BREEDING BIOLOGY AND CONSERVATION OF HAWKSBILL TURTLES, *ERETMOCHELYS IMBRICATA* L., ON COUSIN ISLAND, SEYCHELLES

A. W. DIAMOND

*Scientific Administrator, Cousin Island, Seychelles**

ABSTRACT

A two-year tagging programme on Cousin Island, Seychelles showed that Hawksbills nested between September and March, each female nesting on average four times at intervals of 15 *to* 18 *days. Females did not nest in successive years but the number of years between breeding attempts is not known. Twenty to thirty females now nest each year; the number of nests has increased markedly since the island became a nature reserve in* 1968. *Some females tried to nest on other islands in the same season, although those returning to Cousin usually did so within* 50 *m of their previous nest. The average clutch was* 182, *the largest recorded for any sea turtle, and the maximum estimate of average nest success was* 86%. *Present exploitation in the Seychelles is unsound from both biological and sociological points of view, exploiting the vulnerable breeding stock for a luxury product ('tortoiseshell') while wasting potentially valuable protein. It is recommended that future policy should concentrate instead on harvesting eggs for human consumption, while totally protecting adults, thus diverting valuable protein from natural predators to the local human population. This policy would exploit the stage of the turtle's life cycle best adapted to sustain high losses with minimum effect on breeding stocks, to the mutual benefit of turtle and local human populations.*

INTRODUCTION

The Seychelles (4–5°S; 55–56°E) are a group of very small granite islands in the western Indian Ocean. Cousin Island (27 ha) is a nature reserve, acquired in 1968 by the International Council for Bird Preservation (British Section) primarily because three endangered forms of Seychelles landbird survive there (Percy, 1970).

Previous studies of Seychelles sea turtles (Hornell, 1927; Hirth, 1967; Frazier, 1974) have concentrated on the Green turtle, *Chelonia mydas* L., both because

* Present address: Department of Zoology, University of Nairobi, P.O. Box 30197, Nairobi, Kenya.

Biol. Conserv. (9) (1976)—

of its greater economic importance and because there was inadequate information about the Hawksbill turtle. Of the two species of sea turtle which breed in the Seychelles, the Green turtle has been intensively harvested for its meat and calipee (used in turtle soup), and as a result is almost extinct although it has been completely protected since 1968. The Hawksbill turtle is exploited only for the shell, which is made into 'tortoiseshell' ornaments for sale to tourists, the meat being sometimes poisonous, and has not yet declined measurably although it is coming under increasing pressure as the islands are developed for tourism. This pressure now restricts nesting to the remoter beaches on the larger islands, and to the beaches of the smaller, more secluded islands. Cousin, with scarcely 2 km of beach and five or six human inhabitants, is now one of the main nesting grounds; Frazier (1975) found it one of the most important Hawksbill nesting areas in the western Indian Ocean, north of Madagascar.

So little is known of the biology of this increasingly threatened species that, during my residence on Cousin as Scientific Administrator from 1973 to 1975, considerable effort was devoted to a study of its basic breeding biology and to establishing an effective conservation programme.

METHODS

M. J. Penny in 1970 and D. E. B. Lloyd from 1971 to 1973 kept daily records of the number of turtles coming ashore. I continued this work with the assistance of my wife and R. T. Bresson, using the following routine: each day from the beginning of the season the beaches were patrolled as often as possible, especially around high tide. Particular attention was paid to the continuous stretch of sand running from the north-west corner (Cannon) round the east coast to La Saline (Fig. 1), which was visited three or four times a day, but the isolated beach of Anse Frégate was also checked at least once on most days. Hawksbills commonly nest in the daytime on Cousin, unlike the nocturnal Green turtle, and leave conspicuous tracks in the sand. When a track was found it was followed up the beach and the success or otherwise of the nesting attempt was assessed. Each set of tracks leaving the sea and returning to it was recorded as an 'arrival'. The position of the nest or arrival was recorded, by reference to lettered stakes placed every 50 m along the top of the beach. The time the turtle came ashore, if known, was noted and also whether or not eggs were laid. This was often difficult to determine but our skill at doing so increased throughout the study; in the first season, for example, we could not be sure whether or not 22 of the 116 arrivals had laid, whereas in 1973–74 only 9 out of 159 were in doubt (19% and 6% respectively). A typical track left by a turtle which nested successfully is shown in Fig. 2.

If the turtle itself was seen, we kept well out of sight until it either began to lay, or started back down to the sea. We checked both front flippers for a tag, and

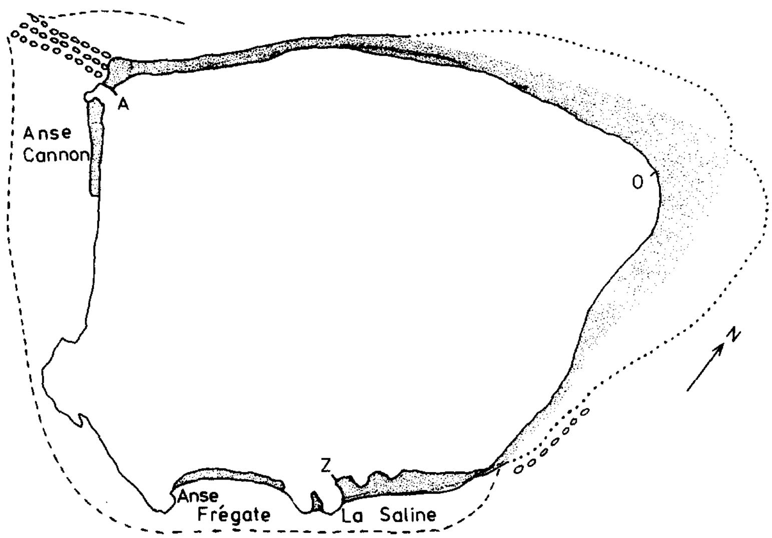

Fig. 1. Sketch map of Cousin Island. Permanent beaches, stippled: approximate extent of temporary seasonal beaches, dotted lines: barrier reef, dashed lines: boulders offshore, circles.

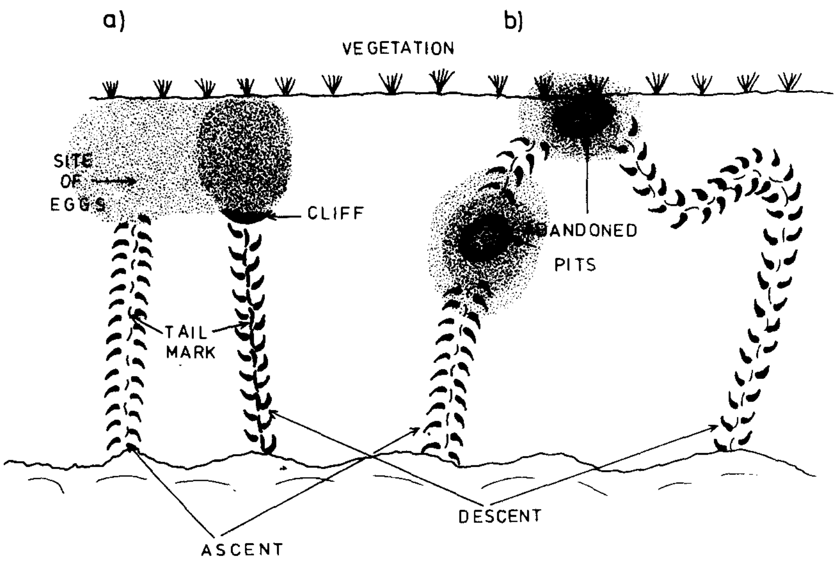

Fig. 2. Diagrammatic sketch of tracks left by a turtle on (a) successful, (b) unsuccessful nesting attempt. Extent and degree of disturbance of sand indicated by extent and density of stippling.

either read the tag or fitted one as appropriate. The tags used were standard turtle tags supplied by Professor Archie Carr of the University of Florida, bearing a return address, a unique serial number, and the word 'Reward'. Turtles could safely be examined or tagged only when they were laying; if disturbed at any other stage of their landfall they would return to the sea at once (cf. Green turtles, which Hendrickson (1958) could safely tag while they were covering the nest after laying, without causing them to abandon their mission).

TABLE 1.
NUMBERS OF TURTLES ARRIVING, LAYING AND HANDLED ON BEACH PATROLS

Season	*Arrivals*	*Laid*			*Not laid*		*? laid*		*Total*
		Handled	*Missed*	*Total*	*Handled*	*Missed*	*Handled*	*Missed*	*assignable*
1973–74	137	30	25	55	15	24	4	18	116
1974–75	166	45	50	95	17	39	2	6	159

Some nests were excavated too close to the sea and would have been washed away; these were dug out and the eggs replaced at a safe distance. These were the only cases where the clutch was counted. In 1973–74 many nests were dug out after they had hatched, in order to count the numbers of unhatched eggs and dead hatchlings and to estimate nest success. Otherwise the nests were not disturbed, but most were visited daily from the 50th day until the young emerged, to measure the emergence period.

The raw data from the routine patrols, on which most of the following analysis is based, are summarised in Table 1.

TAXONOMY AND BIOMETRICS

Carr (1952) identified the western Indian Ocean populations as *E. i. bissa* (*squamata*) Agassiz. However, the scalation of one specimen from Aldabra (1000 km west-south-west of Seychelles) investigated by Frazier (1971) showed one character typical of this race and six characteristics of the Atlantic race *E. i. imbricata* L. It seems best, therefore, to follow Frazier in making no subspecific designation until large series are available from many localities. We did not investigate taxonomic details.

Curved measurements in cm of the carapace in nine animals were: length—mean 89·5, range 83·0–91·5; width—mean 80·7, range 76–84. None was weighed.

NESTING ENVIRONMENT

Physical

The Cousin beaches are protected by a barrier reef on only the south and west shores (Fig. 1). Elsewhere, coral or rock is near the surface close inshore but does

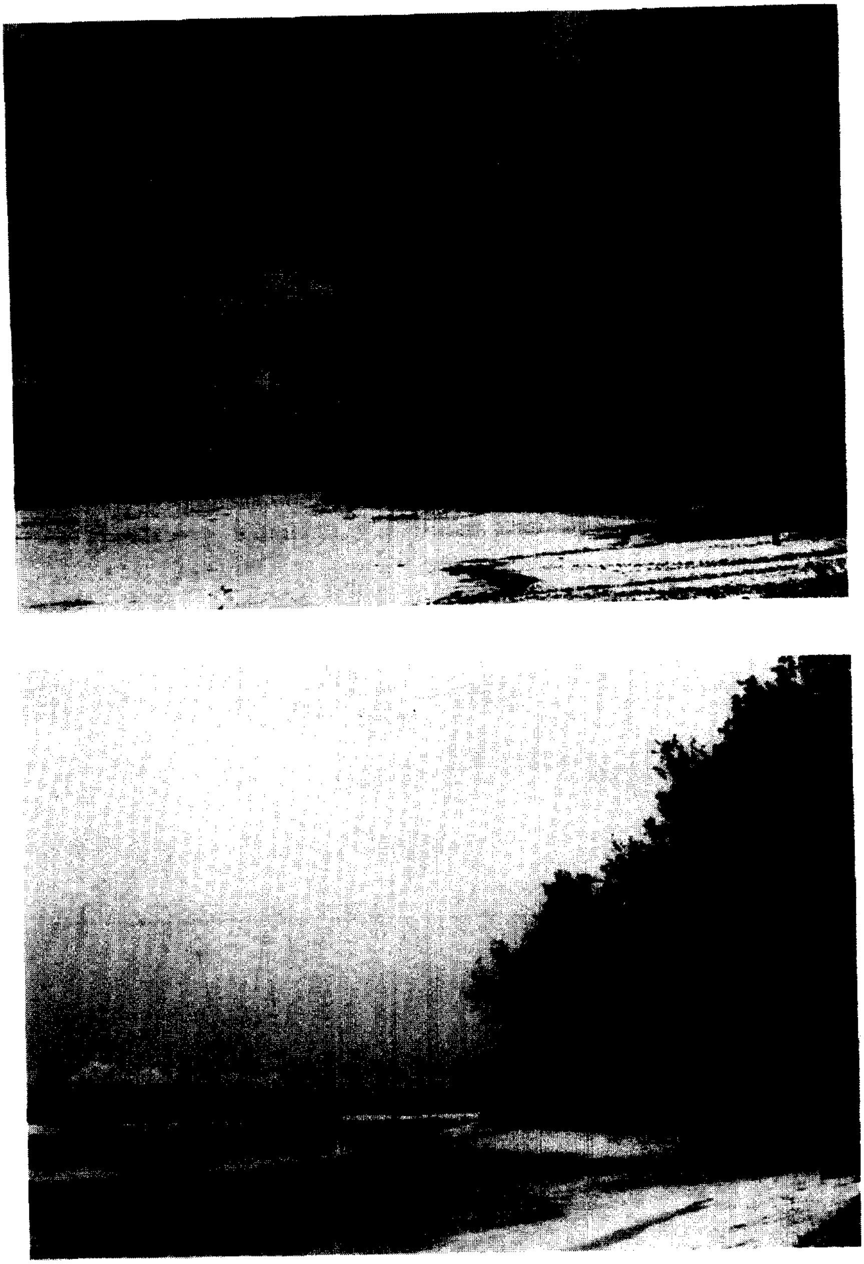

Fig. 3. Two views facing south from east-coast boatshed, taken six months apart, showing seasonal change in beach morphology.

not break the surface at low tide, as the barrier reef does. The north and east shores are therefore less of a hazard to turtles coming ashore. Sandy beaches suitable for nesting extend from Anse Cannon in the north-west to La Saline in the south, with an isolated beach at Anse Frégate. There are, however, marked changes in beach morphology with the seasons; during the south-west trade winds the sand is blown and washed from the east coast around to the north beach, and is returned to the east coast during the north-west monsoon (Fig. 3).

Most turtles nested on the beach platform, often under bushes of *Scaevola taccada* which overhang the high water mark, and some went beyond into denser vegetation but few nested there. The distance from the water's edge to the nest varied from 15 m to 80 m and was estimated to be on average about 25 to 30 m.

Climatic

Seasons in Seychelles are governed mainly by the change in modal wind direction. The south-east trades blow steadily from late April or early May to late September or October. In December, January and early February there are frequent storms, usually northerly (the 'north-west monsoon'), separated by calm periods; the

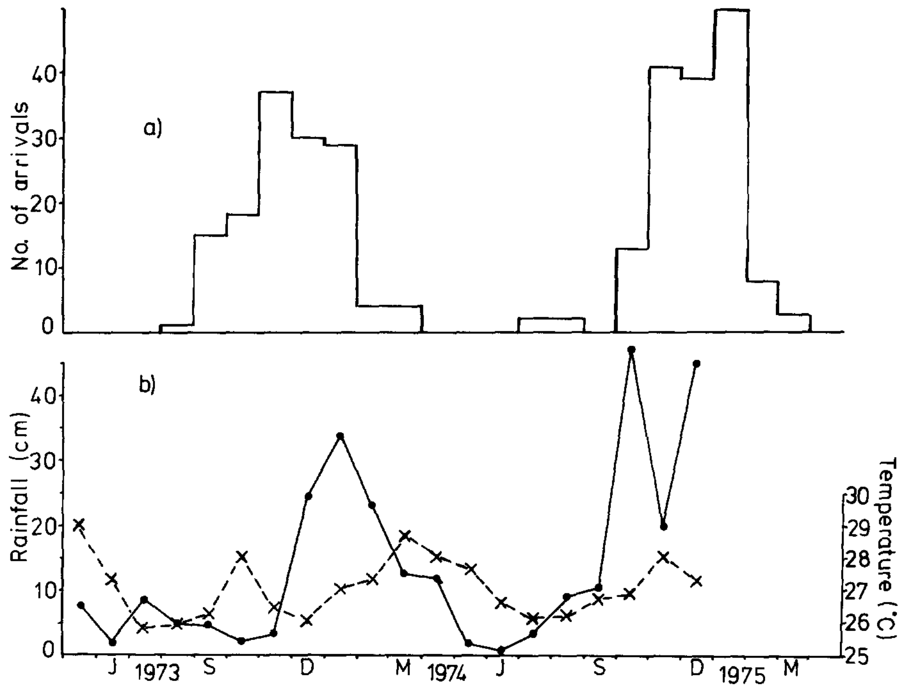

Fig. 4. Monthly distribution of (a) turtle arrivals, (b) total rainfall (full line) and mean dry bulb temperature (broken line).

intervening months are usually calm and hot. Usually, most rain falls between October and April. Figure 4 shows monthly temperature and rainfall figures in relation to turtle nesting.

PREDATORS AND SYMBIONTS

Ghost crabs *Ocypode* spp. (mainly *O. ceratophthalmus*) were the chief predators of both eggs and young. Many of the nests which were dug out to check the fate of eggs and young contained at least one ghost crab, and in two nests, crabs had eaten almost all the eggs. Hatchlings suffered considerable mortality on their way down to the sea, the crabs grasping them by the head or neck and eating the eyes and head before hollowing out the body contents. Once in the sea hatchlings were of course vulnerable to carnivorous fish, but to what extent could not be quantified. No bird was ever seen eating a turtle hatchling and it is unlikely that they would, since most hatchlings emerge at night.

The only adult with a conspicuous wound was a female with the whole left rear flipper missing, presumably bitten off by a shark; this animal came ashore four times in 1974–75 but was not known to lay.

Females coming ashore often carried symbionts on the carapace; these were not identified precisely but were recorded as: encrusting barnacles; algae (pink or white); and filamentous algae (green, red or brown). Most females carried at least one of these types and frequently several.

BREEDING BIOLOGY

Nesting season

In all years since 1971, laying has begun in August or September and continued until February or March (Cousin Island Research Station records). The 1974–75 season was anomalous in that there were two arrivals in early July, two more in August and then none until the second week of October (Fig. 4). The late start to this season may have been connected with whatever unusual marine conditions led to a failure in the food supply of several species of tern (Laridae).

Figure 4 shows that the turtles' breeding season is mainly during the north-west monsoon. Possibly the rain helps to consolidate the sand and make it easier to excavate the nest chamber, but it may also be that the turtles' breeding cycle is related to oceanographic rather than meteorological factors.

Laying behaviour

Nesting behaviour was in most respects very similar to Hendrickson's (1958) very detailed description of the Green turtle in south-east Asia. A few minor

TABLE 2
DURATION (MINUTES) OF SUCCESSIVE STAGES OF NESTING

	Climbing beach	*Digging*	*Laying*	*Covering*	*Total*
Mean	62	32	20	(25)	147
Range	40–105	23–40	16–25	—	90–270
N	6	2	5	1	5

differences in the Cousin Hawksbills were noted, *i.e.* turtles ascending the beach usually moved the limbs alternately rather than all together, and when alarmed the whole body could be raised off the ground and the animal moved very fast, still moving quadripedally, for 20 m or more at a time. The body pit was shallower than a Green turtle's, rarely deep enough to hide the turtle below the level of the sand. Between digging the body pit, mainly with the fore flippers, and excavating the egg chamber with the hind flippers, there was no intervening period of shaping the body pit with the hind flippers (though J. Frazier (pers. comm.) has seen this sometimes). Finally, the total time spent laying (mean 150 min) was rather shorter than in Green turtles (170 min).

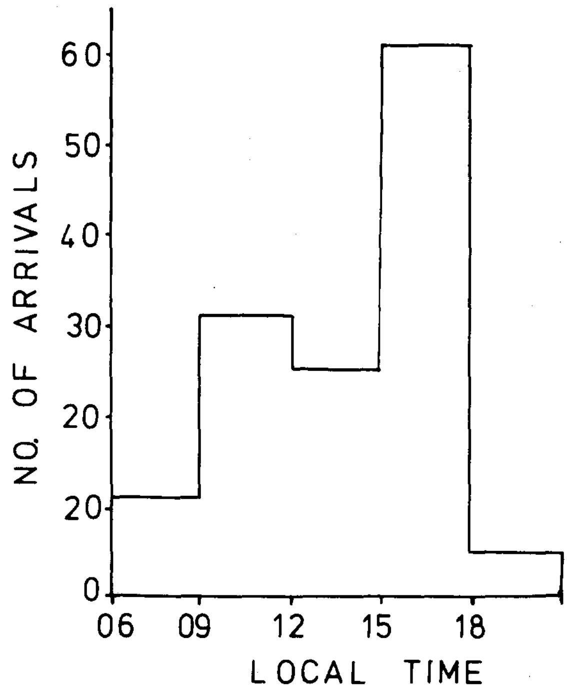

Fig. 5. Time of day of turtle arrivals (both seasons combined).

The times spent in the successive stages of nesting are shown in Table 2.

Time of arrival

Most turtles came ashore between 0900 h and 1800 h, and almost half in the late afternoon (1500 h to 1800 h) (Fig. 5). To some extent these data are biassed by the largely diurnal activity of the observers, but it was rare to find tracks of turtles that had come up between our last check one day and our first the next. Our only record of a turtle actually laying at night is of one that came ashore at 1730 h, dug several holes that were abandoned and finally finished covering her eggs at about 2200 h.

In the field one had the strong impression that turtles were more likely to come ashore when the tide was high, as one might expect, but the data show no statistically significant relation between time of arrival and state of tide. Perhaps the relatively small size and light weight of Hawksbills, compared, for example, with Greens which may have a very markedly tidal pattern of arrival (Hughes, 1970; Bustard, 1972), and the relatively small tidal range in Seychelles (about 1·5 m at spring tide), make it easier for Hawksbills to negotiate offshore reefs and shallow beachrock at most stages of tide.

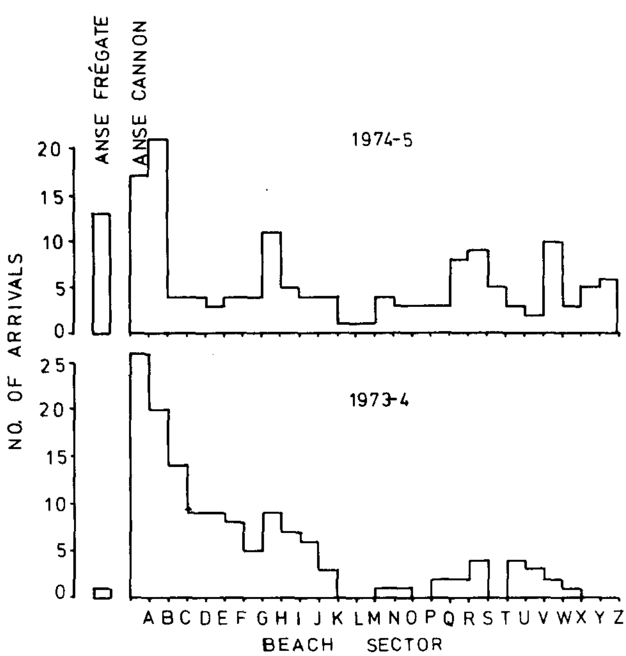

Fig. 6. Number of arrivals recorded on each 50-m beach sector. Anse Frégate and Anse Cannon are also each approximately 50 m long.

Nest location and site return

In both seasons the north-west corner of the island was preferred (Fig. 6); this part of the beach, though narrow, is more protected than any other from the major seasonal changes in beach morphology and is thus less affected by currents, and the water offshore is less turbid than off the other beaches.

The apparent differences between the two seasons, in the use of Anse Frégate and section Q/R to Y/Z (Fig. 6), are not statistically significant (Median test, $p > 0{\cdot}05$). Marked turtles normally returned to within a few hundred metres of their previous arrival.

Four turtles moved to different islands in the same season that they had been tagged on Cousin; one in 1973–74, and two the next season, moved to the coast of Praslin immediately opposite Cousin (2–4 km away), and one tagged on Cousin in October 1974 was recaptured 18 days later on Grand Soeur, an island about 27 km by sea from Cousin.

It is still not known whether Hawksbills migrate although Carr *et al.* (1966) think Caribbean populations do. In the Seychelles, recapture information has so far been inadequate, but provided the tagging programme is continued it should be possible to determine the pattern of seasonal and longer term movements more accurately.

Proportion laying

The proportion of layings to arrivals was 47% in 1973–74 and 60% in 1974–75 (Table 1). Turtles disguise genuine nests very carefully, while an abortive nesting attempt is usually more obvious. Doubtful cases were therefore more likely to be real nests. The higher proportion laying in the second season is probably due to our greater confidence in interpreting doubtful cases of nesting, most of these proving on closer examination to be genuine nests.

Frequency of laying

No turtle tagged in 1973–74 was recaptured the next season, confirming that Hawksbills, like Green, Loggerhead *Caretta caretta* (L.) and Leathery turtles *Dermochelys coriacea* (L.), but unlike the Kemp's and Olive Ridley's *Lepidochelys kempi* (Gorman) and *L. olivacea* (Eschscholtz) do not usually breed in successive seasons.

From recaptures of tagged turtles, the mean number of times each female was known to lay in a season was 1·9 in 1973–74 and 2·1 in 1974–75. However, in only 54·5% (1973–74) and 47·4% (1974–75) of the nests was the female actually seen; allowing for these measures of catching efficiency gives estimates of laying frequency of $1{\cdot}9/0{\cdot}545 = 3{\cdot}5$ in 1973–74, and $2{\cdot}1/0{\cdot}474 = 4{\cdot}3$ in 1974–75.

Laying interval

From recaptures of marked animals, the mean laying intervals and their standard deviations in the two seasons were, respectively, $16{\cdot}8 \pm 1{\cdot}7$ days, and $15{\cdot}1 \pm 1{\cdot}1$

days; the difference is significant (t-test, $p < 0{\cdot}01$). These intervals compare with those of 10–11 days for Green turtles (Hendrickson, 1958) and 13–18 days for Loggerheads (Hughes, 1974).

Clutch size, egg size, incubation period and nest success

The mean number of eggs in nine complete clutches was 182 (S.D. 24, range 160–242). The weight (g) and diameter (mm) of ten eggs in each of three nests 28, 32 and 48 days after laying, were as follows: weight $29{\cdot}8 \pm 0{\cdot}6$, $30{\cdot}5 \pm 1{\cdot}4$, $26{\cdot}5 \pm 1{\cdot}0$; diameter $37{\cdot}8 \pm 0{\cdot}3$, $38{\cdot}5 \pm 0{\cdot}9$, $36{\cdot}2 \pm 0{\cdot}6$, respectively. The mean of 16 incubation periods was 60 days (S.D. 8·2, range 47–77), and of 31 emergence periods 62 days (S.D. 6·6, range 56–79). In six nests moved out of reach of high tides, emergence periods were apparently slightly delayed (mean 68, S.D. 6·1, range 64–78 days). In two of these nests, the eggs were re-buried with one side of the nest up against a glass sheet to facilitate observation of the young between hatching and emergence. In one of these, all the young left within four days of hatching; in the other, emergence took six days from hatching, and young left the nest over a period of four days. In none of the nests where emergence was observed closely was the process an explosive departure of the whole brood such as Carr (1968) and Bustard (1972) described in Green turtles in Central America and eastern Australia respectively. Rather, there were usually several minor emergences of 10 to 30 young at a time, such as Hendrickson (1958) described for Green turtles in south-east Asia.

Hatching success and emergence rate were estimated as follows. The unhatched eggs remaining in nests dug out after all the young had emerged, averaged 18·5 (range 0–71) per nest; taking this from the mean clutch size ($182 - 18{\cdot}5 = 163{\cdot}5$) gives a hatching success of 90%. The number of dead young averaged 7·9 (range 0–67) per nest; subtracting these from the average number of eggs hatching ($163{\cdot}5 - 7{\cdot}9 = 155{\cdot}6$) gives an emergence rate—the number of young leaving the nest alive as a proportion of the number of young hatching—of 95%. Combining the two measures gives an overall average nest success—the number of young leaving the nest as a proportion of all eggs laid—of 86%. This is a maximum estimate as it assumes that all eggs which were not left unhatched in the nest after the young left actually hatched, whereas of course many may have been eaten by ghost crabs or other predators. However, although in some nests a large proportion of eggs were eaten by crabs, the great majority of nests showed little crab damage and it is unlikely that average nest success was below 70–80%. The estimate also excludes nests which would have been washed away by the sea; there were nine such nests in 1973–74.

In one or two cases, the cause of death of hatchlings in the nest was obvious. One clutch, for example, was laid in sand with a very high soil content, and the hatchlings were simply unable to dig their way out because the soil was too heavy for them to move. Mortality after emergence was not measured but, as described under 'Predators', could be heavy. One nest, where the young emerged during the day instead of at night, was situated several metres inland from the beach crest and was surrounded by vegetation (*Achyranthes aspera*) 1 m or more tall, obscuring the hatchlings' view of everything but the sky immediately above; they were evidently disoriented, wandered at random about the nest area and many died of desiccation.

Growth rates

In late January 1974, ten hatchlings from one nest were put in a concrete tank (about 75 × 75 × 20 cm) filled with seawater, and their growth rates (weight and straight length of carapace) measured over the next six months (Fig. 7). Two other hatchlings, both from the same nest, were added a week later; these were slightly deformed by a transverse medial fold across the body, as if they had not straightened out completely after uncurling themselves from the egg, and although both appeared quite normal after a couple of weeks, one died after five weeks and the other at nine weeks.

Young were fed on finely-chopped fish—fresh when available, but sometimes frozen—and were kept in seawater changed every two or three days. All developed an infection, apparently fungal, around the eyes, often involving substantial tissue loss to the head; several treatments were tried but the most successful was daily topical application of 'Pragmatar', a proprietary oil-based fungicide for the treatment of human skin conditions such as dandruff.

Growth rates (Fig. 7) were extremely variable. The two young which grew fastest were conspicuous from the first few days of feeding (which began at four days) in being able to dive deeper and stay submerged longer than their fellows, thereby gaining access to food fragments which drifted to the bottom when missed by their more buoyant companions.

Seven of the ten originally healthy hatchlings survived to seven months; three of the largest then became listless, would not feed, and died, on successive days, and the survivors were liberated soon afterwards.

A yearling Hawksbill was rescued from inadequate conditions in an hotel on Mahé and reared in the same tank for six months, increasing in weight from 430 g to 1245 g. It was released at La Saline, and was seen again on several occasions by people swimming in the very shallow lagoon off Anse Frégate, where small wild Hawksbills were also often seen.

POPULATION SIZE

Before the island was acquired by ICBP and the turtles protected, 10 to 20 females came ashore each season, most being killed (this according to the manager of the island, Mr W. Germain). The subsequent increase in the number of arrivals each season is shown in Fig. 8, which indicates that arrivals have increased approxi-

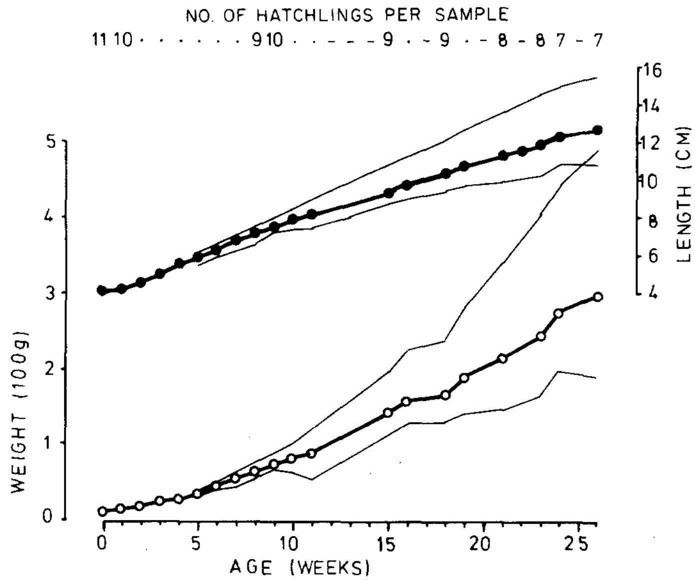

Fig. 7. Growth of captive hatchlings from 29 January to 27 July 1974.

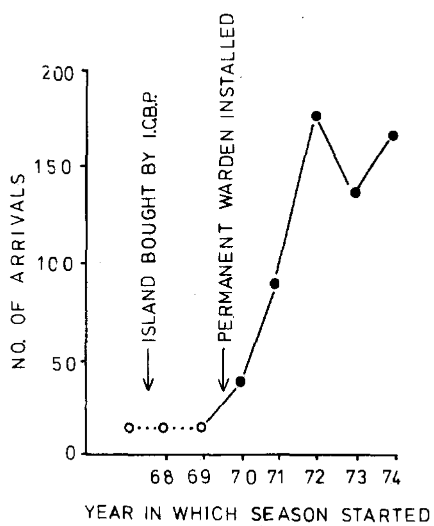

Fig. 8. Number of arrivals recorded in each season since acquisition of Cousin Island as a nature reserve. Data from records of Cousin Island Research Station; records before 1970 from W. Germain (pers. comm.).

mately ten-fold in the few years that protection has been in force (see also Frazier (1974)). A resident warden was first present in 1970 and numbers increased during the three following seasons. The decrease in the 1973–74 season probably reflects the achievement of a more or less natural, stable population, showing the year-to-year fluctuations which are characteristic of sea turtle populations and which result from non-annual breeding by individuals.

Figure 8 shows the number of arrivals rather than individuals and so is misleading in terms of population size, since once a female was killed it could not account for more arrivals. The number of females nesting each year has probably only doubled during this period. The number of females nesting per season can be calculated as fol'ows. In 1973–74, 19 animals were tagged. However, of 116 arrivals (from the start of tagging, which began when there had already been 21 arrivals), only 49 were handled, *i.e.* the catching efficiency was 49/116 = 42%. Each marked female was handled on average 2·53 times, hence the number of arrivals made per female is estimated by 2·53/0·42 = 6. Thus, if each female made six arrivals during the season, and there were 137 arrivals in the season, the total number of females beaching during the season is 137/6 = 23 (to the nearest whole animal). The corresponding calculation for the 1974–75 season (166 arrivals, 24 females tagged, 41 % catching efficiency, 2·5 arrivals per marked female) gives an estimated population of 27. It is not known how many years intervene between successive breeding seasons of individuals.

CONSERVATION

Current legislation and enforcement

Hawksbills are protected under Seychelles law in three ways:

(1) eggs may not be eaten and, if shelled eggs are found inside a female that has been killed, they should be buried in the sand above high-water mark;

(2) no turtle of carapace length under 61 cm may be killed or taken;

(3) no turtle may be killed or taken in the sea within 1000 m of high-water mark, anywhere in the Seychelles (though they may be taken on the beach with the land-owner's permission).

This last law was first enforced in Seychelles in 1973, when the 1000 m zone around Cousin was patrolled by boat by island staff and poachers were warned off. In 1974 the four corners of the zone were marked by brightly painted steel marker buoys, attached by steel chain to concrete mooring blocks on the sea floor, which proved an even more effective deterrent. Enforcement elsewhere in the Seychelles is difficult as it is hardly practicable to mark the limits of the 1000 m zone throughout the whole archipelago.

Enforcement of these laws is rare elsewhere than on Cousin, partly because of the lack of police manpower, partly through ignorance of the law, and partly through a lack of appreciation of the importance of conserving this particular natural resource. During my residence in Seychelles the police, under Commissioner Booth, were extremely helpful and co-operative, and a series of lectures on conservation legislation, given by me as Scientific Administrator of Cousin, was begun at the Police Training School on Praslin.

In addition to the laws described above, there are detailed regulations governing the licensing of shell plates for sale. Export of shell is now prohibited, but visitors take out of the country ornaments made of 'tortoiseshell', and indeed whole stuffed turtles, in apparent contravention of this law.

Recommended future policy

A single female Hawksbill may lay over 700 eggs in a season and if she is allowed three breeding seasons in her life (probably a conservative estimate in natural conditions) she could produce over 2000 eggs. Of these only two need survive (to replace her and her mate) to keep the population stable; the remaining 99·9% may die before reaching maturity. Conversely, a turtle which has survived to reproductive age represents a great biological investment and should be rigorously protected.

The law at present protects the egg and immature stages while the breeding female on the beach (when she is most vulnerable) may be taken. Current legislation is thus biologically inappropriate and is likely to accelerate depletion of stocks, rather than to conserve them as it was designed to do. It would be far more rational to divert the high losses of eggs, which the species is adapted to sustain, from natural predators into human consumption.

Hawksbill meat is not much eaten in the Seychelles, since it is sometimes poisonous; but turtle eggs are highly nutritious, and those of Hawksbills particularly so, being about 22% protein (Suwelo, 1971). At present the animals are exploited solely for the shell, and make no contribution to local food supplies. Rather, in a misguided attempt to safeguard future stocks of the shell, the major potential source of protein is specifically excluded from consumption by law. Hendrickson (1958), describing the exploitation of Green turtles in south-east Asia, stated the case perfectly: 'no luxury demand should be allowed to produce a net nutritional loss . . . particularly where past history indicates that the form of exploitation necessary to supply the luxury demand obliterates the industry concerned after a time'.

Exploitation of eggs rather than shell is a sounder proposition economically as well as biologically, since the demand for eggs as food will be reliable and predictable, whereas that for shell is dependent on the vagaries of international trade in tourists and plastics.

Although there is as yet no reliable evidence of any change in numbers of Hawksbills in the Seychelles (Frazier, 1971), this is most likely because inadequate records have been kept. The species as a whole is gravely endangered, being listed in the IUCN Red Data Book as Species Category 1 (highest priority): 'Endangered. Actively threatened with extinction. Continued survival unlikely without the implementation of special protective measures' (Honneger, 1970).

The Seychelles have already witnessed the decline to near-extinction of one valuable turtle species, the Green turtle (Frazier, 1974), and if this example is not to be repeated with Hawksbills a radical change in conservation policy is called for. It is recommended, therefore, that the following changes be made in the legislation regarding Hawksbill turtles in the Seychelles:

(1) that total protection be afforded to all adults larger than 75 cm curved carapace length (*i.e.* the breeding stock).

(2) that a rational policy of harvesting eggs for local consumption based on sound biological grounds with strict supervision and constant monitoring of the population be instigated.

In this way, instead of supplying an erratic luxury demand for a few more years until numbers dwindle to near-extinction, the Hawksbill turtles of the Seychelles will be able to continue to provide much-needed protein for the local people.

ACKNOWLEDGEMENTS

R. T. Bresson and my wife did a great deal of the field work. Professor Archie Carr supplied tagging equipment and advice. Financial support for research and conservation was generously donated by the Fauna Preservation Society and is gratefully acknowledged. Field work and writing up were supported by the International Council for Bird Preservation (British Section), who also made available the facilities of the Geigy Laboratory, and these too are warmly appreciated. J. R. Wilson kindly supplied data recorded after 17 January 1975. D. Bourn, D. E. B. Lloyd, Dr M. J. Coe and Dr J. Frazier improved the manuscript by their comments, and Dr Frazier not only first stimulated my interest in turtles but helped me to set up the study on Cousin.

REFERENCES

Bustard, R. (1972). *Sea turtles. Their natural history and conservation.* London, Collins.
Carr, A. (1952). *Handbook of turtles.* New York, Comstock.
Carr, A. (1968). *The turtle. A natural history of sea turtles.* London, Cassell.
Carr, A., Hirth, H. & Ogren, L. (1966). The ecology and migrations of sea turtles, 6. The Hawksbill turtle in the Caribbean Sea. *Am. Mus. Novit.*, No. 2248, 1–29.
Frazier, J. (1971). Observations on sea turtles at Aldabra Atoll. *Phil. Trans. R. Soc. Lond. B*, **260**, 373–410.
Frazier, J. (1974). Sea turtles in Seychelles. *Biol. Conserv.*, **6**, 71–3.
Frazier, J. (1975). Marine turtles of the western Indian Ocean. *Oryx*, **13**, 164–75.
Hendrickson, J. R. (1958). The green sea turtle, *Chelonia mydas* (Linn.) in Malaya and Sarawak. *Proc. Zool. Soc., Lond.*, **130**, 455–535.

HIRTH, H. F. (1967). *Report of the Governments of Southern Yemen and the Seychelles Islands on the green turtle resource of South Arabia, and the status of the green turtle in the Seychelles Islands.* Rep. FAO/UNDP (TA), (2467).
HONNEGER, R. E. (1970). *Red Data Book*, **3**, *Amphibia and Reptilia.* Morges, IUCN.
HORNELL, J. (1927). *The turtle fisheries of the Seychelles Islands.* London, HMSO.
HUGHES, G. R. (1970). Further studies on marine turtles of Tongaland, 3. *Lammergeyer*, **12**, 7–25.
HUGHES, G. R. (1974). *The sea turtles of South-East Africa, II.* The biology of the Tongaland Loggerhead Turtle *Caretta caretta* L. with comments on the Leatherback Turtle *Dermochelys coriacea* L. and the Green Turtle *Chelonia mydas* L. in the study region. *Invest. Rep. oceanogr. Res. Inst.*, No. 36.
PERCY, Lord R. (1970). Cousin Island Nature Reserve in the Seychelles, Indian Ocean. *Biol. Conserv.*, **2**, 225–7.
SUWELO, I. S. (1971). Sea Turtles in Indonesia. In *Marine turtles. Proceedings of the second working meeting of marine turtle specialists, Morges,* 8–10 *March* 1971. *I.U.C.N. Publs New ser. Supp. paper* (31), 85–9.