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OBSERVATIONS ON LOGGERHEAD SEA TURTLE *CARETTA CARETTA* ACTIVITY DURING THREE NESTING SEASONS (1977–1979) IN ZAKYNTHOS, GREECE

D. MARGARITOULIS

Herodotou 34, Politia, Athens, Greece

ABSTRACT

Data collected during the 1977, 1978 and 1979 seasons showed that a remarkable sea turtle population of unknown size and origin utilizes Zakynthos' small southern beaches as nesting areas. Preliminary surveys indicate that nesting activity on Sekania, Dafni and Gherakas beaches averaged 18·1 emergences and 10·77 nestings per night, most of which were concentrated on Sekania beach. Observed adults and young were identified as Caretta caretta *with a mean carapace length of 80·4 cm for females and 40·4 mm for hatchlings. The importance of this newly discovered rookery is emphasized and the need to maintain present population levels through realistic conservation measures is discussed.*

INTRODUCTION

In August 1977 during a vacation on the island of Zakynthos I noticed sea turtle tracks on an isolated beach. Subsequent visits to the same beach, as well as to other beaches of the region, showed intense use by nesting turtles. I therefore camped close to the main nesting area and began collecting data.

Examination of the existing literature showed that although sea turtles are often recorded in the Greek seas (Mertens & Wermuth, 1960; Ondrias, 1968), extremely little is known of their nesting on the Greek shoreline (Mertens, 1961). As far as can be ascertained there has been no previous publication on Zakynthos sea turtles, except a Master's dissertation on the effects of tourism on Zakynthos in which Marinos (1977) mentioned that sea turtles were nesting on the southern coast of the island. The limited number of local residents who are aware of the existence of turtles generally view the animals with indifference.

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Zakynthos, situated in the Ionian Sea (lat. 37°38′ N to 37°56′ N, long. 20°42′ E to 20°59′ E), is characterized by mild weather and abundant sunshine. The recent increase in tourism has certainly had an impact on the island's ecology. Sandy beaches on previous isolated parts of the island have been opened to development without assessing their ecological value. Beach development primarily threatens sea turtles which utilize these beaches as nesting areas.

In order to initiate action to prevent the loss of these areas, it was imperative to map the breeding habitat and to obtain estimates of the turtle activity on every beach. Since it is known that sea turtles exhibit fluctuations in their nesting numbers every season (Carr & Carr, 1970; Hughes, 1971; Davis & Whiting, 1977), it was thought necessary for the survey to cover a number of nesting seasons.

This paper presents data and observations collected during the 1977, 1978 and 1979 nesting seasons. Some of these data, forwarded to the Greek Ministry of Coordination through the Goulandris Natural History Museum, have led to the Greek Government recently declaring (March 1980) the most important rookeries as protected.

THE STUDY AREA

Nesting takes place on several of the small beaches fringing the Gulf of Lagana in the southern part of Zakynthos (Fig. 1). A short description of their status is given below.

Gherakas

A 450–500 m long, 20–30 m wide, beach, separated from the flat interior fields by a sheer cliff. The beach has easy access by a road. In 1978 a taverna was built in the interior (200 m from the cliff) and the road was repaired. This resulted in an increase of people visiting the beach, mostly during the day. Campfires and lights of tourists who spend the night on the beach greatly disturb emerging turtles.

Dafni

A 250 m long beach, of which only 100 m is considered as suitable for nesting. Vehicular access to the beach can be effected through a 3 km unpaved road usually in bad condition. A small hut, not visible from the sea, operated as a taverna in 1977 and 1978 seasons. This attracted a few people to camp there, but usually their tents and lights were not visible from the nesting beach because of the dense vegetation. In 1978 and 1979 much of the sand was removed by sea currents and the greater part of the beach became unsuitable for nesting due to exposed stones.

Sekania

Sekania beach comprises two parts separated from each other by a small rocky

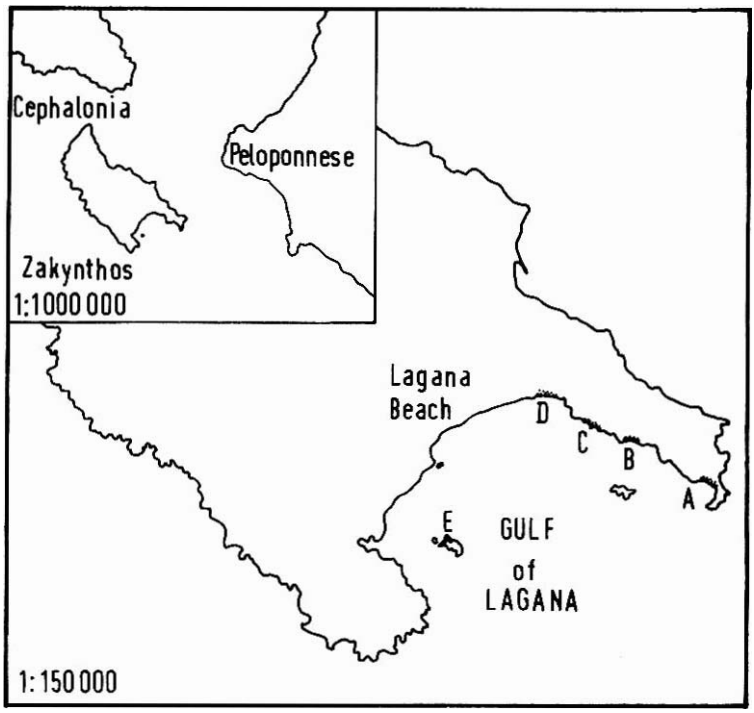

Fig. 1. Sketch map showing Zakynthos loggerhead rookeries (A, Gherakas; B, Dafni; C, Sekania; D, Kalamaki; E, Marathonissi).

headland. The effective nesting area is 300–350 m long and its width ranges from 10 to 30 m. The region is backed by steep hills covered with maquis vegetation. It is the most isolated of the Zakynthos rookeries, seldom visited by people. Access to Sekania can be effected either by foot or by boat, by a safe approach at the eastern part of the beach, the other part being difficult to reach from the sea because of rocks scattered in the shallows.

Kalamaki

A 250 m fairly isolated beach separated from the main Lagana beach (Fig. 1) by a rocky hill. No detailed survey has been conducted but occasional visits have shown remarkable nesting activity. The area has easy vehicular access and is visited by many people during the day.

Marathonissi

A small beach on the NE part of the uninhabited island of Marathonissi. No detailed survey has been conducted but preliminary observations have shown

nesting activity. In contrast to Sekania beach, which is geomorphologically not visible from motorboats that venture in the Gulf and from Lagana hotels, Marathonissi beach is conspicuous and attracts many people.

METHODS

Field work comprising beach surveys and night observations was conducted on the beaches of Gherakas, Dafni and Sekania from a base camp on Dafni, during parts of the periods 20 August to 26 August 1977; 28 July to 14 August 1978; 5 August to 25 August 1979.

Beach surveys

Counts of fresh tracks of adult females and hatchlings were made on the beaches early in the morning. After counting, the tracks were partly obliterated in order to avoid confusion with the next day's counting. The number of fresh nests was also recorded but this was somewhat uncertain since no nests were excavated to make sure they contained eggs. To minimize the error due to the overlapping of hatchlings' tracks, this counting was done mostly in the splash zone where the brood's dispersion is greatest. The nests from which the hatchlings' tracks originated (hatched nests) were marked and watched for five consecutive days for possible new emergences.

Night observations

A number of nesting females were observed and measured during night hours. Nesting females were located by patrolling the splash zone at intervals of about 30 min. No lights were used during the patrol. The aim was to spot tracks of just-emerged turtles that were moving or nesting up the beach. After some practice their fresh tracks were clearly distinguished on the wet sand.

Great care was taken to avoid disturbing the turtles. As soon as a fresh track was spotted it was followed slowly and quietly, in a prone position, until the animal was visible, possible from a distance of 3–4 m, on nights with a clear sky and no moon. Only nesting turtles were approached closely, and this from behind, to check on the progress of their nesting procedure. If the turtle was in the final stage of nest excavation, observation was continued from the approach position ($\sim$0·5 m); otherwise the initial watching position was resumed. Face-to-face encounters with emerging females at the splash zone was avoided by immediate retreat.

When oviposition commenced, eggs were counted with the use of a dim flashlight as they were laid. Sometimes the counting of eggs was facilitated by removing some sand from the edge of the nest towards the observer. This was done with great care and without touching the turtle. During the covering of the nest the turtle was identified and the curved length of its carapace measured.

RESULTS AND OBSERVATIONS

Observations on adults

Most of the observed adults were nesting females (N = 42). All were identified as *Caretta caretta* by counting costal plates and by general inspection. Curved carapace length-frequency is given in Fig. 2 for 27 measured females in the three seasons (mean length ± S.D.: 80·4 ± 6·2 cm). Clutch size (mean ± S.D.) was 100·2 ± 11·6 eggs for 9 laying turtles, observed over the three seasons.

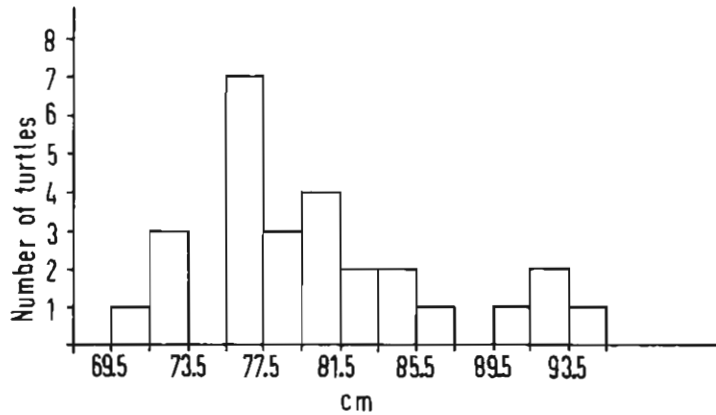

Fig. 2. Frequency of curved carapace length in female loggerhead turtles at Zakynthos, measured during the 1977, 1978 and 1979 nesting seasons.

A limited number of unidentified adults (N = 6) were encountered in the water, close to the coast of the internesting area. All of them, observed individually from a boat, were swimming slowly, surfacing for air from time to time.

In August 1978 at noon a female was spotted in the shallows of Sekania (depth 1·2 m), resting on the sandy bottom. Three male turtles were watching her intently from a distance of 7–8 m in deeper water (~3 m) but made no attempt to approach her. After a while the female, obviously disturbed by my presence, swam to deeper water where she disappeared, followed by the males. The behaviour of females coming to rest in shallow waters is explained by Bustard (1972) as a means of avoiding the attentions of males, who do not venture into the shallows. Although actual mating was not observed, the presence of males in Zakynthos waters provides evidence that mating takes place in the internesting area.

Nesting activity

Data from beach surveys are summarized in Table 1. Mean total nesting activity based on the above data is estimated to be 18·1 emergences/night and 10·77 nestings/night.

TABLE 1

RESULTS OF BEACH SURVEYS ON ZAKYNTHOS ROOKERIES DURING 1977, 1978 AND 1979

Beach	*Season*	*Emergences/night*			*Fresh nests/night*			*Hatched nests/night*			*Hatchlings/night*		
		Average	*Range*	*N*	*Average*	*Range*	*N*	*Average*	*Range*	*N*	*Average*	*Range*	*N*
Gherakas	1977	4	—	1	1	—	1	1	—	1	17·0	—	1
	1978	2·4	1–4	5	0·8	0–3	5	1	—	2	33·0	—	2
	1979	1·28	0–3	7	0·28	0–1	7	1·14	0–3	7	17·3	0–43	7
	Average	2·56			0·69			1·04			22·4		
Dafni	1977	2·28	0–5	7	1·28	0–3	7	2·00	1–3	7	49·5	15–86	7
	1978	1·67	0–4	18	0·61	0–2	18	0·62	0–2	8	18·7	0–46	8
	1979	2·57	0–6	21	0·76	0–3	21	0·85	0–3	21	22·0	2–83	21
	Average	2·17			0·88			1·15			30·0		
Sekania	1977	12·0	8–16	4	8·0	6–10	4	11·0	8–14	4	418·0	256–584	4
	1978	14·88	10–20	9	10·4	6–16	9	4·0	2–6	5	150·0	88–288	5
	1979	13·25	4–20	8	9·2	4–16	8	8·2	2–16	8	278·0	46–580	8
	Average	13·37			9·2			7·74			282·0		
Total		18·1			10·77			9·93			334·4		

Major activity on Sekania is attributed to the relative isolation of the beach. During study periods very few people were seen at Sekania compared with the other beaches. High nesting success on Sekania (Table 2), although possibly overestimated due to the assumption that all nests contained eggs, presents additional evidence that nesting conditions there are much better than in the other areas. Apart from its isolation, the ample sand on Sekania beach, lying far back, provides ideal

TABLE 2
PERCENTAGE OF SUCCESSFUL NESTINGS ON ZAKYNTHOS BEACHES

Season	*Gherakas*	*Dafni*	*Sekania*
1977	25·0%	56·2%	66·7%
1978	33·4%	36·7%	70·1%
1979	22·2%	29·6%	69·8%
Overall	28·0%	36·0%	69·4%

Overall values are not averages of the mean values calculated for every season but have been derived directly from the original data over the three seasons as a whole.

ground for nesting turtles (Fig. 3). Low nesting success on Dafni, in 1978 and 1979 as compared with 1977 (Table 2), may be attributed to sand drifting by sea currents causing exposure of stones and rocks which impeded nesting. Operation of the taverna at Dafni in 1977 and 1978 may also have disturbed nesting turtles and is probably related to increases of values in Table 1 between the nesting season of 1978 and that of 1979.

Observations on hatchlings

Early morning beach surveys showed that most young emerge during night hours. Nevertheless, lone hatchlings were frequently encountered on their way to the water during early morning hours.

Natural emergence of the brood during daylight was observed in three cases. Nest sites were located by the uppermost young protruding from the sand. In two other cases the uppermost young failed to activate and remained immobile partially under the surface of the sand. Pulling them out around 1000 h caused emergence of the greater part of the brood, as described by Bustard (1967).

All hatchlings observed on Zakynthos' rookeries (N = 150) were identified as *Caretta caretta*. Identification was done by counting costal and inframarginal plates and by general inspection.

Length and width straight carapace measurements on a sample of 20 hatchlings from one nest gave the following results (mean ± S.D.): length 40·4 ± 0·7 mm, width 33·9 ± 0·7 mm.

Fig. 3. Partial view of Sekania beach, the major loggerhead rookery in Zakynthos. (Photo D. Margaritoulis, 1978).

Activity of emerging young

Data from beach surveys are summarized in Table 1. The average number of hatchlings/night varied according to the observation period. In the 1977 observation period (20–26 August) activity of hatchlings seemed to be at its maximum. Emergence of hatchlings in the 1978 (28 July–14 August) and 1979 (5–25 August) observation periods started on the 7 and 5 August, respectively. Although 5 August was the first observation day for the 1979 season, the absence of old hatchling tracks on the beaches, when local residents reported no wind or rain that could have obliterated them, suggested this date as the beginning of the appearance of hatchlings in 1979.

Abrupt starting of hatchling appearance and local information confirm that nesting activity is strongly seasonal, as expected in a temperate region such as Zakynthos. Assuming an incubation period of 50 days (unpublished data), it is estimated from the above that the nesting season starts in the middle of June.

Evidence of nesting activity prior to observation periods can be derived by counting hatched nests which presumably correspond to nestings 50 days before. Comparison of counted fresh and hatched nests is given in Table 3 for periods after

TABLE 3

AVERAGE NUMBERS OF FRESH AND HATCHED NESTS PER NIGHT ON ZAKYNTHOS BEACHES

Observation period	*Gherakas*		*Dafni*		*Sekania*		*Total*	
	Fresh	*Hatched*	*Fresh*	*Hatched*	*Fresh*	*Hatched*	*Fresh*	*Hatched*
20–26 August 1977	1?	1?	1·28	2·00	8·00	11·0	10·28	14·0
7–14 August 1978	0?	1?	0·62	0·62	7·6	4·0	8·22	5·62
5–25 August 1979	0·28	1·14	0·76	0·85	9·2	8·2	10·24	10·19

? inadequate sample.

the start of hatchling appearance. Although it is hard to assess nesting distribution through a nesting season due to many parameters that influence turtle emergence, there is some evidence in Table 3 that nesting increases rather sharply at the beginning of the season and falls off towards the end. This is also suggested by the hatchling numbers in day-to-day observations.

With the assumption that hatched nests produced all their hatchlings during the observation period, the total number of hatchling tracks divided by the total number of hatched nests gives the average number of emerged hatchlings/nest (Table 4). In many cases, however, the number of observations was too small to allow a complete count of the brood, part of which continued to emerge after the last observation or had already emerged before the first observation. Hence, the figures in Table 4 are almost certainly underestimated.

TABLE 4

AVERAGE NUMBER OF EMERGED HATCHLINGS PER NEST ON ZAKYNTHOS BEACHES

Season	*Gherakas*	*Dafni*	*Sekania*
1977	17?	24·7	38·0
1978	33?	30·0	37·5
1979	15·1	25·7	33·7
Overall	18·5?	25·9	35·7

? inadequate sample.
Overall values are not averages of the mean values calculated for every season but have been derived directly from the original data over the three seasons as a whole, e.g. the total number of emerged hatchlings divided by the total number of hatched nests over the three seasons for Gherakas, Dafni and Sekania.

DISCUSSION

The study shows clearly that a previously unknown loggerhead population utilizes the southern beaches of Zakynthos as nesting areas. Additional information on renesting frequency and reproductive cycle duration is necessary to estimate population size. There is some evidence from local residents that turtle numbers have been greatly reduced in recent years but data are not available on the extent of the reduction. Since turtles and their eggs are not exploited in Zakynthos it is thought that depletion has been caused mainly by beach development.

Although the number of measured adults and hatchlings does not represent an adequate sample, a comparison with similar measurements in other rookeries (Table 5) shows that Zakynthos loggerheads are smaller.

Local fishermen report that numbers of sea turtles nested on Lagana beach in the past (Fig. 1). This 4 km beach was opened to tourism some years ago and as a result

TABLE 5
SIZE COMPARISON OF LOGGERHEADS FROM ZAKYNTHOS AND OTHER LOCALITIES

Locality (Source)	*Females*	*Hatchlings*	
	Mean carapace length cm (N)	*Mean carapace length mm (N)*	*Mean carapace width mm (N)*
Zakynthos (present study)	80·4 (27)	40·4 (20)	33·9 (20)
Florida 1972 (Davis & Whiting, 1977)	96·4 (25)	—	—
Florida 1973 (Davis & Whiting, 1977)	90·5 (50)	—	—
Georgia (Caldwell *et al.*, 1959)	95·9 (110)[a]	—	—
S. Carolina (Caldwell, 1959)	92·7 (18)[a]	45 (398)	35·5 (398)
Tongaland 1970–71 (Hughes, 1972)	93·7 (154)	45·2 (58)	36·3 (58)

[a] Original data converted from inches to cm.

is brightly lit on summer nights by hotels and traffic. Even under these circumstances some turtles still emerge on this beach but rarely nest there. Although rookery transfers of loggerheads have been reported in Florida (Davis & Whiting, 1977) and Georgia (Caldwell, 1962) due to beach disturbances, it is not known whether Lagana turtles have been extirpated or have transferred their nesting to adjacent beaches of the Gulf. This could be determined if the comparison of present with previous nesting activity on those beaches showed a marked increase. Although inhabitants in the area report nesting activity on adjacent beaches prior to Lagana's development, data are not sufficient to allow such a comparison.

It is known that the homing instinct in sea turtles can be very strong but its mechanism is poorly understood (Carr & Carr, 1972). Bustard (1972), trying to explain low tag recoveries on specific beaches, suggests that turtles have a tendency to return not to the exact location of previous nesting, but to the same general area. Carr *et al.* (1978), discussing reproductive homing in the Caribbean green turtle, postulate that the wandering of females from the racial rookery probably ensured survival of populations when nesting beaches were destroyed. Talbert *et al.* (1980), evaluating renesting results of loggerheads in South Carolina, support the idea that nest site fidelity in *Caretta* is considerably more flexible than in other cheloniids. This seems to be the case in Zakynthos, considering the proximity of the adjacent beaches in the Gulf of Lagana.

CONSERVATION

The Zakynthos nesting beaches present the unprecedented opportunity to watch and study sea turtles in Europe. Above all, they provide breeding grounds for a Mediterranean population of unknown size and origin.

It is hoped that the Greek Government's declaration protecting the nesting

beaches is the first step towards establishing a *Caretta* sanctuary in Zakynthos. It appears, however, that this declaration has no practical meaning unless it is accompanied by specific conservation measures covered by legislation. Implementation of conservation measures must take into account the biological needs of the species and follow the lines of IUCN's Sea Turtle Conservation Strategy.

The goal is to maintain present population levels, preserving the nesting beaches and especially Sekania, which is considered to be the critical nesting habitat. This is not a feasible task. Private interests and increasing tourism are undoubtedly placing substantial pressure on the development of the nesting beaches. Sad evidence of this is the opening of a private road in Sekania, in April 1980, one month after the protection announcement. It is apparent that vehicular access to Sekania beach, apart from damaging the ecological integrity of the area, will soon be used for developmental purposes. With no other potentially suitable nesting areas in the region, the remnants of the once flourishing Zakynthos loggerhead population face extinction.

A positive and practical means to safeguard the nesting habitat would be the immediate acquisition of at least the most important area, apparently Sekania, by the Greek Government or a private organization, and the implementation of a rational land-use plan in the other areas. The realization of this plan, requiring little effort and expenditure due to the favourable geomorphology of the area, would be sufficient to ensure the future of the nesting beaches and to maintain present population levels.

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