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Observations on Predation of Marine Turtle Nests at Akyatan, Turkey, Eastern Mediterranean

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Akyatan Beach, Turkey, has the highest number of green turtle (*Chelonia mydas*) nests in the Mediterranean (Gerosa et al., 1996) and is among the few nesting sites left in the Eastern part of the basin. Akyatan is situated on the southeast coast of Turkey, in the Cukurova region, which was a large alluvial river delta. The total length of the beach is 19.7 km measured from the mouth of a drainage canal located south of Tuzla, to Akyatan Dalyani which is the outflow of Akyatan Lake (Fig. 1).

The research was focused on 4 km of the total beach situated between km 13 and km 17 along the beach. According to Gerosa et al. (1996) 43.1% of all nests are laid in this area, which is also the zone with the highest density of nests (53.5 nest/km). The beach of fine sand is rather homogeneous throughout its length. The transverse profile is mainly flat and reaches the foot of a dune after 40–50 m width, ending at an artificial *Acacia* sp. forest. Low dune vegetation is already present at the beginning of the front dune zone, becoming more and more prevalent when reaching the dune. The study area is entirely included in the Akyatan Permanent Wildlife Reserve, which is managed by the Corps of Foresters and by the National Park Division of the Adana District.

We describe research carried out at Akyatan as part of a program that began in 1994, with a general survey aimed to estimate the presence of green turtles (*Chelonia mydas*) and loggerhead turtles (*Caretta caretta*) in the area (Gerosa et al., 1996). The intention of our work was to investigate predator species, nest predation rates, and timing of the nest predation at Akyatan. Predators of marine turtles eat eggs, hatchlings, juveniles, and adults. This study focused on egg predators such as canids (foxes, jackals, and dogs).

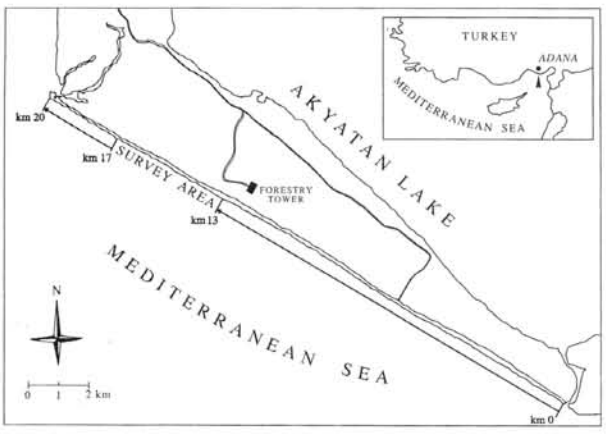

Figure 1. Map of study site at Akyatan Beach, Turkey.

Methods. — From 12 June until 25 August 1995, turtle nests and predator tracks were recorded by at least two persons walking the total length of the survey area every morning from 0500 to 1200 hrs. The date that was assigned to each recorded track corresponded to the turtle emergence from the previous night. The species, *C. mydas* and *C. caretta,* were identified primarily by considering the symmetry vs. asymmetry of the tracks. In some cases nests were unable to be identified.

Visual characteristics of tracks in the sand were observed in order to distinguish between false crawls and nest sites (Gerosa et al., 1996). The nests were not opened, in order to avoid affecting egg development or to influence predator behavior. The egg chamber was precisely identified when the egg laying process was observed during the night or when either predation or hatching occurred.

In order to avoid recording the same nest more than once, each was marked with a numbered stick and mapped. All distance measurements were made with a 20 m tape (± 0.5 cm) along a straight perpendicular line from the nest to the water line and to the dune.

Predators walking across soft surfaces left tracks which were clearly recognizable, particularly on the wet sand near the shoreline. They were therefore identified by their prints in the sand during the morning survey and date, time, and nest number recorded.

In order to analyze the spatial distribution of predation along a transverse profile of the beach and to identify any preference for a particular zone by predators, nests were grouped in zones in relation to their distance from the dune. Zone 1 was the flat zone in front of the dune which was characterized as open sand with scattered vegetation, and with presence of natural and unnatural debris; Zone 2 was the back dune zone with thicker vegetation reaching the *Acacia* sp. woods located behind the beach. Nests located on the dune were included in Zone 1 and nests were grouped every 10 m in this analysis.

The data collected from the survey area were analyzed using non-parametric statistical tests (Siegel and Castellan, 1988). The rejection level for the null hypothesis in all statistical tests was $p = 0.05$. Although a complete data set was unobtainable for some of the nests, they were included in the analyses when appropriate.

Results. — During the eleven weeks at Akyatan Beach, 237 nests were recorded in the survey area. The egg chamber location was known precisely for 141 nests and oviposition date was recorded for 206 nests. As the nesting season had already started by the day of our arrival, 31 nests were found on the beach at the start of the survey period.

Most of the nests (86.9%) belonged to *C. mydas*, with 5.1% of nests being *C. caretta*, and 8.0% not identifiable to species. A total of 63 nests (26.6%) was depredated during the observation period (Table 1).

Table 1. Marine turtle species nesting at Akyatan Beach, 1995. Predation percentage calculated on the number of nests of each species.

Species	No. Nests	% of Nests	No. Depredated Nests	% Depredated Nests
C. mydas	206	86.9	49	23.8
C. caretta	12	5.1	4	33.3
Unidentified	19	8.0	10	52.6
Total	237		63	26.6

The spatial distribution of nest predation along a transverse beach profile showed that 44 out of 70 (62.9%) nests laid in front of the dune were depredated and 18 out of 71 nests (25.4%) laid behind the dune were depredated (Fig. 2). Chi-squared test demontrated a significant difference between the observed and expected value ($\chi^2 = 20.12$, df = 1, $p < 0.001$). Fewer nests than expected were taken by predators from the back dune zone; nests in the foreshore zone were destroyed more than expected.

The temporal distribution of newly laid nests and depredated nests was obtained on a daily basis during the study period. Most egg laying occurred before 23 July, whereas predation was minimal until the beginning of July (Fig. 3).

An increase in predation activity was recorded through July until the beginning of August with a peak of 6 depredated nests on 1 August. After this phase, predation declined, although a considerable number of available nests were still present on the beach (Fig. 4). Available nests are the number of newly laid nests each day plus the number of nests laid before 12 June minus nests found empty after predation.

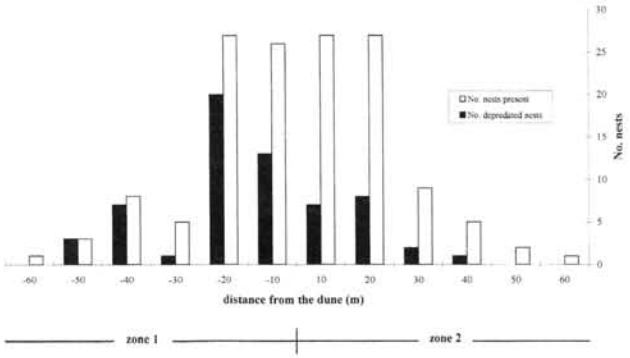

Figure 2. Spatial distribution of nests present and depredated nests in relation to their distance from the dune; Zone 1 = front dune zone, Zone 2 = back dune zone.

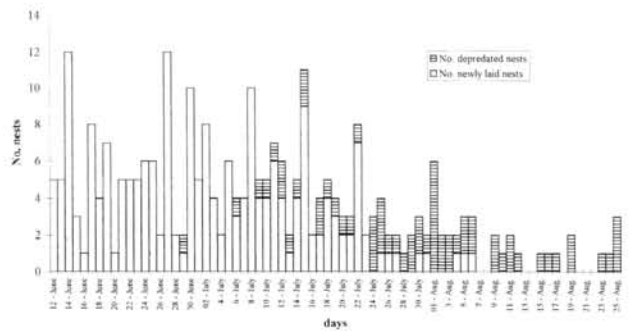

Figure 3. Nightly variation in nesting and predation during the 1995 nesting season.

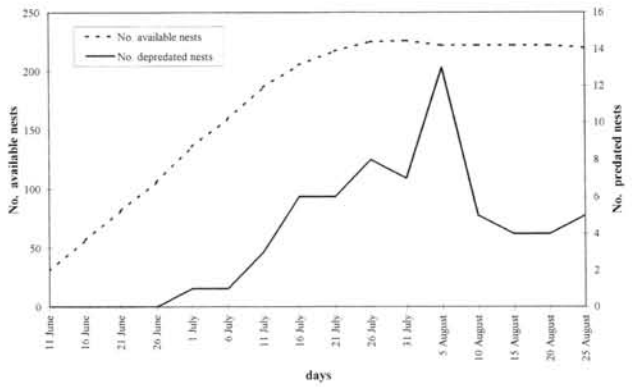

Figure 4. Temporal distribution of predation activity. Number of nests were grouped in days of five. Available nests = newly laid nests each night plus the number of nests laid before 12 June, minus depredated nests.

The majority (83%) of nests were taken by predators after the fourth week of development; the interval between the date of oviposition and predation (pre-predation time) had a mean value of 35.5 days (S.D. = 9.9).

Discussion. — According to Gerosa et al. (1996) and Brown and Macdonald (1995) Akyatan is the most important nesting beach for *C. mydas* in the Mediterranean, with low presence of *C. caretta* nests.

Canids, belonging to three different species, fox (*Vulpes vulpes*), golden jackal (*Canis aureus*), and feral dog (*Canis familiaris*), are also common on other Turkish nesting beaches: Goksu Delta (van Piggelen and Strijbosch, 1993; Brown, 1993), Kazanli (Baran et al., 1991), Dalyan (Macdonald et al., 1994), Belek, Fethiye, and Patara (Baran and Kasparek, 1989), Side and Alanya (Geldiay et al., 1982). Foxes and jackals were always present on Akyatan Beach throughout the entire research period. The latter rarely preyed upon nests (nests depredated by jackals $n = 1$, by foxes $n = 38$); according to Peters and Verhoeven (1992), the impact of jackals on hatchlings is more relevant than on nests. At Akyatan their damage on hatchlings was not evaluated, although it appeared significant.

As far as our observed nest predation rate at Akyatan is concerned, it is much lower (26.6%) than the 67.7% observed in 1992 by Brown and Macdonald (1995). The reason for the difference between the predation rates found in 1992 and in 1995 may be due to different survey methods used or that predation rates vary year by year. In order to reach

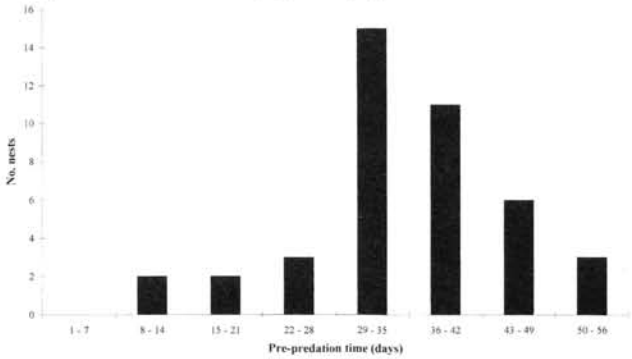

Figure 5. Interval of time between date of oviposition and predation (pre-predation time).

conclusions regarding this difference, it will be necessary to carry out yearly investigations.

The other Turkish *C. mydas* nesting beaches cannot be compared with Akyatan because no records at Samandagi were found and Kazanli was under different threats, such as agricultural encroachment, and light and chemical pollution (Coley and Smart, 1992). In addition, Akyatan cannot be compared with nesting beaches in Northern Cyprus because reports on predation there refer to beaches where *C. caretta* nests were more frequent than *C. mydas* and there were different groups of predator species (foxes and dogs) present. Nest protection (wire screens) were also applied to some nests (Broderick and Godley, 1996).

Nest position in relation to the dune was relevant to the occurance of predation. Nests located in the front dune zone were depredated more than in the back dune zone. This is probably due to foxes appearing to show a preference for patrolling the front dune zone. Here they may have a higher liklihood of finding nests and the nest digging process may be facilitated by a thinner layer of dry sand. Therefore, the dune can be seen as a kind of obstacle delimiting predator activity to the front dune zone.

Predation rate calculated only on the number of nests present in the front dune zone was 62.9%, similar to the overall predation rate of 67.7% found in 1992 (Brown and Macdonald, 1995). The high overall predation rate found in Brown and Macdonald (1995) could be due to an underestimation of the number of nests present in the back dune zone where nests are less likely to be identified unless they have just been laid the night before.

Other researchers have found that nest predation is often high over the first two nights after oviposition, when turtle signs such as tracks in the sand and cloacal fluid are still detectable on the beach, and also frequently occurs just before the emergence of hatchlings (Stancyk, 1982; Demetropoulus and Hadijchristophorou, 1989; van Piggelen and Strjibosch, 1993). At Akyatan during 1995 the first case of nest predation was recorded when the season was already advanced (29 June) and predators found nests throughout the incubation period. Predators at Akyatan did not appear able to find nests before the fourth week of incubation: firstly, no nests had been predated before 29 June, although fox tracks were constantly observed on the beach since the beginning of the research; secondly, predators raided nests after the fourth week of incubation although younger nests were also available on the beach. As the season progressed, the number of available nests on the beach increased, and the predation rate increased until the beginning of August, when hatching started. At this stage the diet of canids changed as hatchlings were an easy source of food on the beach (Fig. 4) and egg predation decreased.

Investigations need to be carried out to identify the cues that predators may use to discover turtle nests. This could be of great benefit to sea turtle conservation programs in order to adopt the best method of nest protection from depredation. Further studies on predation of hatchlings by canids are also needed. A complimentary study on canid populations would help in elucidating interactions between predators and prey. Finally, longer surveys on longer portions of the entire beach would also be necessary before setting up a predation management program.

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