Population and nesting ecology of the Green Turtle, *Chelonia mydas*, and the Loggerhead Turtle, *Caretta caretta*, in northern Cyprus

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Abstract: The reproductive ecology of marine turtles in northern Cyprus, during the nesting seasons of 1992–1995, is described. Nesting was monitored on 88 beaches. *Caretta caretta* was found to be more widely distributed, nesting on 84 beaches, compared to the 56 on which *Chelonia mydas* nested. Up to 461 *C. mydas* and 519 *C. caretta* nests were recorded in any one season. These may constitute up to 30% and 10% of the estimated Mediterranean nesting populations of these species, respectively. Data are presented regarding spatial and temporal distribution of nesting, reproductive parameters, fate of nests and threats faced. The main threats to these populations were found to be: potential beach development for recreational use, sand extraction, incidental catch in fisheries, pollution and nest depredation by foxes and feral dogs.

Kurzfassung: Während der Jahre 1992–1995 wurde die Fortpflanzungsbiologie der Meeresschildkröten auf 88 Stränden im Norden Zyperns untersucht. Die Unechte Karettschildkröte *Caretta caretta* ist mit 84 Niststränden weiter verbreitet als die Suppenschildkröte *Chelonia mydas*, deren Nisten auf 56 Stränden festgestellt wurde. Pro Legeperiode wurden bis zu 461 Nester von *C. mydas* und 519 von *C. caretta* ermittelt. Dies bedeutet, daß hier bis zu 30% bzw. 10% der Mittelmeerpopulation zur Reproduktion schreitet. Die räumliche und zeitliche Verteilung der Eiablage, verschiedene reproduktionsbiologische Parameter, das Schicksal der Nester sowie die Gefahren für die Population werden beschrieben. Die Hauptgefährdungsursachen für beide Arten sind Erschließung der Strände für Tourismus und Freizeitaktivitäten, Sandabbau, Beifang in der Fischerei, Verschmutzung sowie Nestraub durch Füchse und streunende Hunde.

Key words: Marine turtles, Mediterranean, *Chelonia mydas*, *Caretta caretta*, northern Cyprus, reproduction, Loggerhead Turtle, Green Turtle.

Introduction

In the Mediterranean, two species of marine turtle, *Chelonia mydas* (the Green Turtle) and *Caretta caretta* (the Loggerhead Turtle) have been recorded as nesting. Both species are protected under the *Convention on the Conservation of European Wildlife and Natural Habitats* (*Bern Convention*) and the *Convention for the International Trade in Endangered Species* (CITES) and classified as „endangered" and „vulnerable" respectively by the IUCN (International Union for the Conservation of Nature and Natural Resources, the World Conservation Union). In a review of the status, distribution and conservation of these populations (GROOMBRIDGE 1990), it was estimated that, in this region, as few as 300–400 *C. mydas* and 2000 *C. caretta* females might nest annually. It was also recommended that both species should be treated as „endangered" in the Mediterranean.

By 1990, the major nesting beaches identified for *C. caretta* were in Greece and Turkey, with smaller numbers recorded in Cyprus, Libya, Tunisia, Israel and Italy. Distribution of *C. mydas* nesting was found to be much more localised, the only substantial nesting areas being

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Fig. 1. Main nesting sites of *Chelonia mydas* in northern Cyprus, with an index of nest abundance at each site.

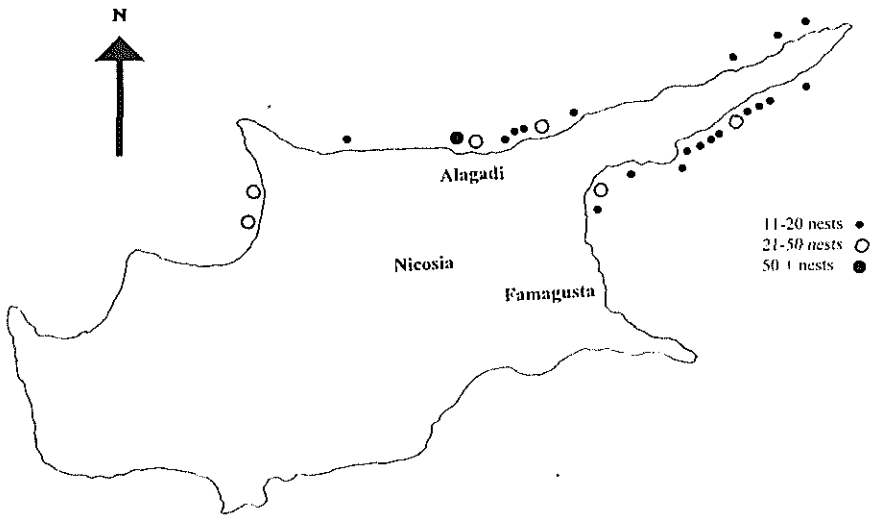


Fig. 2. Main nesting sites of *Caretta caretta* in northern Cyprus, with an index of nest abundance at each site.

Turkey and Cyprus, with a few nests also recorded in Israel. A 1995 survey of the Libyan coast, has revealed the possibility of greater populations of *C. caretta* than previously recorded (pers. comm. MEDASSET, UK). Additional recent surveys have added Egypt and Syria to the list of minor nesting areas for *C. caretta* (KASPAREK 1993a, 1993b, 1995).

Fig. 3. Alagadi beach, the most important nesting beach of both *Caretta caretta* and *Chelonia mydas* in northern Cyprus.

Whereas the populations in southern Cyprus have been studied for many years, (DEMETROPOULOS & HADJICHRISTOPHOROU 1989, 1995), where 75 *C. caretta* and 25 *C. mydas* females are thought to nest annually (GROOMBRIDGE & WHITMORE 1989), the populations in northern Cyprus have only recently been researched. In 1988, the first published survey of marine turtles in northern Cyprus was carried out (GROOMBRIDGE 1988; GROOMBRIDGE & WHITMORE 1989). During this 28 day study, 218 nests were recorded, resulting in an estimate of the annual nesting population of 25–50 *C. mydas* and 50–75 C. *caretta*. However, subsequent field surveys by local conservation volunteers suggested greater numbers than these (pers. comm. I. E. BELL, Society for Protection of Turtles in Northern Cyprus). Since 1992, these populations have been monitored annually (BRODERICK & GODLEY 1993, 1994, 1995; GODLEY & BRODERICK 1992, 1994, 1995). This paper describes some of the results of this work.

Study area and methodology

The island of Cyprus lies in the eastern Mediterranean close to the southern coast of Turkey. This study was carried out around the coastline of northern Cyprus, between 1992 and 1995, from late May until October each year, except in 1992 when work was undertaken slightly later in the season. Work was carried out by volunteers from the University of Glasgow, in conjunction with local volunteers and officials. Data were collected in two main ways: Firstly, an intensive study site was monitored at the main nesting beaches of Alagadi (Figs. 1 and 3). In

Tab. 1. The total number of nests recorded 1992–1995 in northern Cyprus with resultant population estimates, obtained by dividing the number of recorded nests by a factor of 3. *C.m.* = *Chelonia mydas*, *C.c.* = *Caretta caretta*, unid. = unidentified species.

	number of nests recorded			*population estimate*		
	C.m.	*C.c.*	unid.	*C.m.*	*C.c.*	unid.
1992	81	65	55	27	22	18
1993	320	245	6	107	82	2
1994	461	519	0	154	173	0
1995	358	518	0	119	173	0

addition, the rest of the coastline was surveyed every 3–6 days, depending upon logistics and resources, with a tendency towards reducing these survey intervals as the project has progressed.

Nesting Data

Throughout the nesting season, the two beaches at Alagadi were surveyed nightly. When an adult female or fresh track was encountered, species was identified from track morphology. *C. mydas* makes a symmetrical crawl track, whereas that of *C. caretta* is markedly asymmetrical. If the female was not present, the activity was categorised as one of the following:

a) „successful nesting activity" was recorded when a crawl track visibly lead to an area of disturbed sand where digging and covering had occurred. With *C. mydas*, nesting activity involves a great deal of covering up by the turtle which leaves an associated pit. In comparison, very little sand disturbance occurs when *C. caretta* nests.

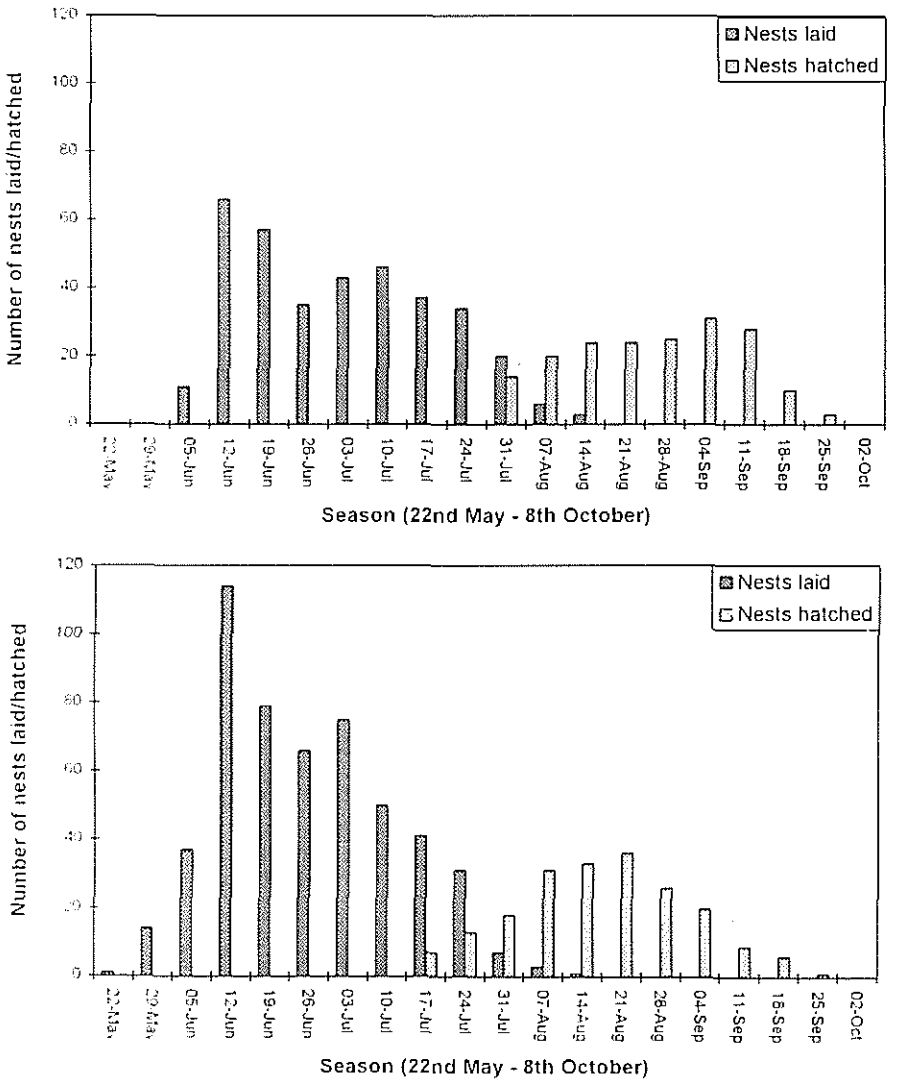
b) „false crawl attempt" was recorded when some digging had been undertaken, but successful nesting had not occurred.

c) „false crawl U-turn" was recorded when a turtle made no nesting attempt, but simply crawled onto the beach and then returned to the sea.

If the female was present, activity was observed. For successful nesting activities, at the onset of laying, curved carapace measurements, of both length and width, were taken. Turtles were examined for distinguishing features and any existing tags. After laying was completed, a small numbered plastic nest tag was placed in the nest above the egg chamber. If the adult was not tagged, plastic tags (Jumbo tags or Supertags, Dalton Supplies Ltd., UK) were placed through the trailing edge of both fore flippers in the position recommended by LIMPUS (1992). Both the colours of, and numbers on the tags differed each year. Repetition was avoided, so as to ease identification of older tags which became worn. Positions of all activities on the beach were triangulated, to posts at 50m intervals at the back of the beach, using 50 and 100 m tape measures. Tracks were subsequently raked over to avoid double counting. Daytime surveys of other nesting beaches were carried out according to the same protocol as activities at Alagadi, where the female was not observed.

Nest predation and other threats to marine turtles

Throughout the season, any evidence of nest predation was recorded. This was usually signalled by the presence of egg shells scattered around the remnants of an excavated egg chamber. Signs



Figs. 4–5. The temporal distribution of nesting and hatching of marine turtles in northern Cyprus, 1995. Fig. 4 (above): Green Turtle, *Chelonia mydas*. Fig. 5 (below): Loggerhead Turtle, *Caretta caretta*.

of predators, such as fox or dog tracks were also recorded. In addition, any other threats discovered were described and investigated.

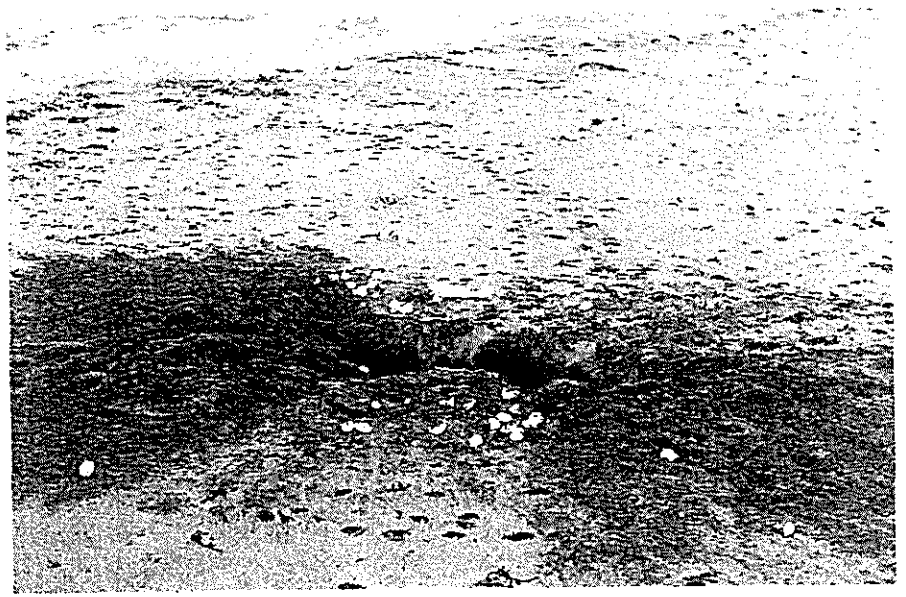


Fig. 6. Predated marine turtle nest in northern Cyprus.

Hatching data

At Alagadi, beaches were surveyed at dawn for signs of hatching from mid-July until mid-October. This was signalled by the presence of numerous small tracks, creating a mottled effect over the dry sand, caused by hatchlings which had previously crawled to the sea. Hatchling tracks were then traced back to the epicentre of activity. Any predator disturbance was noted. If there were less than 20 hatchling tracks apparent, the nest was left undisturbed and caged for protection. Once complete hatching was thought to have occurred, position of the activity with respect to beach markers was recorded and the nest was then excavated by hand. Care was needed at this point, as live hatchlings could be found in the sand column. Any live hatchlings were released or retained for release the following night. From hatchlings and embryos found, the species which laid the clutch could be identified. From nest contents, per ntage hatching could be estimated. Nest tags aided in correlating laying and hatching dates and hence the calculation of incubation periods. All nest debris was removed from the beach to avoid causing confusion or attracting predators. As with adult tracks, hatchling tracks were raked over to avoid subsequent double counting. The extensive surveying was conducted according to a similar protocol. The only differences being, that surveying was not daily and, due to high predation levels, all hatched nests were excavated on the same day as they were discovered.

Tab. 2. The dates of the nesting and hatching seasons of *Chelonia mydas* and *Caretta caretta* in northern Cyprus, 1993–1995.

	Chelonia mydas		*Caretta caretta*	
	nesting	***hatching***	***nesting***	***hatching***
1993	16th June–25th Aug.	5th Aug.–8th Oct.	15th June–12th Aug.	3rd Aug.–8th Sept
1994	31st May–5th Aug.	29th July–24th Sept.	31st May–7th Aug.	18th July–24th Sept.
1995	6th June–9th Aug.	4th Aug.–25th Sept.	24th May–19th Aug.	20th July–1st Oct.

Results

Spatial distribution of nesting

Over the four years, marine turtle nesting has been recorded on 88 beaches, constituting some 40 km, around the coast of northern Cyprus. These varied in length from 50 m to in excess of 3 km. Detailed descriptions of individual beaches can be found in GODLEY & BRODERICK (1992). *C. mydas* nested on 56 of these beaches and *C. caretta* on 84. Only 4 beaches were used exclusively by *C. mydas* whereas 32 beaches had only *C. caretta* nesting on them. Figs. 1 and 2 illustrate the distribution of the main nesting sites of *C. mydas* and *C. caretta*, respectively. Few beaches held more than 20 nests in any season, 7 in the case of *C.caretta* and 13 in the case of *C. mydas*. The main nesting site at Alagadi was the site of over 50 nests of each species in all nesting seasons. This is also the most densely nested site, since the two beaches here measure less than 3 km, in total.

Tab. 1 gives the number of nests recorded in each of the four years of this study, 1994 being the most prolific year to date for both species, with 461 *C. mydas* nests and 519 *C. caretta* nests recorded. In addition, an approximate estimate of numbers of nesting females per season is given, with 154 *C. mydas* and 173 *C. caretta* females thought to have nested in 1994. These figures are generated by dividing the number of nests by a factor of 3, the estimated mean of number of nests laid per female in any season (GROOMBRIDGE 1990). There were no nests which were not identified to species in 1994 and 1995 due to increased surveying frequency.

Temporal distribution of nesting and hatching

Figs. 4 and 5 illustrate the temporal distribution of nesting and hatching, throughout northern Cyprus in 1995, of *C. mydas* and *C. caretta*, respectively. Tab. 2 gives the dates of the first and last nests laid and hatched for each species in each of 1993, 1994 and 1995. Most nesting is in June and July with hatching occurring mainly in August and September, however, considerable variation exists between years.

Size of nesting females

Tab. 3 shows the sizes of nesting females measured at Alagadi, between 1992 and 1995. Where a female nested more than once in a season, and variation existed in the measurements taken, the mean size was entered into the data set. Each female is thus represented only once in any one year. The annual mean curved carapace length of nesting *C. mydas* females ranged from 88.9 to 95.6 cm (absolute range 78–106 cm) and annual mean widths ranged from 80.7 to 84.8

Tab. 3. The adult female curved carapace lengths (CCL) and widths (CCW) of *Chelonia mydas* and *Caretta caretta* with standard errors, sample sizes and ranges, for each year of the study, 1992–1995.

	C. mydas		*C. caretta*	
	mean CCL±SE	mean CCW±SE	mean CCL±SE	mean CCW±SE
1992	92.1 ±2.14, n=12 (78–99)	81.7 ±1.61, n=12 (70–86.5)	71.1 ±1.69, n=6 (66–76)	63.8 ±1.67, n=6 (59–70)
1993	88.9 ±1.21, n=16 (79–96)	80.9 ±1.24, n=16 (74–89)	77.9 ±1.83, n=8 (71–86.5)	68.2 ±1.91,n=8 (63–77)
1994	95.6 ±1.03, n=22 (86–105.7)	84.8 ±1.50, n=22 (68–96.7)	72.5 ±0.77, n=25 (66–81.7)	64.5 ±0.73, n=25 (59–72)
1995	90.5 ±1.44, n=19 (78.7–101.5)	80.7 ±1.76, n=19 (63–95)	73.3 ±0.78, n=39 (65–83)	65.5 ±0.75, n=39 (54.5–75)
overall mean	92.0 ±0.74 n=69 (78–105.7)	82.2 ±0.79 n=69 (63–96.7)	73.4 ±0.53 n=78 (65–86.5)	65.3 ±0.50 n=78 (54.5–77)

cm (absolute range 63–96 cm). The range of annual mean lengths of the smaller *C. caretta* were between 71.1 and 77.9 cm (absolute range 65–86 cm) and annual mean widths ranged from 63.8 to 68.2 cm (absolute range 54–77 cm). Overall mean values for the four years of the study are given to ease comparison with data published by other workers.

Nesting behaviour

Over the four years of this study, 59 *C. mydas* and 84 *C. caretta* females, nesting on the main beaches at Alagadi, have been tagged. In 1994, 33% of the *C. mydas* and 17% *C. caretta* females which were tagged in 1992 returned to nest. In 1995, a further 50% of these *C. mydas* and 70% of the *C. caretta* females returned. Thus, 83% of all individuals tagged in 1992 have returned to nest to date. One *C. caretta* female tagged in 1993 returned to nest in 1994 and 1995. No other females tagged in 1993 or 1994 have yet returned.

Tab. 4 shows data derived from these tagging studies. Inter-nesting intervals; the number of days between the laying of subsequent clutches for individual females in a given season, and the incubation periods of nests are given for each species. Inter-nesting periods of *C. mydas* ranged from 10–16 days, with yearly means ranging from 12.7–13.1 days. The overall mean for *C. mydas* was 12.9 days. The inter-nesting periods of *C. caretta* ranged from 11–17 days, with annual means ranging from 13.0–14.0 days. The overall mean period for *C. caretta* was 13.4 days. Incubation periods were longer in *C. mydas*, with annual means ranging from 50.6–51.4 days, overall mean 51.1 days (absolute range 44–59 days). The annual mean incubation periods of *C. caretta* nests ranged from 47.9–48.1 days, overall mean 48.0 days (absolute range 42–60 days).

Hatching

The overall mean clutch sizes were 115.5 for *C. mydas* and 70.0 for *C. caretta*. Yearly mean clutch sizes of *C. mydas* ranged from 106.9–123.1 eggs (absolute range 23–199 eggs) with *C. caretta* yearly mean clutch sizes ranging from 60.1–75.7 eggs (absolute range 12–126). Of the nests which hatched, percentage success was high for both species, the overall mean hatching

Fig. 7. Loggerhead Turtle (*Caretta caretta*) nesting at night.

success for *C. mydas* was 84.2% (absolute range 9–100%) for *C. mydas* nests. The overall mean hatching success for *C.caretta* nests was 79.1% (absolute range 2.5–100). Tab. 5 shows mean clutch sizes and mean percentage hatching success of nests from throughout northern Cyprus. Hatching success is given as the percentage of total eggs in the clutch which hatched.

Fate of nests

The fate of nests laid in 1994 is shown in Tab. 6 for each of the two species and those which were not identified to species at hatching or predation. If no embryo or hatchling remains were found in hatched nests, accurate species identification was not always possible, hence many nests were recorded as unidentified. However, of nests laid, 42% were recorded as hatched, 27% totally predated, 9% at least partly hatched with evidence of predation, therefore, for 22% of nests, fate was not determined.

Discussion

Spatial distribution of nesting

Figs. 1 and 2 illustrate the widespread nature of the nesting beaches for both species around the coastline of northern Cyprus. In addition, many of the beaches play host to the nesting of both species. There are few beaches in the Mediterranean that have both species nesting in significant numbers. The Alagadi beaches however, which constitute the most important nesting site in northern Cyprus, have approximately equal numbers of nests laid of each of the

Tab. 4. Mean internesting periods and incubation periods with standard errors, sample sizes and ranges for *C. mydas* and *C. caretta* northern Cyprus for the years 1993–1995.

	inter-nesting period (days)		incubation period (days)	
year	*C. mydas*	*C. caretta*	*C. mydas*	*C. caretta*
1993	13.1 ±0.42, n=15 (10–16)	–	50.6 ±0.57, n=24 (45–54)	47.9 ±0.62, n=17 (44–53)
1994	13.1 ±0.32, n=18 (11–16)	14.0 ±0.48, n=12 (12–17)	51.4 ±0.53, n=45 (45–59)	47.9 ±0.36, n=58 (43–55)
1995	12.7 ±0.28, n=34 (10–16)	13.0 ±0.32, n=20 (11–17)	51.0 ±0.55, n=52 (44–59)	48.1 ±0.55, n=40 (42–60)
overall mean	12.9 ±0.19 n=67 (10–16)	13.4 ±0.27 n=32 (11–17)	51.1 ±0.32 n= 121 (44–59)	48.0 ±0.27 n=115 (42–60)

two species. Although all but 4 of the beaches on which *C. mydas* are found to nest also have nests of *C. caretta*, 32 beaches have only *C. caretta* nesting on them. This may be due to the nature of these beaches, an idea supported by the fact that many lie in the more sheltered areas, such as those of Famagusta Bay (on the east coast). This affects both the slope, depth and qualities of the sand, possibly making these beaches unsuitable for the deeper nests of *C. mydas*.

GROOMBRIDGE (1990) estimated 300–400 *C. mydas* and 2000 *C. caretta* females nesting annually in the Mediterranean. Assuming these estimates are reliable, the northern Cyprus population estimates, calculated by the same methods, suggest that in the region of 30–40% of the total *C. mydas* population and 5–10% of the *C. caretta* population of the Mediterranean nest in this region. Data collected in 1992 are thought to have yielded underestimates of nesting numbers, as some beaches were not discovered until subsequent seasons and extensive surveying did not begin on all the major beaches until mid-June.

The estimate of population size and its accuracy will be discussed in greater depth in a separate publication in preparation. However, it should be noted that there will certainly be some variation in the mean number of clutches laid by populations of nesting turtles both between species, between years and between sites. It is therefore important to study these factors so that more accurate estimates of population size can be generated.

Seasonal distribution of nesting and hatching

There appears to be wide variation in the nesting seasons of the two species of marine turtles cited in the literature for the Mediterranean. In the 1994 season, MARGARITOULIS & DIMOPOULOS (1994) recorded the first nesting activity in Zakynthos, Greece, on the 28th May, with the last on the 3rd of September. In the south of Cyprus, both species generally nest from mid-June until mid-August (DEMETROPOULOS & HADJICHRISTOPHOROU 1989), however some variation has been noted (DEMETROPOULOS & HADJICHRISTOPHOROU 1995). At Kazanli, Turkey, *C. mydas* has been recorded nesting from June until early August (COLEY & SMART 1991). Clearly there are geographical and, as the data from this study indicate, annual variations in the marine turtle nesting season in the Mediterranean. In northern Cyprus, for example, nesting in 1993 started later than in 1994 and 1995, possibly due to the atypically cool weather that prevailed in May.

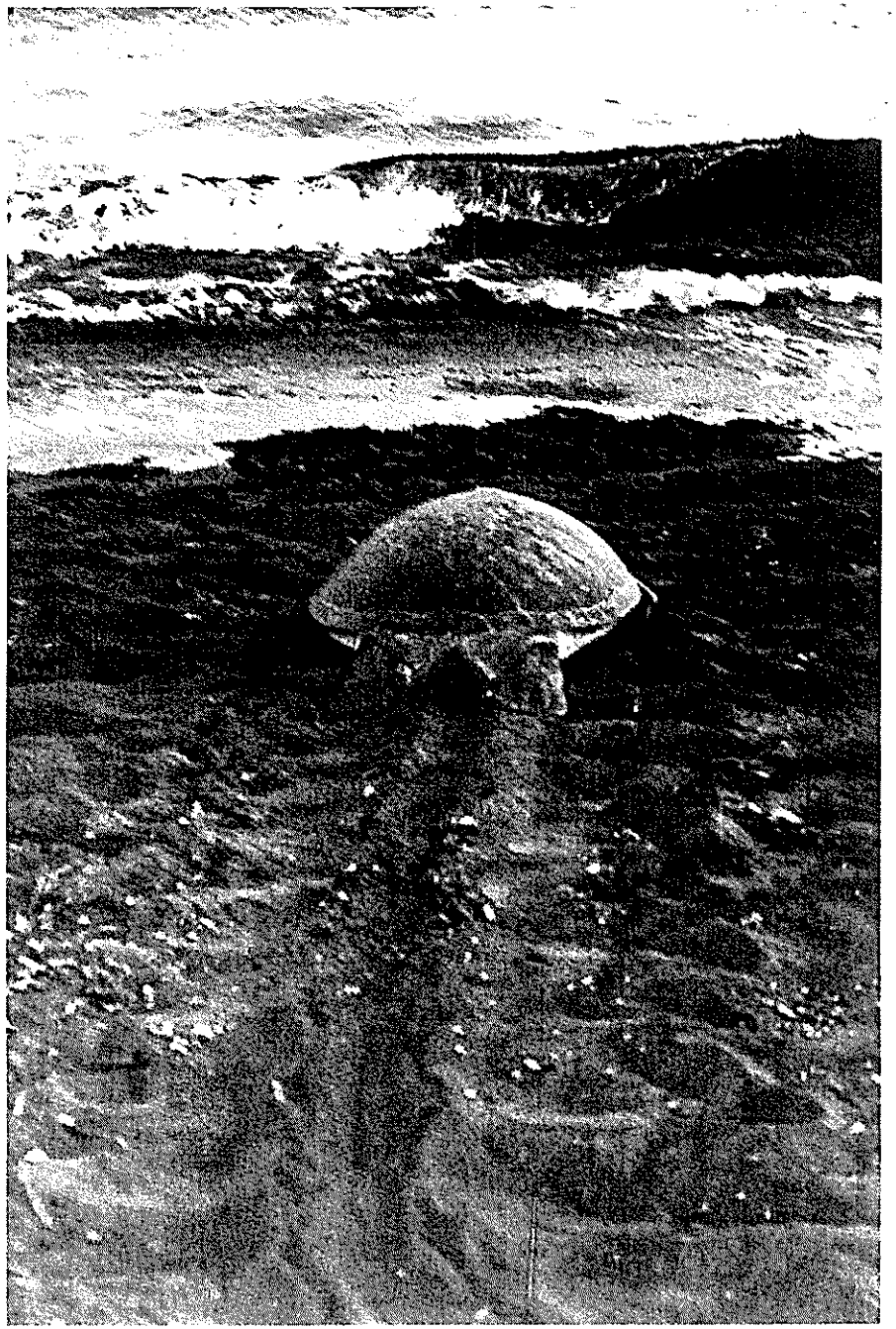


Fig. 8. Green Turtle crawling to sea at dawn showing track.

Tab. 5. Clutch sizes and relative hatching success (%) of hatched nests for all beaches in northern Cyprus, 1992–1995.

	mean clutch size ±SE		mean hatching success (%) ±SE	
	C. mydas	*C. caretta*	*C. mydas*	*C. caretta*
1992	112.6 ±3.56 n= 36	60.1 ±2.89 n= 30	85.3 ±3.06 n= 34	80.8 ±4.20 n= 32
1993	106.9 ±3.32 n= 48	75.7 ±3.92 n= 34	83.9 ±2.95 n= 46	82.7 ±3.37 n= 34
1994	123.1 ±3.04 n=127	70.4 ±1.90 n=128	83.8 ±1.78 n=125	81.6 ±1.72 n=124
1995	112.3 ±2.55 n=136	70.5 ±1.98 n=131	84.4 ±1.65 n=136	75.3 ±1.83 n=131
mean	115.5 ±1.63 n=347	70.0 ±1.21 n=323	84.2 ±1.04 n=341	79.1 ±1.16 n=321

Carapace size of nesting females

Most studies of *C. caretta* outside the Mediterranean find even larger nesting females, ranging from 90 to 100cm mean length (DODD 1988). Measurements for *C. caretta* female mean carapace lengths ranging from 71 to 78 cm, are smaller in northern Cyprus than those recorded in Greece. SUTHERLAND (1985) quotes a mean carapace length for nesting *C. caretta* on Zakynthos, Greece beaches as 81.2 cm. MARGARITOULIS (1989) gives the mean curved carapace length for *C. caretta*, at Kiparissia Bay, Greece as 83.1 cm. In Turkey, however, KASKA (1993) reported mean curved carapace measurements of 73.8cm length for *C. caretta* at Kizilot and BARAN & KASPAREK (1989a) gave an overall mean curved carapace length for the Turkish Mediterranean coast of 75.6 cm. A statistical comparison using a t-test was made to compare these female sizes. *C. caretta* females nesting in Cyprus have significantly smaller curved carapace lengths than those nesting in Greece ($t = 16.29$, $p < 0.001$, d.f. = 148) and those nesting in Turkey ($t = 3.52$, $p<0.001$, d.f. = 157) according to data from MARGARITOULIS (1989) and BARAN & KASPAREK (1989a). These statistics point to a possibility of subpopulations within the Mediterranean.

As with *C. caretta*, *C. mydas* individuals in the Mediterranean are notably smaller than those found in other regions (ERHART 1982). Mean curved carapace lengths ranging from 88 to 96 cm for *C. mydas* nesting in northern Cyprus are similar to those found in Turkey, the only other major nesting site of this species in the Mediterranean. GEROSA et al. (1995), in a study conducted on Akyatan beach in Turkey, recorded mean curved carapace lengths of *C. mydas* as 92.1cm. COLEY & SMART (1992) cite mean curved carapace length of *C. mydas* of 96 cm at Kazanli, Turkey. These data were however, based on a sample size of only 4 individuals. BARAN & KASPAREK (1989a), however quote a mean curved carapace length for *C. mydas* in Turkey as a whole as 90.1 cm, significantly smaller than the overall mean found in northern Cyprus ($t = 2.31$, $p< 0.05$, d.f. = 109).

Statistical analyses are not used to compare the differences found between years, due to the possible confounding effect of pseudoreplication. Returning females were present in more than one year and would thus be over-represented. Mean sizes for individual years are given to illustrate variation between years. In addition to the possibility of different subpopulations nesting in different geographical areas, marked inter-annual variation at one nesting site may also indicate the possibility of temporally separated demes. Only results from genetic studies will help elucidate whether this is the case.

Tab. 6. Fate of 461 *C. mydas* and 519 *C. caretta* nests laid in 1994, in northern Cyprus. Numbers in brackets are percentage of total nests for each species.

fate	*C. mydas*	*C. caretta*	unidentified	% of total nests
hatched	174 (38)	168 (32)	68	42
predated	15 (3)	57 (11)	193	27
hatched & predated	28 (6)	28 (5)	36	9
known fate	217 (47)	253 (49)	297	78

Specifics of nesting behaviour

The mean inter-nesting period for marine turtles around the world is given as between 9–15 days, with each female laying 2–10 clutches in a given year (ERHART 1982). For *C. mydas* on Ascension island, this period is cited as 14 days, and as 12.1 days in Tortuguero, Costa Rica (MORTIMER & CARR 1987). No other relevant data are available for mean inter-nesting periods of *C. mydas* nesting in the Mediterranean. It is interesting to note that *C. mydas* tends to have a shorter inter-nesting interval than *C. caretta*, even though it produces larger clutches, however larger sample sizes are needed before any conclusions are drawn from these data. MARGARITOULIS (1989) gives the inter-nesting period for *C. caretta* in Greece as 15.2 days. This is longer than the 13–14 days recorded in Cyprus. The possible reasons why inter-nesting intervals are shorter in Cyprus might be due to the smaller clutch size in Cyprus, a difference in levels of nutritional availability or be due to the higher prevailing temperatures which could possibly increase metabolism and therefore the rate of egg production.

The general range of incubation periods for marine turtle nests world-wide is quoted in the literature as 50–70 days (HIRTH 1980). MARGARITOULIS (1989) quotes a mean of 55.5 days for *C. caretta* in Peloponnesus, Greece. PETERS & VERHOEVEN (1992) cite 55 days for *C. caretta* in the Göksu Delta, Turkey. For *C. mydas* nesting in Turkey, a mean incubation period of 54 days has been reported at Akyatan (GEROSA et al. 1995). The shorter incubation periods of 50–51 days for *C. mydas* and 47–48 days for *C. caretta* could be due to the warmer climate found in Cyprus compared to other sites where marine turtle nesting studies have been undertaken in the Mediterranean. Other studies have shown that an increase in temperature decreases the incubation period (BILLETT et al. 1992).

Hatching

The mean clutch size varies greatly from place to place. World-wide, mean clutch sizes for *C. mydas* vary from between 81 to 147 eggs and 101 to 126 eggs for *C. caretta* (HIRTH 1980). In Turkey, the mean clutch size of *C. caretta* was 91.7 eggs in the Göksu Delta (PETERS & VERHOEVEN 1992), whereas at Patara mean clutch was found to be 70 eggs (KASKA 1993). In Greece, a mean clutch size of 117.7 eggs was recorded in Peloponnesus (MARGARITOULIS 1989). *C. mydas* in Akyatan, Turkey, had a mean clutch size of 123 eggs in 1994 (GEROSA et al. 1995). The mean clutch sizes for *C. caretta* nesting in northern Cyprus of 60 to 76 eggs are much lower than those recorded elsewhere in the Mediterranean, except at Patara. Although there are few data available to compare other nesting populations of *C. mydas* in the

Mediterranean the results found in this study of 106 to 123 eggs are well within the range of those found elsewhere in the world and also by GEROSA et al. (1995) in Turkey.

The hatching success of *C. caretta* in northern Cyprus of 75–83% compares favourably to that found elsewhere in the Mediterranean. MARGARITOULIS & DIMOPOULOS (1994) give a mean hatching success for *C. caretta* in Zakynthos, Greece, as 67.7%. Whereas, MARGARITOULIS et al. (1994) give a percentage of 73.4% for *C. caretta* at Kiparissia Bay, Greece. In the Göksu Delta, Turkey, PETERS & VERHOEVEN (1992) give the mean hatching success as 77% for *C. caretta*. For *C. mydas*, values of 80–85% in each of the four years of this study, are higher than those found for *C. caretta*. This may, in part, be due to the more stable conditions of temperature and moisture that would be expected in the deeper nests of *C. mydas*.

Fate of nests

Due to the extensive nature of much of this study, it was not possible to mark every nest to give it an absolute identity. Thus, if no remains were found at hatching or predation, then firm species identification by positional data alone, was not always possible. For this reason it is not possible to directly compare the fate of nests of each species separately. This is since those recorded as, „species unknown", are either *C. caretta* or *C. mydas* nests. From the data shown in Tab. 6, it can be seen that predation was a significant problem in 1994, with 36% of nests affected. This was similar in all years. However, 42 % of nests did hatch with 9% hatched and predated, either during or after hatching, so increasing the total hatched to 51%. It is thought that this is an underestimate as it is easier to miss the tracks of a set of hatchlings than those of a nesting adult whilst operating a 3-day surveying regime. Thus, the 22% of nests with no assigned fate should be considered a maximum number, with some of these likely to have hatched, but not have been recorded. The other nests which should possibly be considered as contributing part to this statistic are; infertile, infected, clutches parasitised by insects and their larvae, those inundated or washed away by tides or those laid in situations with other unfavourable nest conditions.

Threats to northern Cyprus turtle populations

Impact of recreational use of beaches

In northern Cyprus, many of the problems associated with recreational use of the beaches have not yet reached the proportions they have in places such as Zakynthos (ARIANOUTSOU 1988; WARREN & ANTONOPOULOU 1990) and southern Turkey (BARAN & KASPAREK 1989b). Tourism is still at a relatively low level, but is increasing. Most nesting beaches have no associated development, very little human usage and often, are several kilometres away from the nearest village or surfaced road. Some beaches on the east coast, near Gazimagusa (Famagusta), and on the north coast, near Girne (Kyrenia), have been heavily developed for tourism. This has resulted in the degradation of the coastline with respect to marine turtle nesting and hatching. However, these beaches are in the minority and nesting still does occur at a low level. Much of current beach usage is a result of recreational use by local people.

Fig. 9. Pollution with plastic litter on a major Green Turtle nesting beach in northern Cyprus.

The major sites where this could have a significant effect on nesting turtles are at the two most prolific nesting beaches, at Alagadi. These are also public bathing beaches. This is where the largest number of turtles and nests come into contact with human activity and the possible associated detrimental effects. In the summer of 1994, the Department of Environmental Protection declared these beaches closed between 8 p.m. and 8 a.m., throughout the marine turtle reproductive season. This has been successfully policed and enforced in both the 1994 and 1995 seasons. In addition, parts of the beach are now cordoned off to the public during the day on an effort to protect nests. Fires and vehicles are also prohibited. One small restaurant has been built behind one of the beaches. This is only open during the day and its negative impact on sea turtle reproductive success is likely to be minimal. Hand-in-hand with this increased official involvement with the management of these two beaches, has come a more effective beach cleaning regime and public awareness campaign. Unfortunately, the directive to protect the turtles at these beaches is not yet enshrined in local legislation.

Sand extraction

Sand extraction on a small scale has been found to be a considerable problem at many turtle nesting beaches in northern Cyprus. In 1993, approximately 100 tonnes of sand were being removed from behind the Alagadi beaches on a daily basis. On occasion, vehicles were removing sand from as close as 50 m above the high water mark. Successful lobbying has resulted in a cessation of these activities at Alagadi. Unfortunately the beach is now more stony

in these areas, as sand blown to the back of the beach now has no dunes to confine it. Parts are no longer suitable for turtles to nest.

Incidental catch in fisheries

There is no established turtle fishery or evidence of any trade in turtle parts in northern Cyprus. Turtles appear to be killed by some fishermen following damage to nets by accidental entrapment. There are also a few records of turtles being shot by spear-fishermen. Each year approximately 10–30 stranded turtles of various sizes are discovered. Many have traumatic lesions. The majority are dead, however 1–2 each year are found alive, entangled in debris such as discarded fishing net, and subsequently released.

Pollution

A vast amount of marine litter is washed on to the beaches of northern Cyprus. Much of this appears to be of south-eastern Mediterranean origin, with a large proportion being plastic and medical waste (BRODERICK 1994). A similar situation is found on the adjacent mainland (Orontes River delta, Turkey, BARAN & KASPAREK 1989b, entire Syrian coast KASPAREK 1995, Lebanon KASPAREK, pers. comm.). This is not only potentially damaging to nesting and hatching turtles, but is aesthetically displeasing to local people and tourists using beaches. The north coast of the island is particularly prone to litter deposition, due to prevailing currents (pers. comm. ILKAY SALIHOGLU, Middle Eastern Technical University). Local authorities have made attempts to clear some beaches, however resources are lacking and these efforts will have to be ongoing to minimise possible negative influences.

Predation by foxes and dogs

Although adult turtles on Mediterranean beaches face little predation threat, many animals prey upon their eggs and hatchlings. No harvest of eggs by man has been observed. The terrestrial predators are Red Foxes (*Vulpes vulpes*), feral and domestic dogs, Ghost Crabs (*Ocypode cursor*) and scavenging birds such as Hooded Crows and Magpies (*Corvus corone cornix* and *Pica pica*). In northern Cyprus, all of the above have been found to depredate turtle nests and hatchlings, the main predators being foxes and dogs. This is similar to findings on beaches in the south of Cyprus, where foxes can be responsible for disturbing up to 70% of nests (DEMETROPOULOS & HADJICHRISTOPHOROU 1989). The majority of predation in northern Cyprus occurs either during late incubation or during the hatching period. Very little predation is associated with laying. Although 9% of recorded predation by canids was associated with signs of hatching, it is likely that this is an underestimate, with more nests assigned as predated without hatching, being partly hatched. However, disturbance caused by the initial predation and secondary scavenging by birds and crabs will mask prior hatchling tracks.

The possible solutions to this significant problem of predation have been comprehensively reviewed (STANCYK 1982). Control in this case is problematic because the nesting is diffuse, with at least 88 beaches being used throughout a lengthy coastline. In 1994, a pilot screening programme was instituted, using wire and bamboo screens to cover the nests, allowing hatchlings out, but acting as a barrier to predators. This was met with a degree of success. The

Fig. 10. Dead Loggerhead Turtle (Caretta caretta) found on the shore and showing head trauma.

main difficulty was accurately determining the exact position of the clutch and therefore, where to best place screens, especially in the case of *C. mydas* nests which can be extensively covered. Other problems encountered were; screens being disrupted by nesting females and bamboo screens being destroyed by predators.

Recommendations

In four years, a thorough baseline of biological knowledge of marine turtles in northern Cyprus has been established. Using these data, a proposal has been made to the local authorities in northern Cyprus recommending the protection of the 10 main nesting beaches, in particular those which hold the majority of *C. mydas* nesting. In addition we recommend that conservation efforts and protection of nests be concentrated on these beaches which have been shown to hold over 70% of these nests. The size of these populations and the relative lack of direct threats to them demonstrate northern Cyprus to be a critical habitat for Mediterranean marine turtles, especially *C. mydas*.

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On *Vipera ammodytes transcaucasiana* (Viperidae) from Perşembe, Black Sea region of Turkey

by Cemal Varol Tok and Yusuf Kumlutaş

Abstract: The Transcaucasian Nose-horned Viper *Vipera ammodytes transcaucasiana* is recorded from Perşembe, Ordu province of Turkey. The morphological characteristics of this subspecies have been studied and some biological and ecological characteristics are described.

Kurzfassung: Die kaukasische Unterart der Sandotter (Europäische Hornotter) *Vipera ammodytes transcaucasiana* wird von Perşembe, Provinz Ordu, Türkei, gemeldet. Die morphologischen Merkmale wurden untersucht und einige biologische und ökologische Merkmale mitgeteilt.

Key words: *Vipera ammodytes transcaucasiana*, distribution, morphology, Black Sea Region.

Introduction

Vipera ammodytes transcaucasiana was first described from Borschomi near Tiflis (Caucasus) by BOULENGER in 1913. Subsequently, it has become known from the Caucasus, north-eastern and eastern Anatolia, the Turkish Central Black Sea region, and from western Iran (TERENTJEV & CHERNOV 1965, DERJUGIN 1901, EISELT & BARAN 1970, BARAN 1976, BAŞOĞLU & BARAN 1980). OBST (1983) and HERRMANN et al. (1987) have accepted the taxon as a full species, *Vipera transcaucasiana*, whereas ENGELMANN et al. (1986) assigned it to a subspecies as *Vipera ammodytes transcaucasiana*.

TEYNIÉ (1991) stated that specimens from the vicinity of Istanbul resemble *V. a. transcaucasiana*. He stated that the forms living in Anatolia are generally similar to *V. a. transcaucasiana*, but some specimens from the vicinity of Bursa, Adapazarı and Istanbul have some of the features of *V. a. montandoni* and *V. a. meridionalis*.

DERJUGIN (1901) assigned specimens from Borçka in the Artvin province to *V. ammodytes*. EISELT & BARAN (1970) included these specimens as *V. a. transcaucasiana*, described by BOULENGER in 1913.

EISELT & BARAN (1970) described two specimens from Kösedağ near Zara, Sivas province, as *V. a. transcaucasiana*. NILSON et al. (1988) reported this taxon from Ordu (Central Black Sea Region), Zonguldak (Western Black Sea Region), Adapazarı (Marmara Region) and Konya (Inner Anatolian Region) according to their own records and information received from TROJKAN, SOCHUREC and local people. They also included Kuşadası (Aegean Region) in the range of *V. a. transcaucasiana*, based on EISELT & BARAN (1970), but such a record is not given in that paper. EISELT & BARAN (1970) had reported an exeuvium from Kuşadası with an unusual number of 149 ventrals. Although this number deviates from the range of *V. a. meridionalis* and is closer to *V. a. montandoni*, Kuşadası is not included in the range of *V. a. meridionalis*.

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