Kemp's Ridley Turtle or Atlantic Ridley

Lepidochelys kempi

P. C. H. PRITCHARD & RENÉ MÁRQUEZ M.

IUCN MONOGRAPH NO 2 : MARINE TURTLE SERIES

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compiled by
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Foreword

This volume is the second in a series of publications by the International Union for Conservation of Nature and Natural Resources entitled 'IUCN Monographs', which will present scientific treatises on subjects of special concern to the conservation of the world's natural resources. It is also the second in a series of papers on sea turtles which are being prepared by the Marine Turtle Specialist Group of the IUCN's Survival Service Commission, the first being entitled 'The Leatherback or Leathery Turtle *Dermochelys coriacea*', also by Peter C. H. Pritchard and published by IUCN in 1971.

One of the principal functions of the IUCN Marine Turtle Specialist Group is to collect and disseminate scientific information on sea turtles, both to stimulate further research into their biology and to provide a basis for more effective management. IUCN is confident that the publication of this latest monograph on Kemp's Ridley (*Lepidochelys kempi*) will do much to further these aims.

Other monographs on the sea turtles are in the course of preparation, but in view of the recent publication of Dr. H F. Hirth's* monograph on the green turtle (*Chelonia mydas*), it is unlikely that a monograph on this species will be published in the present series, at least in the foreseeable future.

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* Hirth, H. F. 1971 Synopsis of biological data on the green turtle *Chelonia mydas* (Lynnaeus) 1758. FAO Fisheries Synopsis No. 85; i-iii, 1 : 1-8 : 19. Rome.

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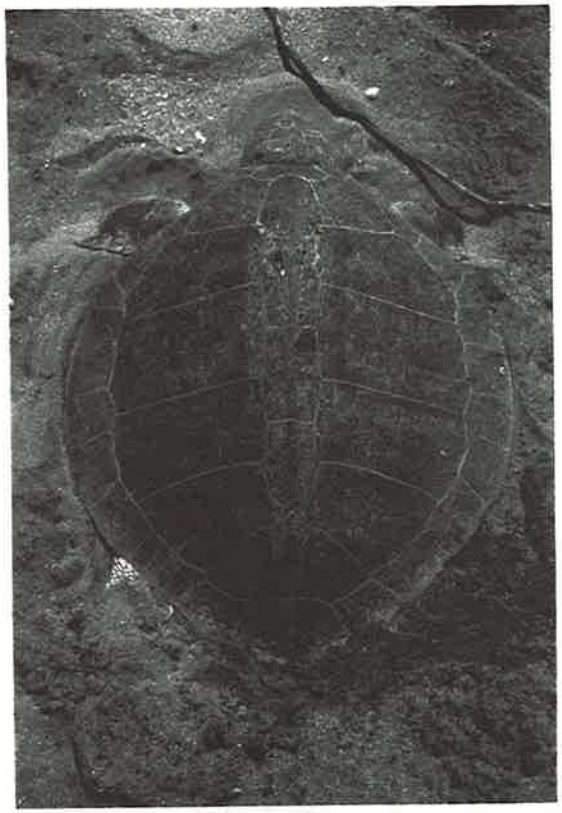


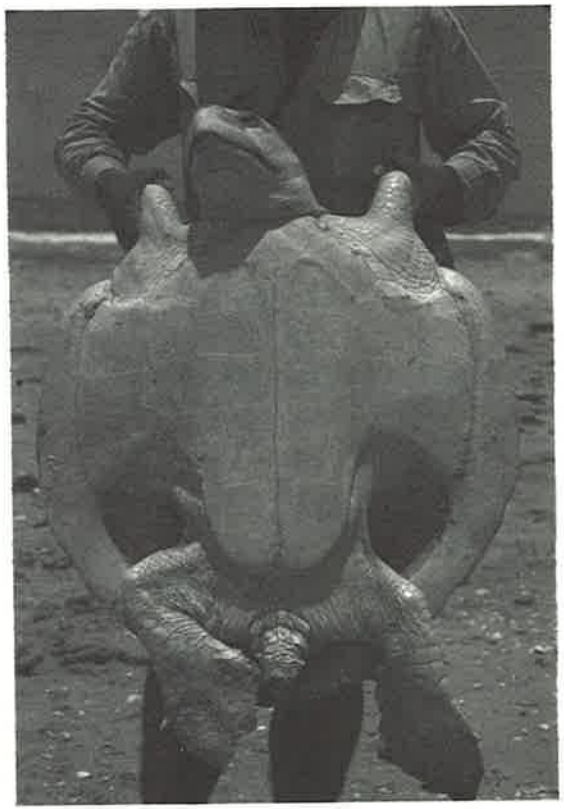


PLATE I

Lepidochelys kempi — Kemp's Ridley turtle, adult female: dorsal and ventral views. Rancho Nuevo, Tamaulipas, Mexico. *Photographs by Peter Pritchard*

PLATE I

Lepidochelys kempi — Kemp's Ridley turtle, adult female: dorsal and ventral views. Rancho Nuevo, Tamaulipas, Mexico. *Photographs by Peter Pritchard*

SYNONYMY

1880 *Thalassochelys* (*Colpochelys*) *kempii* GARMAN, Bull. Mus. Comp. Zool. Cambridge, 6: 123; Key West, Florida (Smith & Taylor 1950)

1889 *Thalassochelys kempii* BOULENGER, Cat. Chelon. Rhynchoceph. Crocod. Brit. Mus.: 186.

1890 *Lepidochelys kempii* BAUR, Amer. Natural., New York, 24: 487.

1909 *Caretta kempi* SIEBENROCK, Synopsis der rezenten Schildkröten. Zool. Jahrb., Suppl., 10: 427-618.

1930 *Colpochelys kempi* DERANIYAGALA, The Testudinata of Ceylon. Ceylon Jour. Sci. Sec. B, 16: 43-88, pls. 7-13.

1939 *Caretta kempi* STEJNEGER & BARBOUR, A check list of North American amphibians and reptiles. Cambridge, Mass., Harvard Univ. Press. 4th. Ed. Pp. i-xvi, 1-207.

1942 *Lepidochelys kempii* CARR, Notes on sea turtles. P oc. of the New England Zool. Club, XXI, Pp. 1-16, pls. 1-4.

SUBSPECIES

None, although this species is sometimes considered a subspecies of the Pacific or olive ridley *Lepidochelys olivacea*, for example by Schmidt (1953) and Loveridge and Williams (1957). Arguments for full specific status for *kempi* are presented by Pritchard (1969).

COMMON NAMES

Kemp's ridley (preferred); Atlantic ridley; ridley; bastard turtle; mulatto turtle; Mexican ridley; Kemp's loggerhead; Mexican loggerhead; Bastardschildkröte (German); Bastardschildpad (Dutch); Tortue bâtarde (French); Tortuga bastarda (Cuba); Tortuga lora (Mexico); Cotorra (Mexico); Caguama (Mexico).

DESCRIPTION

Kemp's ridley is a small sea turtle with a flattened and exceedingly broad carapace — in many immature individuals the carapace is about as wide as long. The head is rather large and triangular in shape when viewed from above. The orbits are rather small and the jaws are massive, with longitudinal ridges on both the bony and the horny surfaces. Hatchlings are dark grey-black in color, often with traces of white on the umbilical prominence and on the plastral ridges. As the turtle grows, the plastron loses its dark pigment, becoming white in immature specimens and yellow as maturity is approached. The dorsal surfaces also become lighter with growth, and in the adult are olive-green in color, though half-grown specimens are usually grey (but sometimes brownish or blackish) dorsally, and very old specimens may revert to a grey color. The carapace surface is composed of five central (vertebral) scutes, five pairs of costal (lateral) scutes, twelve pairs of marginal scutes, a single nuchal, and a pair of supracaudals. Variations from this condition are comparatively rare, but there may on occasion be an extra central (usually intercalated between centrals IV and V), an extra costal (rarely an extra one on both sides), or an extra marginal on one or both sides. The plastron consists of paired gular,

humeral, pectoral, abdominal, femoral and anal scutes; an interanal may be present, and there may be one or two intergular scutes. There are nearly always four pairs of intramarginal scutes, each of which is perforated near its hind margin by a pore which penetrates deep into the bone. Kemp's ridley has a well-ossified shell, with no open fontanelles between the distal ends of the ribs in mature specimens. The front flippers are relatively short, and each bears only a single visible claw in mature specimens, though hatchlings show a very small distally-located second claw on each foreflipper.

Kemp's ridley may be distinguished from the olive ridley (also known as the Pacific ridley) by the presence of only five pairs of costal scutes – a condition which only obtains in a very small percentage of olive ridleys, the usual count for that species being between six and nine on each side. Kemp's ridley also has a heavier, more flattened and relatively wider carapace, with the mid-marginal scutes about as wide as long (much longer than wide in *olivacea*). Kemp's ridley has smaller orbits, and a much more solidly constructed skull, than *olivacea*, and has alveolar ridges not only on the rhamphotheca but also on the underlying bone. The lower jaw too shows numerous differences between the two species (see Pritchard 1969: 90 for further details).

Kemp's ridley is easily distinguished from the loggerhead (*Caretta caretta*) by the olive-green or greyish dorsal coloration (red-brown in the loggerhead), smaller adult size (carapace length less than 30" (76.2 cm) for ridleys, up to about 48" (122 cm) for loggerheads), broader shell (width averages 95-97 percent of carapace length in mature *kempi*, much less in *Caretta*), much smaller head (about five inches (12.7 cm) wide in adult *kempi*, up to about ten inches (25.4 cm) wide in *Caretta*), and the presence of a single, long scale beneath each side of the lower jaw (usually three scales occupy this area in *Caretta*). *Caretta* also typically has only three inframarginals on each side, which are not perforated by pores.

Lepidochelys kempi is immediately distinguishable from *Chelonia* and *Eretmochelys* by the presence of five costal scutes on each side of the carapace (four in *Chelonia* and *Eretmochelys*), and the rather large, broadly triangular head (small and rounded in *Chelonia*, small and pointed in *Eretmochelys*).

SIZE

Kemp's ridley and its relative the olive ridley are the smallest of the sea turtles. Two hundred and three mature females measured on the nesting beach by Chavez *et al.* (1967: 13) ranged in carapace length from 23.4 inches to 29.5 inches (595 to 750 mm); average carapace length was 26.4 inches (646.4 mm). Carapace width ranged from 22.2 inches to 28.6 inches (565 to 725 mm), with an average of 24.6 inches (624.2 mm). Weights of 17 mature females ranged from 86 to 108.5 lbs (39 to 49.3 kg). Márquez (in press, a) reported a slightly smaller mature female, 580 mm long and weighing 32 kg. Ridleys of mature size are found in coastal waters of the western half of the Gulf of Mexico, but the population on the west coast of Florida is composed of smaller individuals; these range in carapace length from 10.25 inches to 25.5 inches (26.0 to 64.7 cm), and in weight from 7 lbs. (3.1 kg) to 58.5 lbs (26.5 kg) (Carr and Caldwell 1956). The disproportion between the 63 cm, 39 kg specimen from the Tamaulipas nesting beach and the 64.7 cm, 26.5 kg largest specimen from Florida is striking, but is presumably attributable to oscillations in weight during different phases of the reproductive cycle. For example, a season's eggs may easily weigh 8 kg, and it is also likely that a ridley will metabolize several kilograms of fat in the course of its breeding migration.

State	Sex	Total length (mm)	Carapace length (mm)	Max. width (mm)	Head length (mm)	Head width (mm)	Total weight (kg)
Veracruz	male	930	720	610	180	—	39.0
Veracruz	male	890	660	595	165	—	38.5
Tamaulipas	male	880	660	630	170	140	33.0
Tamaulipas	male	730	535	550	150	115	19.5
Tamaulipas	female	780	580	550	110	—	32.0
Tamaulipas	female	940	710	680	170	140	42.0
Tamaulipas	mean of 281 females	880	650	620	171	131	38.9

Growth rates for Kemp's ridley have been investigated by Márquez, using captive hatchlings and observing season-to-season increases in tagged adult females. These data, which are presented in figs. 1 to 3, suggest that first maturity is reached after about six years.

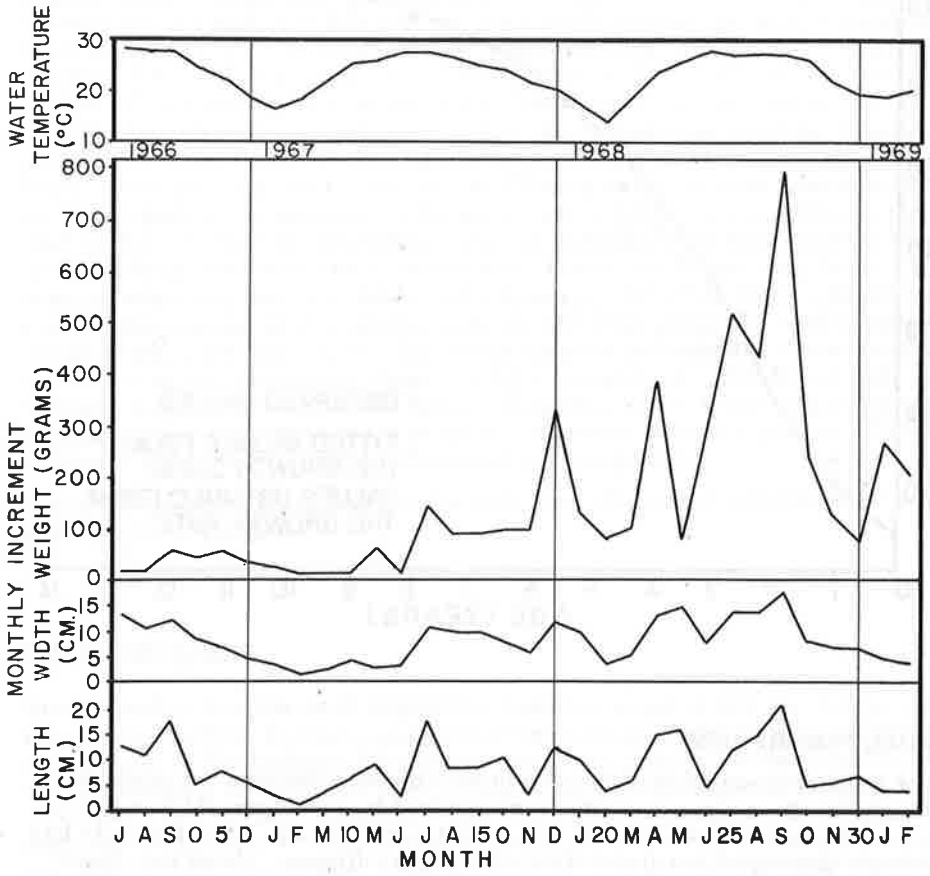


Fig. 1

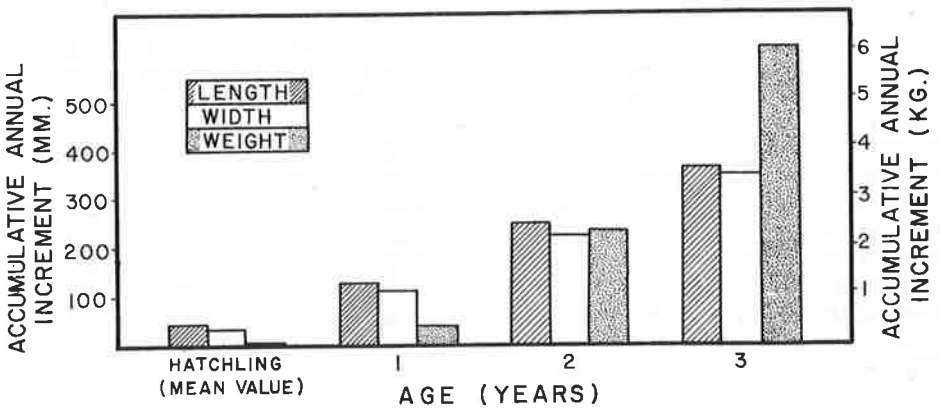


Fig. 2

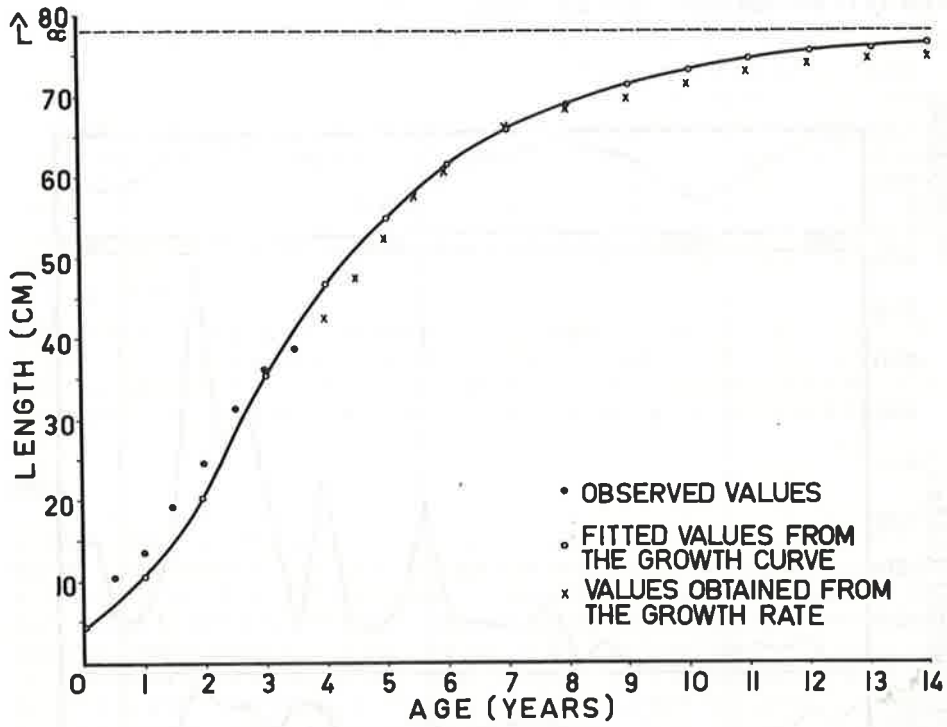
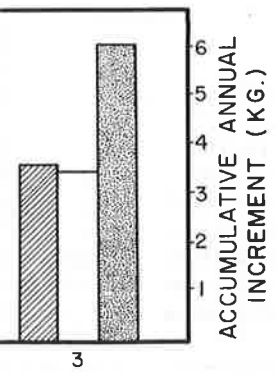
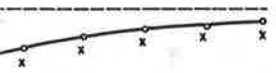


Fig. 3

SEXUAL DIMORPHISM

There is no demonstrable difference in average size between the sexes at maturity, but the male can easily be recognized by its longer, thicker tail, which is strongly prehensile and has a hard, cornified tip. Also, the male has a strongly developed, recurved claw on each fore flipper. These two claws, together with the claw-like tail tip, provide a strong grappling arrangement to allow the male to cling firmly to the female during copulation.





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longer, thicker tail,
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rappling arrangement to
pulation.

COPULATION

Kemp's ridley apparently copulates during the nesting season and in the general vicinity of the nesting beach. Chávez *et al.* (1967: 21) record a copulating pair being watched for 15 minutes offshore from Barra del Ostional several miles north of Rancho Nuevo, Tamaulipas, Mexico, on 21 May 1966; the turtles were not disturbed by a boat passing about five metres away.

Márquez (in press, a) records that copulating pairs are first seen at the beginning of April, and that couples may stay embraced for several hours. The film of the *arribada* of 18 June 1947, mentioned below, shows an over-zealous male coming ashore and attempting to mount a nesting female. Chávez *et al.* (1967: 21) mention the frequent occurrence of obviously recent scars on the second central lamina of nesting female ridleys, indicating that copulation often occurs shortly before nesting.

DIET

Márquez (in press, a) dissected two female and two male Kemp's ridleys of mature size, and concluded that the diet consists of crustaceans (bottom-living coastal forms), fish, jellyfish and molluscs (cephalopods and egg cases of squid). Gastropods and echinoderms are also eaten (Montoya 1966: 33). De Sola and Abrams (1933: 12) record pieces of the Spotted Lady Crab (*Palyonichus ocellatus*) in ridley stomachs, and Carr (1942: 10) found remains of the Dolly Varden Crab (*Hepatus epheliticus*) in two specimens from Florida. Hardy (1962: 219) found numerous fragments of crab shell, almost certainly pertaining to the blue crab *Callinectes sapidus*, in a ridley from Virginia. An additional stout cheliped in the stomach of the same ridley probably came from a large mud crab (*Panopeus* or *Menippe*). Dobie *et al.* (1961: 110) examined the stomach and intestinal contents of two ridleys from Louisiana; in one they found a half crab together with several abdominal appendages which probably came from *Callinectes sapidus* or *C. ornatus;* gastropods of the genus *Nassarius;* and some small woody plant fragments. The second specimen contained more *Nassarius*, and clams of the genera *Nuculana, Corbula*, and probably *Mulinia*, as well as 'several mud balls of about two millimetres diameter'. Other genera of organisms that have been found in ridley stomachs include *Ovalipes, Calappa, Portunus, Sicyonia, Lutjanus, Leiostomus* and *Arenaeus*.

The few ridleys taken in Europe that have been dissected had almost or completely empty stomachs.

BREEDING RANGE

Kemp's ridley has the most restricted breeding range of any sea turtle. Almost the entire breeding female population of the species nests on the southern part of the coast of Tamaulipas, Mexico, not always in exactly the same place, but usually within a few miles of Rancho Nuevo, in the Municipio de Aldama (Carr 1963: 298; Hilderbrand, 1963; Chávez *et al.*, 1967). Nesting in this area is typically in the form of massive synchronized diurnal aggregations; these nesting aggregations are known by the Spanish term *'arribada'* (arrival). A few individuals nest a little to the north and south of the breeding area, in Padre

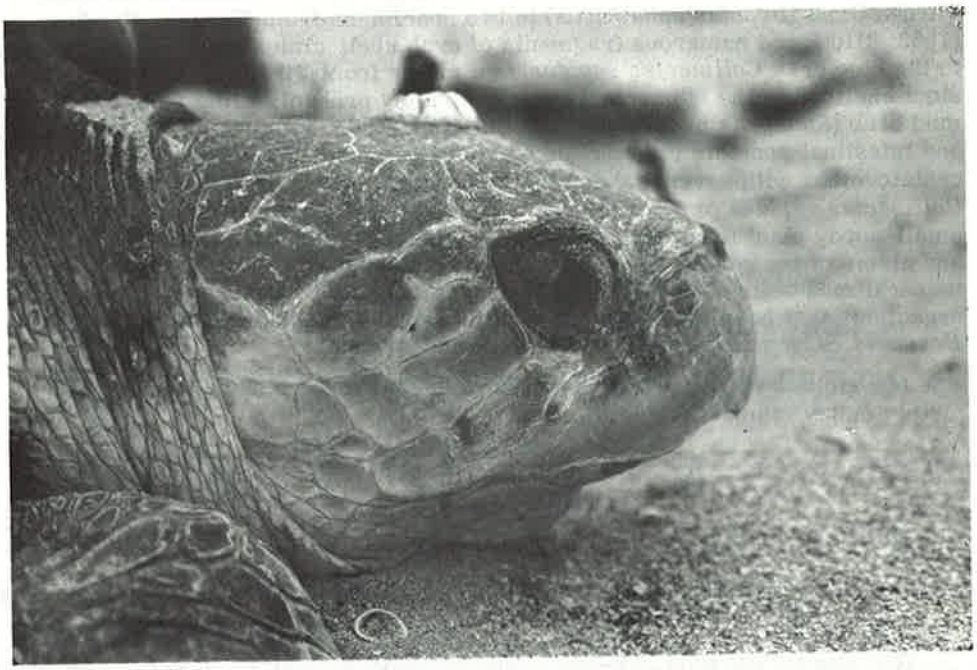

PLATE II

Kemp's Ridley turtle. Above: female on nesting beach; below: head of female. Rancho Nuevo, Tamaulipas, Mexico. *Photographs by Peter Pritchard*

; below: head of female.

raphs by Peter Pritchard

Island, Texas (Carr 1961: 11; Werler 1951: 48), between Tuxpan and Alvarado, Veracruz (Carr and Caldwell 1958: 246), near Montepio (Carr 1961a: 10), near Coatzocoalcos, Veracruz, and near Laguna de Mecoacan, Tabasco (Márquez, in press, a), but these appear to be stragglers from the main Tamaulipas population. Various reports of ridleys nesting in other areas, e.g. near Miami, Florida, or in the Azores (Deraniyagala 1957: 110 and 1943: 89), or in the Florida Keys (Garman, 1880: 124), appear to be based on misidentifications.

TYPE OF BEACH USED FOR NESTING

The Tamaulipas nesting beach is a broad, white sand beach, hundreds of miles long, with tides of relatively low amplitude. There is a well-defined 'médano', or elevated and vegetated dune area, behind most of the beach. In some sectors the beach is covered with large pebbles and rocks. Except that it is remote from human habitation the shore here has no overtly unusual features. However, nesting does frequently take place on stretches of the beach which are backed up either by extensive swampy areas or by moderately large, open bodies of shallow water which have seasonal narrow connections to the ocean. Possibly this nesting site preference reflects an adaptation to avoid terrestrial predators, particularly coyotes. As such, the adaptation has not worked very well, but it probably does mean that prowling coyotes have to walk somewhat further than otherwise to find a turtle nest. Other adaptations that might minimize such predation are discussed in a later section.

NESTING PROCESS

The following account describes the nesting of a Kemp's ridley witnessed by Pritchard at Rancho Nuevo, Tamaulipas; the turtle left the sea at 12.30 P.M. on 16 May 1968.

0 mins. The turtle emerged from the sea and started walking straight across the beach, perpendicular to the shoreline. The mode of progression involved alternating, 'walking' movements of the four flippers, similar to the gait of a hawksbill, and contrasting with the 'breast-stroke' land movement of the heavier green turtle and leatherback.

5 mins. Still walking across beach, resting intermittently. The course had now shifted from due west to west with a slightly southerly component.

8 mins. Now climbing with some difficulty over driftwood and litter on upper part of beach. At this point she started pushing her snout about violently in loose sand with strong thrusting movements of the neck.

12 mins. Started walking in a northerly direction; moved only a few yards, thrusting snout strongly down into the sand.

14 mins. With front flippers anchored and head pointing slightly to the north of straight inland, the turtle started excavating her nest cavity with her hind flippers, the hind part of her shell moving through a large angle between insertions of alternate hind flippers in the growing cavity.

17 mins. Digging still proceeding without interruption; front part of the animal now being raised high up with each digging movement in order to allow the tips of the hind flippers to reach as deep into the cavity as possible The nuchal tendons were tense and prominent throughout the excavation. Insertion of each hind flipper into the nest cavity was preceded by a sharp forward flick of the same flipper, which threw the excavated sand about six feet in front of the turtle's head. Throughout the excavation the eyes were open; sand adhered to the moist area around the eye but the 'tears' were not nearly as copious as in nesting green turtles or leatherbacks.

29 mins. Nest cavity now completed; the turtle stopped digging and, with hind flippers splayed out flat and far apart, she started laying. Actual oviposition lasted about twelve minutes and was accompanied by deep, throaty breathing. The eyes were now closed; there was considerable buccal action and some partial opening of the mouth. Periodically the head and shoulders were withdrawn slightly. From observations of other turtles these contractions immediately preceded the dropping of a batch of one to three or four eggs.

41 mins. Oviposition completed; the turtle started filling in the nest cavity with curling-round movements of her hind flippers. Each flipper came into light contact with the tail and opposite thigh while drawing sand into the cavity.

41½ mins. With eyes open and distal parts of her foreflippers still anchored in the sand, the turtle flattened the sand beneath her by means of vigorous thumps of alternating sides of her shell. The hind flippers patted the sand flat with movements in almost perfect synchrony with the rocking shell movements. In between bursts of four or five thumps the turtle pulled sand towards the tail with the hind flippers.

44 mins. Front flippers moved for the first time since the onset of excavation of the nest cavity; they made sluggish movements throwing sand backward between bursts of shell rocking.

45½ mins. Thumping with shell ceased and the turtle started throwing sand backwards with simultaneous movements of one front flipper and the hind flipper on the opposite side. Several movements with such a combination of flippers would take place, then the opposing pair would come into action. Such series of movements were occasionally interrupted by simultaneous sand-flinging movements of the two front flippers. These movements carried the turtle away from the nest site along a sinuous path. After a few yards the turtle turned round to the right, and rested briefly.

49 mins. Turtle returned to the sea.

The process described above showed no significant variation in other Kemp's ridleys whose nesting was witnessed. Even the unwavering march direct from the sea to the dry sand of the nesting site seemed to be invariable, while oviposition in all cases witnessed took place with the turtle's head pointing more or less directly inland. Local people as well as other visitors confirmed that the total time from emergence to return to the sea took within a few minutes of fifty minutes in all cases they had witnessed. However, Chávez *et al.* (1967: 22) found that most turtles turned to the *left* after nesting in order to regain a seaward orientation.

The distance the turtle walks from the sea before nesting is very variable. Márquez recorded the following distances of the nest from the mid-tide mark for 146 nests made during the 1967 season:

Distance (metres)	Frequency	Percentage
0-5	1	0.68
6-10	4	2.74
11-15	2	1.37
16-20	9	6.16
21-25	8	5.47
26-30	5	3.43
31-35	6	4.11
36-40	14	9.59
41-45	10	6.85
46-50	25	17.12
51-55	50	34.25
56-60	12	8.22

A distance of 56-60 metres corresponds to the highest point of the dune area behind the beach.

Márquez recorded the following data on nest depth for 147 nests made during the 1967 season; minimum depth refers to the distance from the surface of the undisturbed sand to the upper surface of the topmost eggs; maximum depth refers to the distance from the sand surface to the lower surface of the bottommost eggs.

Depth range (cm)	Minimum depth Frequency	Percentage	Maximum depth Frequency	Percentage
0-5	1	0.69		
6-10	1	0.69		
11-15	2	1.38		
16-20	25	17.24		
21-25	51	35.17		
26-30	46	31.72	1	0.68
31-35	18	12.41	11	7.48
36-40	1	0.69	72	48.98
41-45			57	38.76
46-50			6	4.08

(Minimum depths were not recorded in two cases).

There appears to be no difference in the nesting process of Kemp's ridleys nesting individually or by the thousand in an *arribada;* however, turtles nesting in aggregations may be less easy to disturb and frighten back to the sea than turtles nesting alone. The nesting process does not differ in any significant way from that of *L. olivacea,* except that it takes place by day instead of by night.

NESTING FREQUENCY

Inter-nesting intervals for *Lepidochelys kempi* have been recorded only a few times. Chávez *et al.* (1967: 26) recorded the following intervals (in days) for

individuals found nesting twice at Rancho Nuevo in 1966: 20, 24, 24, 28, 28, 28, 28, 49; intervals between nesting emergences for two individuals found three times were: 27 and 26 days; 28 and 23 days. Supplementary data for the 1967 season are: one individual re-appeared the following day; three between 20 and 24 days; one after 42 days (Chávez 1968: 9). These data would suggest that the normal inter-nesting interval for Kemp's ridley is of the order of 20-28 days, but such a conclusion should be approached cautiously in view of the paucity of the data.

The two species of ridley are the only sea turtle species known to nest regularly in successive years, though it is now known that the green turtle, the leatherback and the loggerhead may do so on occasion (Schulz, pers. comm.; Pritchard, pers. obs.; Hughes, pers. comm.). Chávez (1968: 11) records nine cases of ridleys nesting in both 1966 and in 1967. In 1970 Pritchard found seven ridleys nesting at Rancho Nuevo that had been tagged in previous years; data for these are set out at the top of the opposite page.

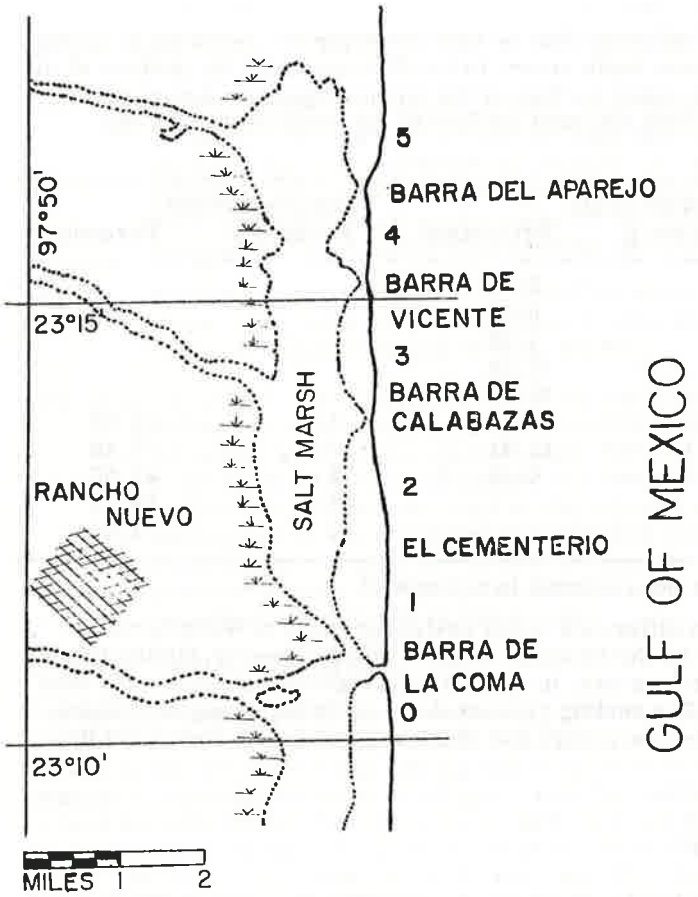

Fig. 4

A1154, tagged 31 May 1966, re-nested 2 May 1970

A1263, tagged 4 June 1966, re-nested 8 June 1967 (Chávez 1968: 11), and again 1 May 1970.

A1488, tagged 8 June 1967, re-nested 1 May 1970

A4605, tagged 21 June 1968, re-nested 1 May 1970

A4849, tagged 23 May 1968, re-nested 2 May 1970

A4468 and A4916, both tagged in 1969 (precise date uncertain), both re-nested 2 May 1970.

LOCALIZATION OF NESTING ACTIVITY

The beach in the vicinity of Rancho Nuevo, Tamaulipas, Mexico, which is essentially the only place in the world where Kemp's ridley nests, may for convenience be divided into five zones (as shown in Fig. 4):

(i) From Barra Coma north to El Cementario (about 1.5 km).

(ii) From El Cementario north to Barra Calabazas (about 4.5 km).

(iii) From Barra Calabazas north to Barra or Boca San Vicente (about 4 km).

(iv) From Barra San Vicente north to Barra del Aparejo (about 3 km).

(v) North of Barra del Aparejo.

Nesting was concentrated in zones i and iii in 1966, and in zones ii, iii, and iv in 1967.

Chávez (1968: 11) gives the following records of nesting location for Kemp's ridleys seen in both 1966 and 1967 at Rancho Nuevo:

Tag no.	Nesting location in 1966	Nesting location in 1967
A1002	700 m north of Barra Calabazas	50 m north of Barra Calabazas
A1010	Between Barra Coma and Barra Calabazas	Between El Cementerio and Barra Calabazas
A1012	Between Barra Coma and Barra Calabazas	Between Cachimba and Boca San Vicente
A1232	1 km south of Barra Calabazas	10 m north of Cachimba
A1251	Between Barra Coma and Barra Calabazas	Between El Cementerio and Barra Calabazas
A1252	Between Barra Coma and Barra Calabazas	Between Cachimba and Boca San Vicente
A1260	4.2 km south of Barra Coma	Between Cachimba and Boca San Vicente
A1263	1.5 km south of Barra Calabazas	Between Cachimba and Boca San Vicente
A1280	Barra Coma	Between Barra Coma and El Cementerio

(Cachimba is located about half way between Barra Calabazas and Boca San Vicente).

CLUTCH SIZE

Márquez counted eggs in 170 nests during the 1967 season, and found clutch sizes distributed as follows:

Range	Frequency	Percentage
51-60	2	1.2
61-70	0	0
71-80	4	2.4
81-90	13	7.6
91-100	25	14.7
101-110	40	23.5
111-120	43	25.3
121-130	26	15.3
131-140	13	7.6
141-150	3	1.8
151-160	1	0.6

In addition, six nests contained less than ten eggs, another contained eleven, and another twelve; in all these cases traces of coyotes or of black vultures (*Coragyps atratus*) were present, and it is presumed that many other eggs in these nests were eaten by these predators.

Chávez *et al.* (1967: 28) found that the number of eggs in 271 *L. kempi* clutches from Rancho Nuevo ranged from 54 to 185, the mean being 110 and 62 percent of individuals laying between 100 and 129 eggs (which suggests a standard deviation of about ±11). Nineteen clutches counted by Pritchard at Rancho Nuevo in the early part of the 1968 season contained from 93 to 135 eggs (mean 116.0, S.D. ±12.5). Thirty-seven nests counted by Pritchard in May 1970 contained from 80 to 134 eggs, with one very small clutch of only 54 eggs. Mean clutch size was 105.7 (107.1 discounting the small clutch).

INCUBATION PERIOD

Chávez *et al.* (1967: 32) found the incubation period for 1,664 hatchling ridleys to range from 50 to 70 days. Most emergences took place between 53 and 56 days, and only three hatchlings took longer than 61 days to emerge.

FERTILITY OF EGGS

Chávez *et al.* (1967: 34) found that eighteen transplanted nests, ranging in number of eggs from 72 to 138, produced hatching percentages ranging from 43.0 to 95.5, with a mean of 65.4 percent. Percentage hatch of non-transplanted nests would be difficult to determine, since the majority of such nests are quickly destroyed by coyotes.

SIZE AND COLOUR OF EGGS

Márquez measured the maximum and minimum diameters of 192 eggs of *L. kempi*, taken when freshly laid from several nests, as follows:

	Diameter			
	Minimum		Maximum	
Range (mm)	Frequency	Percentage	Frequency	Percentage
34.6-35.5	2	1.0		
35.6-36	3	1.6	1	0.5
36.1-36.5	18	9.4	3	1.6
36.6-37	30	15.6	7	3.6
37.1-37.5	28	14.6	8	4.2
37.6-38	32	16.7	29	15.1
38.1-38.5	19	9.9	28	14.6
38.6-39	24	12.5	45	23.4
39.1-39.5	15	7.8	15	7.8
39.6-40	14	7.3	30	15.6
40.1-40.5	5	2.6	10	5.2
40.6-41	2	1.0	10	5.2
41.1-41.5			3	1.6
41.6-42			0	0
42.1-42.5			0	0
42.6-43			1	0.5
43.1-43.5			0	0
43.6-44			1	0.5
44.1-44.5			0	0
44.6-45			0	0
45.1-45.5			1	0.5

The weights of the same sample of 192 eggs were distributed as follows:

Range (gm)	Frequency	Percentage
24.1-25	3	1.6
25.1-26	3	1.6
26.1-27	5	2.6
27.1-28	15	7.8
28.1-29	31	16.1
29.1-30	50	26.0
30.1-31	29	15.1
31.1-32	16	8.3
32.1-33	18	9.4
33.1-34	9	4.7
34.1-35	4	2.1
35.1-36	3	1.6
36.1-37	3	1.6
37.1-38	2	1.0
38.1-39	—	—
39.1-40	—	—
40.1-41	1	0.5

Chávez *et al.*(1967: 27) measured 221 eggs laid by thirteen females; diameters ranged from 35.0 mm to 44.5 mm, with a mean diameter of 38.9 mm. However, these authors also found that abnormal eggs may be as small as 20 mm, or as large as 50 mm, in diameter, while still others were elongate, dumb-bell shaped or with wart-like protruberances. The eggs are always white in colour and have flexible shells; they usually have a slight dent when laid, but become turgid during development by osmotic uptake of water.

TWIN EMBRYOS

Chávez *et al.*(1967: 27-28) recorded two elongate, twin-yolked eggs, one 77.5 mm by 35.1 mm, and the other 80.0 mm long and with width ranging from 37.9 to 39.9 mm. There is no definite record of a single egg producing two viable embryos of hatchlings.

INJURIES

Chávez *et al* (1967: 17-18) found that 39 out of 285 females examined showed mutilations, recent injuries or scars; these injuries most commonly took the form of bites on the flippers, and it is not rare to find specimens totally lacking one of the hind flippers. Twelve of the specimens examined by Chávez *et al.*had bites out of the carapace, usually towards the rear, and sometimes turtles are seen with huge, though well healed, bites which may completely expose the dorsal aspect of one of the hind flippers.

A young (267 mm) ridley found dead near Perranporth, Cornwall, England, in February 1969 had both front flippers and the left hind flipper torn off, but the cause of this mutilation was not evident.

TIMING OF NESTING

The nesting season for *Lepidochelys kempi* is concentrated in the months of May and June; Chávez (1968: 6) gives dates of tagging for the 285 individuals tagged at Rancho Nuevo in 1966. One was tagged 21 April, one on 22 April and three on 6 July, but all the others were tagged in May and June, 127 of them on 31 May.

Kemp's ridley is unique among sea turtles in habitually nesting by daylight; diurnal nesting is extremely rare for all other sea turtle species. The earliest emergence of *L.kempi* at Rancho Nuevo observed by Chávez *et al.* (1967: 21) was at 8.25 A.M.; the latest was at 6.25 P.M. However, Chávez was informed that three individuals had nested by night on 11 May 1966, preceding an *arribada* on the following day, and he himself saw an ancient, mutilated female lay eleven eggs in a shallow depression in the sand shortly after midnight on 1 June 1966. Also, Márquez (in press, a) quotes Márquez and Contreras (in press) to the effect that *arribadas*, though usually commencing by daylight, may continue into the night.

The survival value of the diurnal nesting habit of Kemp's ridley is obscure. It might be construed as a device to lessen the danger of the nest being ransacked by the coyotes that patrol the beach at Rancho Nuevo, as Hildebrand (1963: 109) has argued. On the other hand, Márquez (in press, a) records having observed coyotes destroying ridley nests by day as well as by night.

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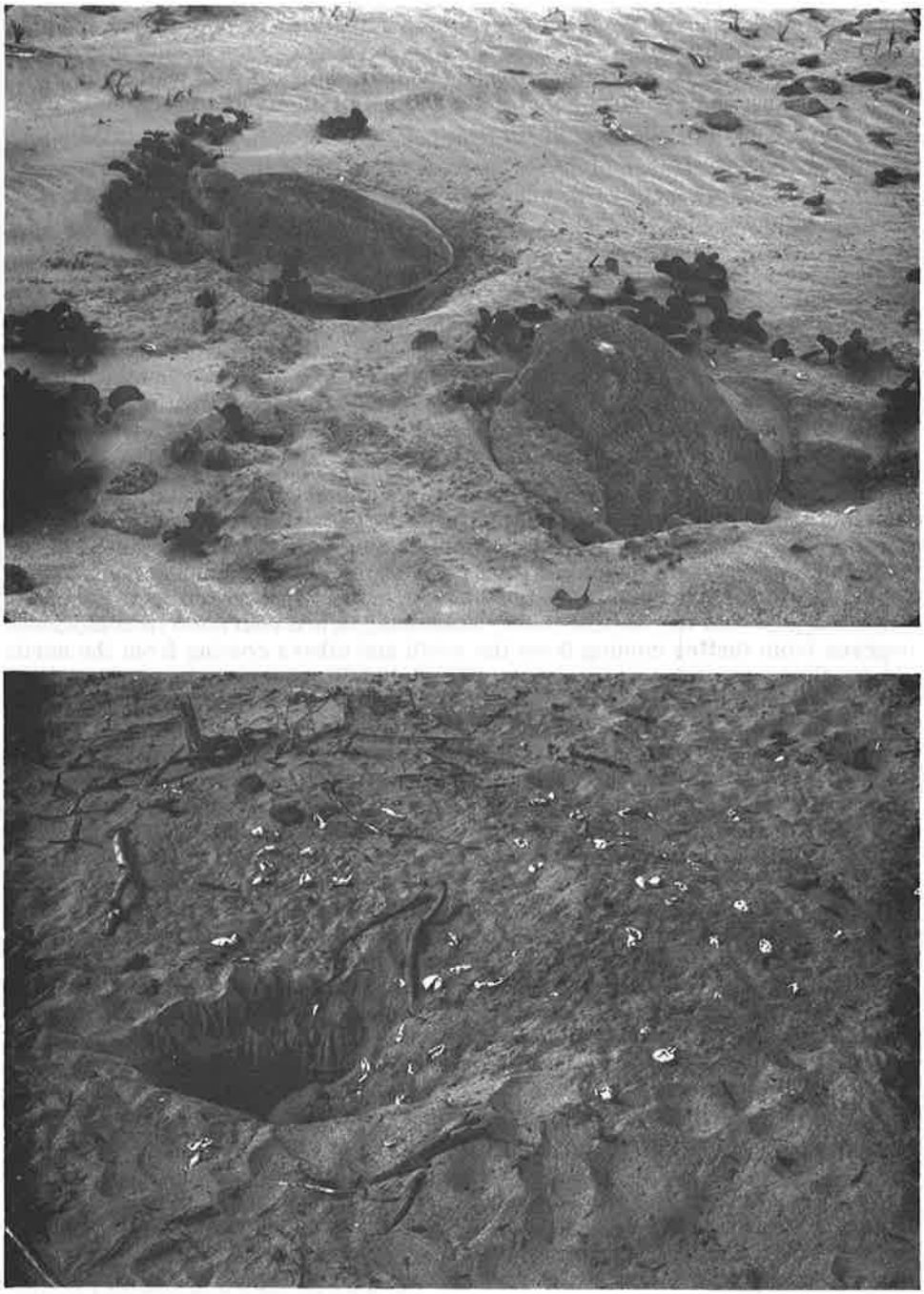

PLATE III

Kemp's Ridley turtle. Above: female excavating nest; below: nest destroyed by coyotes.

Rancho Nuevo, Tamaulipas, Mexico. *Photographs by Peter Pritchard*

Nesting emergences of Kemp's ridley, whether isolated or aggregated, tend to correlate markedly with a strong wind from the north. Such a wind may assist in obscuring the very lightly impressed spoor of the ridley, as well as in elminating traces of odour, so that sight and smell-motivated predators will have more trouble finding the nest.

The whys and wherefores of *arribada*-formation—the formation of aggregated, synchronous emergences of thousands of female turtles—are still largely unknown. It seems unlikely that the turtles are simply responding individually to the same rare combination of nesting cues, since they do not group in the same place each time; the different *arribada* sites, even within a season, may be several miles apart. The survival value of the trait may be that the local predator populations are bewildered by the sudden huge abundance of potential prey—the adult turtles, their eggs, or, two months later, the hatchlings—and, although they may consume all they can, the manifestation is over so rapidly that many of the turtles will survive, and excessively high predator population levels will be inhibited simply because they cannot be sustained by one or two big meals a year.

How an *arribada* is formed or maintained is a subject for speculation. It is possible that the ridleys migrate to the nesting ground in aggregations, accreting more recruits as they get closer to their destination, and that these aggregations simply remain intact until the right combination of environmental parameters prompts them to nest. However, the tagging experiments outlined below suggest that the Rancho Nuevo assemblages are recruited in comparable degrees from turtles coming from the south and others coming from the north; yet for those years for which data are available, it appears to be common for there to be more turtles in one of the *arribadas* of the season than in all the others together. Moreover, the turtles tagged during the *arribada* of 31 May 1966, dispersed both towards Campeche and towards Texas and Louisiana, and it may be presumed that they returned to the localities from which they came. Consequently, it must be concluded that ridleys have some way of finding each other, and of forming and maintaining aggregations, once they have reached their destination near Rancho Nuevo. Possibly they do this by visual means, since the water in this area is reasonably clear. However, it is also possible that some pheromonal secretion is involved, as Carr (1963) has postulated. The two species of ridley are the only sea turtles with a complete and well-developed series of secretory pores along the inframarginals, and they are the only turtles that are known to form *arribadas*. However, such discussions must remain, for the present, at the level of speculation.

HATCHLINGS

Chávez *et al.* (1967: 12) found hatchlings of Kemp's ridley from Tamaulipas to range in carapace length from 38 to 46 mm, in width from 30 to 40 mm, and in weight from 13.5 to 21 gm. Carr and Caldwell (1958) found four hatchlings from Veracruz to fall between these limits. The young differ from the adults in their proportionately longer flippers, larger heads, and broader central scutes, and in their colour, which is uniformly blackish-grey except perhaps for slightly lighter markings around the anus, the umbilicus, the trailing edge of the fore flippers, the points of the four plastral ridges (especially the inner two), the nostrils and the nasal scutes, the posterior edges of the plastral scutes, the posterior corner of each maxillary scale, and the midventral tip of the beak. The overall outline of the carapace is essentially similar to that of the adult, but becomes slightly broader with maturity (the reverse of what happens

with most turtles). The carapace bears three strong longitudinal keels in the hatchlings, and the plastron four; the inframarginal pores are already evident. The scutes are slightly imbricate at birth, but become juxtaposed with growth. An egg-tooth is present at hatching, and may persist for 40-50 days. Partial albinism (e.g. of the hind flippers and tail) is not unknown in hatchlings, but complete albinism is usually associated with lethal head deformities (especially absent eyes and an asymmetrical, deformed mouth).

Chávez *et al.* (1967) found that hatchlings of *L. kempi* emerge in the early morning hours; 1664 hatchlings observed all emerged between the hours of 5.17 and 7.00 A.M.; however in some cases some hatching had taken place in the night before the nests were inspected.

The mechanism of emergence appears to be similar to that of other sea turtle species. One to three days before a nest erupts, the sand immediately above the egg cavity drops, so as to form a shallow depression in the surface. Emergence is normally 'explosive'—a substantial proportion of the hatchlings within a nest emerging within a few minutes. Individual emergences, however, are also frequently observed.

To date, hatchlings of *L. kempi* have not been raised to maturity under captive conditions. However, this is mainly because hatchlings were unobtainable until recent years, and even now can only be obtained from one beach in the world at one time of the year. Half-grown and adult specimens adapt well to captivity, and have survived in public aquaria for many years.

NATURAL AND HUMAN WASTAGE OF EGGS, HATCHLINGS AND ADULTS

As mentioned previously, coyotes (*Canis latrans*) are major predators on the eggs of Kemp's ridley; single nests are almost always destroyed by coyotes within 24 hours unless they are transfered to a protected hatchery, and a proportion of those nests laid during *arribadas* are also destroyed by this predator. The ghose crab *Ocypode albicans* is a serious predator on both the eggs and emerged hatchlings. Until recent years man was a massive-scale predator on ridley eggs at Rancho Nuevo, but now this activity is illegal and has become sporadic. Hatchling turtles on their way to the sea are molested by black vultures or 'zopilotes' (*Coragyps atratus*); according to Chávez *et al.* these birds are absent from the nesting area until mid-May and June, when the first turtles start to hatch out. Hildebrand (1963) recorded two species of fish (*Caranx hippos* and *Sciaenops ocellata*) as definitely known to eat baby Kemp's ridleys, and Chávez *et al.* (1967) were informed by local villagers that one specimen of *Sciaenops* caught at Boca San Vicente had eleven newly-hatched ridleys in its stomach.

Organized at-sea capture of ridleys is concentrated at two places: Cedar Key, Florida, where the catch is made up almost entirely of immature turtles, and Campeche, Mexico, where adult turtles are taken, along with larger numbers of immature loggerheads (*Caretta caretta*). However, the capture in these two places is probably not as serious a drain on Kemp's ridley populations as accidental capture in trawls and shrimp nets. These nets are usually pulled up at such infrequent intervals that the turtle has drowned by the time it reaches the surface; and if it has not, it is usually dispatched without delay by the crews of the fishing boats, since a sea turtle can do considerable damage to a net. Some turtles are killed when they come ashore to nest in Tamaulipas, but this is no longer legal, and only a few are killed this way each year. Natural predation on adult Kemp's ridleys at sea has not been investigated, but judging by the

proportion of mutilated and amputee individuals which come ashore to nest in Tamaulipas, it is probable that many others are killed by the same predators (presumably large sharks).

MIGRATIONS

Two tagging programmes (those of Chávez, 1968, and of Pritchard, hitherto unpublished) have demonstrated essentially the same fact: that ridleys, after nesting at Rancho Nuevo, remain within the Gulf of Mexico, but move in comparable numbers north (mostly to Louisiana) and south (mostly to Campeche). Chávez recorded recoveries of 17 out of the 285 nesting females tagged by him at Rancho Nuevo in 1966. Of these, one was taken at Key West, Florida, 5 were caught off the Louisiana coast, 3 off the Texas coast, one near Alvarado, Veracruz, one near Dos Bocas, Tabasco, and 6 from the coast of Campeche. Eleven of these 17 specimens were caught in shrimp trawls, and four in shark nets. Pritchard found that, of 80 nesting females tagged in May 1970, four were caught off the Louisiana coast, one near the mouth of the Panuco River, Tamaulipas, and one north of Ciudad del Carmen, Campeche. All recoveries were made within a few miles of the shore, and it appears probable that the normal migrations of this species do not involve any open-sea crossing. Chávez calculated that the minimum average speeds of the two turtles which moved the greatest distance in the shortest time were 24.0 and 29.5 km per day.

Mature Kemp's ridleys have only been found within the Gulf of Mexico, but it seems possible that newly-hatched ridleys embark on a several-year-long trip that takes them well outside the limits of the Gulf. On the eastern coast of the Gulf of Mexico, mature ridleys are rarely caught, but moderate (though currently diminishing) numbers of ridleys a few inches short of mature dimensions are found there (Carr and Caldwell 1958). Ridleys are unknown from the Bahamas. The species is known from the Dry Tortugas and Key West (Carr 1942: 10), and on the Atlantic coast of Florida from Fernandina Beach, St. Augustine, Cape Canaveral and Melbourne (Carr, 1955). Records are unaccountably very scarce on the Atlantic coast south of Melbourne, but there is a sight record for Salerno (Carr 1942: 11).

From the coast of Georgia, ridleys have been recorded from Sapelo Island (Martof 1963: 71), from 1½ miles off St. Simon's Island (AMNH 46781), and from 'S.E. Georgia' (De Sola and Abrams 1933: 11). There are no records from South Carolina, but from North Carolina the species is known from Cape Hatteras (Hay 1908: 184) and from Beaufort (Coker 1906: 57). From Virginia there are records from Reedville (USNM 86814); from 3 miles south of Great Wicomico Lighthouse (USNM 137573); and from Gloucester Point (Hardy 1962: 219). From Maryland there are records from Parker's Creek (Hardy 1962: 217, 218); from Camp Bay Breeze, near Lushy, Calvert Co. (Hardy 1962: 218); and from the mouth of Jones Falls, Baltimore Harbour (Hardy 1962: 218). The species is known from Atlantic City, New Jersey (Hay 1908: 184), and from the following localities in New York: New York Harbour (AMNH 28863); Oyster Beach, Nassau County, Long Island (AMNH 44867); Short Beach, Jones Inlet, Jones Beach State Park, Nassau County, Long Island (AMNH 69604); West Meadow Beach of Long Island Sound, near Setauket, Suffolk Co. (AMNH 88344); Long Island Sound (Babcock 1938: 46); Staten Island (AMNH 9723); Lower New York Bay (De Sola 1931: 135).

There is no diminution in records as we proceed further north. Dodge (1944) lists seven records from the coast of Massachusetts, while Carr (1957) men-

tions an astonishing observation, passed on to him by William Schevill of the Woods Hole Oceanographic Institute, of several dozen yearling ridleys out of a 'whole fleet of such turtles' being stranded on Woods Hole beaches after travelling out of Buzzards Bay into Vineyard Sound. There is also a record from the coast of Maine, four from Nova Scotia, one from Cape Breton Island, and a questionable record from Cape Race, Newfoundland (Bleakney 1955, 1965). There is also one record from Bermuda (Mowbray and Caldwell, 1958), and one from the Azores (Deraniyagala 1939). From the Republic of Ireland there are two records from Galway Bay (NMI 108: 1934 and NMI 49: 1941), one from Miltown Malbay, Co. Clare (Deraniyagala 1938a and b, NMI 92: 1928), one from Valentia Island, Co. Kerry (NMI 14: 1921) and one from Pulleen Harbour, Bantry, Co. Cork (Brongersma 1972: 168). There is a record from the Scilly Islands (BMNH 1925. 12. 23. 1) and from the Channel Islands (Beaumont, Jersey, BMNH 1950. 1. 2. 70). The British mainland records are from Scotland (Loch na Claise off Loch Inchard, by Kinlochbervie, Sutherland; and Troon, Ayrshire; Brongersma 1972: 164), from Wales (Mochras Island, Merioneth; Freshwater West, Pembroke; and Kenfig Dunes, Glamorgan; Brongersma 1972: 164); and from England, six of the eight existing records being from Cornwall (Polzeath; Treyarnon Beach, 4 miles west of Padstow; Penhale Point, near Perranporth; Portreath Beach, NW of Redruth; Newlyn Harbour; and Malpas, near Truro), and the two others from Pagham Beach, Sussex, and Woolacombe Sands, Devon; Brongersma 1972: 164-167. There are two records from the Netherlands (Island of Terschelling; and Scharendijke, Island of Schouwen), and two from France (Les Portes, Ile de Ré, Charente-Maritime; and St. Jean-de-Luz, Basses-Pyrénées), Brongersma 1972, 170-171. There are no definite records south of France on the east coast of the Atlantic; however, it is possible that the species sometimes enters the Mediterranean. A turtle figured by Despott (1930) and labeled *Chelonia mydas*, with the locality given as Malta, was considered by Carr (1957: 48) to be a *Lepidochelys kempi*, but Brongersma (1972) considered it to be a loggerhead, *Caretta caretta*, which is a species known to breed in the Mediterranean. Dr. Ralph Hathaway informs me that Tunisian fishermen recognize a species of sea turtle with a conspicuously wide carapace that is so rare that one is lucky to see a single specimen in a lifetime. This turtle is locally known as 'zig-zag', an Arabic vulgarism for copulation — the turtle's flesh is considered so powerfully aphrodisiac that the lucky finder of a specimen can virtually name whatever price for the turtle that he wishes.

There is no good record of *Lepidochelys kempi* from the Caribbean; Dunn's (1918) record from Jamaica, although repeated by Pope (1939: 288), is refuted by Lewis (1940: 56), Grant (in Carr 1952: 397), and Caldwell (1961: 277). The Venezuelan records of Donoso-Barros (1964) and Flores (1966) clearly refer to *Lepidochelys olivacea*. The record of a ridley from Gibara, Cuba (Aguayo, 1953) is thought by Carr (1957: 46), who examined the specimen, to refer to an *olivacea*, not a *kempi*. Loveridge and Williams (1957: 496) refer to 'intergrades' between *kempi* and *olivacea* from the Cameroons. These were merely hatchlings of *L. olivacea*, some of which had five costals on each side of the carapace. (The costal count character, normally the only way of distinguishing juveniles of the two species of *Lepidochelys*, clearly breaks down here. However adults may be separated by a number of characters, quite apart from the costal count.)

Locality records for *L. kempi* from both sides of the Atlantic are presented in chart form by Brongersma 1972 (charts 3 and 8).

As well as we can reconstruct from the observed distribution and size range of immature ridleys, it appears most likely that after a ridley hatches and

enters the sea in southern Tamaulipas, Mexico, it swims actively for some hours or days to eliminate the danger of being thrown back on the shore, and then drifts more or less passively (perhaps at times in association with floating mats of *Sargassum* weed) in a clockwise direction in the Gulf of Mexico, passing with the Gulf Stream south of Florida and up the eastern coast of the United States. During this time it is feeding and growing, and by the time it reaches the area offshore from New England it is large and strong enough to become an active swimmer rather than a passive drifter — by now it has a carapace length of about ten inches to one foot (25.4 to 30.5 cm). At this stage it reverses its previous direction of travel, and gradually migrates southward, so that by the time it is nearly mature it has reached the Gulf coast of Florida, and a little later, when maturity is reached, it has reached the crustacean-rich areas off the mouth of the Mississippi and near Laguna del Carmen, Campeche. In late Spring in each breeding year (which, apparently, means every year for at least some individuals) both males and females make a reproductive migration to southern Tamaulipas, and return afterwards to the feeding grounds from which they came.

Some young turtles are apparently caught in the Gulf Stream when they have reached the waters of the eastern United States, and are involuntarily carried across the Atlantic to the coasts of Europe. It is likely that the size of such turtles when they arrive in Europe is little greater than that when they left the Americas, since the open sea is an alien habitat which would offer them little chance of following a normal dietary regimen. Thus, the very small ridley (99.7 mm in carapace length) caught at Corvo, Azores (Deraniyagala 1939) probably left American shores as a very young turtle shortly after passing through the Florida Straits. Those turtles which stranded further north, which are almost always between 200 and 300 mm in length, had probably spent several months moving up the Atlantic coast of the United States before being caught by the Gulf Stream and transported to correspondingly more northerly points on the eastern shores of the Atlantic.

This projected migration of ridleys from the nesting ground in Tamaulipas to the waters off the north-eastern United States raises the question of what the turtles may do in the winter months, when water temperatures become much lower than those at which most turtle species remain active. Presumably they must either have the ability to sustain activity at low ambient temperatures, or they must become torpid. Winter torpor has not been described for any species of sea turtle, but it is noteworthy that turtle fishermen on the Gulf Coast of Florida, especially at Cedar Key, remark that ridleys disappear in the winter, and that when first seen in the spring their shells are covered with mud. This observation suggests that ridleys may actually burrow into the mud — which is present especially around estuarine situations on many parts of the shore of the United States — when temperatures become too low for normal activity levels, and that they may remain buried until the onset of warmer weather in the spring. Those turtles which failed to embed themselves in time, then, would be the ones that would be drifted in a more or less inactive state to the coasts of the British Isles and Europe, where they are known to arrive principally in the months of November and December.

PARASITES AND EPIZOOPHYTIC ORGANISMS

Kemp's ridley does not have the same tendency as the loggerhead and the hawksbill to become heavily studded with large barnacles; nevertheless quite a large proportion of the mature females at Rancho Nuevo have a few small or

medium-sized barnacles, of uncertain species, attached to the carapace, the plastron or the top of the head. The internal parasites of this species have not been investigated.

WORLD POPULATION ESTIMATES

The only type of population estimate for Kemp's ridley which we can make is one based on mature females only; there is no way of estimating the numbers of either males or juveniles. Since Kemp's ridley is apparently only known to nest at or near Rancho Nuevo, Tamaulipas, we may estimate the minimum world population of females on the basis of the estimated number of turtles in the largest *arribada* of the season. In 1947 it was estimated that 40, 000 turtles nested in one *arribada*, while in recent years no *arribada* of Kemp's ridley numbering more than 3, 000 to 5, 000 turtles has been seen, and during 1970 and 1971 the principal *arribadas* were estimated to number 2, 000 to 2, 500 turtles. There are probably now only, 2, 500 to 5, 000 mature female Kemp's ridleys in the world.

SURVIVAL SITUATION AND PROSPECTS

Kemp's ridley is clearly a seriously threatened species, and it is vitally important that solid protection be given to the nesting area as well as all possible efforts made to lessen the number of ridleys caught at sea. The Mexican government has had commendably thorough patrols of the nesting beach for the last few seasons, with large numbers of eggs being transplanted to a central, protected hatchery to protect them from both human and canine predators. Nevertheless the politics of this programme are unsteady, and as the commercial importance of Kemp's ridley necessarily diminishes, it becomes harder for the conservation crews to obtain sufficient government funds for adequate protection of the breeding colony. Moreover the demand for turtle leather, although diminishing, is still high, and commercial establishments have in recent years made strong overtures to the Mexican government for permission to kill nesting ridleys on the beach for their skins. A contract was in fact given to one such company in 1970, and only sheer luck prevented it from meeting up with a sizeable *arribada*. The species is not protected in Florida, despite recommendations made by many conservationists that the species should be completely protected. To allow the commercial exploitation of a species as depleted as *kempi* is surely a cynical anachronism, and a sad testimonial to the lobbying power of commercial interests.

Probably the most serious problem of all, however, and the hardest to control, is the accidental capture and drowning of ridleys in shrimp trawls, and to a lesser extent, shark nets, particularly as they migrate to and from the nesting grounds. Of the 285 female ridleys tagged by Chávez in 1966, at least 17 had been caught in these ways by August 1967; and at least 6 of the 80 tagged by Pritchard in 1970 have already been caught, and the tags returned.

Márquez estimates that the accidental and clandestine catch of Kemp's ridleys in Mexico amounts to around 5 tons, or say 125 turtles, annually.

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