flora and fauna in different habitats is absolutely essential.

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**XIth Technical Meeting of IUCN
Third Session: Part 4, Plants.**

SUMMARY OF DISCUSSION

Dr Silas called for greater co-operation between animal and plant conservationists. Most sanctuaries and National Parks in India had been created primarily to protect animal species. Many of them, however, undoubtedly contained threatened plant species and he recommended that inventories of these species be undertaken in reserved areas and that much greater attention be paid to their protection. New sanctuaries would clearly be required to protect those species which did not occur in reserved areas at the present time. In addition, he recommended careful scrutiny of provisional lists of threatened plant species to ensure that they did, in fact, satisfy the criteria for Red Data Book status.

Mr Scott stated that he was shocked at the numbers of plant taxa that had disappeared in recent years. He hoped that the publication of the first plant volume of the Red Data Book, in 1970, and conferences such as this one, would focus attention on this serious problem. He considered that there was an urgent need for botanical gardens in different Phytogeographical regions, which should bear the principal responsibility for the establishment of seed banks, and cultivation and propagation of threatened species.

Dr Mitra endorsed the views of other speakers on the need for, and future roles of botanical gardens. He was of the opinion that greater attention should be directed to curbing the activities of professional plant hunters, who were the greatest menace to the survival of many indigenous species such as orchids and medicinal plants.

Dr. Santapau firmly supported the statement that National Parks and equivalent reserves were intended to protect plant as well as animal species. These resources should not be commercially exploited and under no circumstances should exotics be introduced into these reserves.

Appendix

SURVIVAL SERVICE COMMISSION

Minutes of an open meeting of the Commission held in Committee Room B of the Vigyan Bhavan, New Delhi on the evening of Saturday, November 29th, 1969, commencing at 1815 h. to consider:

Conservation Projects for Threatened Species in South Asia

Present: The Chairman and eleven members of the Commission, together with a number of local and overseas delegates attending the 10th General Assembly of IUCN. Fifty-four persons were present at the close of the meeting.

SSC. O 69/1 Breeding Stock of Asiatic Lion

Mr Fitter considered that there was a need to increase the number of captive breeding units of Asiatic lion. The African lion bred readily in Britain and, if the proposal had the approval of the Indian delegates present, the Fauna Preservation Society were prepared to finance the establishment of a captive breeding unit for the Asiatic lion in the United Kingdom. Mr Joslin supported this proposal; there were some 67 Asiatic lions presently held in Indian zoos. About 30 animals had been bred in captivity but this figure included the progeny of African and Asian cross-breeding. Certain European and North American zoos, such as London, Prague and Detroit, were interested in breeding Asiatic lion and advantage should be taken of this enthusiasm. It was most important to keep the stocks pure. Surplus animals could be used for re-introduction in the wild.

Mr Arjan Singh pointed out that the lions re-introduced into Chandraprabha forest in Uttar Pradesh had now disappeared without trace. Dr Leyhausen considered that captive-born lions re-introduced into the wild lacked hunting skill and required training before release. It was stated that deterioration of musculature had been demonstrated in captive animals, and a number of delegates considered that money spent on captive breeding would be better employed in protecting the species in the wild and that only wild animals should be used for re-introduction.

After further discussion, however, it was agreed that future improvements in techniques could overcome the present difficulties of re-introducing captive stock into the wild, that captive breeding was a valid means of ensuring against possible extinction of a species, and that advantage should be taken of the Fauna Preservation Society's offer. Mr Fitter's proposal was therefore approved, with the recommendation that adequate provision should be made to maintain purity of the breeding stock.

SSC. O 69/2 Conservation of Pygmy Hog in Assam

The Secretary of the Commission summarized the background to this subject. A report had been received on the existence of a sounder of pygmy hog in a forest area in Assam. The forest was said to be threatened by exploitation. The Hon. Director of the Jersey Wildlife Trust had offered to finance an expedition to capture a group of these animals for captive breeding. It was virtually impossible however to make any recommendation until the exact location and status of the habitat were known. The Commission's original informant, Captain Tessler-Yandell, had sent no further report, but Mr M. J. S. Mackensie hoped to make contact with him and to visit the area in February. Unless any delegate had comments to make on this subject, it was recommended that further action should await Mr Mackensie's report.

Mr Stracey commented that pygmy hogs were exceptionally difficult to locate and that few people in Assam had ever seen one. He recommended that any plans for their conservation should involve the co-operation of the Forest Department in Assam. The Secretary agreed to keep Mr Stracey informed of developments.

SSC. O 69/3 Rehabilitation of Cheetah in India

The Chairman outlined Mrs Joy Adamson's proposal for the introduction or re-introduction of cheetahs into some appropriate area in India, in which a group of cubs would be maintained in the wild, but would be kept under human observation and provided with meat for the first nine months or so. She estimated that four and a half years would be required to produce two breeding generations of cheetahs.

Dr Schaller considered that this project should be rejected, partly because he questioned the efficiency of the technique, but, more particularly, because there was presently no suitable area in India in which cheetahs could be introduced. In Africa, he had followed a cheetah with cubs for 26 consecutive days during which she had killed 21 Thomson's gazelles and 1 hare. He doubted if any region in India had a sufficiently high natural prey population to sustain this rate of killing.

The Point Calimere Sanctuary was rejected as a possible re-introduction site because the principal prey species, the blackbuck, was also a seriously depleted species. Similarly, the Andaman Islands were rejected because a rain forest area was not considered to be a suitable habitat for cheetah. Mr Fitter considered that it would be wrong to apply to Iran for Asiatic cheetah for re-introduction into the Indian sub-continent, because the Iranian cheetah population was already dangerously low. In fact, the Felidae specialists who were present considered that there were no distinguishing features between the African and Asian animals and that there was no objection, on these grounds, to introducing African cheetah into India.

It was agreed to reject the project.

SSC. O 69/4 Study and Conservation of the Hangul:

The Secretary reported that the World Wildlife Fund proposed to give high priority to the project to send an ecologist to Kashmir, in February 1970, to organize an accurate census of the hangul, or Kashmir Stag, and to prepare a simple management plan for Dachigam Sanctuary.

Mr Wani, the Game Warden, Srinagar, welcomed the proposal and confirmed his Government's support for the project. He stated, in answer to an inquiry, that steps were being taken to increase the penalties for poaching hangul.

SSC. O 69/5 Conservation of the Tiger in India:

The Chairman read a letter from Mrs Anne Wright, which raised the following subjects:

- (1) Although the export of tiger skins from India is banned, any tourist can take one out in his luggage as a 'personal trophy'. The Indian Board for Wildlife had recommended that each trophy should be accompanied by a letter from the local Divisional Forest Officer, stating where the animal was shot and by whom. It was understood that this recommendation had been accepted officially, but the Customs Officials in Calcutta, for example, had not been informed and no checks were made.
- (2) Many shops in Calcutta, and elsewhere, were offering tiger skins, which had almost certainly been poached, for sale to tourists; It was recommended that skins offered for sale should also be certified by D.F.O.'s in the same manner as for personal trophies.
- (3) Large numbers of tigers were still being shot in some States. Mr Imman's article in the IUCN Special Issue of 'Cheetah' (Vol. 12 No. 1 1969) recorded high kills within a small radius of forest. It was recommended that much stricter control should be exercised over Shikar Companies and the numbers of animals that they killed.

An involved discussion followed between officials of the Forest Department and other delegates, on the control of tiger skin exports from which the following salient points emerged:

The commercial export of tiger skins from India was totally banned on August 15th 1968. Individual skins may still be taken out of the country in accompanied baggage. Following the Indian Board for Wildlife's recommendation in July 1969, the Government ordered that no more tiger skins were to be exported by tourists, without certified proof of origin. It has proved impossible to implement this ruling, however, without the registration of all

stocks of trophies presently held by shopkeepers and others. Although customs and excise were controlled by the Central Government, wildlife was a State matter and State legislation was required before owners could be compelled to declare trophies, and local and overseas trade in skins could be controlled. The Inspector-General of Forests informed the delegates that consultations were being held with the Ministry of Trade to find a means of circumventing the present impasse, although at the present time, he could not divulge the details. The suggestion that the Government should compensate shopkeepers for their old stocks of tiger skins was rejected as impracticable—so many private individuals owned trophies, which could be subsequently offered for sale. It was finally agreed to recommend that the Indian Government should publish a moratorium on tiger skins to the effect that all trophies that were not registered within six months would be liable to confiscation. New trophies acquired after the closing date of the moratorium would require immediate certification.

On the conservation of the tiger in the wild, many delegates pointed out that, regardless of current speculation on actual populations, there was no doubt that the tiger in India was being subjected to considerable pressure. Numbers were being seriously reduced by loss and degradation of habitat, poaching, and shooting and poisoning in cultivation areas, supposedly in defence of life and domesticated stock. It was confirmed that thirty-four tigers had been poisoned in Madhya Pradesh, for example, and it was unanimously agreed to recommend to the Indian Government that poisoning of tigers, on any pretext, should be banned. It was also recommended that claims to the effect that certain tigers were man-eaters or confirmed stock thieves should be thoroughly investigated before permission to kill them is granted. Many delegates requested a complete ban on shooting until competent investigation had revealed the true status of the tiger. State legislation would be required to implement a total ban on hunting in all areas, but three States, in which tigers still existed, already had the necessary laws, and it was recommended that pressure should be exerted on the remainder to follow suit. The Inspector-General of Forests stated that, whilst he could make no commitment at the present time, an application to the Forest Department to ban tiger hunting in Forest Reserves would be sympathetically considered.

Dr Leyhausen strongly urged much closer control, or a complete ban, on tiger hunts in Assam. As far as the skull is a measure of animal size, it was not the Siberian tiger that produced the largest specimens of the species, but the Assam tiger. As hunters always shot the biggest animals there was a real danger that the race would be exterminated.

It was appreciated that a tiger hunting ban might cause initial financial loss to the Government and Shikar Companies, but it was considered that the latter could switch to photographic safaris, which would probably appeal to a much wider range of tourists. It was recommended that the Survival Service Commission should appoint a Specialist Group to stimulate collection of data on tigers and other rare or depleted Felidae.

Mr Fitter recommended that the nominate race of the tiger should be added to the Red Data Book. Many delegates agreed, but Dr Schaller pointed out that if the range of the nominate race extended into Indo-China, as it probably did, it could not be regarded as a world threatened species and was therefore ineligible. Mr Joslin suggested that rate of decline was of more significance than total numbers, however, and the meeting agreed to record a strong recommendation that the nominate race of the tiger be included in the Red Book.

SSC. O 69/6 Red Data Book Status—Asian Animals:

Various delegates recommended that the following animals should be considered for Red Data Book Status:

Liontailed macaque	<i>Macaca silenus</i>
Stumptailed macaque	<i>Macaca speciosa</i>
Golden langur	<i>Presbytis geei</i>
Rusty spotted cat	<i>Felis rubiginosa</i>
Possibly all races of the Markhor	<i>Capra falconeri</i>
Musk deer	<i>Moschus moschiferus</i>

Dr McClure recommended that the new species of Swallow described in Thailand should also be included in the Red Book. Mr Ranjit Singh stated that he had a whole list of animals for consideration—if some of them could not be included in the Red Book, they should, at least, be removed from the vermin list!

The Chairman requested all delegates who had recommended new additions to send notes on the status of the animals, preferably under similar headings to those used in Red Data sheets, to the Survival Service Commission (c/o UICN, 1110 Morges, Switzerland). This information would be forwarded to the compilers of the appropriate Red Data Book volume for consideration.

The meeting approved Mr Ranjit Singh's suggestion that India should compile its own Red Book of nationally threatened species. Mr Perry recommended that Mr Harry Goodwin should prepare a statement on how the United States Red Book is compiled, for circulation to interested countries.

The meeting closed at 21.30 hours.

Index

CONTRIBUTORS OF PAPERS AND TO THE DISCUSSIONS

Figures in heavy type refer to the page numbers of Papers

ALVAREZ, J. B.	46-51, 68-73
ARJAN SINGH	52-56 , 57, 128
BEHURA, B.K.	82
BISWAS, BISWAMOY	82
DANIEL, J.C.	75-76
DHARMAKUMARSINHJI, K. S.	74
FITTER, R.S.R.	128, 129, 130
GLASGOW, L.L.	82
GUPTA, P.D.	63-67 , 74
HOLLOWAY, C. W. (Sec. S.S.C, Editor)	9,128,129
JOSLIN, P.	24-33 , 57, 128, 130
KAUL, O.N.	115-126
LEYHAUSEN, P.	128, 130
McCLURE, H.E.	82, 131
MAHESHWARI, J. K.	89-94
MELVILLE, R.	103-107
MISRA, R. N.	77-81
MITRA, S.N.	127
MOUNTFORT, G.R.	57
ODEND'HAL, S.	57
PATEL, Mrs Almitra H.	57
PERRY, J.	131
PRAKASH, MAHENDRA	82
QURESHI, I.M.	115-126
RANJIT SINH	131
RIPLEY, S. Dillon	37,74
SAHNI,K.C.	95-102
SALIM ALI	58-62
SANKHALA, K. S.	34-45
SANTAPAU, H.	83-88 , 127
SAVAGE, C.D.W.	74
SCHALLER, G.B.	11-23 , 57, 129, 130
SCOTT, P.M. (Chairman)	74, 127, 129, 131
SEVERINGHAUS, S. R.	57
SILAS, E. G.	127
SIMON, N. S.	11-23
SONI, R.C.	57, 130
SPURWAY, Mrs Helen	57
SREEMADHAVAN, C. P.	108-114
SRIVASTAVA, P. B. L.	57
STRACEY, P. D.	57, 128
SUBRAMANYAM, K.	108-114
TIWARI, K. K.	82
VIJAI SINGH	