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SEA TURTLES OF THE GUIANAS

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SEA TURTLES OF THE GUIANAS

PETER C. H. PRITCHARD[1]

SYNOPSIS: Summarizes investigations of turtle nesting beaches in Guyana during August 1964, August 1965, and April 1967, in Surinam during May to July 1966, May to July 1967, and June-July 1968, and in French Guiana in June and July 1967. Four species of sea turtles nest on beaches in Guyana, particularly Shell Beach: *Chelonia mydas, Eretmochelys imbricata, Dermochelys coriacea* and *Lepidochelys olivacea*. The same four species nest in Surinam, although *Eretmochelys* does so only rarely. *Lepidochelys* sometimes forms huge nesting aggregations at Eilanti, Surinam, and individuals have been shown to nest at the same place in successive years. *Dermochelys, Chelonia,* and probably *Eretmochelys* all nest in large numbers in French Guiana, particularly at Silébache Beach. Survival and conservation of sea turtles in northern South America are discussed.

TABLE OF CONTENTS

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Introduction

Early accounts of sea turtles nesting in northeastern South America mention both Surinam (Kappler, 1881) and Cayenne (Lacepede, 1847). The occurrence of sea turtles in the waters and on the beaches of the Guianas was known much earlier than this. A map of Surinam drawn by van Gerard of Keulen in 1670 indicates the area between Mot Creek and Wia-Wia Creek (now known as Bigi Santi) as "Schildpad (turtle) Bay". The same name appears on Reimer Ottens' map of 1740. Other than my own few recent notes (Pritchard, 1964, 1966a and b) and the works of Schultz (1964) and Brongersma (1968), few modern references to the turtle populations nesting on this coast exist.

Acknowledgements

I wish to express my gratitude to the trustees of the Browne Fund of the Royal Society for a grant-in-aid covering the cost of the 1965 trip to Guyana. I am also most grateful to Hugh Popenoe of the Department of Tropical Agriculture, University of Florida, for a generous grant which, in conjunction with a grant from the Centre for Latin American Studies, financed the 1966 Surinam expedition. Conservation and scientific work in Surinam and French Guiana in 1967 and 1968 was financed entirely by the World Wildlife Fund. Many members of the Surinam Forest Service, especially J. P. Schultz, F. Bubberman, A. Voorheuven, G. Plak, A. Wolf, and E. Donner, were of inestimable help during my time in Surinam. My supervisor of studies, Archie Carr, was of help in many ways, and from his sources of research support – NSF Grant GB 3910; ONR Contract 580 (12) with the University of Florida; Caribbean Conservation Corporation – furnished tagging equipment and funds for tag-return rewards. The ex-Governor-General of Guyana, H. E. Sir Richard Luyt, very kindly offered me accomodations and much assistance in Georgetown. A number of Guyana Government officials, in particular Mrs. Winifred Gaskin, C. Mc. A. Ashley, M. L. Persaud and D. Shaw, were of invaluable help in different ways. Dennis Joaquin of the Waini River accompanied me to Shell Beach and took an active interest in the project. In French Guiana G. Grivaz of the Forestry Service and Pierre Fourmanoir were exceedingly helpful. P. W. Kent, my biochemistry supervisor at Oxford, was of great assistance with the original grant application. Archie Carr and David Ehrenfeld read the manuscript and made helpful criticisms.

Finally I would like to thank my friends Tom Stubbs, Tom Lesure and Bill Greenhood who accompanied me on the Surinam expeditions and cheerfully joined in many hours of beach-walking at times when normal citizens were asleep.

Study Area

The detailed studies summarized in this paper were conducted on three beaches: Shell Beach, Guyana; Bigi Santi, Surinam; and Eilanti, Surinam.

Shell Beach, North-West District, Guyana — About 6 miles long and running northwest-southeast, this beach reaches its maximum width of about 250 yards about 1 mile from the northwestern tip. It is separated from the mainland by a large mud flat, much of which is exposed at low tide. The lagoon harbours many four-eyed fish *(Anableps)*, sawfish *(Pristis)*, and several unidentified species of sharks. In the open sea are larger sharks, including hammerheads. The most conspicuous birds of the beach are black vultures, spoonbills, scarlet ibis, flamingos and egrets. Beach and lagoon both become narrower southeastward, eventually becoming simply a continuation of the narrow barrier beach fringing much of the coast of the North-West District.*

Shell Beach is mobile, having apparently moved 4 miles towards Venezuela in the last 3 years. Piles set in the beach when it was used as an emergency landing strip in 1939 now stand in the sea between 15 and 20 miles southeast of the beach's present location. The beach profile is inclined steeply just above the high tide mark. Much of this higher area is covered with a dense growth of beach morning glory, but this is sparse on the newly-deposited northwest end of the beach.

Bigi Santi, Surinam — This name is applied to the stretch of beach between Matapica Creek and Wia-Wia Bank. The section on which the present study was conducted is about 40 miles east of the mouth

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*Some of the more clearly defined separate beaches between Shell Beach and the Essequibo Mouth have names, e.g. Papaya Beach, Father's Beach, Turtle Beach. Other beaches in Guyana used by turtles for nesting include Punta Playa on the Venezuelan border, 63 Beach near the mouth of the Corantijn River, Mahaica-Mahaicony Beach between Georgetown and the Berbice River, Suddie Beach on the west bank of the Essequibo, beaches on several of the Essequibo Islands, e.g. Zeelandia Beach on Wakenaam Island, Dauntless Point on Leguan Island; there is also an 8-mile stretch of good turtle beach on Tiger Island.

of the Surinam River. For detailed maps of this beach and also of Eilanti Beach see Schultz (1964). The beach is backed by extensive swampy areas, but not by open bodies of water. Like Shell Beach, Bigi Santi is rapidly moving westward. The changing coastline is exposing large expanses of previously suffocated forest, and the many dead tree trunks are so rotten that they can be pushed over with one hand. The beach material is sand and broken shell, in contrast to that of Shell Beach which is pure shell.

The general aspect of the beach and its concomitant bird and fish fauna are similar to those of Shell Beach.

Eilanti, Surinam – This is the name given to a small beach at the tip of a point of land on the west side of the mouth of the wide Marowijne River, which forms the border between French Guiana and Surinam. The beach is about ½ mile in length. A great mud bank has been deposited off the beach, about ½ mile of which is exposed at low tide. At one time Eilanti was an island, but silting has reduced the original break with the mainland to a narrow inlet, 100 yards or so in length, at the west end of the beach. Schultz (1964) gives maps showing the progressive alteration of the beach.

Methods

Lengths refered to in this paper refer to the straight-line shell length, measured from the nuchal lamina to the rearmost projection of the carapace. Plastral lengths are median; widths maximum. At first I measured the turtles with a caliper made from aluminum slats and a rollup metal tape, later I used a steel tree caliper. Weights were taken by turning the turtle and tying the flippers diagonally together and attaching a Salter's 10 cwt capacity self-recording dynamometer, adjusted for use in a vertical position, to the intersection of the diagonal cords; a stick passed through the upper ring of the dynamometer is raised until the turtle is just lifted off the ground. In this way one man can weigh the largest ridley or hawksbill, but two or more are needed for a green turtle, and at least six for a leatherback.

Turtles were tagged with Hasco brand cattle ear-tags clipped through the inner trailing edge of the front flipper. These tags are inscribed in Spanish and English, offering a reward for their return to the University of Florida. The tagging efforts of Carr and his co-workers at the University of Florida over the last 12 years have accustomed many of the turtle fishermen of the Caribbean, Gulf of

Mexico, and South Atlantic to watch for the tags and to return them promptly.

Shell terminology in this paper follows that used by Carr (1952).

SPECIES ACCOUNTS

Chelonia mydas

GUYANA

The green turtle, locally known as 'bettia', nests at Papaya Beach where fresh eggs and an adult carapace were seen 29 April 1967, on Turtle Beach where six shells were seen on the same date, and probably at Dauntless Point, Leguan Island. According to N. O. Poonai of the Guyana Museum, nesting also occurs on 63 Beach, Tiger Island Beach, Suddie Beach, Zeelandia Beach, and Mahaica-Mahaicony Beach. The most used nesting beach appears to be Shell Beach (also called Kamwatta Beach) in the North-West District.

Nesting season and periodicity: – In 1964 and 1965 visits were made to Shell Beach in August, which was probably near the peak of the hawksbill season but well after the green turtle peak; only 11 green turtles nested on Shell Beach between 6 and 27 August 1965. Arawak turtle hunters, questioned about the peak and extent of green turtle nesting in Guyana, stated that the earliest appear in March and continue abundantly through July, with only stragglers thereafter. This was corroborated by a third visit to Shell Beach in April 1967, when at least five or six green turtles, often more, nested each night. Parties of negroes and Amerindians on the beach were slaughtering virtually every turtle that nested.

One green turtle, tagged while nesting 7 August, nested again 20 August, when it was caught by turtle hunters. This internesting period of 13 days is of the same order as that at Tortuguero ($M = 12.5$ days, Carr & Ogren, 1960), Ascension ($M = 14.5$ days, Carr & Hirth, 1962), and the Talang Islands off Sarawak ($M = 10.5$ days, Hendrickson, 1958).

CARAPACE SIZE AND EGG DIMENSIONS:

Carapace size and egg dimensions: For dimensions of some green turtle carapaces measured on Shell Beach see Table 1 and Figure 1. Six clutches of green turtle eggs from Shell Beach ranged in number from 106 to 138. Four random normal eggs had the following dimensions (in mm.): 46 x 48; 47 x 49; 46 x 47; 46 x 48; one abnormal egg measured 56 x 44 mm.

Table 1. Carapace dimensions of mature female *Chelonia mydas*, Shell Beach, Guyana (in inches)

Length	Width	Length	Width
38	30¾	42¼	29½
38½	31¼	42¼	32¼
38¾	32	42¼	32½
40	32½	42¼	33
40¼	29¾	42¼	33¼
40½	31½	42½	31
41	30¾	42½	35
41	32	42¾	30¾
41	32¾	42¾	33¾
41¼	32¼	42¾	34
41½	29¾	42¾	34½
41½	30¾	43	33
41½	31	43	33½
41½	31¾	43	33½
41½	32¾	43½	29½
41½	33	43½	32
41½	33	44½	32¼
41½	33	44½	33
41¾	30½	45	34
42	32¼	45¾	34
42	32½	46	32
42	34		

Nesting behavior: — Nesting of the green turtle in Guyana was, as far as could be discerned, identical to that Carr and Giovanolli (1957) describe for females from Tortuguero. According to Jerome da Silva, turtles nesting on the populated Essequibo Coast are much more easily disturbed than those on Shell Beach, where we were able to watch the whole nesting procedure from the stage of digging the body pit under continuous flashlight illumination.

Green turtles in both Guyana and Surinam have the habit of making 'half-moons' (non-nesting exploratory emergences) as they do at Tortuguero and on other mainland beaches. The rather charming belief was expressed to me that these half-moons are made by male turtles in search of a suitable place for their mates to nest. Trial nest excavation also occurs, a turtle sometimes digging in four or five places before actually nesting.

Population structure: — That the Guyana green turtle population is composed at least in part of immature individuals is demonstrated by my receiving third-hand a 7-pound individual with a carapace measuring 11½" x 9½", with no other data than 'taken by a trawler off the Guyana coast' on 28 July. This is about as small as green turtles are found anywhere, apart from hatchlings on nesting beaches;

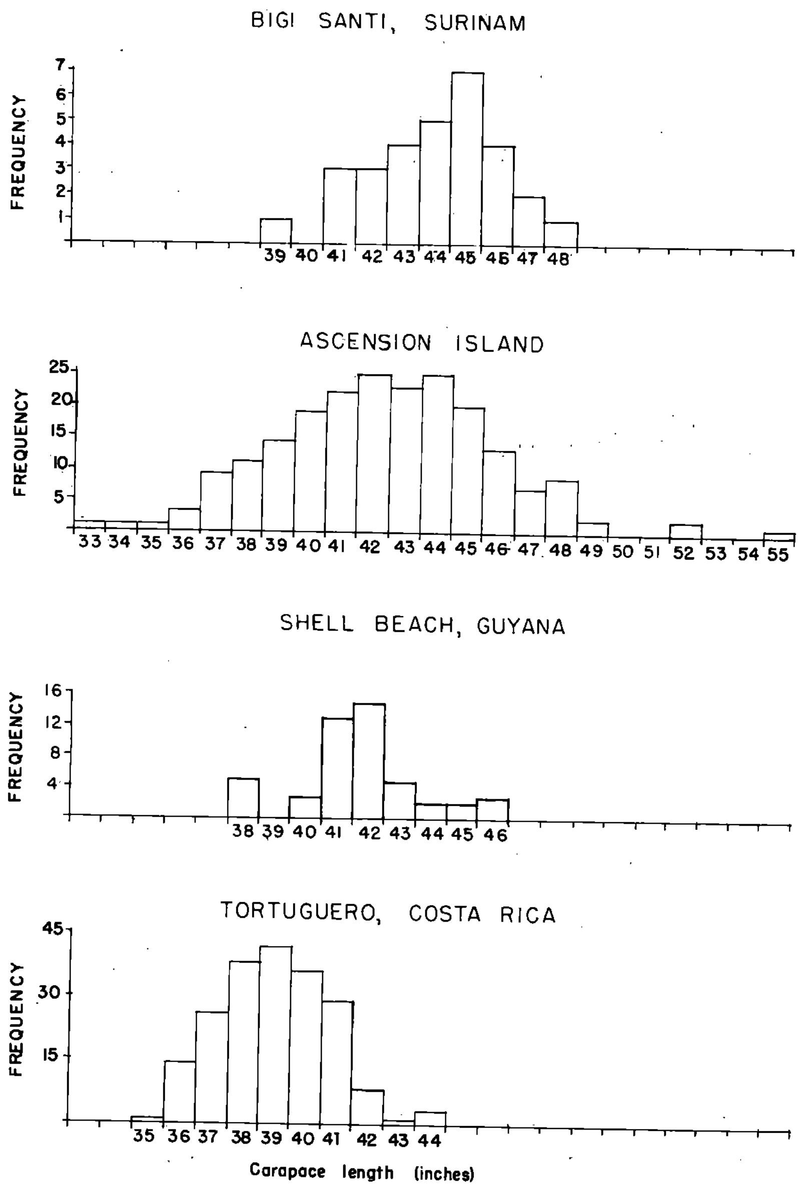

Figure 1. Carapace lengths of mature female green turtles *(Chelonia mydas)* from four selected localities; Ascension Island data from field notes of H. Hirth; Tortuguero data from Carr and Ogren (1960).

it was probably about 1 year old and, as no turtle grass grows in this area, had probably not yet developed the herbivorous diet of the half-grown and adult turtles. When I released the turtle, untagged, on the beach at Georgetown, its seaward orientation had not been disturbed by several days in a bathtub.

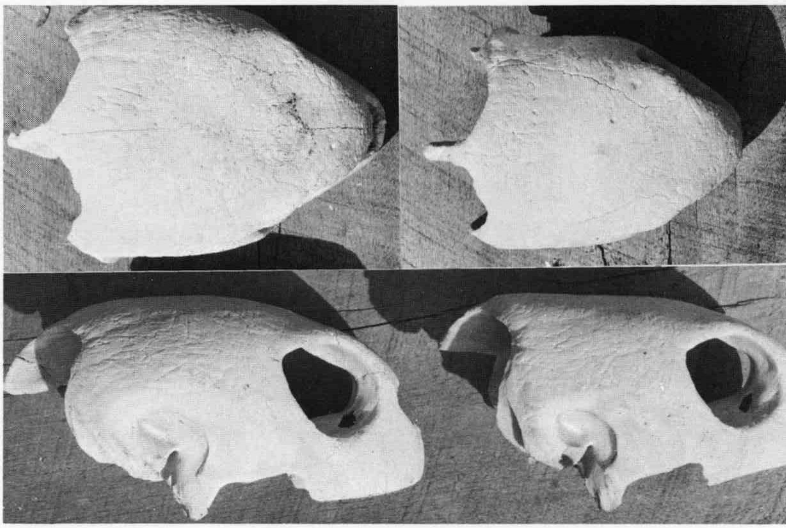

Figure 2. Two types of green turtle skull from shell Beach, Guyana; left: large bulbous-topped type; right: flat-topped, small type.

SURINAM

Here the local name of the green turtle is "krape". The species nests fairly abundantly on Bigi Santi and also on the beaches near and in the mouth of the Marowijne River (Eilanti, Tijger Bank, Babboon Santi). Nesting occurs on Marowijne beaches far enough upstream for the water to be fresh or only slightly brackish.

Nesting season and periodicity: – On Surinam beaches green turtles nest most abundantly in April and May, but a few stragglers persist until June or early July. We tagged 30 green turtles at Bigi Santi between 5 and 14 May, and between 24 May and 6 June 1966; about 30 more nests were discovered after the turtle returned to the sea. We tagged 44 more green turtles at Eilanti and Bigi Santi in May and June 1967. During the 2 months of the peak season an average of four or five green turtles nest each night at Eilanti. About this number also nested each night on Bigi Santi during the 1966 season, but in 1967 considerably more, occasionally up to 15 or more per night, and in 1968 sometimes many more than this. The following individual internesting intervals (in days) were recorded: 13, 13, 13, 15, 16, 21, 28, 29. Except for the 21 day record, these are commensurate with the average internesting period of other areas, 13 to 14 days.

Size of mature females: – Surinam green turtles are unusually large (Table 2); the average length of 60 mature females was 44.02″, nearly 2 inches longer than the average of the Ascension Island colony, previously thought to be the largest. Lengths ranged from 39½ to 48 inches, and weights from 266 to 493 pounds. The only male measured had a carapace 43″ long and 32¼″ wide.

Evidence of migration: – Only one tagged green turtle from Surinam has been recovered to date, a 45-inch individual which was

Table 2. DIMENSIONS OF MATURE FEMALE *Chelonia mydas* FROM BIGI SANTI, SURINAM (IN INCHES)

Carapace length	Carapace width	Plastron length	Head width	Weight (Lbs.)
39½	31¾	33	5½	312
41½	31½	33½	6	329
41¾	32	34	5½	–
41¾	33½	32	6	344
42½	32½	35¾	6¾	340
42½	32½	34½	6	286
42¾	33½	34½	5¾	350
43	32	34	5¾	266
43	36	34½	5½	330
43½	34½	–	5¾	–
43½	34½	37	6	355
44	33½	35½	6	379
44	34	32½	5¾	–
44	34¾	–	5¾	–
44½	33½	34	5¾	405
44½	34	34½	6	359
44½	36	36	6	394
44¾	34	36½	6	462
45	35	35¼	6¼	450
45	34¾	–	6	–
45	35¾	37	6	–
45¼	33	36	6	399
45¼	34¾	36	6	417
45¾	35½	37	6½	392
45¾	35¾	36	6	–
46	34	37¼	6¼	462
46¼	34	36¼	5¾	396
46½	34¾	–	6	–
47	33½	36¾	6	–
47¼	34	34½	6	392
48	37	39½	6½	493

found, only 6 weeks after tagging at Bigi Santi, near São Luis on the coast of Brazil (Figure 3). This journey represents a swim of at least 1000 miles against the prevailing current. It will be interesting to see if more returns confirm this as a regular migration route. This is the first known case of a migrating turtle crossing the Equator.

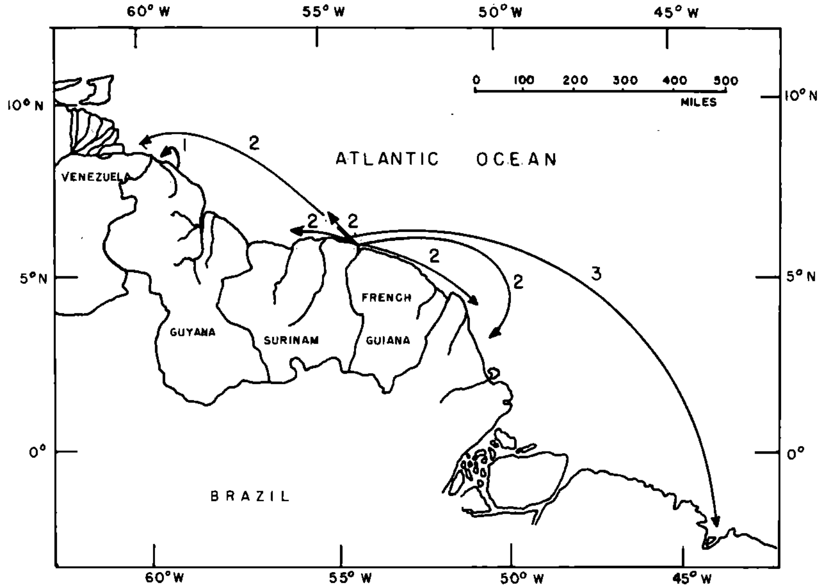

Figure 3. Recovery of tagged turtles: 1: *Eretmochelys imbricata* tagged at Shell Beach; 2: *Lepidochelys olivacea* tagged at Eilanti; 3: *Chelonia mydas* tagged at Bigi Santi (Arrows do not indicate actual routes traveled).

Some of the green turtles at Bigi Santi have rather large barnacles on the carapace; green turtles in other areas remain almost free of barnacles throughout life, although hawksbills and loggerheads are often encrusted with them. The ridleys examined had only occasional small barnacles on the head and shell, while leatherbacks were invariably free of them.

Clutch sizes and incubation periods: – Average number of eggs in 20 green turtle nests from Bigi Santi was 142.8 (range 87-174); average for 248 nests at Eilanti and a small neighboring beach (Dapp Island) was 141.9, the largest number in one nest being 226. This number was rechecked, and is apparently the largest number of eggs known to have been laid by any sea turtle, or indeed any amniote vertebrate, at one time. The average number of eggs per nest at Tortuguero is 110.0; at Ascension, 115.5; at the Sarawak Turtle Islands, 104.7 (Carr and Hirth, 1962). In all cases samples were large enough for the difference in average clutch size to be highly significant.

G. Plak gave me the following records of incubation time (in days) for 40 undisturbed green turtle nests: 47, 52, 54, 55, 55, 55, 55, 55, 56, 56, 57, 57, 57, 57, 58, 58, 58, 58, 59, 59, 59, 59, 59, 59, 60, 60, 60, 60, 60, 60, 60, 60, 61, 61, 61, 61, 62, 63, 64, 64 (M = 58.25 days). The only definite information on fertility percentage is that a clutch of 169 eggs produced 162 viable hatchlings, 2 slow-developing embryos, and 5 infertile eggs (i.e. 97 per cent fertility). Mr. Plak informs me that such percentages are normal for clutches on Bigi Santi where nests are not moved to protected sites after laying. Previously recorded average fertility rates are around 50 per cent (Carr and Hirth, 1962), but such data have always involved transferred nests. Their statement that 'removal of eggs from the nest and installation in artificial nests impose no additional mortality' is probably incorrect. Hendrickson (1958) tried to demonstrate that transfer of eggs imposed no additional mortality by transferring control clutches very carefully and other clutches rather roughly, but probably any moving of the eggs after they are laid will lower the hatching percentage.

The hatchlings from one nest of 169 eggs ranged in carapace length from 51 to 55 mm (M = 5.35 mm; cf 5.17 at Ascension, 4.97 at Tortuguero).

Abnormal green turtle eggs were rare, but one clutch contained a single large elongate egg and another contained four dumbell-shaped eggs.

According to Mr. Plak, green turtles occasionally nest by daylight on Bigi Santi; he had seen emergences at 2:30 PM and at 4:30 PM. Medem (1962) reports a nesting emergence by this species at 10 AM in Colombia.

I once saw green turtles mating at Bigi Santi; at 5 PM on 14 May a pair about 60 yards off the beach remained embraced for at least an hour, but I saw neither the start nor the finish.

Population structure: — Green turtles intermediate in size between hatchling and adult are rarely seen in Surinam, but Schultz (1967) figures a 35 cm specimen taken near the mouth of the Surinam River, and Brongersma (1968) mentions specimens measuring 28.8 and 37.9 cm respectively from the vicinity of the mouth of the Surinam

River, now in the Museum at Leiden (RMNH 13934 and 13935).

French Guiana

According to Lacepede (1847) green turtles used to nest in the vicinity of Cayenne between April and June; at the end of the 18th. century about 300 adults were taken there each year. They probably still nest on several beaches on the Île de Cayenne, in particular Montabo Beach, Bourda Beach, and Montjoly Beach, judging by my interviews with the local people in 1967, although my informants were not very definite as to species. Green turtles are also said to nest on the beach near the mouth of the Mana River, and an aerial reconnaissance of this area in July 1968 showed that, although most of the nesting is unquestionably by leatherbacks, some green turtles also nest here. We could find no evidence of any turtle-nesting on the fine beach at Kourou. The best beach in French Guiana for green turtles is Silébache Beach, a few miles west of the mouth of the Organabo River; it consists of extensive steep-sloping sandy stretches separated by huge deposits of hard, black mud. Mud flats exposed at low tide, similar to those at Eilanti Beach, Surinam, force the turtles to nest by mid- or high tide. I reconnoitered this beach in early June 1967 in the daytime and over a low tide period at night. Fresh tracks and nests of both green turtles and leatherbacks were plentiful, and it seems certain that at least several dozen green turtles nest on this 3-mile beach nightly at the peak of the season. I tagged one green turtle with a 45½ inch carapace that was nesting despite the low tide.

Lepidochelys olivacea

The ridley turtle of the Guianas has been a curiously neglected and persistently misidentified animal. Almost a century ago Kappler (1881) wrote: (quoted in translation from Schultz 1964) "In May and June a smaller turtle, weighing about 60-70 lbs, comes on shore in such numbers (near the Marowijne River) that on some nights about thirty can be caught. The Indians call them *warana (Chelonia corticata)*. These turtles come on shore not only to lay their eggs; but still I never saw a male on land. The eggs are smaller than those of the former (i.e. *Chelonia mydas)*, better to eat, and with yellower yolks. The meat is not so good, and is not eaten." The name *Chelonia corticata* Strauch 1862 is customarily synonymized with *Caretta caretta*, but Kappler's statement that the breeding size of the animal is 60-70 lbs identifies the genus *Lepidochelys* unequivocally. As late as 1957 Carr summarized evidence for the occurance of *Lepidochelys* *olivacea* in the West Atlantic as a single adult from Gibara, Cuba, and rumors of the occasional capture of a turtle fitting the description of a ridley in Trinidad. Brongersma (1961) wrote that it is "likely that the species breeds somewhere in the Guianas, and indeed a further search along these coasts may yield interesting results." As proof of this, he records a hatchling collected in 1911 in Surinam, and he received one himself from a fisherman in Surinam in 1963 (Brongersma 1968). Even Schulz (1964) in his excellent and detailed account of the sea turtles in Surinam misidentifies *Lepidochelys* as *Caretta* (the true identity of the turtles is evident from the photographs). That same year I (Pritchard, 1964) was able definitely to associate the name *Lepidochelys olivacea* with a breeding population of turtles in the West Atlantic.

GUYANA

The ridley nests in reasonable numbers on Shell Beach, where it is known as "teracai" (a name used for *Podocnemis* in Colombia), and also as "parrot-beak", "roach-turtle", and "hawksbill." It probably also nests on Waini Beach, Turtle Beach, and Dauntless Point, Leguan Island.

I found 14 ridley shells on Shell Beach in August 1964, most of them reasonably intact, and 21 more in August 1965. Small turtles such as ridleys are frequently removed alive by turtle hunters, and probably many more nest without molestation. Therefore Shell Beach seems to be a site of considerable ridley nesting activity. The peak of the season probably lies in May and June; in August very little nesting occurred. Only three live animals were seen during the 3-week observation period. Turtle hunters caught two of these, while I tagged and released the third after watching it nest. Egg diameters on Shell Beach ranged from 39 to 40 mm; those of the hawksbill were similar (36-40 mm), but hawksbill eggs could be distinguished by the slight pinkish tinge showing through the shell.

SURINAM

The local name in Surinam is "warana". The species nests in moderate numbers on Bigi Santi; Schulz (1964) recorded 97 nesting emergences there between 29 April and 17 August 1964. Few ridleys nest in April and May when the leatherbacks and green turtles are nesting in numbers, but more do so in June and July. Between 5 May and 6 June 1966, we found only six ridleys on Bigi Santi. The first of these, an unusually heavy specimen (97 lbs) with a 27¼ inch carapace, emerged from the sea at 5 PM on 10 May and carried out its complete nesting process in daylight. Another daytime nesting record for this species is by Caldwell and Casebeer (1964), who found a ridley emerging in mid-afternoon on the Pacific Coast of Costa Rica.

Aggregated emergences:—At Bigi Santi I was informed that the ridley nested in large numbers on certain days in June and July on

Figure 4. A substantial number of the ridleys nesting at Eilanti had shells and limbs damaged, presumably by shark bites. The raw stump of the hind foot of the lower turtle suggests that even adult turtles are vulnerable to shark attacks.

a small beach called Eilanti, near the mouth of the Marowijne River on the French Guiana border. On a routine visit to the area Mr. Plak questioned the natives about this and learned that the first big

Figure 5. General aspect of beach at Eilanti, Surinam. Note the Indian encampments and the black vultures that eat any eggs the Indians break accidentally.

Figure 6. Eilanti Beach, 8 June 1966. Note the tracks made by some of the 500 turtles that nested the night before.

Figure 7. Congestion of ridleys on Eilanti Beach. In the lower picture one turtle crawls back toward the sea over the carapace of another; it was restrained in that position until the camera was made ready.

arrival of ridleys was expected 10 June. Accordingly we arrived at Eilanti a few days early, on 7 June, in the late afternoon, to find many Indians encamped on the beach, all certain that the big group of ridleys would come up that night.

The first turtle emerged with the rising tide by daylight at 5:30 PM. Two more came out before dusk, and after the sun went down they began to come ashore in large numbers. Nearly all the nesting was confined to a stretch about 230 yards long at the eastern end of the ½-mile beach. By 10:50 PM we had tagged 133 turtles and exhausted our supply of tags. At 11:10 PM 97 turtles were nesting simultaneously on a 230-yard stretch, and 115 turtles were present on the entire beach. By 11:45 PM only six turtles were left. By midnight no turtles remained on the beach, and the falling tide exposed extensive mud flats, about ½ mile wide, crossed by the tracks of many turtles returning to sea in only a few inches of water. We estimated at least 400 turtles nested during the night. About 6 AM the next morning we found 16 more turtles nesting by the early morning light; 2 hours later one turtle was still pounding down the sand on its nest site on a very small beach just southwest of Eilanti, on which possibly as many as 100 ridleys had nested during the night. The following night (8 June) the first turtle was found nesting at 6:40 PM. At 7:30 there was again only one turtle on the beach, but at 10:00 PM 26 were nesting, and at 11:30 PM we found 37. An estimated total of between 80 and 100 turtles nested that night. On the night of 9 June we found four nesting at 7:45 PM, and 84 at 1:05 AM. The total for the night was probably near 300.

Though we had to leave the beach the following day, we subsequently learned that after 9 June nesting declined to fewer than

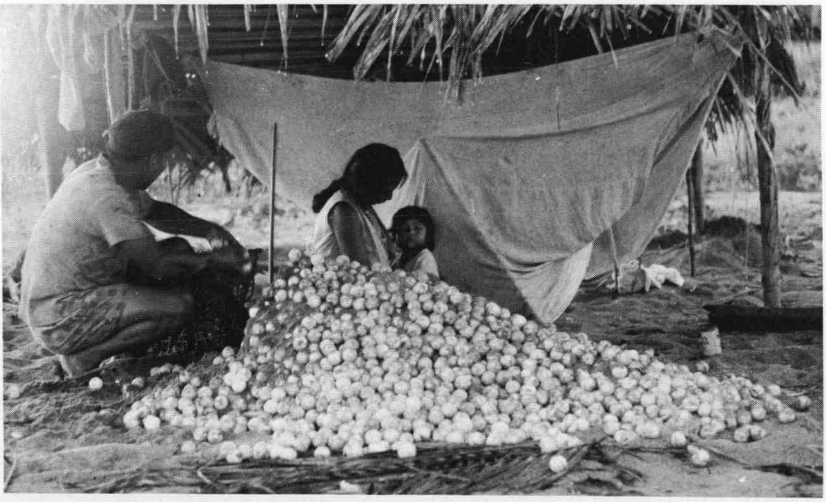

Figure 8. Eight mounds of eggs each of this size were accumulated during the night of 7 June at Eilanti.

15 per night. We did not witness the next big arrival that took place 24 June, but I was told that the numbers were comparable to those of 7 June. Only three turtles tagged on 7 June were reported in the later nesting period.

The last major aggregation of the year was expected on 14 July. We arrived at Eilanti 12 July, but learned that the big group had nested on the 10th, and that not a single turtle had nested on 11 July. About 10 ridleys nested the night of 12 July, and also a 64-inch leatherback, but the following night only two ridleys nested. The next day we left the beach.

Table 3. NUMBERS OF *Lepidochelys olivacea* NESTING EACH NIGHT DURING THE 1967 SEASON AT EILANTI BEACH, SURINAM

25 April	0	15 May	3	4 June	3	24 June	63	14 July	8
26	1	16	1	5	4	25	37	15	10
27	0	17	0	6	11	26	208	16	9
28	1	18	1	7	1	27	61	17	5
29	0	19	7	8	8	28	27	18	0
30	1	20	4	9	9	29	142	19	5
1 May	1	21	1	10	13	30	54	20	10
2	0	22	6	11	152	1 July	35	21	4
3	0	23	0	12	38	2	3	22	6
4	2	24	0	13	260	3	14	23	11
5	0	25	0	14	82	4	11	24	22
6	1	26	3	15	122	5	2	25	5
7	0	27	5	16	6	6	7	26	6
8	0	28	22	17	8	7	5	27	0
9	0	29	23	18	16	8	16	28	29
10	0	30	53	19	7	9	47	29	13
11	0	31	33	20	17	10	98	30	0
12	5	1 June	27	21	5	11	412	31	0
13	4	2	11	22	4	12	96	1 Aug.	0
14	1	3	12	23	22	13	4	2	0

In 1967 we carried out a more protracted study of ridley nesting at Eilanti; Table 3 shows the numbers of turtles nesting each night. These accurate figures were made possible by the cooperation of the Carib Indians of Christiaan Kondre village on the Marowijne River; each man occupied a few yards of the beach each night, marked all nests as they were made, and brought the eggs to our camp in the morning, where we bought them and re-buried them in an artificial hatchery.

The Indians told me that the 1967 nesting was more diffuse than normal, and the periods of aggregated nesting occupied several days each instead of one or two days. Nevertheless a fairly well defined periodicity is evident, with peaks of nesting at approximately 14-day intervals. Thus the mid-point of the first small wave on 30 May was followed by a major aggregation centering on 13 June, another on 27 June, another on 11 July, and a small, tail-end peak centering around 25 July. It was noticeable that, even when a large group of turtles was expected, none materialized unless the wind was fairly strong onshore. A big group was expected 12 June, but there was no wind at all that night and relatively few turtles nested; these few were abnormally skittish and were easily frightened back into the sea. On the other hand, during a night of intensive nesting activity turtles could sometimes be tagged as they came out of the water; after a momentary flinching as the tag perforated the flesh, they continued up the beach and nested normally.

On all nights of aggregated nesting in 1967, the tide was rising at dusk and falling at midnight. It was not unusual for one or two turtles to nest before dark, and moderate nesting took place until high tide was reached, but the turtles did not emerge en masse until much later, and indeed many were so late returning to the sea that they had to struggle through ½ mile of 2-inch deep water over the mud flat.

Internesting intervals (in days) are shown in Table 4. It may

Table 4. Internesting intervals (in days) for *Lepidochelys olivacea* at Eilanti Beach, Surinam

Interval	Frequency	Interval	Frequency	Interval	Frequency
1	19	21	6	41	0
2	7	22	6	42	0
3	5	23	4	43	2
4	3	24	1	44	2
5	6	25	22	45	1
6	3	26	9	46	0
7	1	27	15	47	1
8	0	28	17	48	0
9	0	29	17	49	0
10	0	30	68	50	1
11	4	31	14	51	0
12	4	32	3	52	0
13	4	33	12	53	0
14	11	34	5	54	0
15	6	35	2	55	0
16	12	36	0	56	0
17	41	37	1	57	0
18	23	38	0	58	0
19	18	39	0	59	0
20	10	40	2	60	1

be seen that the most usual intervals occur around 17, 30, and possibly 44 days, with a lone recovery after 60 days. Our immediate conclusion that the 30-day renesters had merely been missed the second time, and recorded the first and third times, is not supported by the small number of turtles found three times. Altogether 1060 turtles were tagged, of which 389 were found nesting twice in the same season, but only 11 were found three times (except for a few cases in which one of the intervals was less than 7 days, when we assume that the turtle did not nest on its first appearance). These eleven nested at the following intervals (in days): 20 & 11; 12 & 17; 12 & 30; 17 & 16; 17, 3 & 28; 18 & 19; 11 & 19; 17 & 16; 17 & 16; 18 & 16; 14 & 16.

It seems most likely that *Lepidochelys olivacea* normally nests twice in a season, at intervals controlled more by external factors (tide and weather) than by the internal factors that seem to control the green turtle's nesting.

A particularly interesting finding was that no less than 39 of the 130 turtles tagged 7 June 1966 renested in 1967 between 31 May and 12 July, and 59, including 28 of the 39 from 1967, renested in 1968. Nine of these nested twice in 1967, on the following dates: 30 May and 28 June; 3 June and 9 June (presumably disturbed the first time); 11 June and 11 July (three individuals); 13 June and 9 July; 13 June and 11 July (two individuals); 14 June and July 10. I have since heard from Rene Marquez that *Lepidochelys kempi* also sometimes nests in successive years, and recently these results have been published (Chavez, 1968). On rare occasions *Caretta caretta* may nest in successive years on the coast of Natal (Hughes et al, 1967).

The local Carib Indians can predict with reasonable accuracy when large nesting aggregations of turtles are expected, and many of them move down to the beach to collect the eggs for the market. The village headman told me that he had been coming to Eilanti to raid ridley nests for 50 years, and that the numbers did not seem to be reduced from former times. This is hard to understand, as I estimated that fewer than 10% of nests on nights of aggregated nesting remained intact, and relatively few individuals nest on other nights. Possibly most of the turtles nesting today are old individuals hatched before systematic nest raiding began. Killing sea turtles is forbidden by Surinam Law, and indeed the Indians showed a solicitous regard for them and feared that I might damage or possibly kill them by leaving them on their backs overnight to photograph in the morning.

One of the ridleys tagged 7 June 1966 was recovered 17 September 1966 near Cape Cassipore, Brazil, by a shrimp trawler. The turtle was taken in water 35 fathoms deep, having traveled about 300 miles upstream. Another was recovered 75 miles offshore from Paramaribo on 20 January 1967. Three of the 1967 group have been recovered, one from near the Orinoco Mouth, one off the coast of Surinam, and one from Brazil between the mouths of the Oyapoque and the Amazon (see Figure 3).

Nesting process. Several writers have hinted at the possibility that *Lepidochelys olivacea* makes massed nesting emergences on Pacific shores of the Americas. Carr (1961) found the apparent scarcity of nesting ridleys on the Pacific coast of Mexico hard to reconcile with the large numbers of sexually mature individuals seen offshore, and concluded that they must be grouping up to nest in some remote, overlooked place. Caldwell (1966) mentions uncorroborated reports of large numbers of turtles nesting in the vicinity of Bahia Banderas, Jalisco, Mexico. Proof of aggregated nesting by the ridley of the East Pacific was not forthcoming until late 1967, when Carr received photographs from Antonio Montoya showing huge numbers of ridleys nesting together on a few kilometers of beach in northern Guerrero, Mexico. Montoya estimated that on one occasion 15,000 turtles nested in a 24-hour period, and on another occasion 30,000 nested in 18 hours. Nesting thus took place both by daylight, as is almost invariable with *L. kempi,* and by night, as is normal with Surinam *L. olivacea.* Similar large aggregations have since been found on the coasts of Jalisco and Oaxaca.

Two questions arise: how do the turtles manage to synchronize and localize their nesting in this fashion, and why do they do it? The first question touches upon the larger and as yet unsolved problems of sea turtle navigation, discussed at length by Carr (1964, 1967). The problem of synchronization of nesting, peculiar to the genus *Lepidochelys,* has yet to be discussed in the literature. It seems unlikely that eggs ripen within the body of the gravid female ridley in such perfect synchrony that the urge to lay, brought about by pressure of eggs from within, comes upon the whole population simultaneously. It is more likely that the eggs ripen in approximate but not perfect synchrony, and that the female can hold the shelled eggs for a reasonably long period until the right combination of tide, moon, and wind brings about an independent urge to lay in all the local turtles simultaneously. This theory must be viewed in the light of the common observation that a turtle frightened back to the sea before it nests will usually try to nest again either later the same night or the following night. It seems likely that, once a turtle comes voluntarily from the sea to nest, the eggs start moving towards the cloaca and produce a pressure that can be relieved only by laying the entire clutch. If the turtle has not yet tried to leave the sea, apparently the eggs may be held much longer.

The advantage of massed nesting (*arribada* formation) is similarly not obvious; some benefit must be gained, as the *arribada* is a highly organized trait, certainly not the result of random chance, and must require constant selective pressure to maintain. One of the reasons most commonly given is to overwhelm predators, particularly predators on the eggs and hatchlings, with such a bewildering abundance of prey, available for such a short time, that even though the predators eat all they can, large numbers will still survive. It has now been shown that *arribadas* in Surinam, Tamaulipas (Carr 1963) and Guerrero all take place only during strong onshore winds and, even in Honduras where *arribada* formation is yet to be demonstrated, more turtles nest on windy nights than on calm nights. This too must have a reason, and it has been suggested that strong winds may in some way help the turtles to "ride the waves" and be speeded on to the beach. Much more likely to me is the fact that a strong wind will help cover up the tracks and nests of the ridley and thus render them less conspicuous. Little short of a tornado will obliterate the tracks of a green turtle or leatherback, but the track of a ridley is so shallow that wind-blown sand can erase it quickly. William Greenhood has suggested that a strong wind helps to dislodge the mosquitoes that descend in clouds upon ridleys nesting in Surinam, and this reason too may have some substance.

As no detailed account of the nesting of *Lepidochelys olivacea* in the Atlantic has been published, the following description of the nesting process of an Eilanti individual may be of interest.

The turtle, found crawling up the beach with its carapace still wet, paused occasionally as she walked straight to the vegetation line, turned back a short way, and immediately began digging the body pit. Using rather disorganized strokes of all four flippers, the front ones usually working together (Figure 9), the rear ones alternately, she completed the pit in 4 minutes. She started digging the nest cavity at the rear of the body pit with great energy, but soon became rather sluggish. Her shell moved from side to side through

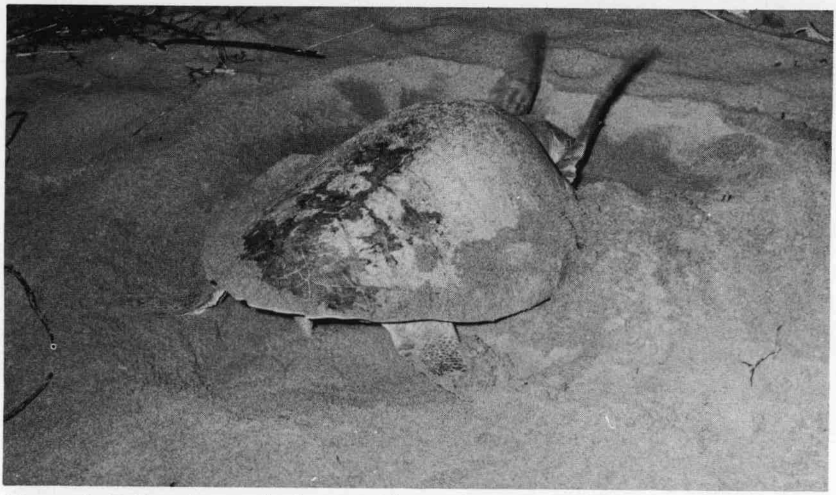

Figure 9. Ridley digging body pit with simultaneous strokes of the front flippers.

a wide angle as she dipped her flippers alternately in the cavity. She jerked each flipper forward sharply before re-inserting it in the hole. As the cavity deepened her shell dipped lower to let the flipper scrape sand off the bottom. At first she moved the rear part of her carapace in a simple down-up movement, but towards the

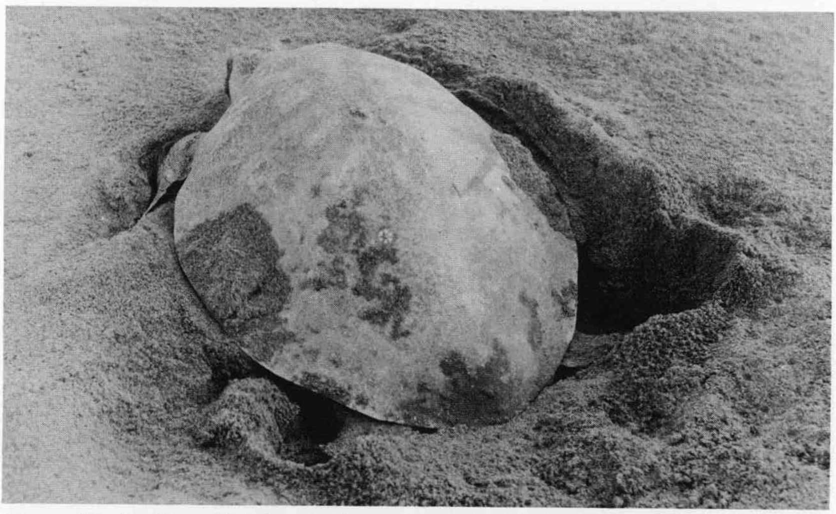

Figure 10. Position of ridley during oviposition. Note the fore-flippers anchored in the sand and the widely-spaced hind flippers.

end of the excavation this movement became a little more complicated; she lowered the rear part of her shell to the full extent, the front of the shell raised high on the forelimbs and the neck lowered; then she raised the rear a little, lowered it the same amount, and finally raised it fully before switching to the other flipper. When the egg cavity reached its final flask shape, she continued to jerk the flipper sharply forward as if about to re-insert it in the cavity, but instead she merely curled the flipper and drew it under the overhanging rear margin of the carapace. There was no obvious reason for this movement, which she made about three times with each flipper.

Oviposition commenced with the foreflippers still braced in the sand and the hind flippers splayed outwards (Figure 10). The sequence of movements preceding each deposition of one, two, three, or four eggs was as follows: 1) humeral region drawn slightly inwards and head simultaneously slightly extended, 2) above move-

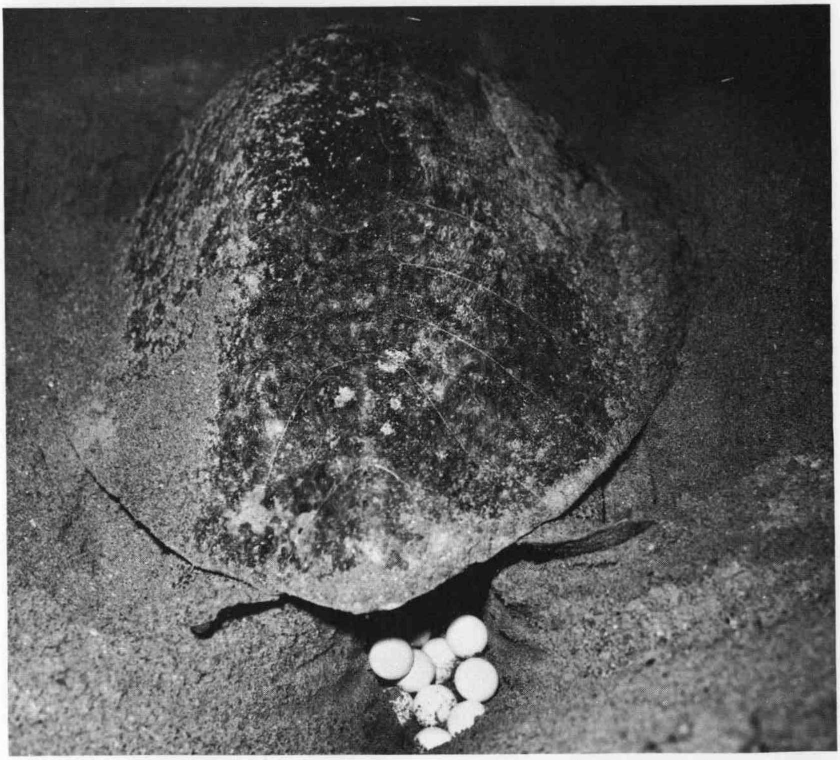

Figure 11. As the eggs are laid the rear margin of the hind flippers curls upwards.

ments reversed, 3) rear part of shell moved up and down through a few millimeters with rear margins of hind flippers raised simultaneously (Figure 11), 4) eggs deposited. From time to time during oviposition she raised her head considerably and took a deep breath. About a minute after laying the last egg, she pulled sand into the egg cavity by alternate movement of the hind flippers. As soon as the hole was filled she pounded the loose sand down with alternate sides of the carapace. During this movement she braced her front flippers in the sand with her head pointed down and almost resting on the sand but providing no anchorage. She thumped down the side of her carapace and the hind flipper on the same side almost simultaneously (Figure 12). After a few minutes she stopped pounding

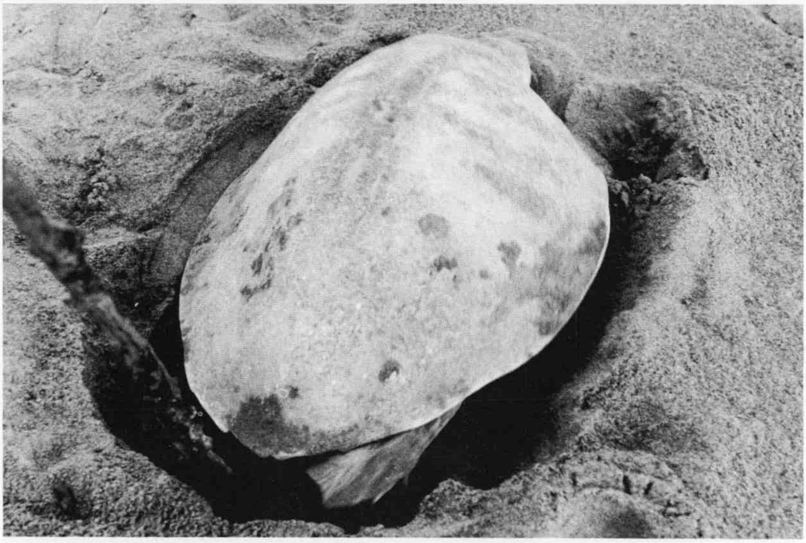

Figure 12. The sand over the nest site is pounded down with side-to-side movements of the shell; the turtle has just tilted sharply to the left, compressing the sand with the shell margin.

and with the hind flippers drew more sand into a small pile under the rear of her carapace. She then resumed thumping, always with a side-to-side rocking movement, never with the whole plastron. Then she began to throw sand backwards with one foreflipper and the opposite hind flipper (Figure 13). This movement generated a slight turning effect and a slight motion away from the nest site. After four or five swipes she counteracted the turning movement with a single quick step and repeated the maneuver with the opposite flippers. This

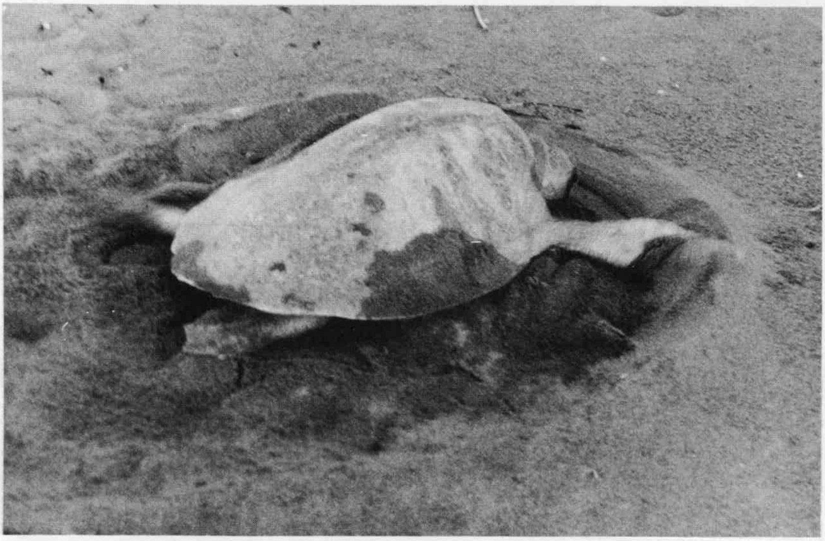

Figure 13. Sand is swept over the nest site with strokes of one foreflipper acting in conjunction with the opposite hind flipper.

continued for a long time, while she moved about 5 feet away, then turned round and returned toward the nest, possibly disoriented by the light. Into this movement she interposed a few simultaneous swipes of her fore flippers. Gradually the movement became the standard walking which carried her part way to the sea. Shortly before she reached the sea she turned a tight circle and thereafter seemed completely disoriented, again possibly by the flashlight. Eventually it was necessary to help her into the sea.

I timed another turtle as she went through the same motions as follows:

1:24 AM	Emerged from sea.
1:26	Selected nest site and started body pit.
1:30	Started excavating nest cavity.
1:45	Changed digging movement to flipper-curling movement (see above).
1:46	Starting ovipositing.
1:55	Began to fill egg cavity.
1:56	Commenced sand pounding.
2:00	First front flipper movement.
2:09	Started moving towards sea.
2:10	Reached sea.

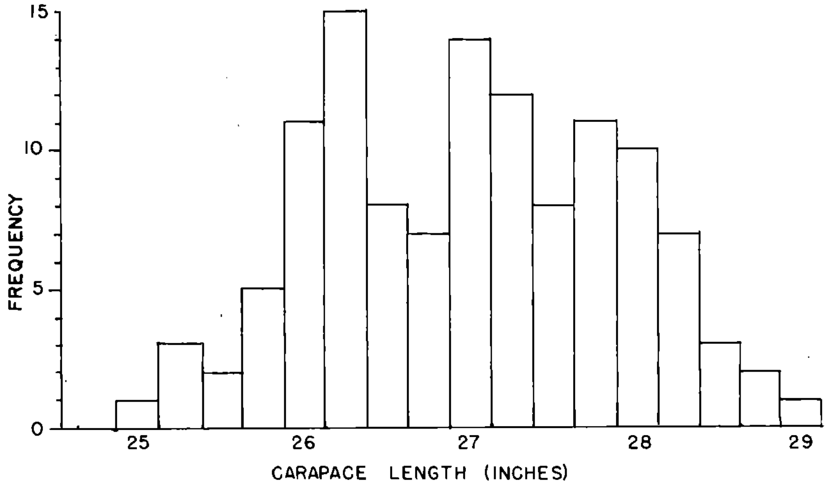

Figure 14. Overall carapace lengths of mature female ridley turtles *(Lepidochelys olivacea)* from Shell Beach, Guyana; Bigi Santi, Surinam; and Eilanti, Surinam.

Although the Indians warned me that a flashlight would disturb the turtles, I found them remarkably oblivious to disturbances of this or other kinds, even before they had begun to nest. The whole process from emergence to reentry seemed completely automatic. Impatient Indians frequently dragged the turtle away from the nest as soon as the last egg was laid; the turtle went through the covering-up and sand-pounding motions as if it had not been removed.

Carapace measurements. — Mature female ridleys fall in a rather narrow size range, the vast majority having a carapace length between 26 and 28 inches. The smallest of 241 individuals measured had a carapace length of 24.5, the largest 29.125 inches. Figure 14 shows the carapace length distribution for 120 random adult female ridleys; Table 5 gives more detailed measurements for 21 individuals. Carr (1952) found the carapace length of mature female *Lepidochelys olivacea* from Pacific Honduras to range from 25.4 to 27.2 inches. My own studies in this area show that some females reach maturity at as little as 23 inches, while the largest of 100 individuals measured was 29.5 inches, which is larger than any known from Surinam. The species may reach a slightly larger size in the Indian Ocean than elsewhere; the record for the species is apparently held by a 31.1 inch Ceylon female (Deraniyagala, 1939).

Clutch size. — Clutch size for 928 Surinam ridley nests ranged from 30 to 168 eggs; average was 116.072 eggs per nest, and only 4

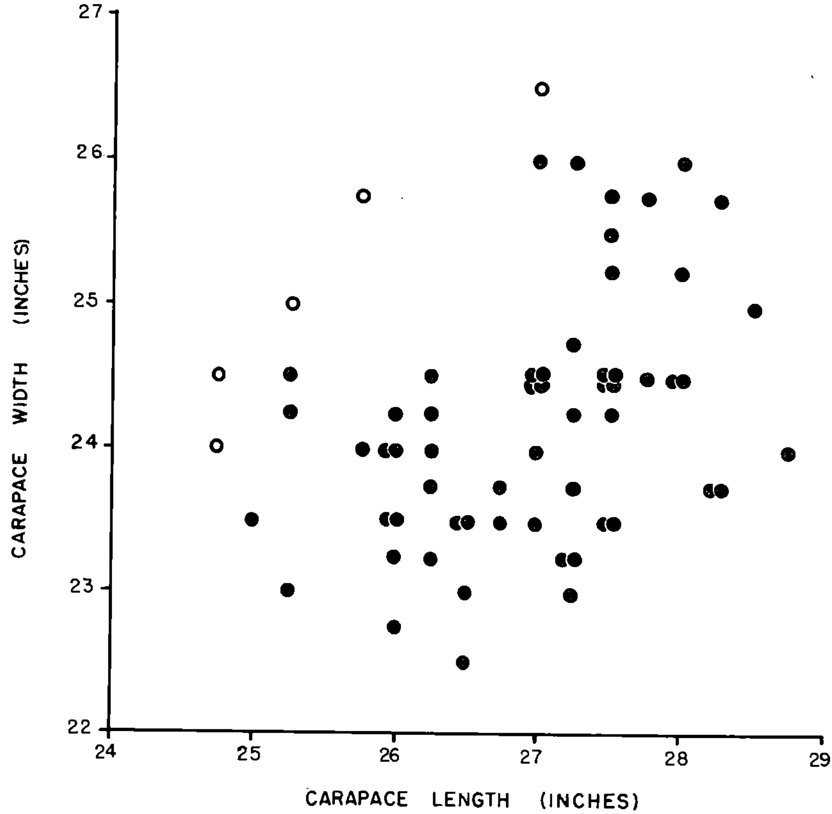

Figure 15. Carapace width plotted against carapace length for 59 mature female *Lepidochelys olivacea* from Guyana and Surinam and 5 mature female *Lepidochelys kempi* from the Gulf of Mexico. Closed circles: *L. olivacea*; open circles: *L. kempi*.

nests contained less than 70 eggs, and only 4 more than 155. No data are available for Surinam ridleys for correlating shell length with clutch size, but out of 45 random Honduras ridleys the 20 that exceeded 26.25 inches in carapace length laid on average 123.8 eggs, while the remaining 25 turtles averaged only 95.9 eggs each.

Carapace laminae. – *Lepidochelys olivacea* is unique among living turtles in showing a striking polymorphism of the carapace laminae. The lateral laminae average about 7 on each side, but vary from 10 to 18 or more for both sides. The central laminae also vary from 5 to 9 in number, although there seems to be only slight correlation between high central counts and high lateral counts (Figure 16).

Table 5. DIMENSIONS OF MATURE FEMALE *Lepidochelys olivacea* FROM SURINAM (IN INCHES)

Carapace length	Carapace width	Plastron length	Head width	Weight* (Lbs.)
25¼	23	19½	5	68
26	24¼	20¼	5	76
26¼	23¼	20	5¼	—
26¼	23¾	20½	5¼	68
26½	22¼	20¼	5½	78
26½	23	21	5	71
26½	23½	21	5¼	82
27	23½	20¼	5¼	—
27	24	21¾	5	76
27	24¼	21	5½	—
27	24½	21	5	76
27¼	23	21¼	5¼	80
27¼	24¼	20¼	5¼	87
27¼	24¾	21¾	5¼	97
27½	23½	21¼	5	77
27½	24¼	21	5¼	—
27½	24½	21	5½	83
27½	25¼	20½	5¼	—
28	24½	21¾	5¼	—
28	25¼	21	5¾	—
28¼	23¾	21¾	5½	77

*All weights taken after oviposition.

The marginals are reasonably constant at 12 on each side. The plastral laminae are much more stable than those of the carapace, but the intergular scute may be absent, single, or double.

The lateral laminae of *Lepidochelys olivacea* are clearly divisible into whole laminae and half laminae, the whole laminae being homologous to the five laterals of *L. kempi.* Displacement of the homologues of the seams of *L. kempi* is usually slight, though in cases of extreme splitting to 8 or 9 laterals the seams become displaced to lessen the size of the small first lateral and the large last central. In almost every case division took place in the rearmost laterals; for example a 6-6 count is produced by division of the 5th laterals on each side, or an 8-8 count by division of laterals 3, 4, and 5. One exception is a shell with a 7-6 count in which only lateral 4 on the right hand side was divided. It seems impossible to rationalize this multiscutate condition in terms of function; the extra seams in no way alter the hydrodynamic form of the animal, and the laminae are so thin that their precise arrangement could have no effect on the overall strength of the carapace. Nor could it have any significant disruptive or other effect on the animal's appearance, as one

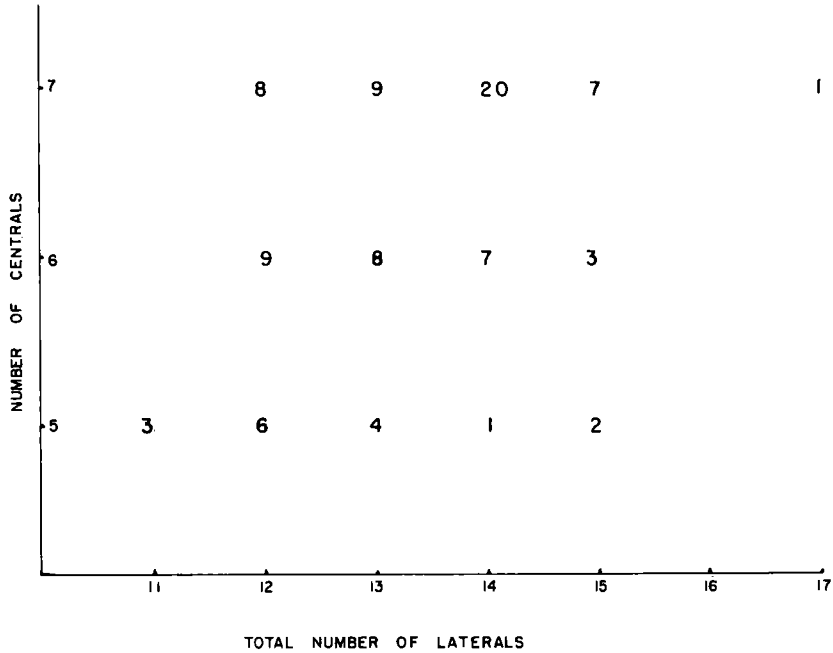

Figure 16. Number of central laminae plotted against total number of lateral laminae for 88 sibling hatchling *Lepidochelys olivacea* from Bigi Santi, Surinam.

usually has to look very closely at adult ridleys to see the lamina boundaries at all (Figure 19).

Carr (1957) suggests that the number of lateral laminae in *Lepidochelys olivacea* is geographically correlated. The present data suggest that this may be true on a broad, statistical basis, but certainly no more than this (Figure 17). It is nonetheless interesting to compare the frequency of occurrence of turtles with only five lateral scutes on each side in the Surinam and East Pacific populations. This lamina count is of course the normal (and very stable) one for the Atlantic ridley, *Lepidochelys kempi* and is the feature most commonly used for distinguishing the species. The only specimens of *L. olivacea* with this count mentioned in the literature are two sibling hatchlings from the Cameroons (Loveridge and Williams, 1957) and 3 out of 378 Ceylonese specimens (Deraniyagala, 1939). Also an adult ridley shell from the Pacific coast of Mexico (Chiapas) in the Chicago Natural History Museum has only five laterals on each side. In Surinam this low count was found to be rare indeed,

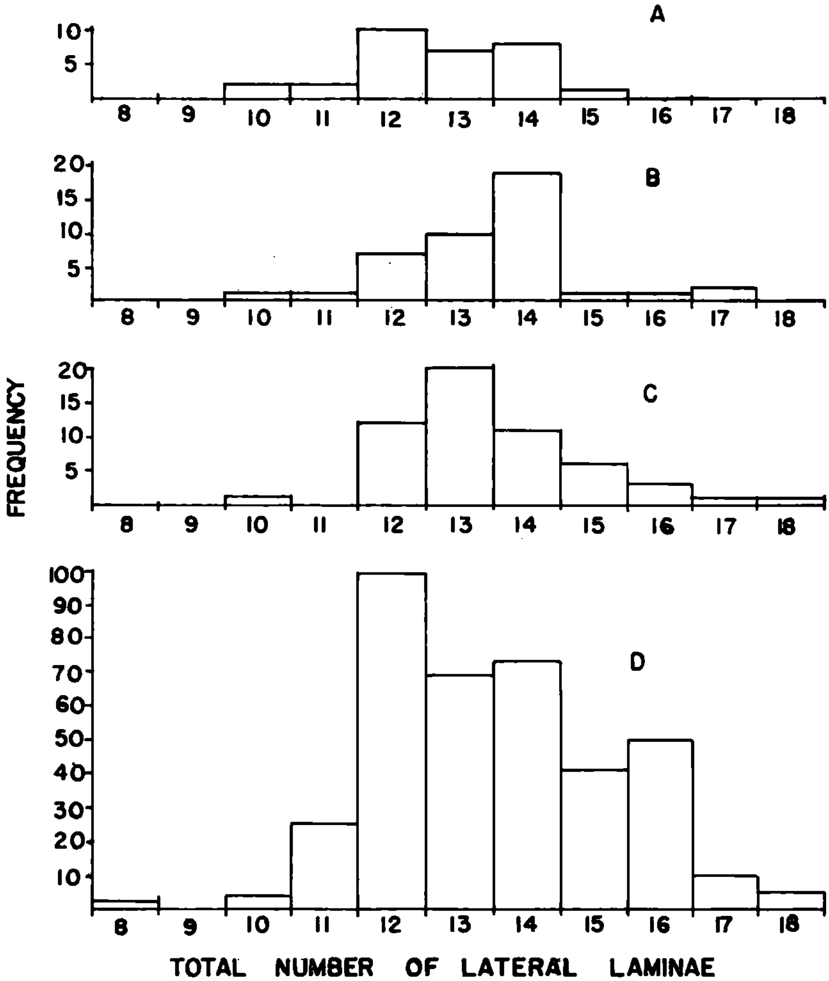

Figure 17. Histogram showing the lack of correlation of total number of lateral laminae of *Lepidochelys olivacea* with locality; A: miscellaneous West African localities (data from Carr, 1957); B: Shell Beach, Guyana; C: Eilanti, Surinam; D: Ceylon (Data from Deraniyagala, 1939).

shown by only 3 out of 762 individuals, but approximately 1 out of 5 adult Honduras ridleys had five laterals on each side, and one group of 126 hatchlings included 26 5-5 counts.

Derāniyagala (1939) writes that a low average lamina count is a tendency of certain broods of hatchlings. This seems borne out

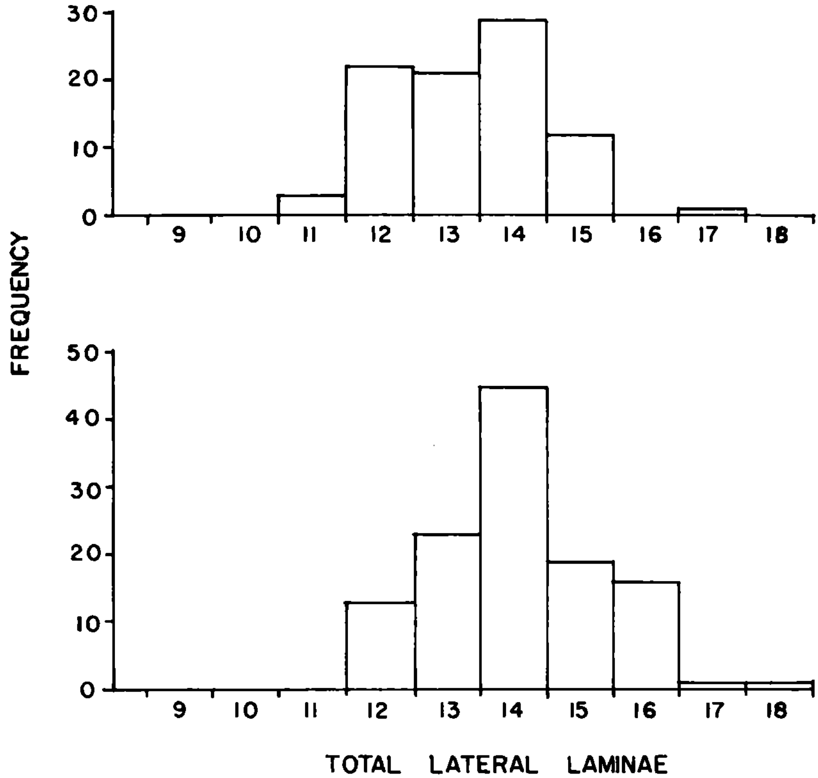

Figure 18. Histogram showing variation in total lateral lamina counts within two complete clutches of *Lepidochelys olivacea* from Big Santi, Surinam.

by an analysis of three clutches of hatchlings from Isla de Ratones, Honduras, shown in Table 6, which were not hatched under natural conditions: brood 1 was hatched in Florida after the eggs had been brought back by car, and broods 2 and 3 were hatched in artificial nests 20 miles from the place of deposition. The extreme counts shown by broods 1 and 3 could well have been produced by transporting the eggs. Lynn and Ullrich (1950) produced hatchling *Chrysemys* and *Chelydra* with similar abnormalities experimentally by subjecting the eggs to suboptimal moisture conditions.

The central laminae of *L. olivacea* show a variation in number in the same way as the laterals; of 474 Surinam specimens 72 had 5 centrals, 200 had 6, 185 had 7, 16 had 8, and 1 had 9. The marginals are less variable, about 90 per cent of specimens having 12 on each side (not counting the paired supracaudals); other counts recorded

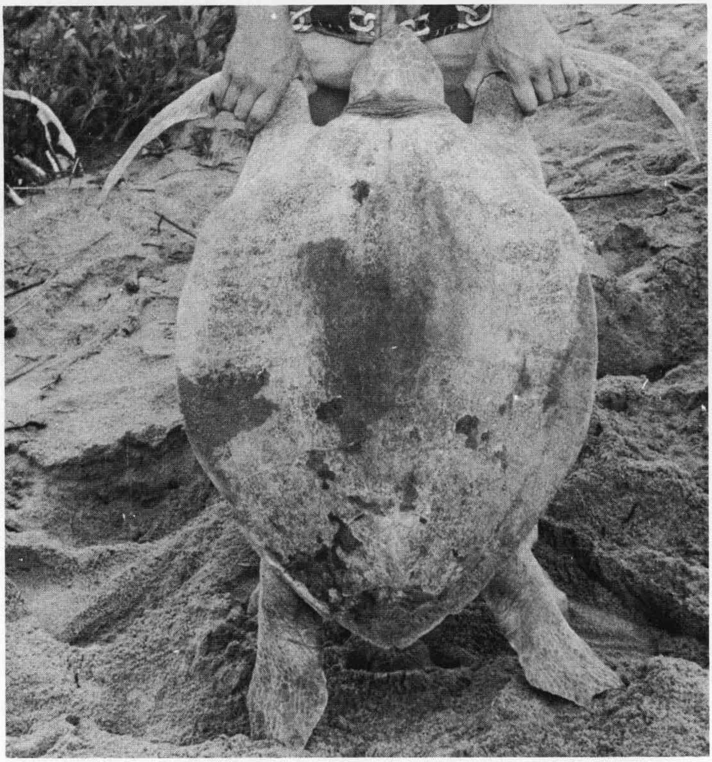

Figure 19. Adult *Lepidochelys olivacea* from Eilanti, Surinam, showing the indistinct lamina borders frequently found in this population. This individual has only five lateral laminae on each side.

were: 11-11, 11-12, 13-11, 12-13, 13-13, 14-12, 15-15. Out of 259 specimens 120 had no intergular lamina, 66 had one, and 73 had two.

Asymmetry in the number of lateral laminae is nearly as frequent in *L. olivacea* as symmetry; of 208 Surinam hatchlings 86 were asymmetrical. Of these, 51 had more laminae on the left than on the right, and 35 had the reverse. This agrees with Carr (1952) "In East Pacific specimens (at least) the higher number is usually found on the left side."

Adults of *L. olivacea* with the 5-5 lateral count are still distinguishable from *L. kempi* by the high, flat-topped carapace (Figure 21) and also by the olive-green rather than gray colouration. Also *kempi* averages a little wider than *olivacea* (Figure 15), the marginal laminae in the region of greatest width being wider than long, instead of the reverse. One commonly finds specimens of *kempi*, particularly young ones, in which the carapace as a whole is wider

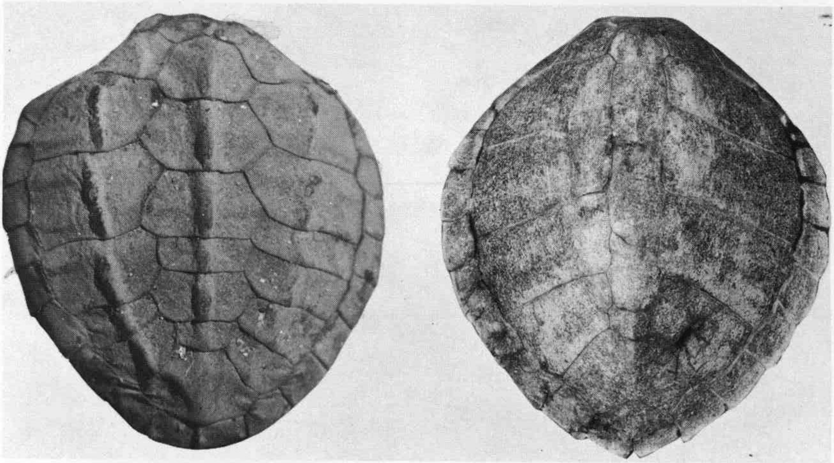

Figure 20. Shell of adult *Lepidochelys olivacea* from Shell Beach, Guyana, (right) with five lateral laminae on each side; shell of hatchling (left) for comparison. Note overall retention of carapace outline, but marked narrowing of central laminae with growth.

Table 6. Lateral lamina counts for three broods of *Lepidochelys olivacea* from Isla de Ratones, Honduras

Lateral laminae	NUMBER OF TURTLES Brood 1	Brood 2	Brood 3
2-3	1	–	–
4-4	8	–	–
5-4	3	–	–
5-5	5	26	–
5-6	3	11	–
6-5	4	8	–
6-6	2	43	5
7-5	–	4	–
6-7	–	13	–
7-6	–	6	2
7-7	–	1	7
6-8	–	5	–
7-8	–	4	4
8-7	–	–	10
8-8	–	4	32
7-9	–	–	1
9-7	–	–	5
8-9	–	–	8
9-8	–	–	9
10-7	–	–	1
9-9	–	–	10
9-10	–	–	1
10-9	–	1	1
10-10	–	–	4
10-11	–	–	1

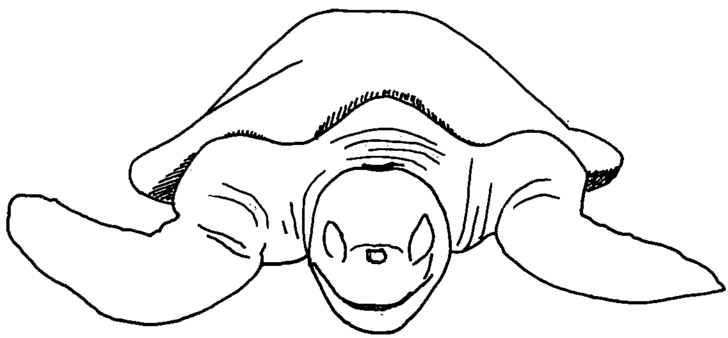

Figure 21. Anterior profile of *Lepidochelys olivacea* from Eilanti, showing the elevated, flat-topped carapace.

than long, a condition I have never found in *olivacea*. Skulls of the two species are very similar, but the alveolar surface of *kempi* has a definite bony ridge while that of *olivacea* is practically flat. Other skull differences include the relatively larger orbit of *olivacea*, as well as the greater minimum width across the pterygoids. For these reasons I believe maintaining *kempi* and *olivacea* as distinct species is well justified, although *olivacea* overlaps with *kempi* in three characteristics formerly considered peculiar to *kempi* viz.:

1) *L. olivacea* shows some aggregated nesting emergences.
2) It sometimes nests by daylight.
3) It sometimes has only five lateral laminae on each side.

Many of the female ridleys at Eilanti had the thin horny laminae in the rear third of the carapace missing, exposing a layer of thin, tough, black tissue with the consistency of hand rubber. Possibly the laminae in this region were eroded by friction with the male's plastron during copulation.

Hatching percentages for ridley nests on Bigi Santi are strikingly high. All the eggs in a clutch of 88 hatched normal offspring. Of another clutch of 126 eggs, 3 opened before hatching all contained living embryos. Of the remainder 118 hatched, 2 were infertile, and 3 were slow developers. The following incubation periods were recorded by Mr. Plak (timed from laying of eggs to emergence of young at surface, in days): 49, 50, 51, 51, 51, 51, 53, 53, 54, 55, 55, 56, 57, 58, 58, 59, 59, 59, 61, 62, 62, 62. All clutches were allowed to hatch where they were laid. The hatchling ridleys were uniform gray-black in color with a small white mark at each side at the supralabial scale, another on the hind part of the umbilical protruberance, and more where the ridges of the plastron cross the abdominal and femoral laminae. The extreme border of the carapace and a very thin line along the trailing edge of both fore and hind flippers were also white. This coloration is similar to that of hatchling *kempi* described by Carr and Caldwell (1958), except that *olivacea* lacks the thin white mark in the anal region.

French Guiana

Apparently the ridley is rare here, and I have no positive evidence of nesting, although local Indians told me that a few nest on the beaches on the French Guiana side of the mouth of the Marowijne River. There is little doubt that these merely represent a spillover from the large ridley rookery at Eilanti. Shrimp trawlers quite frequently catch ridleys in deep water off the coast of French Guiana, and this area is probably an important feeding ground for the ridleys that nest at Eilanti. I saw shells of two adult ridleys which had been caught at sea in a fisherman's camp between the mouth of the Organabo River and Silébache Beach.

Discussion

At present I can offer no opinion on the probable length of time the ridley has been established in the Guianas. The fact that its presence there was overlooked until so recently is irrelevant, as the species has been familiar to locals, if not to scientists, for many years (Kappler, 1881). Nevertheless the restriction of the species to a relatively small part of the coast of South America does suggest that the population there was 'seeded' by gravid individuals drifting from West Africa, where they breed over a wide area. In future studies the writer hopes to ascertain whether the Guianese ridley shows stronger morphological and behavioral affinity with the West African or with the East Pacific population. No ridley of either species has ever been found in the Caribbean. Pope (1939) records a ridley from Jamaica, but Caldwell (1961), refutes its occurrence there. Some sort of ridley, presumably *kempi*, is reported to nest in small numbers in Quintana Roo (Carr, 1957); and the fishermen of Isla Fuerte, near the mouth of the River Sinu in Colombia, express familiarity with a ridley-like turtle (Medem, 1962).

Dermochelys coriacea

Guyana

In Guyana, the leatherback is called *matamata*, a curious use of this name which possibly refers to any turtle with a strikingly ridged shell. It nests on Shell Beach, probably in rather small numbers. I have seen no living specimens there, but I found remains of two leatherbacks slaughtered in August 1964 and four more in August 1965. Meat-hungry Amerindians kill these turtles, usually considered inedible, with vigorous machete blows on the head and neck, and carve them up for food. Three more or less intact carapaces I found had lengths of 55, 61, and 65 inches. N. O. Poonai tells me a "fair amount" of leatherback nesting also occurs at Punta Playa, on the Guyana/Venezuela border.

The following data may help establish the nesting season of the leatherback in Guyana: two leatherbacks were found freshly killed on Shell Beach in mid-May by Dennis Joaquin, a settler on the Waini River who gave much help with the project; two independent witnesses agreed that a large scuffed-up area of sand was a leatherback nest that had been made 'about a month ago', i.e. early July; a leatherback nest almost ready to hatch, probably 6 or 7 weeks old, was exposed by wave action on 6 August and the young destroyed by vultures. From these data we may infer that leatherback nesting in Guyana occurs from at least early May to early July, the same as the nesting season of the species in Trinidad (Carr 1956) and in Surinam. According to Jerome da Silva, a local turtle hunter and egg collector, an occasional individual nests as early as January, earlier than any other species.

SURINAM

The local Carib name is *couana*. The species nests in fair numbers on Bigi Santi; in early May 1966 about three nests were made each night on the 3-mile stretch of beach east of the research camp, but after 24 May the leatherback season seemed to end abruptly. We found one specimen nesting at Eilanti on 12 July. In the 1968 season it was not rare for 9 or 10 leatherbacks to nest in one night at Bigi Santi.

An interesting belief in Surinam is that two kinds of leatherbacks nest in the country, known respectively as *sixikanti* and *aitkanti* (6-sides and 8-sides). Schulz (1964) gives nesting data for the two forms separately. When I wrote him for details of the difference between the two he replied "I have never had the opportunity to ascertain the difference between 8- and 6-kanti, as I did not personally see the last one; I hope you will have more success in the project." All the 25 leatherbacks that I examined in Surinam were aitkanti, possibly because we arrived late in the season and the 6-kanti supposedly nests earlier than the 8-kanti. I asked Mr. G. Plak, the chief game warden in Surinam, if he could elaborate on the differences. According to Plak, they are as follows:

The terms aitkanti and sixikanti refer to the number of flat sides visible when the animal is resting in the normal position on its plastron. Thus the aitkanti has six sides on the carapace, bounded by the seven ridges, and the outermost side of the plastron on each side is also visible when the animal is on its belly, giving a total of eight. The aitkanti is reportedly a little longer and substantially heavier than the sixikanti, having a much more massive shoulder region. In addition, the sixikanti lacks the vertebral ridge, while this is very well defined in the aitkanti. Completed nests of the two types may also be distinguished, as that of the sixikanti is relatively smooth, and the imprints of the foreflippers in the sand do not show turned-over tips, while the completed aitkanti nest includes piles of sand thrown up by the foreflippers, and the imprints of the fore-flippers show the last 4 inches or so of the flippers to be folded back. The normal egg complement of the sixikanti is reportedly 50-65, while the aitkanti lays upwards of 70 normal eggs. Hatchlings of the two forms are said to be indistinguishable. Any discussion of the significance of this apparently dichotomous population must await the description of the sixikanti by a competent zoologist.

Size of mature females: – Mature female leatherbacks from Surinam had the dimensions shown in Table 7. These are very

Table 7. Dimensions of mature female *Dermochelys coriacea* from Bici Santi and Eilanti, Surinam (in inches)

Carapace length	Carapace width	Head width	Plastron length
58½	31	9	43
59½	35½	10	–
60	–	–	–
60	–	–	–
61	–	9½	–
62	33	10	–
62	36	10	–
63	–	9	–
63½	–	10	–
64	33	8¾	48
64	–	10½	–
64	–	–	–
64	–	9¾	–
65	–	10	–
66½	41	10¼	–
67	–	10¾	–

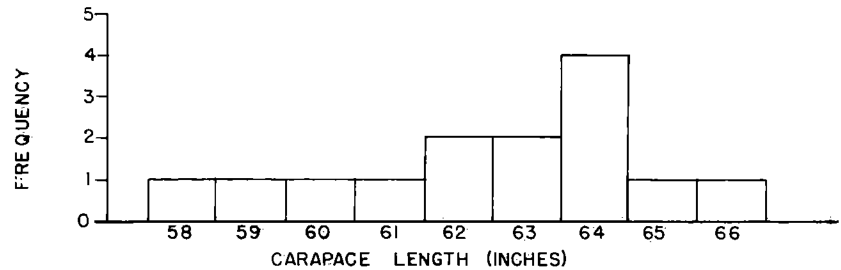

Figure 22. Carapace lengths of adult female *Dermochelys coriacea* from Surinam.

similar to those found by Hughes et al (1967). Substantially larger leatherbacks have been found in Florida; Caldwell (1958) mentions two with carapace lengths of 74″ and 79″ respectively. The method of measurement was not stated, but over-the-curve and straight-line measurements for leatherbacks differ by only a couple of inches. Most of the Surinam leatherbacks we found were too big to turn — hence the dearth of measurements of plastral lengths — but we managed to turn and weigh the smallest one found. Its carapace length was 58.5 inches, its weight 651 pounds. Even severely molested leatherbacks made little show of pugnacity but the sheer force of their movements on land and the vigor of their flailing flippers when turned make one treat them with caution. None of them emitted the loud sounds that have been reported for disturbed leatherbacks; their stomach gurgling and their deep, throaty breathing were the loudest sounds we heard them make.

Leatherbacks nesting on Bigi Santi start digging the egg cavity a few minutes after selecting the nest site. They excavate no deep body pit, which contrasts sharply with leatherbacks in Costa Rica, where they dig a pit so deep that the top of the carapace is level with the surface of the sand. Dr. Carr tells me that a Costa Rican, returning home drunk along Matina Beach, fell into a leatherback pit and had his wrist broken by a slap from the turtle within. No such accident is possible in Surinam, where the turtle's plastron is hardly lowered below the surface of the sand, and the nests are correspondingly so much shallower than those in Costa Rica that the eggs are much easier to find with a probe. Whether or not a body pit is dug probably depends on the depth of the dry surface sand; the turtle must reach moist sand before it can scoop out the flask-shaped nest cavity.

I made the following field notes on Bigi Santi 11 May 1966: The turtle was found facing towards the sea. After a number of

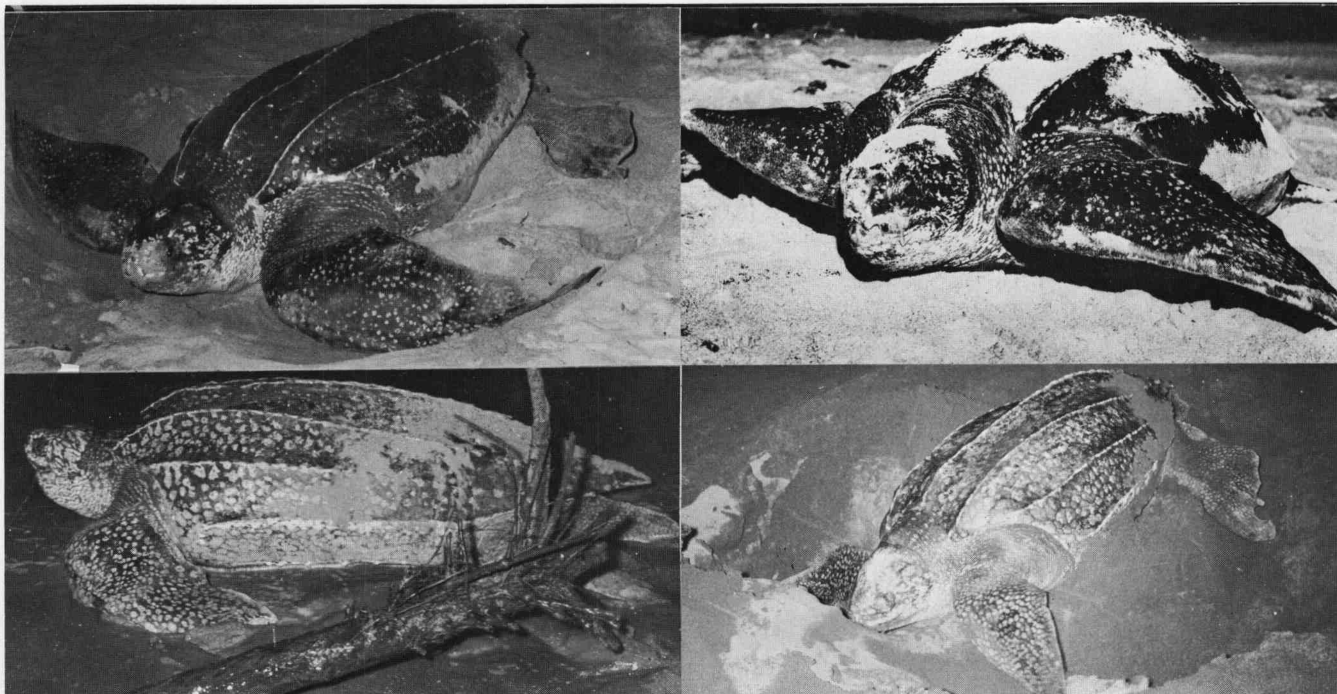

Figure 23. Left, above and below: leatherback turtles from Surinam. The range of the spotted pattern of these two turtles encompasses that of a Florida leatherback (above right), and a Costa Rica leatherback (below, right), as well as that of the Indo-Pacific leatherbacks shown in Figure 24.

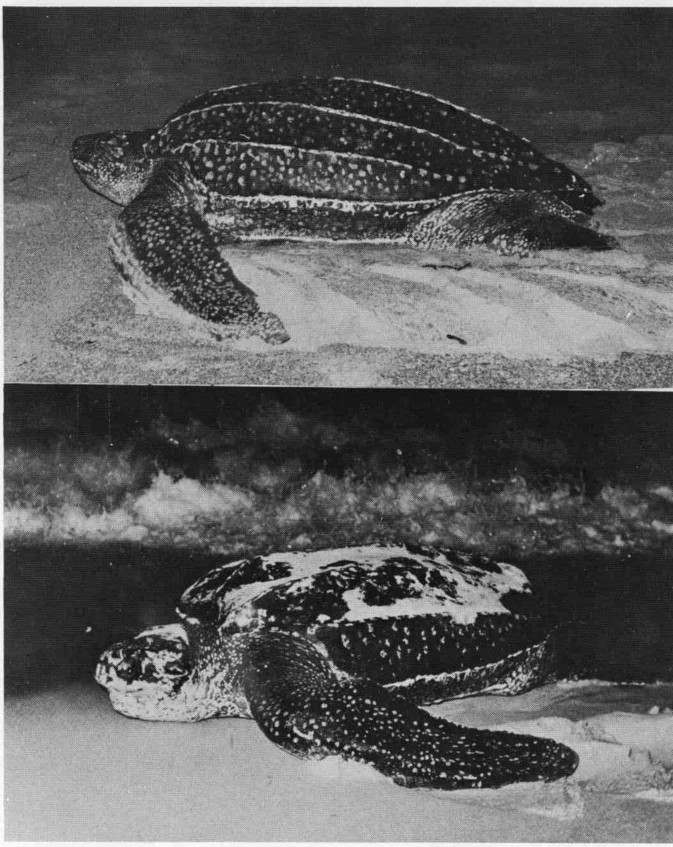

Figure 24. (above): a Tongaland Leatherback; (below): a Trengganu, Malaya, leatherback.

movements involving the front flippers, not observed closely because of the dark, she reversed her position, facing inland. She then sprayed a considerable amount of sand on her back and began to dig the egg cavity. Using her hind flippers alternately, she scraped two or three times with the leading edge of each at the opposite side of the hole before lifting out a quantity of sand, which she pushed away with a sharp forward jerk just before reinserting the flipper in the cavity, much as do other species of sea turtle. When she was scraping at the cavity with one flipper, she pressed her tail against the opposite side of the mouth of the cavity, smoothing sand away with an active muscular movement of the tail and cruro-caudal fold.

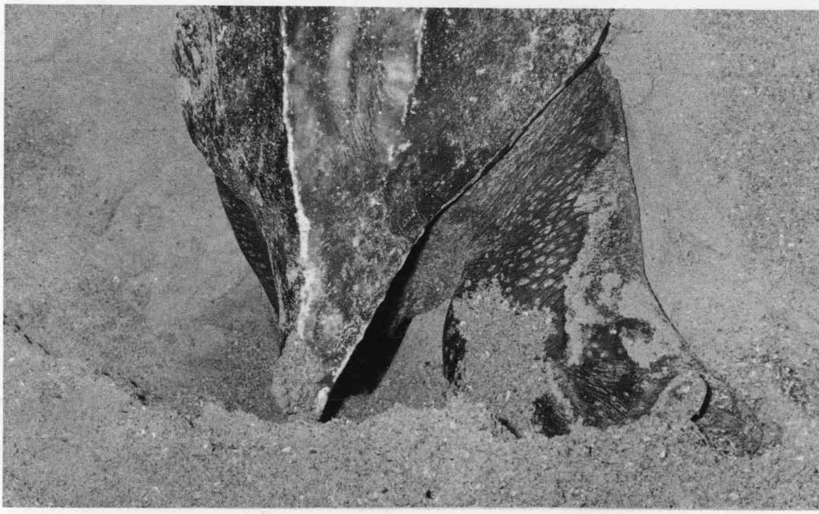

Figure 25. Position of flippers of leatherback during oviposition. The left flipper is inside the nest cavity.

She shifted the rear part of her carapace through about 15 inches between each excavation, the force for this movement being generated by the fixed hind flipper (i.e. the one which had just been removed from the nest cavity). Her foreflippers remained anchored throughout the operation. The maximum depth of the cavity was reached fairly quickly, but enlarging the base to give the cavity its flask shape took a long time and was carried out very thoroughly.

Then with one hind flipper still in the nest cavity (Figure 25) she started to lay the eggs. The flippers overlapped each other slightly, so that a little sand had to be cleared away to see the eggs. The first ones were all of normal size, but she produced a quantity of undersized eggs towards the end of the clutch. During each deposition she tilted her carapace very slightly just before actually dropping the eggs. From time to time she raised her head sharply. Some contraction of the muscular surface of her hind flippers was noticed during deposition, but no actual movement of the limbs.

When she presumably had laid all her eggs, she swept sand into the cavity with her hind flippers. After each sweep the flipper flattened the sand down with up to about eight slaps. When the cavity was full and a pile of sand had formed over it, she swept the pile left and right with alternating movements of her hind limbs. She continued this movement for some time until the nest spot was

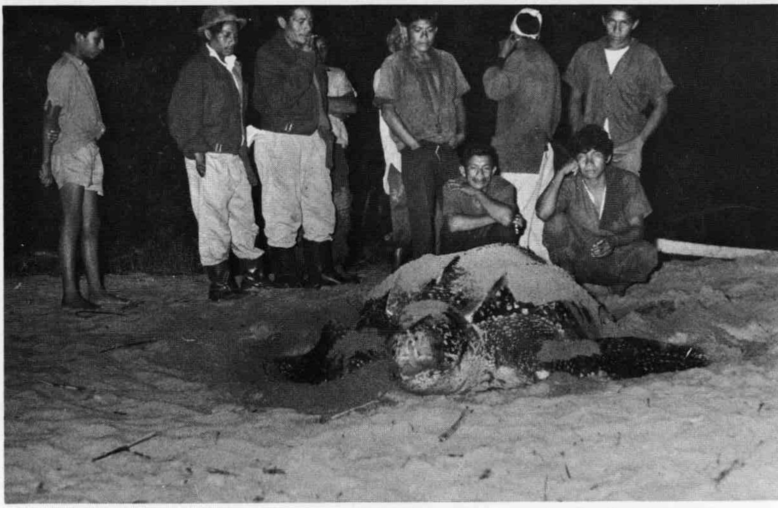

Figure 26. Carib Indians at Eilanti waiting to collect leatherback eggs.

completely hidden, then the hind limbs stopped and she swept sand back with a powerful simultaneous movement of her forelimbs. The alternation of these two movements carried her about 5 yards from the nest site. After about 3 yards she laid a few more undersized eggs on the ground. Gradually she changed the sand-sweeping

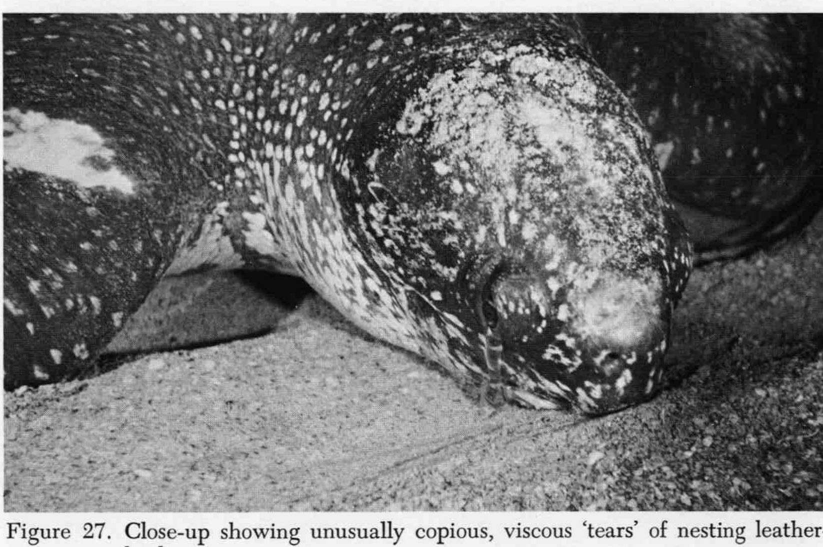

Figure 27. Close-up showing unusually copious, viscous 'tears' of nesting leatherback.

movement to a humping-forward movement that carried her back to the sea.

Another turtle watched 6 June started digging the egg cavity with the trailing edge of her hind flippers. This gradually became the normal movement using the leading edge, but her left flipper seemed injured and, although she went through the normal digging motion with it, she moved it awkwardly and could not remove sand with it. Another turtle nesting in deep dry sand spent more than 70 minutes digging the nest cavity. Since she was unable to reach moist sand layers she was unable to give the cavity a flask shape. Still another turtle not only nested well below the high tide mark but also was unable to dig the nest cavity because of some hind flipper malfunction. I had both to dig the egg cavity for her by hand and then move the eggs higher up the beach out of reach of the tide.

Leatherbacks occasionally leave the sea by day on Bigi Santi. I saw emergences at 4:15 PM and 6:15 PM (still light) on 7 May, but although we watched from a safe distance the turtle returned to the sea without nesting in both cases. I was told that earlier in the season leatherbacks had been seen emerging at 8:00 AM and 4:15 PM.

Internesting period, clutch size, abnormal eggs, and incubation period: Leatherback nests on Bigi Santi invariably include a proportion of undersized eggs, as they do elsewhere. We found no true dumbbell-shaped eggs, but some of the undersized ones had knob-like swellings. I recorded the following egg complements: 58 normal + 40 undersized, 69 + 11, 70 + 1, 83 + 23, 100 + 35, 101 + 39, 120 + 12, 126 + 40. Some other nests, in which only normal eggs were counted, contained the following numbers of eggs: 57, 65, 66, 70, 72, 72, 72, 75, 76, 79, 81, 83, 84, 86, 87, 90, 92, 98, 100, 102, 106, 113 (M for Natal leatherbacks: 106 normal (SD 22), 30 undersized (SD 27), Hughes et al, 1967; 6 nests from Matina and Tortuguero Beaches, Costa Rica, contained respectively 66 normal + 38 undersized; 45 + 7, 73 + 34, 80 + 41; 74 + ?, 66 + ?, Carr and Ogren 1959).

One turtle laid 10 undersized eggs, then was apparently disturbed by the flashlight and she returned to the sea without covering up. In several of the clutches examined a small minority of the eggs had green flecks. Deraniyagala (1939) records the same phenomenon in Ceylon leatherback eggs. Intervals recorded (in days) between nesting emergences of tagged individuals are 32, 29, 28, 21, 11, 11, 9, suggesting an internesting period of about 10 days. Hughes et al (1967) report a similar period for leatherbacks in Natal. One individual, disturbed before nesting, returned about 1½ hours later a mile up the beach.

I obtained no data myself on incubation, but Mr. Plak recorded the following periods (in days) in 1964 for eggs allowed to hatch where they were laid: 60, 60, 60, 61, 63, 65, 68. The only information I have on fertility percentage is that, of a clutch containing 70 normal eggs and 1 undersized, all 70 normal eggs hatched and produced viable offspring. A random 25 of the hatchlings ranged in length from 5.6 to 6.0 cm, and in width from 3.9 to 4.4 cm; 12 from another nest ranged from 5.91 to 6.39 cm, and 27 from a third nest from 5.46 to 6.06 cm. In appearance they were indistinguishable from photographs of West African hatchlings in Villiers (1957). When released on the beach they turned in the orientation circles Carr and Ogren (1959) describe for Costa Rican leatherback hatchlings; some of the circles were very small and complete, but others were large and rambling or incomplete. Tracks of adults too frequently showed tight circles.

Injuries – Several of the adult leatherbacks had notches in the hind flippers, possibly from shark bites. All the adult turtles of this species seen in Surinam had a curious pink area on the crown of the head. At first we assumed that this was the site of an old injury, in which the skin had healed but to which pigment had not returned, but its constancy suggests it is more likely caused by friction with the chin or mouth of the male during copulation.

French Guiana

Kappler (1881) mentions that the leatherback, though seldom found in Surinam, is plentiful in those parts of French Guiana where rocks are plentiful in the sea. Geyskes (1945) makes similar remarks. According to Indian reports, nesting occurs from early May to July and August, both near Cayenne and near the mouth of the Organabo River. Extensive nesting in the latter area was proved by my visit to Silébache Beach 6 June 1967; although I was only able to explore the beach during a low tide period, when mud banks prevent the turtles from emerging, this beach is clearly one of the principal leatherback nesting grounds in the hemisphere and indeed the world. For 3 miles along the beach we were rarely out of sight of a fresh leatherback track and some sections were so cut up with tracks and nests that walking along the beach was difficult. A local fisherman told me that during offshore shark fishing, he usually caught during the 2- to 3-month season about one leatherback per day, which he killed and cut up for shark bait and for any shelled eggs it might contain. It seems certain that at least several dozen leatherbacks nest each night at Silébache during the peak of the season, compared with about 80 per night on the 7½-mile beach in Trengganu, Malaya, which is considered the largest known leatherback colony. Silébache Beach is known to the Marowijne Indians, who occasionally make the difficult journey by sea and fill their boats with eggs. One Indian to whom I spoke reported collecting 2000 eggs on a recent trip, finding about 100 normal eggs in a nest, with the usual undersized ones always present as well.

We found small pieces of leatherback shell on the beaches of Montabo, within the Cayenne city limits, and according to reports nesting also occurs at Montjoly Beach, Bourda Beach, and Kourou Beach.

It is interesting that the coastal Indians in French Guiana also recognize the two types of leatherback described to me in Surinam; the local Carib names for the two types are *tukutubuking* for the 8-kanti and *tibisibisiching* for the 6-kanti. The latter was reported to nest earlier in the year than the former, an observation corroborated by Surinam informants.

Discussion

Some authors still follow Garman (1884) in recognizing the Atlantic and Indo-Pacific leatherbacks as distinct subspecies (*coriacea* and *schlegeli*). Garman published no description of the differences between these forms, but it has been suggested that the difference lies in the size and number of the light spots on the carapace and the extremities. Figure 23 shows two leatherbacks from Surinam, not particularly chosen to show the extremes in coloration. Leatherbacks from Tongaland (Figure 24), Florida (Figure 23), Costa Rica (Figure 23), and Trengganu (Figure 24) can be seen to lie well within the range of variation of spotting of those from Surinam. Some Atlantic leatherbacks (photos in Carr, 1952 and Villiers, 1957) are almost without spots on the shell. Carr (1952) remarks that the spots are more pronounced in small adults than in large ones, and I believe Surinam leatherbacks bears this out, though I did not think of checking it at the time. Possibly the spots become smaller and less distinct as the turtle grows older and larger.

It is often stated that the leatherback is the rarest of the sea turtles, and that it may be on its way to extinction. Fitter (1961) estimated the world leatherback population to be possibly as low as 1000 mature females, of which 850 nested at Trengganu, Malaya. I cannot accept these estimates. While leatherback populations are probably smaller than green turtle populations, this is almost certainly because the equilibrium numbers in undisturbed habitat are smaller. In fact it may be the least seriously threatened of the sea turtles. It is of little commercial value, its meat being oily and to most people inedible, (though a sample I ate in French Guiana was very tasty), and its shell is not utilized. These factors combine to make human predation on the adults small. The eggs, though edible, are buried deep in the sand, and thereby gain a certain immunity to discovery by the usual mammalian and reptilian predators, and to some extent humans (though eggers are a serious problem in the Malayan and Costa Rican rookeries).

Leatherbacks are hardly ever found at sea in the tropics, and specimens of intermediate size are almost unknown. A possible reason for this is that the leatherback may be able to remain at great depths at all times except when breeding, and to obtain enough oxygen for its needs by pharyngeal respiration without having to surface to breathe. The curious papillose structure in the leatherback's throat may serve as an oxygen exchanger, though it has also been suggested that this structure serves to prevent the jellyfish on which this turtle feeds from sliding back up the throat (Bleakney 1965). Another possibly significant fact is that healthy, active leatherbacks are encountered in cold northern waters with a frequency that seems to preclude accidental drifting; 30 leatherbacks are recorded from the British Isles, while numerous records also exist for Japan, Siberia, Norway, Nova Scotia, Maine, and Newfoundland (Bleakney 1965). Leatherbacks from the latter areas are active and have stomachs full of jellyfish *(Cyanea capillata artica)*, suggesting that the habitat is not so hostile as to inhibit feeding. MacAskie and Forrester (1962) report vigorous activity in a leatherback in water as cold as 53°F (11.7°C) in the Queen Charlotte Islands, a temperature at which most reptiles are extremely sluggish. Perhaps the leatherback has achieved a degree of endothermy; its large size, barrel-like shape and 2-inch layer of oily connective tissue under the shell would certainly help retain metabolic heat. In an attempt to shed some light on this problem, Nicholas Mrosovsky and I tried to get deep-body temperatures of adult female leatherbacks and two other species of sea turtle by taking the temperature of the interior of just-laid eggs. Four leatherbacks gave temperatures of: 30.0, 30.0, 30.5, 31.25°C. Two green turtles gave temperatures of 29.0 and 30.25°, while three ridleys gave 28.0, 29.0 and 29.50°. Sea temperature was approximately 28°C.

A drawback to the above argument is that no other animal is known that combines the features of pharyngeal respiration with endothermy. A possible explanation, without a shred of direct evidence but which at least fits the facts, is that the leatherback is ectothermous in tropical waters and lives at great depths, respiring by pharyngeal oxygen exchange, while in cold northern waters it becomes endothermous and breathes atmospheric oxygen; the latter habit would account for the relatively frequent sighting and capture of leatherbacks in the north. No small leatherbacks have been found in northern waters; perhaps the young turtles remain in the tropics until they reach adult size, possibly feeding on more substantial food than the jellyfish that apparently form the principal subsistence of the adult leatherbacks caught around Nova Scotia.

An alternative hypothesis is that the leatherback has developed a fishlike metabolism, in which cold ambient temperature is not incompatible with moderately high degrees of activity. Much progress will be made towards a solution to this problem when deep-body and cloacal temperature measurements are available for leatherbacks in northern waters.

Eretmochelys imbricata

Guyana

Called "carey" in Guyana, I found hawksbill turtles nesting in fair numbers on Shell Beach in August. Although the relative abundance of their shells and skulls on the beach suggested that nesting had been in progress for some months, I saw 14 nesting emergences and found 12 other fresh nests during the 3-week observation period. The mean carapace length of 33.1 inches is close to that for Tortuguero hawksbills (M = 32.72, n = 62; Carr et al., 1966).

The heaviest specimen I found (165 pounds after oviposition) was unusually heavy for a hawksbill, though a long way short of the record held by a 280-pound turtle from the Cayman Islands (Lewis, 1940). This record hawksbill, unless unusually fat, must have been about 42 inches long, as big as a big green turtle. The shells of most hawksbills found had large barnacles, as they do at Tortuguero (Carr et al., 1966). On the other hand the green turtles and ridleys on Shell Beach were practically free of them.

The hawksbills usually completed nesting within an hour, but

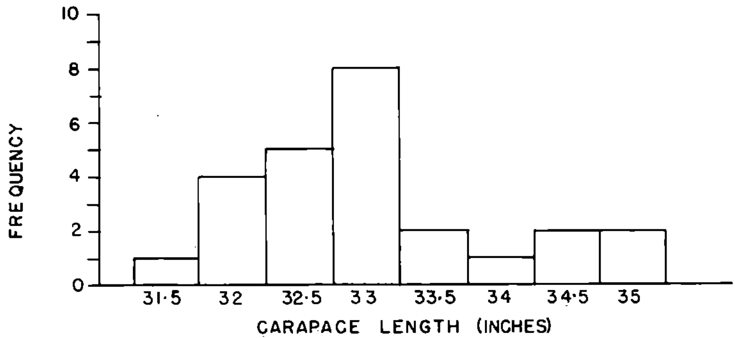

Figure 28. Overall carapace lengths of adult female *Eretmochelys imbricata* from Shell Beach, Guyana.

Table 8. DIMENSIONS OF MATURE FEMALE *Eretmochelys imbricata*, SHELL BEACH, GUYANA (IN INCHES)

Empty carapaces:	Length	Width		
	31½	23¼		
	32	23½		
	32¼	24		
	33	25		
	33	25½		
	33	25¾		
	33¼	26		
	33¾	24		
	34	25		
	34¼	25½		
	34¾	26½		
Living specimens:			Plastral length	Weight (Lbs.)
	32	22½	23½	98
	32	25	26	—
	32½	22	24	139
	32½	22½	25¾	134
	32½	24½	25	133
	32½	24½	25½	130
	33	22½	25½	118
	33	23	26	—
	33	24½	24½	134
	33	25½	25½	165
	33½	24	25½	145
	35	24	26	139

one turtle produced a clutch of broken and deformed eggs according to the following prolonged schedule:

2:00 AM Turtle found digging nest cavity.

2:23 Cavity completed

2:29 First egg laid, after several minutes straining, with occasional raising of the margins of the hind flippers. The next egg was squashed and broken in the cloaca. She went on to lay a totally deformed clutch; many eggs were broken before laying, some were small and ovoid, and others were in long strings. She also produced a few apparently normal eggs. Each deposition was accompanied by a curling-up of the margin of the hind flippers, an invariable stereotype of the nesting of this species. Sometimes two eggs delivered side by side caused abnormal distention of the cloaca.

3:10 Last egg laid. The turtle did not seem to realize when the eggs stopped coming, and she went on straining for several minutes. This waiting period was not observed for other hawksbills, but it is a frequent practice for green turtles.

3:27 Turtle, still straining, was deliberately disturbed by blows on head and shell, and she finally started covering.

3:35 Nest cavity filled. Turtle left without filling in body pit.

Two turtles were accidentally disturbed before they had started nesting; they were tagged and allowed to return to the sea. One returned later the same night, the other the following night.

Clutch size and egg dimensions: Clutches of the following sizes were found: 139, 145, 152, 159, 167, 169, 176. (M = 158; cf M = 161.1 at Tortuguero, Carr et al., 1966).

Egg diameters ranged from 36 to 40 mm. I found no abnormal eggs other than those mentioned above. Hawksbill turtles on Shell Beach were no more pugnacious than the green turtles, and never attempted to bite. Turned hawksbills slapped for a time, but soon quieted down, and they could be left until the following morning without injuring the edges of their flippers.

Surinam

The local name here is *carett.* It is rare and the only one I saw was an empty shell at an Indian encampment near Eilanti. Four nests were recorded by the Surinam Forest Service in 1964, on 16 June and 4, 5, and 25 July. Ten hatchlings from one of these nests preserved by Forest Service personnel ranged in carapace length from 4.13 to 4.37 cm, in width from 2.79 to 3.17 cm, and in plastral length from 3.33 to 3.60 cm. No laminar variation was evident within this series; all ten had 11 marginals and 4 laterals on each side, 5 vertebrals, 2 supracaudals, 1 nuchal, 1 intergular and 1 interanal. Deraniyagala (1939) also found no laminar variation in 18 sibling hatchlings, but in another clutch laid by a clearly senile female with completely closed carapacial fontanelles half of the 22 young examined showed deviations from the typical laminar condition.

Kappler (1881) wrote the following notes on the hawksbill in Surinam (in translation from Schulz 1964): "Very seldom, and never earlier than June, the caret turtle *(Chelonia imbricata)* comes on land. She weighs about a hundred pounds, and the upper jaw is beaked just like a parrot. The meat is not eaten, and the people even say that it is poisonous. This is the source of true tortoiseshell, and one turtle sometimes yields 1½ to 2½ kg. of the material. It is very beautiful, but people do not value it as highly as that of the East Indies. The caret is called *waroa* by the Indians. Another one, *Chelonia onychochelys kraussi* (Gray) is similar in form and color but the shell is thinner and has no value at all."

French Guiana

The hawksbill is reportedly seen often in the waters around Devil's Island, and nesting probably occurs abundantly on several beaches in the country. According to local reports hawksbills nest on all three beaches of the Île de Cayenne, and I found hawksbill tracks and nests at Silébache Beach 6 June. I also saw quite a number of mounted hawksbill heads and shells in hotels and restaurants in St. Laurent and Cayenne.

An Indian I spoke with told me that two types of hawksbills occur in French Guiana, one small enough for one man to lift off the ground, the other a heavy load for two people. He stressed the point that the two were distinct and that the small kind does not grow into the big kind. Possibly the larger ones are loggerheads, and represent an interesting outlying breeding enclave of this species. In the hope of shedding some light on this problem I recently examined the type material of Gray's *Onychochelys kraussi,* a sea turtle from French Guiana, in the British Museum. The material, consisting of a large stuffed adult with a 36-inch carapace and the skull of another individual, is unquestionably referable to *Eretmochelys imbricata.* Gray was probably familiar only with immature hawksbills, and did not realize that adults could reach this size.

Caretta caretta

The true loggerhead, *Caretta caretta,* has never been found nesting in the Guianas, but Carr (1956), reports it occurs in deep water off Trinidad perhaps 150 miles from Guyana, and Brongersma (1968) records three specimens, at least two of them about half grown, from Surinam waters. The species occurs occasionally in Southern Brazil (a large adult skull in the British Museum is from Itapema Beach, Northern Santa Catarina State, Brazil), but the only South American nesting grounds appear to be on the coast of Colombia.

Economics and the Future

At present no laws protect sea turtles in Guyana. The principal nesting area, Shell Beach, was until recently partially protected by

Figure 29. In Guyana sea turtles are exploited for their meat as well as their eggs; this large hawksbill turtle was taken while nesting on Shell Beach.

its remoteness. Today parties of hunters make their way to Shell Beach during the nesting season, camp there for a few days, collect as many eggs as they can find, and usually carry off, dead or alive, one or more of the nesting turtles (Figure 29). These hunters, Portuguese, Negro, or Amerindian, come either from the North-West District or from the Pomeroon area, and travel in small sailboats, some of which are power-assisted. In 1967 we found that an offshore oil prospecting company had established a shore radio base on Shell Beach, and the two full-time caretakers were killing almost all turtles that nested for their meat, which they preserved by sun-drying. Following Venezuela's claim to the entire North-West District in the summer of 1968, I read in the Guyana "Graphic" that the oil company was ceasing operations in the Shell Beach area.

Apparently a live adult hawksbill sells for only $5 ($3 US) in the North-West District, but will fetch $15 in the Pomeroon, where an adult green sells for $35-40. The higher price of the green turtle merely reflects the greater amount of meat obtainable from it; no preference for the flavor of the green turtle was expressed. The leatherback is considered inedible by all except Amerindians, who kill them and cut them up where they find them. Turtle eggs fetch 1 cent to 5 cents BWI each, according to temporary scarcity; about 3000 were removed during my stay. As a rudimentary conservation measure I reburied 1518 eggs within 12 hours of their being laid, in a series of carefully disguised artificial nests; these probably hatched, though egg destruction by sand crabs as Caldwell (1959) describes is possible. Some eggs are lost by being laid too close to the sea where the beach is being eroded.

Estimating the number of nesting turtles killed on Shell Beach each year is very difficult, but it is probably at least 100, and possibly many more. Even in the large green turtle colonies of Ascension, Aldabra, Tortuguero, and the Talang Islands, the total number of breeding individuals is only of the order of a few thousands, and small colonies such as that of Guyana probably number only a few hundred mature individuals. Two independent informants, Harold Hirth and Jack Frazier, inform me that the Aldabra nesting colony has now been virtually exterminated by overhunting of the nesting females, either on the beaches or in the lagoon. Offshore harpooners and beach *veladores* have also made a serious dent in the Tortuguero population, where the 1968 season was by far the poorest on record.

Ample evidence now demonstrates that slaughter of nesting females is the surest way to decimate the population, and for this reason governments in many countries have passed laws protecting turtles on nesting beaches. It is highly desirable that such laws be passed and enforced in Guyana, and recommendations to this effect have been made several times in the last 4 years, though up to now they have been ignored. If laws are not passed, increased turtle exploitation will follow increased population pressures, and the inevitable result will be the extermination of the Guyana turtle nesting colonies.

The Surinam Government has been commendably alert to its responsibilities to protect its relatively newly discovered sea turtle populations. Killing sea turtles is strictly prohibited everywhere in the country, and so far as I could judge this ban is rarely infringed. It is also illegal to take eggs anywhere in the Wia-Wia Nature Reserve, which includes Bigi Santi, an important nesting ground for the green turtle and the leatherback. Egg taking is legal on beaches near the Marowijne River, and the Indians in this region resent any attempt to interfere with their rights to this resource. The Indians can predict quite accurately when the massive aggregations of nesting ridleys are due to arrive on the beach at Eilanti. They move down to the beach and endure two or three sleepless nights in order to collect as many eggs as possible, and very few escape them. The exploitation is highly organized, and the village captain allots each man a small section of the beach on which to collect eggs. Huge piles of turtle eggs accumulate in the Indians' huts on these *arribada* nights (Figure 13); they are taken to Paramaribo by boat and sold wholesale for approximately 15 guilders (ca. $8.50 US) per thousand. The retail price in Paramaribo is about one guilder for 30.

Apparently the best way to ensure the continued existence of these spectacular aggregations of turtles would be to prevent exploitation of eggs on Eilanti completely in certain years. This was done in 1967 and 1968 by purchasing the entire season's production of eggs with funds from the World Wildlife Fund. In 1967 these were transferred to an artificial hatchery, and a hatching percentage of 60-70 per cent was achieved; in 1968 they were allowed to hatch in situ.

No laws protect sea turtles in French Guiana at present, and the consequences of killing leatherbacks for shark bait at the present rate will eventually be serious. Large numbers of eggs are collected at Silébache Beach, but as the beach is quite long and remote it suffers nothing like the 100 per cent loss normal at Eilanti. Fair numbers of turtles, probably mainly ridleys, are caught at sea by shrimp trawlers. Sometimes these are killed and eaten, sometimes they are released alive.

Recommendations have been made to l'Inscription Maritime at Cayenne that laws protecting the turtles must be passed and enforced, and promises have been received that these will be acted upon. But the remoteness of the main nesting beach from any center of civilization and the energy with which the Indians and creoles hunt turtles and their eggs will continue to make turtle conservation in French Guiana extremely difficult.

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