Nature conservation field course: Protection of sea turtles (*Caretta caretta*) in Turkey 2009

Projektpraktikum: Schutz von Meeresschildkröten (*Caretta caretta*) in der Türkei 2009

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GULET TOURISTIK Österreich im Urlaub

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Executive Summary

Julia Zimprich

The loss of nesting beaches, industrial fishing activities as well as pollution and mass tourism are among the main threats facing the loggerhead turtle. Therefore, for 17 years, the University of Vienna has been collaborating with several Turkish universities and conducting a project in the Specially Protected Area Fethiye. Conducting research on and protecting the endangered loggerhead turtle is the main focus. Every summer, data are collected on three nesting beaches in south-west Turkey: in Yaniklar, Akgöl and Calis. In 2009, sea turtles were monitored during the period from 27 June until 19 September by 23 Austrian students, two Turkish professors along with Turkish students.

Even though the number of nests this year was slightly higher than in 2008, the overall number of nests in the last 17 years shows a gradual decrease.
This year, a total of 92 nests were registered.
On the Yaniklar and Akgöl beaches, 77 nests were found – an increase of 18% compared to 2008. Thirty-nine of these nests were so called secret nests (nests laid before 27 June and first discovered by finding hatchling tracks).
Our survey showed that the turtles had on average 3.03 unsuccessful emergences before they laid a nest on Akgöl beach, while on Yaniklar beach they had to come out 2.56 times.
On Calis beach, 15 nests were found, 2 more than the last year. Ten out of these were secret nests. The turtles had to come out an average of three times to lay one nest.

5690 eggs were counted in Yaniklar and Akgöl (3262 in Yaniklar and 2428 in Akgöl).
The number of hatchlings reaching the sea was between a minimum of 2540 (based on tracks and living hatchlings found) and a maximum of 3417. This maximum value represents the number of empty shells counted during nest examinations minus the number of dead hatchlings.
In Calis, 1117 eggs were laid, of which 949 hatched (a total of 76 %). Here, a minimum of 665 hatchlings reached the sea. The corresponding maximum number of hatchlings calculated was 849.Overall, 6807 eggs were counted on the 3 beaches.

The average distance from the nests to the sea at Calis beach along the promenade was 15.92m and the average distance to the promenade was 6.27 m. On beach sections without the promenade the average distance to the sea was 21.86 m. In Akgöl the average distance from the

nest to the sea was 19 m and in Yaniklar 20 m. We assume that the disturbance by the presence of the promenade is a key reason for the lower average distance to the sea of nests situated along the promenade wall compared to nests in areas without the wall: on beach sections without a promenade, nests were on average about 6 m further inland.

In order to obtain more information on conditions inside a nest, we put Tiny Talks into 5 egg chambers. These small electronic sensors recorded the temperature at intervals of 72 minutes, yielding 20 measurements a day. These values were backed up by daily measurements of air temperatures in both camps. The highest average air temperatures were measured in July. At the same time the Tiny Talks showed the lowest nest temperatures. The nest temperatures increased constantly until August. While the maximum air temperature difference measured in Yaniklar was 28.3° C), the maximum temperature difference inside a nest was 5.9° C (Nr. 11, Tiny Talk 1). This demonstrates the buffering effect of the sand.

A total of 11 different *Caretta caretta* individuals were observed.
In Yaniklar the mean straight carapace measurements were 0.69 m length and 0.53 m width. The curved carapace measurements were 0.81 m length and 0.71 m width.
The incubation time was a minimum of 43 days and a maximum of 66 days, with an overall mean of 52.9 days (SD ± 6.24)

From 16 June until 19 September, 7 turtles were tagged, all of them on Yaniklar beach. A turtle tagged by project members on 4 July was registered 5 days later laying a nest in Calis beach. Another turtle, tagged in 2007 (TRC 2.202), was seen twice on Yaniklar beach. Although the left rear extremity was missing, she was still able to lay a nest.

One dead loggerhead and one dead green turtle were found this year. At 7:49 pm on 4 August, one female loggerhead turtle was found dead at Çaliş beach. It had no tag. An injury was present on the front flipper of the left side. Additionally, the neck and flipper had a net tangled around them. The specimen also had a fishing hook in its mouth.
Furthermore, on 5 August a Green Turtle (*Chelonia mydas*) was found at Yaniklar beach. The cadaver of this female was not examined more closely.

Our investigations indicate that the situation on Calis beach is deteriorating each year. A rapid increase in the number of sun beds and umbrellas was registered in comparison to 2008. The number of sun beds increased by 32.6% and the number of parasols has increased by 10.1%.

This number has decreased slightly in Yaniklar and Akgöl beach, but problems concerning light pollution and litter are still present. There is also an increase in the number of jetskis and motorboats (offered by Lykia Botanika and Majesty Club Tuana), which are used in the protected 200 m zone off the shore. This means a higher risk for adult turtles as well as hatchlings.
We carried out a beach cleaning operation at these locations. In order to protect nests at Akgöl beach, we constructed several barriers. These consisted of a ditch designed to keep tourists and local residents from driving their cars and other vehicles onto the beach.
All changes and events that have a negative impact on nesting beaches were documented with photos.
The classification of loggerhead turtles as endangered (as per the IUCN red list) makes protection of nesting beaches especially vital. In order to ensure the long-term protection in Fethiye Bay, the provisions of the designated “Specially Protected Area” must be strictly adhered to.

The nesting behavior of adult loggerhead (*Caretta caretta*) on Çaliş beach (Fethiye, Turkey)

René Federspieler & Marlies Sperandio

KURZFASSUNG

Im Zeitraum zwischen 27. Juni und 19. September 2009 untersuchten StudentenInnen der Universität Wien am Strand von Çaliş (Fethiye, Türkei) das Nistverhalten der bedrohten Meeresschildkrötenart *Caretta caretta* (Unechte Karettschildkröte). Auf dem ca. drei Kilometer langen Strandabschnitt wurden in regelmäßigen Morgen- und Abendschichten Beobachtungen zum Landgang adulter Schildkröten, Eiablage, sowie den Einfluss anthropogener Störfaktoren (Liegestühle, künstliches Licht u.a.) auf diesen Prozess, gemacht. Die adulten Schildkröten und deren Spuren wurden vermessen und die genaue Position der Nester erfasst. Ein Nest wurde zum Schutz vor Überflutung verlegt („Hatchery"). Insgesamt wurden 12 Spuren und 15 Nester dokumentiert, das sind 2 Nester mehr als im Jahr 2008. Die erhobenen Daten sollen Rückschluss auf die Entwicklung der Population und auf die zunehmende Störung der Schildkröte auf dem vom Tourismus stark geprägten Strand geben.

ABSTRACT

Between 27 June and the 19 September 2009, students from the University of Vienna monitored the nesting behavior of the endangered loggerhead turtle *Caretta caretta* on the beach of Çaliş (Fethiye, Turkey). In two shifts per day, observations about the emergences of the adult turtles, the deposit of eggs and the effects of anthropogenic disturbance during this process were made. The adult turtles and their tracks were measured and the exact position of the nests was located. In total, 12 tracks and 15 nests (2 more than in 2008) were found. The collected data show the population trend as well as the extent of disturbance by increasing tourism on the nesting success.

INTRODUCTION

The loggerhead turtle (*Caretta caretta*) is one of seven marine sea turtle species and can be found in all tropical and subtropical oceans, and is the most common species in the Mediterranean Sea. The first sea turtles appeared 200 million years ago and, today, most species are facing the threat of extinction due to anthropogenic impacts.

An adult *Caretta caretta* (Fig. 1) can reach a carapace length between 85-124 cm and weights of about 80-200 kg (Spotila, 2004). Their disproportionately large head and their powerful jaws allow them to feed on mussels and crustaceans but also on fish and jellyfish (Spotila, 2004) when migrating internationally between different habitats (Witherington et al., 2009). 15-25 years after hatching, the female loggerhead reaches sexual maturity (LeBuff, 1990). Since mating sites are usually far from feeding grounds, the life cycle of adult males and females is closely associated with migration (Miller 1996). During the nesting season in summer, courtship and mating take place at special mating sites along the migration routes, located close to the same beach where the females have hatched. Except for nesting, which takes place every 2-4 years, female loggerheads spend their whole lives in the open water; males do not leave the sea at all (Miller 1996).

Fig. 1: Adult *Caretta caretta.*

Fig. 1: Adulte *Caretta caretta.* Foto: M. Stachowitsch

After successful copulation, the female approaches the beach, usually at night, goes ashore and immediately starts to look for an adequate spot to dig the nest. During one season, a female turtle may go ashore 2-4 times, alternating between beaches and offshore mating areas in an interval of 12-17 days (Spotila, 2004). Once she finds an appropriate place on the beach, she tests the sand and makes one or more body pits by swaying and sweeping away the loose sand with her flippers (Miller et al., 2003). She then begins to dig an approximately 50 cm deep egg chamber with her hind limbs into which she immediately places up to 120 eggs through the extensible cloacal tube (Hailman & Elowson, 1992). During the process of egg laying, the female is relatively insensitive for most types of disturbance (Miller, 1996). After laying the eggs the female covers and packs the egg chamber and camouflages the body pit using all four flippers and returns immediately to the sea (Limpus et al., 1975). The whole process takes approximately one to two hours (Miller, 1996).

During the exhausting period on the beach, the sea turtle is especially vulnerable to different types of anthropogenic disturbance. Particularly in touristic areas, sun beds, sunshades, garbage as well as direct human interference, noise and artificial lights can interrupt the sea turtle's nesting process as well as disorientate both adults and hatchlings. Consequently, the disturbed female often aborts the nesting process and moves to another, often inappropriate nesting site.

Unfortunately, all species of sea turtles are currently listed as threatened or endangered in the International Union for Conservation of Nature (IUCN) red list of threatened species. Since 1996 the loggerhead turtles have been classified as endangered, which means that the species is facing a high risk of extinction in the wild in the near future (IUCN 2009). The trade of sea turtle products was prohibited in 1979 by the Convention on International Trade in Endangered Species (CITES), and sea turtles may not be trapped or killed (CITES 2009). Despite all worldwide and local conservation efforts, loggerhead populations keep on declining all over the world, primarily due to anthropogenic impacts. One of the main threats lies in extensive commercial fishing – each year 60,000 sea turtles are caught in fishing nets in the Mediterranean Sea alone (Caminas, 2004). Increasing tourism and boat traffic at the nesting sites, pollution of beaches and the open ocean, as well as severe habitat destruction menace the populations on land and in the water.

The Mediterranean region is one of the most important breeding habitats for *Caretta caretta*, with nesting beaches in 10 different countries (Caminas, 2004), 17 of them in Turkey. The beach of Çaliş (Fethiye) has been extensively developed for tourism. Hotel construction, extension of infrastructure and increasing touristic use of the shoreline impede the successful nesting of adult females and the undisturbed development of the clutch. In order to assure an effective conservation of sea turtles it is essential to find out more about their life cycle (migration and nesting) and life history elements. The ultimate goal of our work was to promote a permanent coexistence of humans and sea turtles at Çaliş beach.

MATERIAL AND METHODS

Between 27 June and 19 September 2009 students from the University of Vienna observed the nesting behavior of *Caretta caretta* on the beach of Çaliş. Each day the students worked in two shifts. The night shift started at 10:00 pm and lasted for about four hours. During this time period three students walked up and down the beach in order to observe adult turtles during egg deposition. When a turtle was about to return to the sea, data on body size and the

exact nest location were taken and the tracks were measured. Furthermore, during these shifts the students checked on other nests and helped hatchlings reach the sea if necessary. The morning shift lasted from 06:00 am to approximately 08:00 am. During the morning shift, two students inspected the beach for tracks left by turtles between the night and morning shift and checked the nests for hatching turtles. The ‘regular’ night shift ended on 1 August because by then the main nesting season was over and further emergences of adult turtles were improbable. From then on, during the night shift, the students only checked the nests.
When a turtle was spotted on the beach it was important to stay calm and keep tourists away from the beach in order to avoid disturbing of the turtle’s nesting process. Spectators were informed what was happening and asked not to take photos with flashes. After the turtles built the nest, or were about to return back to the sea without laying eggs, they were measured. In order to do so, one student held the turtle (one hand at the caudal end of the carapace and the other one at the cranial) while another student measured the curved carapace length (CCL) and width (CCW) with a measuring tape. In addition, the straight carapace length (SCL) and width (SCW) was measured with a sliding caliper and the turtles were checked for any tags on the flippers. If such a tag was found, the number was noted. Additionally, the turtle was checked for any external deformations or epibionts and released afterwards.

After the turtle had been released attempt was made to locate the exact position of the nest by using a metal rod (“shish”). The sand on top of the egg chamber is much softer than on either side, making it possible to find the nest. Afterwards the nest was triangulated (Fig. 2) with three points (typically on the wall of the promenade or other landmarks) and the distance to the sea and the width of the three beach-zones (dry-zone, moist-zone and wet-zone) were measured. This was important in order to keep track of the nest.

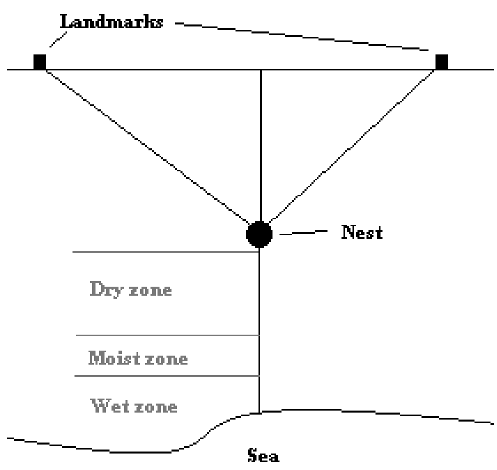


Fig. 2: Schematic illustration of a triangulation
Fig. 2: Skizze einer Triangulation

Additionally, data on track length and track width were collected. Even if the turtle had been disturbed or had not been able to find a suitable place and returned to the sea without building a nest, the track was measured and the body pits were counted.

Fig. 3: Cage at the beach.
Fig. 3: Käfig am Strand.
Foto: R. Federspieler

In addition a special cage was put on top of those nests (Fig. 3) that were laid along the promenade. This was necessary in order to protect the nest against predators and keep the hatchlings from going in the wrong direction at night. The position of the cages was controlled regularly during the morning shift. In order to inform tourists and avoid any misunderstanding or cage displacements, each cage was labeled as "*Caretta caretta* nest" in three different languages (Turkish, English and German).

The hatchlings were briefly detained in this cage at nighttime because, if free, they tend to crawl toward the brightest spot, which in this case would have been the promenade rather than the sea. During the nightshifts the hatchlings were taken to a darker section of the beach and released there. We set them free about 4-5m away from the water so that they had to find their way to the sea by themselves. This process is probably important for the development of the sense of direction in the young turtles.

RESULTS

Nests

In total there were 15 nests on Çaliş Beach, which is two nests more than in 2008. 10 of these 15 nests were so called "secret nests" (C1-C11). All of these were built before the observation period started on 27 June, which is why no tracks or adult turtles building these nests were observed. These secret nests were first noticed when the young turtles hatched. The 4 "regular" nests (1-4) were dug between 9 July and 6 August. An overview of all nests is given in Tab.1.

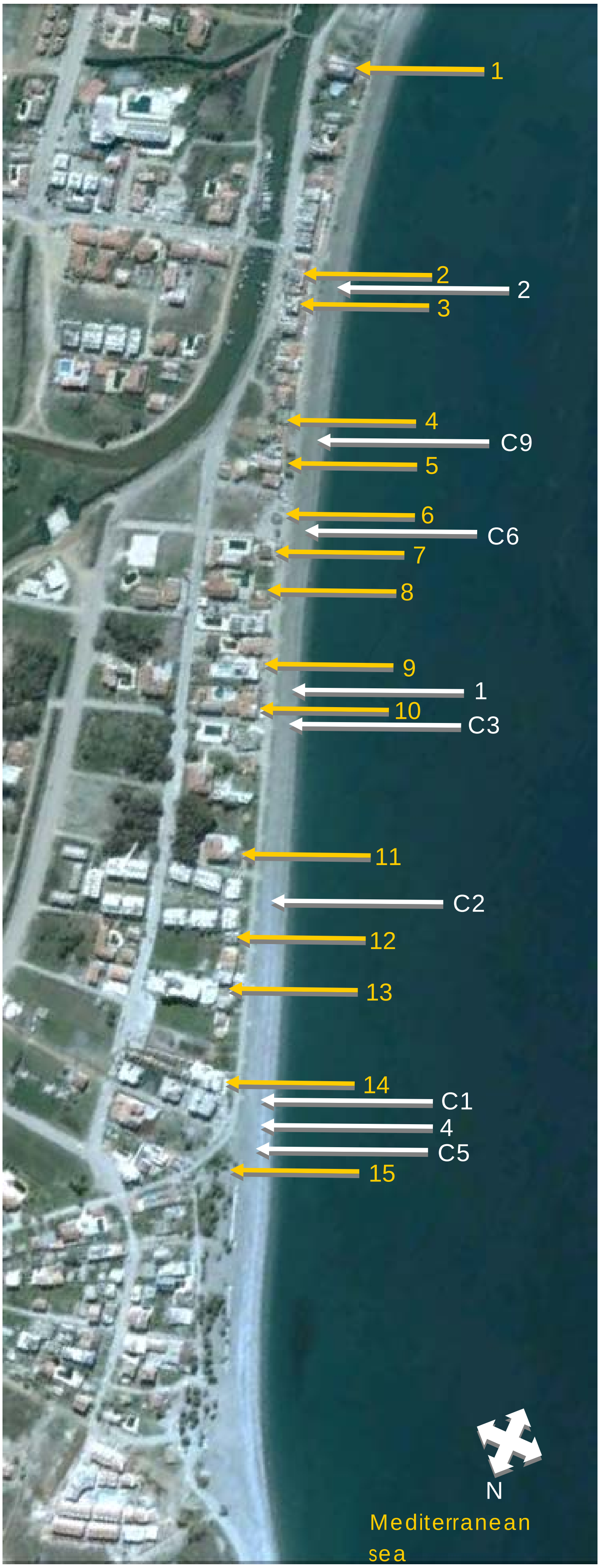
Tab. 1: Overview of all nests on Çaliş Beach 2009. The distance to the sea of nest number 1 is the measurement after the hatchery. "/" no data
Tab. 1: Überblick über alle Nester am Strand von Çaliş 2009. Die Angabe zur „distance to the sea“ von Nest Nummer 1 entspricht der Messung nach der Verlegung des Nestes.“/“ keine Daten vorhanden.

Nest Nr.	Track Number	Nesting Date 2009	Distance to the sea	Dry zone	Moist zone	Wet Zone	Distance to promenade
1	8	09.07	14.40m	9.50m	3.00m	1.90m	4.02m
2	9	10.07	12.26m	/	/	/	7.56m
3	11	14.07	12.70m	7.90m	4.70m	1.10m	No wall
4	12	06.08	25.10m	22.20m	1.90m	1.00m	No wall
C1	/	/	17.10m	/	/	/	8.83m
C2	/	/	12.45m	/	/	/	13.37m
C3	/	/	19.70m	/	/	/	3.00m
C4	/	21.06	21.00m	18.60m	1.10m	1.30m	No wall
C5	/	/	24.00m	/	/	2.30m	4.30m
C6	/	/	15.80m	11.90m	1.10m	2.80m	3.33m
C7	/	/	23.90m	/	/	/	No wall
C8	/	/	/	/	/	/	No wall
C9	/	/	11.71m	/	/	/	5.77m
C10	/	/	25.00m	20.20m	3.70m	1.10m	No wall
C11	/	/	23.50m	17.21m	4.59m	1.70m	No wall

The exact nesting date is known only for nests where the adult turtle or its track was observed in the night or in the morning shift. The nesting date of C4 was provided by a bar owner, who observed the turtle depositing her eggs 13 days before the start of this project.
The average distance of the nests to the sea at sites where the promenade was present was 15.92m, and the average distance to the promenade was 6.27m. The average distance to the sea when no promenade was present was 21.86m.
Nest number 1 was found very close to the sea (4.76m) and ran the risk of being flooded, so a hatchery was made. A self-made egg chamber was excavated, approximately the same depth as the original one, and the eggs were transferred from the original nest soon after they had been laid. The new distance to the sea was then 14.40m (Tab.1). Nest number 3 was disturbed

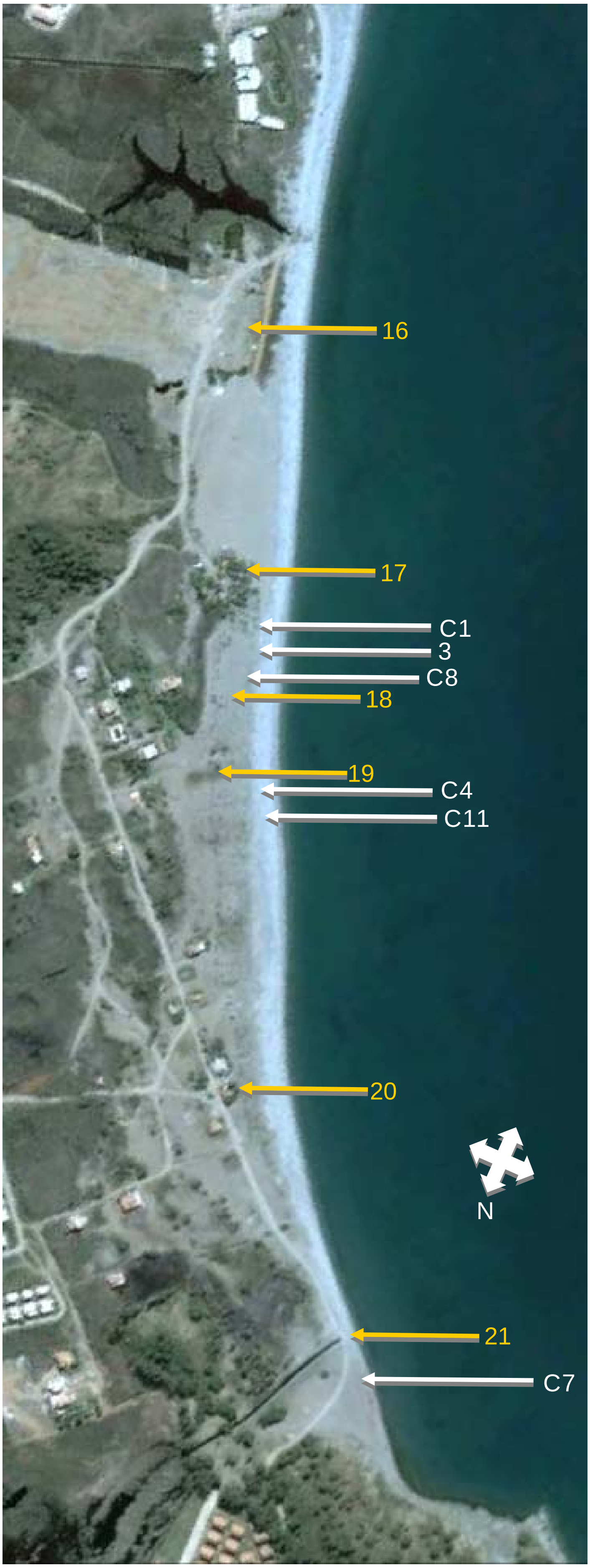
several times. Once a tractor ran over it, and a few days later the nest was opened and some eggs removed (human influence suspected). Nest number 4 was not immediately found. During the night shift the track of the adult turtle was found. The "shish" was used in an attempt to determine the position of a possible nest. Because no nest was found it was assumed that the emergence was unsuccessful, but a few weeks later tracks of hatchlings were found at this position. We therefore concluded that there actually was a nest. Even though many hatchling tracks were observed during the morning shift, it was not possible to locate nest number C8. The nest was located in the middle of a beach bar and the owner watered and swept the sand every night. This blurred the tracks and hindered, determining the exact position of the nest. The position of the nest in Fig. 4b is the position of the tracks found.

Figures 4a and 4b show the distribution of the nests along the beach of Calis. For better orientation and location of the nests, hotels and bars were used as landmarks and are also plotted in the plan (Fig. 4a and 4b). The promenade ends at Baracuda bar. As shown in the figure, the nests were not evenly distributed on the beach. Since the used map is several years old, many new touristic facilities (e.g. Sunset apartments) are not pictured. The lower part of the beach (Fig. 4b) is much more developed for tourism now than it was a few years ago.



1 Hotel Mutlu
2 Delta Hotel
3 Orient Express
4 Serkul Hotel
5 Hotel Idee
6 Mado Ice Cream
7 Lighthouse
8 Area Hotel
9 Çaliş Beach
10 Info Desk
11 Hotel Ceren
12 Turkuaz Market
13 Dolphin Hotel
14 Letoon Hotel
15 Barracuda Bar (Kum City Bar)

Fig. 4a: Location of nests (white labels) on Çaliş beach 2009
Fig. 4a: Lage der Nester am Strand von Çaliş 2009



16	Sunset Beach Club
17	Surf Cafe
18	Sunset Garden Beach Club
19	The Sand`s Beach Bar
20	Birlik Restaurant
21	Drainage

Fig. 4b: Location of nests (white labels) on Çaliş beach 2009
Fig. 4b: Lage der Nester am Strand von Çaliş 2009

Examining the development of the number of nests over the last 15 years reverts a decreasing trend (Fig. 5). The nest numbers did not decrease constantly, however, but there were intermittent peaks in several years, for example in 2004, with 15 more nests than either 2003 or 2005.

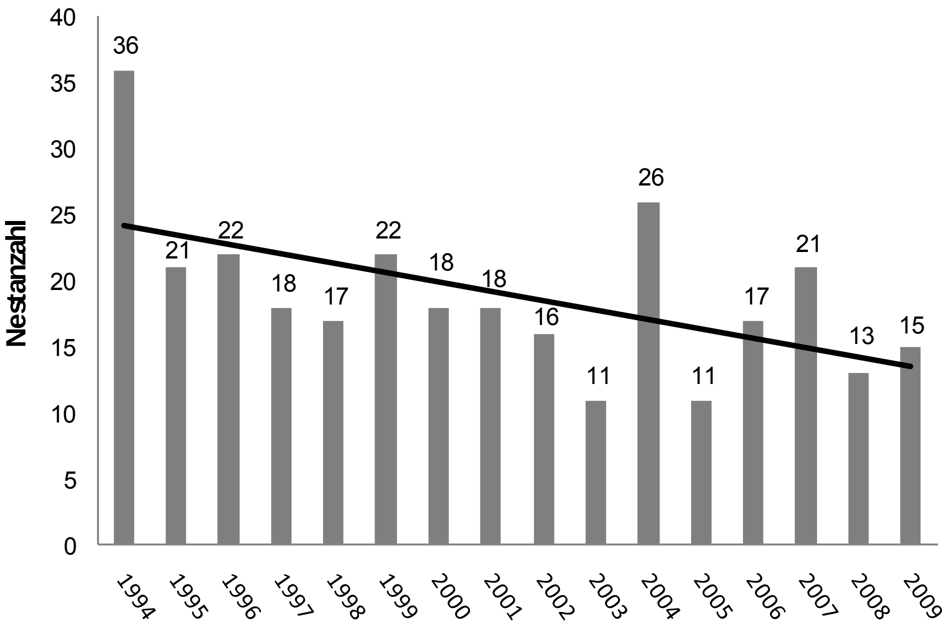


Fig. 5: Number of nests on Çaliş Beach 1994 – 2009. Nest trend is shown by the decreasing trend line. Trend line was determined statistically (Olbrich & Pfabigan, 2008)
Fig. 5: Nestanzahl am Strand von Çaliş 1994 – 2009. Die Trendlinie weist auf eine stete Abnahme der Nestzahl in den letzten 15 Jahren hin. Trendlinie wurde statistisch ermittelt (Olbrich & Pfabigan, 2008)

Tracks

In total, 12 tracks were found on Çaliş beach. Four of them represented successful emergences; seven of the tracks showed one or more body pits. The measurements are shown in Tab. 2. The first four tracks could not be measured exactly because only troughs remained in the beach the tracks were too old to be measured. The “shish” was used to check the troughs for nests.

The average track length, which can be used as one indicator for the level of disturbance of the turtle or the quality of the beach sand, was 39.53m. One assumption is that the longer the track, the smaller the disturbance. Conversely, however, the longer the tracks (and the more body pits dug) the poorer the sand quality. The maximum distance to the sea was 41.50m, but this was as an exceptional case. Only 33.3% (4 nests in 12 tracks) of the observed tracks where associated with successful nesting. The low distance to the sea of track number 8 was the reason for the hatchery for nest nr.1. (Tab. 2.)

Tab. 2: Adult tracks on Çaliş beach 2009. "/" no data.
Tab. 2: Spuren adulter Schildkröten Çaliş 2009. "/" keine Angaben.

Track Nr.	Track Date (2009)	Distance to the sea [m]	Total length of track [m]	Track width [m]	Number of body-pits	Success (Nest Nr.)
1	30.06	8.80	Not visible	/	1	No
2	June	9.40	Not visible	/	2	No
3	June	19.60	Not visible	/	2	No
4	June	29.20	Not visible	/	3	No
5	05.07	21.30	42.60	0.72	0	No
6	05.07	16.00	37.50	0.70	2	No
7	05.07	41.50	105.50	0.57	9	No
8	09.07	4.76	9.10	/	0	Yes: 1
9	10.07	12.26	26.09	0.77	0	Yes: 2
10	11.07	5.70	7.4	0.50	0	No
11	14.07	12.70	28.80	0.68	1	Yes: 3
12	06.08	25.10	59.30	0.60	2	Yes: 4

Adults

Out of the four regular nests that were found, two were identified only due to the tracks found the next morning. In the other two cases, the turtle was observed during nesting. Unfortunately, it was only possible to measure one of the turtles because of an incident with a reporter-team (nest nr. 2) (see report in this volume). The following data of the turtle was obtained (track nr. 8, nest nr. 1):

Tab. 3: Measurements of the adult turtle on 09.07.2009; SCL straight carapace length, SCW, straight carapace width, CCL curved carapace length, CCW curved carapace width.
Tab. 3: Die Maße der adulten Schildkröte vom 09.07.2009; SCL gerade Carapaxlänge, SCW gerade Carapaxbreite, CCL gekurvte Carapaxlänge, CCW gekurvte Carapaxbreite.

SCL	67.5 cm
SCW	48 cm
CCL	76 cm
CCW	67 cm
Tag Nr.	TR 804 (right side)

The turtle built the nest on 9.07.2009 at 01.15 am. Very few epibionts and a slight deformation on the carapace were observed. The tag number indicates that it had been tagged in Turkey (TR).

DISCUSSION

In the monitoring season 2009, 15 nests were laid at Çaliş beach, twelve tracks were found and 2 adults were observed. Compared to 2008 data, two more nests were recorded. Going further back in time, the nest data of the last 15 years in Çaliş shows a decreasing trend in the number of nests. If this trend continues despite all conservation efforts, then there may well be no more nests at Çaliş beach by the year 2030.

Eleven out of 15 nests were laid in June, according to backcalculations from the respective hatching date. The laying of these so called secret nests was observed neither by members of the Vienna team nor by the Turkish team because the observation period did not start until late June. The problem of secret nests can be illustrated based on nest C8, which was built in the midst of a beach bar. Although some hatchling tracks were found, the exact position of the nest was never located and many hatchlings may not have been able to reach the sea. Furthermore, nests that are not detected until the hatchlings hatch are difficult or nearly impossible to protect from human or other influences. Secret nests C7, C10 and C11 were laid at unsuitable sites. Larger stones blocked the opening of the egg chamber, we removed these in order to improve the conditions for the hatchlings. In order to guarantee a more complete data collection as well as an improved protection of the nesting turtles, the observation period in the coming years should be extended to the whole month of June if possible.

During the period of this project (July - September), only two adult females were observed on the beach of Çaliş. The other nests were, as mentioned above, laid in June. The first female was observed and measured on 9 July; she was tagged and her nesting attempt proved to be successful. We assume that this turtle was disturbed during the nesting process either by light and noise or people on the beach because, with a total track length of 9.1 m and a nest distance to the sea of 4.76 m, it was the shortest documented track of this season. This nest was too close to the waterline and a hatchery was dug to protect the eggs from becoming inundated. The second female was observed on 10 July. In spite of strong disturbance caused by a local reporter team and curious spectators, the turtle was able to complete her nesting. The nest distance to the sea (12.26 m) was near the average, but further measurements of body size etc. by our team were impeded by the reporter team.

Only in 4 of the observed 12 tracks could a successful nesting be documented. The reasons for this low success rate could either be direct human interference (especially near the promenade), obstacles on the beach like sun beds, cushions or boats, disturbance by artificial light or noise, but also unsuitable substrate. As shown in Figure 4a and 4b, some sections

along the beach contained no nests this year: The picnic area, for example, a popular place among locals for night swims and beach barbecues, but also the beach area in front of Barracuda Bar and Sunset Beach Club are such beach sections. In these areas a correlation between the extent of disturbance and the absence of turtles and nests can be assumed.
Figure 4a shows that nearly half of the observed beach of Çaliş is narrowed by an intensively illuminated and crowded promenade. We assume that the disturbance by the presence of the promenade could be a reason for the lower average distance to the sea of nests situated along the promenade wall (15.92m) compared to nests in areas not influenced by the promenade wall (21.86m). On beach sections without a promenade, nests were on average about 6m further inland. Nonetheless, nine nests were laid along the promenade wall, and only 6 nests in the remaining beach area. This may reflect the quality of this pure sand stretch compared with the stonier other stretches. Another possible reason why the nests along the promenade were closer to the sea than the nests along the other beach sections might again be the composition of the substrate. The substrate in the area of the promenade mainly consists of loose, fine-grained and mostly dry sand and the access to the beach is level, whereas in other areas of the beach the substrate is more coarse-grained and compact with many larger stones. In these areas, the access is steeper and the turtle has to wander further inland to find a suitable nesting site.

The nesting situation for *Caretta caretta* in Çaliş beach is not ideal. Gathering more information about the nesting behavior of sea turtles by observating and data collection is essential for a sustainable conservation and protection of this key species. In this process, the information provided by and a cooperation with the public is indispensable. During this project we recognized, that the awareness of tourists, but also of locals, regarding sea turtles is poor in most cases. Acts of irresponsibility when encountering a turtle and reckless behavior on the beach can be attributed to this lack of awareness. This situation can partially be explained by the presence of only one old rusty and therefore unreadable sign at one end of the promenade, declaring the area as a “Special protected area”. Even though the Austrian team ran an information desk on the promenade, much more information should be provided to tourists and locals year round. In order to guarantee a comprehensive protection of the sea turtles, the awareness of tourists and locals for the importance of the species in the local and global ecosystem must be raised. This study demonstrates the urgency of further protection of *Caretta caretta* on the beach of Çaliş. Without this project there would be little to prevent an even faster population decline.

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Nesting activity of the Loggerhead Sea Turtle, *Caretta Caretta,* on the beaches Yaniklar and Akgöl at the Turkish Mediterranean coast, 2009

Iwona Lamaszewska and Martin Wittner

KURZFASSUNG

Der Strand von Fethiye stellt einen der wichtigsten Nistplätze von *Caretta caretta* in der Türkei dar. Seit 1994 arbeiten österreichische und türkische daran, Daten über das Nistverhalten der Unechten Karettschildkröte in Fethiye zu sammeln. Heuer wurden die Daten von 16. Juni bis 19. September aufgezeichnet. Die beiden von uns beobachteten Strandabschnitte Akgöl und Yaniklar weisen eine Gesamtlänge von 5,8km auf. Obwohl Fethiye 1988 als Specially Protected Area (geschütztes Gebiet) ausgewiesen wurde, wird die Situation für Unechte Karettschildkröten immer prekärer. Während der Nachtschichten wurden elf adulte Schildkröten vermessen, wobei sieben davon auch markiert wurden. Die während der Morgenschichten gesammelten Daten geben Auskunft über die Form und Länge der tracks (Schildkrötenspuren), Anzahl der bodypits (Körpermulden) und Nester. Während des Beobachtungszeitraumes wurden insgesamt 213 Spuren vermessen, dabei wurden durchschnittlich 2,33 bodypits pro track gezählt. Insgesamt wurden 77 Nester gelegt, was einen Zuwachs von 18% gegenüber dem Vorjahreswert (65 Nester) darstellt. Mehr als die Hälfte (41 Nester) der Gesamtmenge (77 Nester) wurde bereits vor Beginn der Beobachtungen gelegt. Trotzdem nimmt dem linearen Trend zufolge die Gesamtanzahl der Nester seit Beginn der Aufzeichnungen (1994) ab. Potentielle Gründe hierfür liegen in der Meeresverschmutzung, in der Fischerei und im modernen Tourismus, zum Beispiel Licht- und Lärmverschmutzung, nächtliche Strandbesucher und Stranderosion.

ABSTRACT

Fethiye beach represents one of the most important nesting sites of *Caretta caretta* in Turkey. Since 1994 students from Austria and Turkey have been collecting data on the nesting activity of loggerhead turtles in Fethiye. This year’s data were collected from 16 June to 19 September. The observed two beaches Akgöl and Yaniklar have a total length of 5.8 km. Even though Fethiye was designated a Specially Protected Area in 1988, the situation for

loggerheads is getting worse. On the nightshifts, eleven adults were measured and seven of them were tagged. The data collected on morning shifts show the number and shape of the tracks, bodypits and nests. During the observation time, 213 tracks were recorded. On average a turtle dug 2.33 bodypits per track. In total we had 77 nests, which is a plus of 18% compared to 2008 (65 nests). More than the half (41 nests) of the total amount of 77 nests were laid before the observations started. The number of nests shows a decreasing trend over the years, probably reflections of marine pollution, fishery bycatch and modern tourism (e.g. light and noise pollution, human presence at night, beach erosion).

INTRODUCTION

The loggerhead turtle is the most abundant sea turtle species in the Mediterranean. The main nesting concentrations are found in Cyprus, Greece and Turkey. The average annual number of loggerhead nests throughout the Mediterranean is 5031, of which 27.2% (1366 nests per season) are in Turkey (Margaritoulis et al., 2003). According to nest numbers and nest densities among the Turkish nesting beaches, Fethiye Beach represents one of the most important nesting sites of loggerhead turtles (Turkozan, 2000 & Canbolat, 2004 in Özdemir et al, 2008). In the Mediterranean, loggerheads emerge primarily on beaches fronted by mostly sandy areas (Le Vin at al., 1998 in Miller et al., 2003). Yaniklar and Akgöl are two such sandy beaches, which attract adult female loggerheads as well as tourists. Even though Fethiye beach was designated a Specially Protected Area in 1988 (Özdemir et al., 2008), this status does not seem to be acted on. Signs have been put up to inform tourists and local residents about the rules and regulations that have to be followed while using the beach, but most of them are either fallen over, destroyed or placed at remote parts of Yaniklar (Fig.4). Additionally there are two big hotel complexes on the protected beach of Fethiye - Club Tuana and Lykia Botanica. Adult females are sensitive to disturbance while approaching the beach, and rapidly turn and swim away if they feel threatened (Dodd, 1988). The main anthropogenic threats affecting loggerhead nesting areas include vehicular and pedestrian traffic, human presence at night, beachfront lighting and noise, uncontrolled development and construction, beach furniture, sand extraction, beach erosion, beach pollution, marine pollution, planting of vegetation, boat strikes, near-shore fishing, and use of underwater explosives (Margaritoulis et al., 2003). The result in Fethiye has been a decreasing number of nests since 1994.

MATERIAL AND METHODS

At the beaches of Akgöl and Yaniklar, beach surveys and data-collection have been undertaken by Austrian students from the University of Vienna in collaboration with two Turkish professors and several Turkish students from 27 June to 19 September 2009. Additionally, we also used data starting from 16 June 2009 collected by our Turkish colleagues. Teams of 2-3 students and one professor were formed to monitor each beach (Yaniklar and Akgöl) at night and in the morning. The beach of Yaniklar is 4.8 km long and therefore called "long way", while the beach of Akgöl with a length of approximately 1km is called "short way". In the beginning of the season every survey was accompanied by one professor.

Night shifts

Yaniklar beach was surveyed every night from 27 June until 15 July 2009. Additionally we made night surveys on Akgöl beach several times, but we never encountered a sea turtle there and no data was collected. Because hatchlings are hardly visible in the darkness, night shifts stopped when the first nest hatched (16 July).

Night shifts started at 11 o'clock and took 2-4 hours, depending on the number of female turtles encountered and the duration of their nesting activity. Typically, loggerheads require between one and two hours to complete the nesting process (Hirth, 1980 in Miller et al., 2003). During the night the beach was walked from our campsite, Doga Camping, to a certain landmark, known as "lonely tree", which is located mid way along Yaniklar beach (Fig. 7). For a more efficient monitoring, we spread out in a transverse line across the beach: one of us walked next to the waterline, another one along the cobble zone, and the third one close to the vegetation line. Because of the darkness (often the moon was the only source of light) and the loudness of the waves, recognizing an adult female demanded much attention. When we encountered a turtle, we stayed and watched her while she searched for a nesting place and laid her eggs (Fig. 6). During all of her activities, e.g. "emerging from the surf, ascending the beach, excavating the body pit, digging the egg chamber, oviposition, filling in the egg chamber, filling the body pit, and returning to the sea" (Miller et al., 2003), we stayed close to the ground and several meters away to keep out of her field of vision. After she nested and camouflaged the nest, we measured the turtle's curved carapace length and width with a tape measure and her straight carapace length and width with a wooden sliding caliper (Fig. 10). Torches were used only to read the values, taking care to keep the light outside the female's field of vision. In a further step we checked the female's front flippers for a tag and recorded the tag number. If no tag was present we tagged her. The metal tags show a combination of letters and numbers (e.g. TR 805) and an address to which the tag should be sent if discovered. In total, 7 female turtles were tagged this year. Tagging helps get more information about sea turtles, e.g. nesting habits, migration, population dynamics, behavior and range. In a final step we checked the turtle for injuries or other anomalies and the carapace for any epibionts.

Morning shifts

For surveying the beach in the morning two teams of Austrian and Turkish students, led by one professor, were formed. One team walked the Akgöl beach and the other one Yaniklar beach including the "Small beach". The "small beach" is an about 150 meters long beach section, which is separated from Yaniklar beach through a cliff. Surveys normally began around 6 a.m. and involved walking the length of the beach looking for signs of nesting activity (Newbury et al., 2002) (Fig. 9). Again we formed a transverse line for a better efficiency: one of us walked next to the waterline, another one along the cobble zone, and the third one close to the vegetation line. Tracks early in the morning indicated the emergence of mature females from the sea as well as, later in the season, the emergence of hatchlings from nests (Margaritoulis, 2005). With a 30 or 50m long measuring tape we recorded the following parameters of an adult female's track: total track length, track width, number of body pits, distance to the sea (either from the nest, or from the farthest body pit from the sea, or from the farthest spot of the track to the sea). All of this information was written into our "survey book". Additionally, we drew an outline of the shape of the track and marked the sketched bodypits and nests with different symbols. After all data had been recorded, the tracks and other nesting signs such as body pit escarpments were smoothed over to prevent predators from recognizing visual nesting clues and to avoid recounting the same tracks on the following day (Newbury et al., 2002).

Measuring and marking nests

For locating the exact position of the nest, we used a metal rod (Turkish: "Şiş"). We carefully pushed this metal rod through the sand below the last body pit. When the metal rod sank easily into the sand upon reaching the depth of the egg chamber, a nest was detected. We marked the nest with a semicircle of cobbles and numbered the nest (Fig. 5). With a black marker pen we wrote the numbers onto 3 stones: one stone visibly and two upsidedown. We numbered the nests consecutively for a better differentiation and further for a age-related ranking of the nests. We measured the nest's distance to the sea and differentiated the wet, moist and dry zones of this distance. Further, we took location measurements to at least two distinctive beach features (Newbury et al., 2002). In addition we used a Geographical Positioning System (GPS). The nests were marked to allow for re-location at a later date (Newbury et al., 2002). Especially at Akgöl, recording the exact position was very important because often the cobble-semicircle was moved or removed by beach-visitors.

Secret nests

So-called secret nests are nests that were laid before the Austrian team arrived (27 June). Our Turkish colleagues found them without knowledge of the date on which they were laid. Also nests that were not been detected until they started to hatch are termed secret nests. These nests have their own consecutive numbering and additionally were designated with an "A" or a "Y", depending on whether they were laid on Akgöl or on Yaniklar beach.

Hatcheries

If nests were laid at unsuitable sites (e.g. nest too close to the wet zone, nesting on cobble zone), we had to relocate them to a safer area. For this purpose we had to open the nest after the regular morning shift and remove the eggs from the nest. The removed eggs were put into a bucket and transported to a new site. We dug a new nest ("hatchery"), where we placed the eggs in about the same order in a hole having the same depth and width as the original nest (except for nests that had not been deep enough). Then we closed the nest, marked it as usual with a semicircle of cobbles, and marked the nest with an "H" for hatchery and a number. Again we used separate, consecutive numbering for all hatcheries. Finally we recorded the exact position of the nest.

RESULTS

Nests

During the 2009 nesting season, 77 nests were recorded at the beaches of Yaniklar and Akgöl. This is an increase of 18% compared with 2008 (65 nests). 39 out of 77 are so-called "secret nests", which means that they were laid before we arrived in Turkey (27. June) and were later discovered by finding hatchling tracks. Figure 1 shows the number of all nests at Akgöl and Yaniklar.

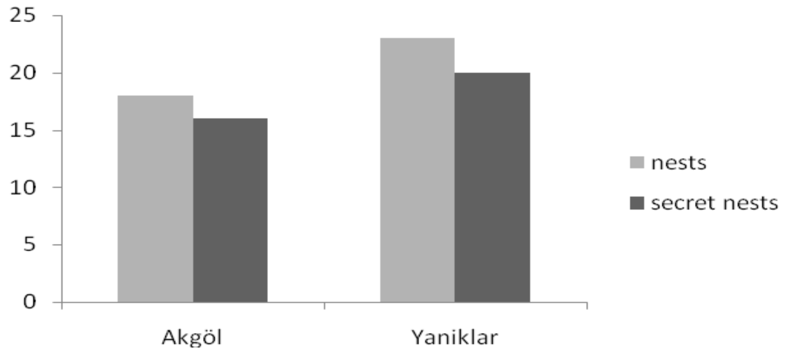


Fig. 1: Nests and “secret nests“– a comparison
Abb. 1: Nester und „geheime Nester“ – im Vergleich

More than half (41 nests) of the 77 nests where laid before our arrival (Fig. 2). The week with the highest nesting activity was from 7.7.09 to 21.7.09 (11 nests).

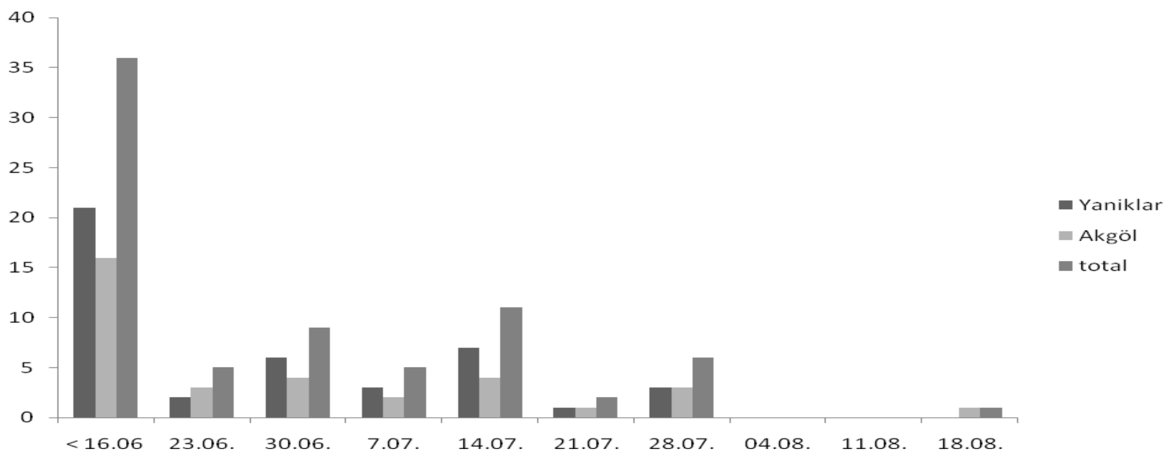


Fig. 2: Nesting activity depending on date
Abb. 2: Datumsbezogene Nistaktivität

In Akgöl we missed 47%, in Yaniklar 53% of all nests, which means that only every second nest was found before hatchling time. Akgöl and Yaniklar nearly show the same percentage, although the beach of Yaniklar is almost 5 times longer than Akgöl beach. In the section called “small beach“, one “secret nest“ and one regular nest was found, but this section is considered to be a part of Yaniklar beach so it is included in the Yaniklar data (Fig. 1). All regular nests (A1-A18, Y1-Y22, S1) were laid between 31.5.09 and 12.8.09, all other nesting dates (AS1-AS16, YS1-YS19, SS1) are unknown. The comparison between laid nests and unsuccessful emergences revealed that an adult female had to come out 3.03 times in Akgöl and 2.56 times in Yaniklar to lay one nest (Fig. 3).

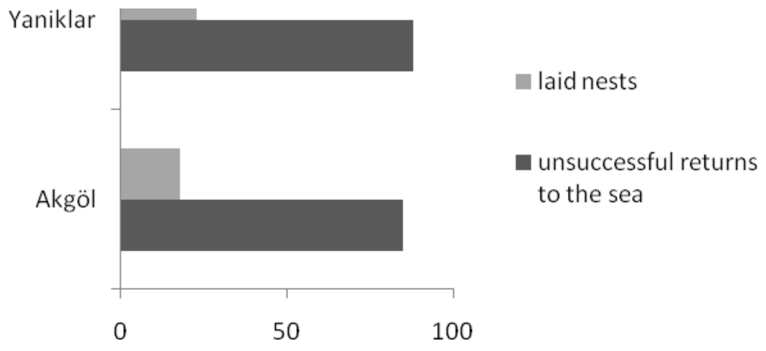


Fig. 3: Comparison of laid nests and unsuccessful emergences
Abb. 3: Vergleich der Nestanzahl und der erfolglosen Landgänge

In Akgöl the average distance from the nest to the sea (Fig. 4) was 19m and in Yaniklar 20.1m. The shortest distance (5.5m) was in Akgöl (NestNr. AS7), the maximum distance was 84.3m and also in Akgöl (NestNr. A6, Akgöl). On this beach one hatchery was made because the nest was laid too close to the water line (NestNr. A9H1, Akgöl). We also had to turn another nest in Yaniklar into a hatchery because the nest was laid exactly on the path and the risk of compact the sand was too high (NestNr. Y9H1, Yaniklar).

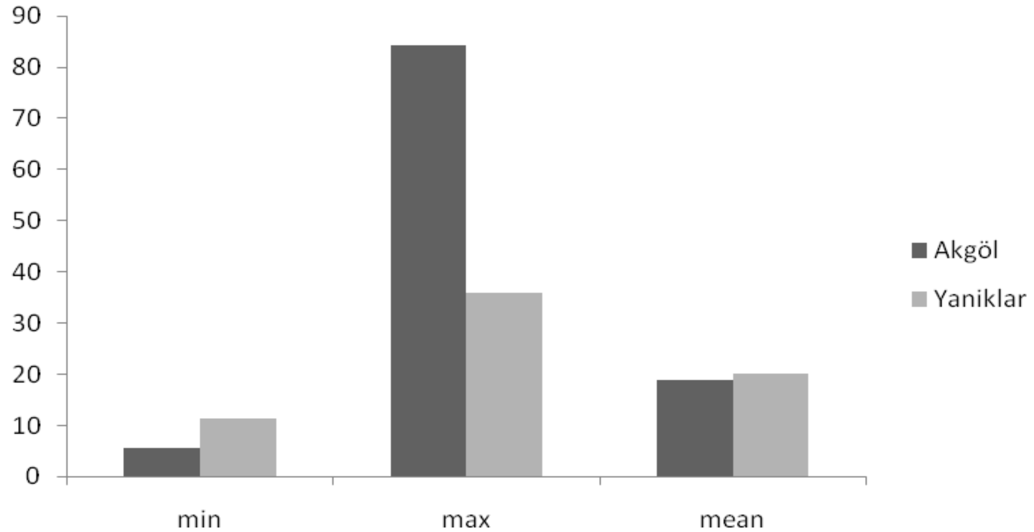
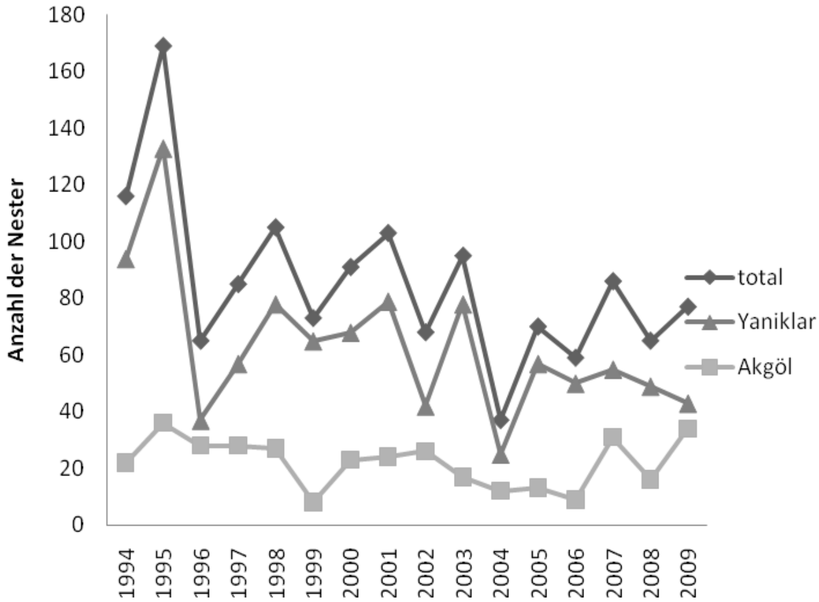


Fig. 4: Nest distance to the waterline
Abb. 4: Nestentfernung von der Wasserlinie

An overview of the last 15 years of recorded nesting data in Akgöl and Yaniklar shows that the total number of nests is still decreasing, although we had 12 nests more than last year (Tab. 1).

year	Yaniklar	Akgöl	**total**
1994	94	22	**116**
1995	133	36	**169**
1996	37	28	**65**
1997	57	28	**85**
1998	78	27	**105**
1999	65	8	**73**
2000	68	23	**91**
2001	79	24	**103**
2002	42	26	**68**
2003	78	17	**95**
2004	25	12	**37**
2005	57	13	**70**
2006	50	9	**59**
2007	55	31	**86**
2008	49	16	**65**
2009	43	34	**77**



Tab.1: Abstract of numbers of nests from 1994 - 2009
Tab.1: Übersicht der Anzahl der Nester 1994 - 2009

Tracks

In Akgöl (Tab.5) the shortest track measured 17.2m (TrackNr. 49), the longest 270m (TrackNr.77). The average track length in Akgöl was 57.66m. The shortest track in Yaniklar was 7.2m (TrackNr. 24) the two longest ones were both 105.2m (TrackNr. 43, 45). The average track length in Yaniklar (Tab.6) was 37.24m. Track widths ranged from 0.47m to 0.86m on both beaches and had an average value of 0.61m. The number of bodypits per track ranged from 0 to 21. In Akgöl we had 184 and in Yaniklar 171 bodypits in total. The average value was 2.33 bodypits per track.

Adults

In total we observed and measured 11 different individuals; two of them (TR2202, TR805) were seen twice. Seven of them were newly tagged by the Turkish professors. All observations were done at Yaniklar beach in Akgöl we have never encountered an emerging turtle. The average data for the straight measurements were 0.69m length and 0.53m width. The curved carapace measures were 0.81m length and 0.71m width. The individual with tag number TR805 had only 3 flippers. Although the left rear extremity was missing, she was able to lay a nest (Nr. Y21).

The raw data and the maps of the beaches of Akgöl and Yaniklar are presented in the attachment.

Tab. 2: Measurements of adult females (in meters), CCL curved carapace length, CCW curved carapace width, SCL straight carapace length, SCW straight carapace width, (new) = newly tagged, n.a. = data not available

Tab. 2: Maße der adulten Weibchen (in Meter), CCL gekurvte Carapaxlänge, CCW gekurvte Carapaxweite, SCL gerade Carapaxlänge, SCW gerade Carapaxweite, (new) = neu markiert, n.a. = keine Daten vorhanden

	date	tagged	SCL	SCW	CCL	CCW
Yaniklar	31.5.	TRC2202	0,60	0,47	0,73	0,65
Yaniklar	25.6.	TR824 (new)	0,72	0,54	0,67	0,55
Yaniklar	4.7.	TR804 (new)	0,64	0,54	0,76	0,66
Yaniklar	5.7.	TR803 (new)	0,72	0,56	0,76	0,70
Yaniklar	6.7.	TRC2202	0,66	0,46	0,79	0,62
Yaniklar	6.7.	TR805 (new)	0,68	0,56	0,76	0,71
Yaniklar	8.7.	TR805	n.a.	n.a.	n.a.	n.a.
Yaniklar	10.7.	no	0,67	0,48	0,76	0,61
Yaniklar	11.7.	TR808 (new)	0,65	0,50	0,67	0,61
Yaniklar	11.7.	no	0,79	0,59	0,85	0,76
Yaniklar	11.7.	no	0,69	0,53	0,71	0,64
Yaniklar	14.7.	TR806 (new)	0,74	0,54	0,78	0,71
Yaniklar	20.7.	TR811 (new)	0,69	0,53	0,73	0,68

DISCUSSION

Based on the nesting data of 2009 (77 nests) in Akgöl and Yaniklar, we had 18% more nesting activity in comparison to 2008 (65 nests). Since the earliest records (1994), strong fluctuations are evident in the number of nests every year. One explanation for this is the naturally fluctuation (Margaritoulis, 2005). Loggerheads lay eggs every 3-4 years, so this would help to explain the little peaks in the data every 3 years. The highest peak was in 1995 with 169 nests since that time, the number of nests shows a gradual, long-term downward trend. In 2004 we reached an all-time low of 37 nests. If we follow these fluctuations, next year should show a new peak. Hopefully we can report a higher number of *Caretta caretta* in Fethiye in 2010.

The potential reasons for the decreasing number of nests and turtles are marine pollution and modern tourism. One example is the plastic bags in the sea, which the turtles can confuse with jellyfish, which are a major food resource.

Also, the light and noise pollution from the hotels at the beach sites disturb the turtles while they search for nesting spots. The illegal removal of sand from the turtle beaches to the hotel areas to create new sandy beaches for the tourists is a negative impact as well. These developments make it hard for the turtles to find the right substrate to dig their egg-chambers. They prefer smooth, loose sand and dig 20 – 50cm deep in the sand.

In total we counted 213 tracks. Some of them were very long, up to 270m. These results show that the turtles had problems finding the right place to dig their egg-chambers. The beach surface condition at Akgöl and Yaniklar is mostly gravel substrate, where it is not possible to lay eggs. This forced the turtles to try again or to cross over the gravel to get to sandy grounds. An interesting aspect is that the Yaniklar beach is almost five times longer than Akgöl. But still there are only 7 unsuccessful emergences more in Yaniklar (Fig. 2). This could be a consequence of the light and noise pollution from the Tuana Hotel, which is noticeable all along Akgöl beach. On the Yaniklar side, after 800m, the beach turns into an inlet, where the light and noise pollution from the other Hotel (Lykia Botanika) is no longer evident. Dodd (1988) argues that loggerheads, before digging their nests remain for a short period of time in the shallow water and scan the beach carefully. The turtle is most sensitive to disturbance at this time and flees rapidly if threatened or if light or noise is present. On some sections of Yaniklar beach the initial beach slopes were very steep, up to 1m, which also causes problems for the turtles.

The turtles dig bodypits to determine the temperature and humidity of the sand and to choose the right place for the nest. We found many tracks without any bodypits and some tracks with 18 or 21. In total we counted 355 bodypits, which is an average of 2.33 per track.

As we never encountered a sea turtle on our night shifts in Akgöl, they must have always emerged after our night shift had finished. This situation is probably associated with the Tuana Hotel, because they turned off their lights and sound equipment at 2 am, which was after our nightshift.

We measured 12 individuals; two of them (TRC 2202, TR 805) were seen twice. TRC 2202 was the only turtle that was tagged in an earlier year. All others were newly tagged on the right front flipper by the Turkish professors. We observed 10 individuals in a period of 10 days, between 4.7. and 14.7., which are 84.6% of all contacts.

Concluding it seems important to integrate the emerged data with the extraneous causes into an overall picture to ensure protection and survival of *Caretta caretta* at the beaches of Akgöl and Yaniklar.

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Fig 5: Hatching nest at Akgöl beach
Abb. 5: Geschlüpfendes Nest am Strand von Akgöl
Photo: Carl-Phillip Kruspe

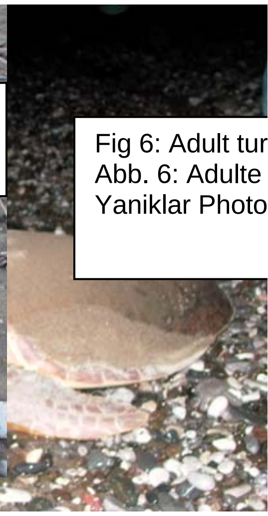

Fig 6: Adult tur
Abb. 6: Adulte
Yaniklar Photo

Fig 7: Yaniklar beach with "lonely tree"
Abb. 7: Strand von Yaniklar mit „lonely tree"
Photo: Iwona Lamaszewska

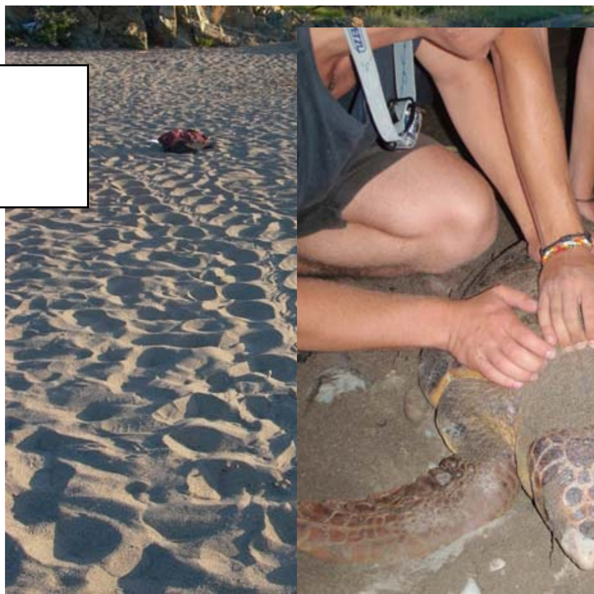

Fig 8: Rusty sign at a
Abb. 8: Rostiges Sch
Strandabschnitt Yani
Photo: Iwona Lamas

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Fig 10: Measuring an adult turtle at Yaniklar beach
Abb. 10: Vermessen einer adulten Schildkröte am Strand von Yaniklar
Photo: Iwona Lamaszwska

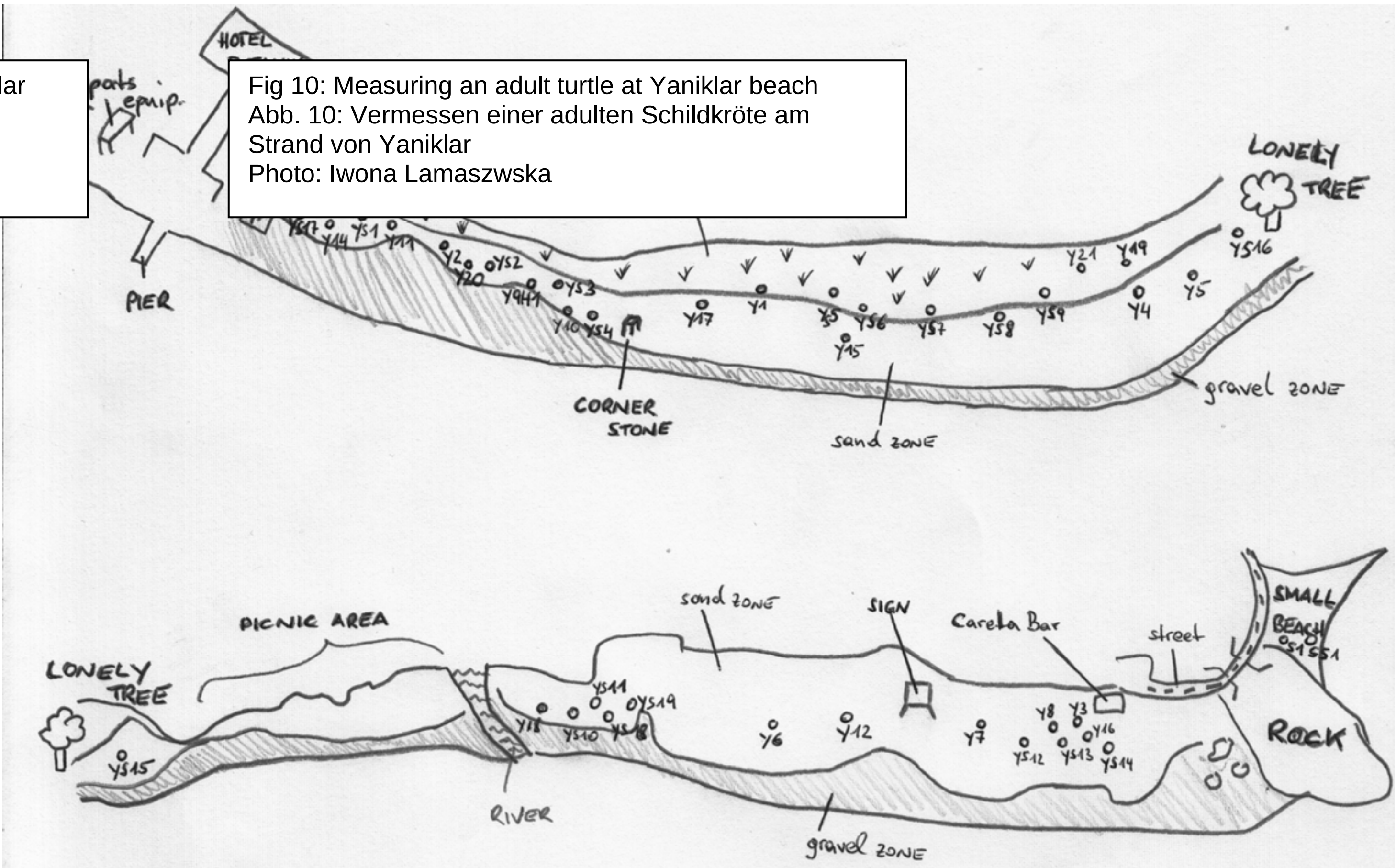

Fig 11: Nest-map of Yaniklar beach
Abb. 11: Nestkarte vom Strandabschnitt Yaniklar

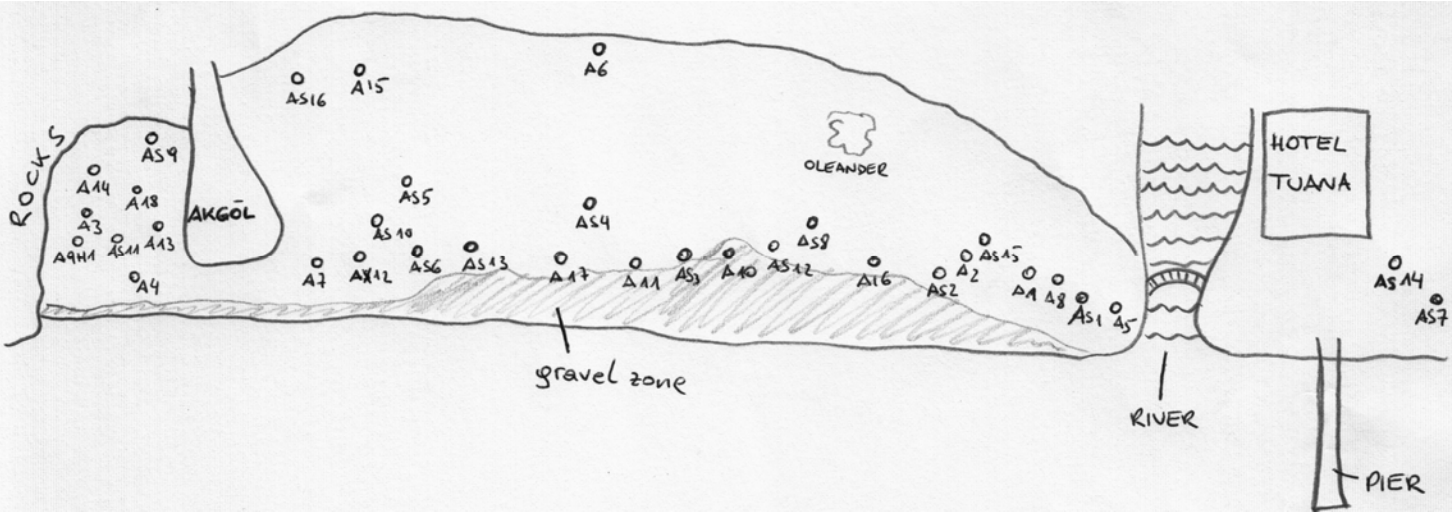

Fig 12: :Nest-map of Akgöl beach
Abb. 12: Nestkarte vom Strandabschnitt Akgöl

Tab.3: nesting data Akgöl (A = nest Akgöl, AS "secret nest" Akgöl, n.a. = data not available, * = hatchery).
Tab.3: Nestdaten Akgöl (A = Nest Akgöl, AS = “secret nest” Akgöl, n.a. = keine Daten vorhanden, *= Nest wurde verlegt).

			Nesting	Distanz zum Meer				Tracklänge	
Nr.	NestNr.	TrackNr.	Datum	dry (1)	moist (2)	wet (3)	total	(sichtbar)	Bodypits
1	A1	-	20.6.	n.a.	n.a.	n.a.	11,00	n.a.	n.a.
2	A2	-	22.6.	n.a.	n.a.	n.a.	11,10	n.a.	n.a.
3	A3	-	22.6.	n.a.	n.a.	n.a.	21,00	n.a.	n.a.
4	A4	-	27.6.	3,20	2,00	1,70	6,90	n.a.	n.a.
5	A5	27	28.6.	7,50	2,70	1,00	11,20	23,00	0
6	A6	31	28.6.	80,00	3,50	0,80	84,30	214,00	3
7	A7	35	29.6.	7,10	1,00	1,90	10,00	21,10	0
8	A8	49	4.7.	2,20	2,80	1,40	6,40	17,20	1
9	*A9H1	50	4.7.	14,00	1,00	1,30	16,30	18,20	0
10	A10	58	8.7.	7,00	2,00	2,00	11,00	33,30	0
11	A11	63	10.7.	3,60	6,70	2,60	12,90	32,70	1
12	A12	64	10.7.	4,15	3,60	2,50	10,25	31,60	0
13	A13	65	11.7.	14,90	1,80	3,00	18,70	44,90	2
14	A14	74	21.7.	18,80	1,00	2,50	22,30	50,00	5
15	A15	77	22.7.	52,40	3,10	2,10	57,60	270,00	18
16	A16	-	24.7.	3,60	2,10	1,80	7,50	n.a.	n.a.
17	A17	87	24.7.	4,40	3,60	2,20	10,20	22,80	1
18	A18	103	12.8.	16,50	1,90	1,10	19,50	71,50	8
19	AS1	-	?	n.a.	n.a.	n.a.	26,1	n.a.	n.a.
20	AS2	-	?	n.a.	n.a.	n.a.	9,8	n.a.	n.a.
21	AS3	-	?	n.a.	n.a.	n.a.	14,3	n.a.	n.a.
22	AS4	-	?	n.a.	n.a.	n.a.	36	n.a.	n.a.
23	AS5	-	?	n.a.	n.a.	n.a.	33	n.a.	n.a.

24	AS6	-	?	n.a.	n.a.	n.a.	11,2	n.a.	n.a.
25	AS7	-	?	n.a.	n.a.	n.a.	5,5	n.a.	n.a.
26	AS8	-	?	n.a.	n.a.	n.a.	15,5	n.a.	n.a.
27	AS9	-	?	28,8	1,3	0,5	30,6	n.a.	n.a.
28	AS10	-	?	16,8	2,8	0,8	20,4	n.a.	n.a.
29	AS11	-	?	n.a.	n.a.	n.a.	15,7	n.a.	n.a.
30	AS12	-	?	9	1,1	1,8	11,9	n.a.	n.a.
31	AS13	-	?	5,4	8,8	1	15,2	n.a.	n.a.
32	AS14	-	?	n.a.	n.a.	n.a.	21,8	n.a.	n.a.
33	AS15	-	?	n.a.	n.a.	n.a.	12,1	n.a.	n.a.
34	AS16	-	?	n.a.	n.a.	n.a.	53,2	n.a.	n.a.

Tab.4: nesting data Yaniklar (Y = nests Yaniklar, YS "secret nest" Yaniklar, S = Nest Small Beach, SS = "secret nest" Small Beach, n.a. = data not available, * = hatchery).

Tab.4: Nestdaten Yaniklar (Y = Nest Yaniklar, YS = "secret nest" Yaniklar, S = Nest Small Beach, SS = "secret nest" Small Beach, n.a. = keine Daten vorhanden, * = Nest wurde verlegt).

			Nesting	Distanz zum Meer				Tracklänge	
Nr.	NestNr.	TrackNr.	Datum	dry (1)	moist (2)	wet (3)	total	(sichtbar)	Bodypits
1	Y1	-	31.5.	n.a.	n.a.	n.a.	11,50	n.a.	n.a.
2	Y2	-	19.6.	n.a.	n.a.	n.a.	14,30	n.a.	n.a.
3	Y3	-	19.6.	n.a.	n.a.	n.a.	35,00	n.a.	n.a.
4	Y4	-	24.6.	n.a.	n.a.	n.a.	14,70	n.a.	n.a.
5	Y5	-	25.6.	n.a.	n.a.	n.a.	13,60	n.a.	n.a.
6	Y6	15	28.6.	23,30	2,95	1,35	27,60	60,70	0
7	Y7	30	30.6.	30,70	2,30	1,10	34,10	91,70	0
8	Y8	31	30.6.	30,90	2,40	0,80	34,10	70,90	0
9	*Y9H1	34	1.7.	10,00	0,90	0,80	11,70	42,30	3
10	Y10	-	1.7.	10,00	1,00	1,30	12,30	n.a.	1
11	Y11	-	3.7.	14,90	1,00	1,70	16,60	n.a.	2
12	Y12	67	10.7.	29,90	1,20	2,80	33,90	n.a.	2
13	Y13	-	11.7.	10,40	1,90	1,00	13,30	n.a.	n.a.
14	Y14	-	11.7.	13,00	4,60	1,50	19,10	n.a.	n.a.
15	Y15	72	11.7.	18,00	1,90	0,60	20,50	15,40	2
16	Y16	73	11.7.	24,20	3,00	1,10	28,30	58,80	2
17	Y17	75	11.7.	31,70	1,80	2,30	35,80	75,40	1
18	Y18	80	14.7.	14,00	1,40	0,60	15,00	n.a.	n.a.
19	Y19	-	16.7.	n.a.	n.a.	n.a.	18,50	n.a.	n.a.
20	Y20	92	22.7.	20,80	1,90	2,00	23,00	57,00	8

Nr.	NestNr.	TrackNr.	Nesting	Distanz zum Meer				Tracklänge	Bodypits
			Datum	dry(1)	moist(2)	wet(3)	total	(sichtbar)	
21	Y21	97	23.7.	7,60	2,90	0,90	11,40	27,00	1
22	Y22	99	23.7.	16,90	3,70	1,20	21,80	52,50	3
23	YS1	-	?	n.a.	n.a.	n.a.	15,30	n.a.	n.a.
24	YS2	-	?	n.a.	n.a.	n.a.	14,90	n.a.	n.a.
25	YS3	-	?	n.a.	n.a.	n.a.	14,80	n.a.	n.a.
26	YS4	-	?	n.a.	n.a.	n.a.	17,20	n.a.	n.a.
27	YS5	-	?	n.a.	n.a.	n.a.	21,00	n.a.	n.a.
28	YS6	-	?	n.a.	n.a.	n.a.	19,00	n.a.	n.a.
29	YS7	-	?	n.a.	n.a.	n.a.	12,00	n.a.	n.a.
30	YS8	-	?	n.a.	n.a.	n.a.	16,20	n.a.	n.a.
31	YS9	-	?	n.a.	n.a.	n.a.	13,00	n.a.	n.a.
32	YS10	-	?	n.a.	n.a.	n.a.	17,90	n.a.	n.a.
33	YS11	-	?	n.a.	n.a.	n.a.	15,40	n.a.	n.a.
34	YS12	-	?	n.a.	n.a.	n.a.	28,80	n.a.	n.a.
35	YS13	-	?	n.a.	n.a.	n.a.	31,20	n.a.	n.a.
36	YS14	-	?	n.a.	n.a.	n.a.	33,00	n.a.	n.a.
37	YS15	-	?	15,40	0,60	0,90	16,90	n.a.	n.a.
38	YS16	-	?	n.a.	n.a.	n.a.	12,90	n.a.	n.a.
39	YS17	-	?	13,60	2,50	1,50	17,60	n.a.	n.a.
40	YS18	-	?	18,20	2,10	1,50	21,80	n.a.	n.a.
41	YS19	-	?	n.a.	n.a.	n.a.	17,00	n.a.	n.a.
42	SS 1	87	?	17,20	2,80	1,00	21,00	n.a.	n.a.
43	S 1	16	28.6.	20,80	0,84	0,96	22,60	49,12	1

Tab.5: emergences in Akgöl (* = nest, n.a. = data not available, **bold** = measured as double distance to sea).
Tab.5: Landgänge in Akgöl (* = Nest vorhanden, n.a = keine Daten vorhanden, **fett** = doppelte Distanz zum Meer).

Nr.	Track Nr.	Datum 2009	Distanz zum Meer	Länge der Spur	Breite	BodyPits
1	1	17.6.	32,00	n.a.	n.a.	Yes
2	2	17.6.	12,00	n.a.	n.a.	Yes
3	3	17.6.	40,00	n.a.	n.a.	Yes
4	4	17.6.	100?	n.a.	n.a.	Yes
5	5	19.6.	7,70	n.a.	n.a.	No
6	6	19.6.	7,70	n.a.	n.a.	No
7	7	21.6.	50,00	n.a.	n.a.	Yes
8	8	21.6.	8,00	n.a.	n.a.	No

9	9	21.6.	25,00	n.a.	n.a.	Yes
10	10	21.6.	15,00	n.a.	n.a.	Yes
11	11	23.6.	8,40	n.a.	n.a.	Yes
12	12	26.6.	9,70	n.a.	n.a.	Yes
13	13	26.6.	9,00	n.a.	n.a.	No
14	14	26.6.	9,00	n.a.	n.a.	No
15	15	27.6.	9,38	**18,76**	n.a.	0
16	16	27.6.	25,55	58,01	0,54	4
17	17	27.6.	17,53	41,23	0,62	2
18	18	27.6.	46,20	157,60	0,58	6
19	19	27.6.	24,20	26,50	0,52	1
20	20	27.6.	24,00	51,80	0,62	1
21	21	27.6.	n.a.	n.a.	0,56	n.a.
22	22	27.6.	29,64	n.a.	n.a.	1
23	23	27.6.	46,80	n.a.	n.a.	2
24	24	27.6.	28,80	106,10	n.a.	3
25	25	27.6.	21,15	44,70	0,58	1
26	26	27.6.	31,50	**63,00**	0,56	n.a.
27	*27	28.6.	11,20	23,00	0,57	n.a.
28	28	28.6.	14,20	32,00	0,66	2
Nr.	Track Nr.	Datum 2009	Distanz zum Meer	Länge der Spur	Breite	Bodypits
29	29	28.6.	31,70	**63,40**	0,61	1
30	30	28.6.	17,00	37,90	0,60	1
31	31	28.6.	84,30	214,00	0,58	3
32	32	28.6.	25,20	62,60	0,51	1
33	33	29.6.	n.a.	n.a.	0,52	1
34	34	29.6.	37,20	78,85	0,52	1
35	*35	29.6.	10,00	21,10	0,58	0
36	36	30.6.	22,60	47,15	0,62	4
37	37	30.6.	14,00	29,10	0,60	0
38	38	30.6.	69,00	252,50	0,57	5
39	39	30.6.	42,50	153,76	0,56	14
40	40	1.7.	21,85	45,70	0,65	4
41	41	1.7.	33,00	81,40	0,54	2
42	42	1.7.	10,00	20,00	0,58	n.a.
43	43	3.7.	19,10	46,10	0,59	3
44	44	3.7.	22,11	44,82	0,50	3
45	45	3.7.	n.a.	n.a.	0,52	n.a.
46	46	3.7.	20,20	n.a.	0,54	n.a.
47	47	3.7.	22,10	61,50	0,60	3
48	48	3.7.	12,10	24,20	0,52	2
49	49	4.7.	8,60	17,20	0,62	1
50	50	4.7.	7,30	18,20	0,62	n.a.
51	51	4.7.	17,60	37,40	0,60	0

52	52	7.7.	13,10	**26,20**	0,58	n.a.
53	53	7.7.	33,50	73,10	0,59	n.a.
54	54	7.7.	15,00	31,50	0,73	2
55	55	8.7.	14,60	n.a.	0,58	n.a.
56	56	8.7.	40,80	n.a.	0,58	2
57	57	8.7.	63,90	157,80	0,60	4
58	*58	8.7.	11,00	33,30	0,52	n.a.
59	59	8.7.	57,00	138,00	0,51	3
60	60	10.7.	11,80	26,70	0,60	0
61	61	10.7.	13,80	31,00	0,59	0
62	62	10.7.	7,40	30,40	0,66	0
63	*63	10.7.	12,90	39,70	0,62	1
64	*64	10.7.	n.a.	31,60	0,60	0
65	*65	11.7.	19,70	44,90	0,60	2
66	66	12.7.	n.a.	n.a.	0,55	0
67	67	15.7.	24,00	53,60	0,73	7
68	68	17.7.	13,60	30,80	0,49	0
69	69	19.7.	12,20	26,20	0,60	2
70	70	19.7.	15,40	36,40	0,75	7
71	71	20.7.	7,50	n.a.	0,55	n.a.
72	72	20.7.	35,80	83,00	0,59	n.a.
Nr.	Track Nr.	Datum 2009	Distanz zum Meer	Länge der Spur	Breite	Bodypits
73	73	21.7.	38,00	167,00	0,62	21
74	*74	21.7.	22,30	50,00	0,62	5
75	75	22.7.	17,06	40,27	0,52	1
76	76	22.7.	20,30	58,10	0,56	0
77	*77	22.7.	57,60	270,00	0,64	18
78	78	23.7.	22,50	52,00	0,62	3
79	79	23.7.	13,20	**26,40**	0,56	2
80	80	23.7.	8,60	**17,20**	0,67	0
81	81	23.7.	14,50	33,00	0,56	0
82	82	23.7.	12,70	27,20	0,63	0
83	83	23.7.	20,00	26,40	0,60	1
84	84	24.7.	7,75	16,50	0,56	n.a.
85	85	24.7.	10,30	**20,60**	0,67	1
86	86	24.7.	14,80	33,40	0,64	1
87	*87	24.7.	10,20	22,80	0,64	1
88	88	25.7.	11,30	23,00	0,54	1
89	89	25.7.	15,20	32,10	0,64	1
90	90	25.7.	25,70	54,00	0,64	0
91	91	25.7.	11,10	23,20	0,67	0
92	92	27.7.	8,40	**16,80**	0,62	n.a.
93	93	31.7.	34,80	133,00	0,63	4
94	94	31.7.	22,00	67,50	0,63	3

95	95	31.7.	30,60	116,00	0,63	3
96	96	31.7.	11,30	22,30	0,63	1
97	97	1.8.	50,60	113,00	0,60	n.a.
98	98	6.8.	10,00	**20,00**	0,58	2
99	99	6.8.	12,70	24,40	0,58	1
100	100	6.8.	11,80	**23,60**	0,58	0
101	101	7.8.	10,60	22,30	0,47	1
102	102	7.8.	15,10	58,10	0,58	3
103	*103	12.8.	22,5	71,5	0,67	8

Tab.6: emergences in Yaniklar (* = nest, # = adult measured, n.a. = data not available, **bold** = measured as double distance to sea).
Tab.6: Landgänge in Yaniklar (* = Nest vorhanden, # = Adulte vermessen, n.a. = keine Daten vorhanden, fett = doppelte Distanz zum Meer).

Nr.	Track Nr.	Datum 2009	Distanz zum Meer	Länge der Spur	Breite	Bodypits
1	1	16.6.	14,2	n.a.	n.a.	yes
2	2	16.6.	16,1	n.a.	n.a.	yes
3	3	16.6.	16,5	n.a.	n.a.	no
4	4	16.6.	18,1	n.a.	n.a.	yes
5	5	16.6.	24,1	n.a.	n.a.	yes
6	6	17.6.	16,4	n.a.	n.a.	no
7	7	17.6.	23,5	n.a.	n.a.	yes
8	8	19.6.	11,9	n.a.	n.a.	yes
9	9	22.6.	8	n.a.	n.a.	no
10	10	22.6.	12	n.a.	n.a.	yes
11	11	22.6.	17	n.a.	n.a.	yes
12	12	22.6.	11,4	n.a.	n.a.	yes
13	13	24.6.	12	n.a.	n.a.	no
14	14	24.6.	15,5	n.a.	n.a.	yes
15	*15	28.6.	27,6	60,7	0,62	0
16	*16	28.6.	22,6	49,12	0,59	1
17	17	29.6.	12,65	**25,3**	0,62	n.a.

18	18	29.6.	17,6	36,7	0,62	n.a.
19	19	29.6.	4,8	**9,6**	n.a.	n.a.
20	20	29.6.	20,6	42,2	0,62	1
21	21	29.6.	13,5	29,5	0,55	2
22	22	29.6.	23,8	55,6	0,62	2
23	23	29.6.	7,5	42	0,6	n.a.
24	24	29.6.	3,6	**7,2**	n.a.	n.a.
25	25	30.6.	17,32	35,81	n.a.	1
26	26	30.6.	22,95	44,8	0,57	3
27	27	30.6.	n.a.	n.a.	0,49	0
28	28	30.6.	n.a.	21,5	0,49	0
29	29	30.6.	n.a.	n.a.	n.a.	n.a.
30	*30	30.6.	36,4	91,7	0,59	0
31	*31	30.6.	34,1	70,9	0,65	0
32	32	30.6.	n.a.	n.a.	0,58	n.a.
33	33	1.7.	9,7	**19,4**	0,53	0
34	*34	1.7.	14,6	42,3	0,58	3
35	35	1.7.	11,6	n.a.	n.a.	2
36	36	1.7.	24,6	n.a.	n.a.	6
37	37	2.7.	17,3	**34,6**	0,62	1
38	38	3.7.	15,2	n.a.	0,54	3
39	39	3.7.	14,6	n.a.	0,59	4
40	#40	5.7.	13,1	**26,2**	0,61	1

Nr.	Track Nr.	Datum 2009	Distanz zum Meer	Länger der Spur	Breite	Bodypits
41	41	5.7.	15	31,5	0,6	2
42	#42	6.7.	13,6	n.a.	0,59	1
43	#43	6.7.	28	105,2	0,65	8
44	44	6.7.	10	24,3	0,7	n.a.
45	45	6.7.	28	105,2	0,7	8
46	46	6.7.	7,2	**14,4**	n.a.	n.a.
47	47	6.7.	19,2	44,5	0,59	0
48	48	6.7.	7,7	**15,4**	0,55	1
49	49	6.7.	29,5	59,5	0,55	1
50	50	6.7.	27	57,3	n.a.	6
51	51	7.7.	16,4	38,9	0,65	5
52	52	7.7.	28,2	60,4	0,65	4
53	53	7.7.	24,6	62,4	0,59	9
54	#54	8.7.	16,4	38,2	0,65	4
55	55	8.7.	7	n.a.	n.a.	0
56	56	8.7.	8,1	n.a.	n.a.	0
57	57	9.7.	16,6	**33,2**	n.a.	1
58	58	9.7.	16,4	33,3	0,7	3
59	59	9.7.	23,2	58	0,71	5
60	60	9.7.	21,8	53,5	0,59	0

61	61	10.7.	12,3	21,8	0,6	1
62	62	10.7.	11,3	**22,6**	n.a.	1
63	63	10.7.	6,4	15,5	0,64	0
64	64	10.7.	6,8	**13,6**	0,64	0
65	65	10.7.	6	**12**	0,64	0
66	66	10.7.	15,3	52,8	0,73	5
67	*67	10.7.	33,9	n.a.	0,68	2
68	68	10.7.	11	**22**	0,68	0
69	69	11.7.	24,2	**48,4**	0,56	1
70	70	11.7.	22,2	46,5	0,68	1
71	71	11.7.	14,3	33,2	0,7	2
72	*72	11.7.	20,5	45,4	0,58	2
73	*73	11.7.	n.a.	58,8	n.a.	2
74	74	11.7.	49,8	94,2	0,62	1
75	75	11.7.	35,8	75,4	0,66	1
76	76	12.7.	17,7	35,4	0,56	1
77	77	12.7.	14,5	37	0,6	4
78	78	12.7.	8,2	18,6	0,78	0
79	79	13.7.	16,6	34	n.a.	3
80	*80	14.7.	16	n.a.	0,62	n.a.
81	81	15.7.	14,4	27,3	0,77	3
82	#82	20.7.	15,1	29,2	0,53	2
83	83	20.7.	20,2	37,1	0,64	2
84	84	21.7.	9,2	18,8	0,68	0
Nr.	Track Nr.	Datum 2009	Distanz zum Meer	Länge der Spur	Breite	Bodypits
85	85	21.7.	4,8	11	0,57	0
86	86	21.7.	16,18	34,1	0,6	3
87	87	21.7.	24,3	49	0,66	2
88	88	21.7.	34	79,3	0,59	3
89	89	21.7.	7,6	16,3	0,7	0
90	90	22.7.	21,7	46,1	0,65	4
91	91	22.7.	13,4	32	0,66	8
92	*92	22.7.	24,7	57	0,62	8
93	93	22.7.	6,5	14,6	0,62	0
94	94	22.7.	7	19	n.a.	2
95	95	23.7.	14	31,2	0,6	3
96	96	23.7.	12,7	28,7	n.a.	3
97	97	23.7.	12,5	27	n.a.	1
98	98	23.7.	6,3	13,86	0,59	0
99	*99	23.7.	21,8	52,5	0,67	3
100	100	23.7.	12,1	25,9	0,65	1
101	101	23.7.	8	24,5	0,65	3
102	102	23.7.	8	**16**	0,54	0
103	103	24.7.	10,1	n.a.	0,7	1

104	104	25.7.	12,7	26,3	0,6	1
105	105	25.7.	11,5	23	0,52	1
106	106	25.7.	10,1	**20,2**	0,66	1
107	107	25.7.	11,5	23,9	0,62	1
108	108	25.7.	4,2	**8,4**	0,86	0
109	109	27.7.	4,9	**9,8**	0,61	0
110	110	27.7.	9,3	21,6	0,61	0

Caretta caretta hatchlings in Çalış 2009

Carl Philip Kruspe, Nikolas Steurer

KURZFASSUNG

Dieser Bericht entstand im Rahmen des Projektpraktikums der Universität Wien zum Schutz der Meeresschildkröten der Art *Caretta caretta*, am Strand von Çalış, einem touristisch genutzten Vorort von Fethiye, der von der Unechten Karettschildkröte als Nistgebiet genutzt wird. Seit nun mehr als 17 Jahren arbeiten türkische Studenten und Studierende der Universität Wien zusammen, um den Artenschutz der Meeresschildkröten zu gewährleisten und um wissenschaftliche Daten zu erheben und auszuwerten. Dadurch ist es möglich, diese mit den Daten vorangegangener Jahre zu vergleichen und Prognosen zu stellen.
In der Saison 2009 waren 15 Nester von *Caretta caretta* vorhanden, bei 11 handelten es sich um sogenannte secret nests. Dies sind Nester deren Eiablagezeitpunkt nicht näher bestimmt werden konnte und erst an Hand von schlüpfenden Schildkröten erkannt wurden. Die Gesamtzahl der Eier betrug 1117, woraus 849 Hatchlinge schlüpften. Die maximale Erfolgsrate beträgt somit 76%. Das Nest #1 musste verlegt werden, eine sogenannte Hatchery wurde vorgenommen, da es sich zu nahe an der Wasserlinie befand.

ABSTRACT

This report was produced in the framework of a course on the conservation of and research on the sea turtle species *Caretta caretta,* organized by the University of Vienna, on the beach of Çalış in Turkey. This is one of three beaches in this specific area used as a nesting ground for these turtles.
For 17 years, Turkish and Austrian students have been working together to protect this area and to collect data about nesting activities, because growing tourism poses an increasing threat to the species. These data are a valuable asset in the long-term monitoring of the population fluctuations of *Caretta caretta*. In the 2009 nesting season, 15 nests were laid. Eleven of them were so-called secret nests because the turtles nested before our team arrived. One of the secret nests was never found – only tracks. The total number of eggs was 1117, producing 849 hatchlings. This represents a success rate of 76%, which is the highest in the history of the project. Nest #1 had to

be moved (so-called hatchery) because it was too close to the waterline.

INTRODUCTION

Female turtles come to the very same beach every 2 to 4 years, due to natal-homing, to lay up to 4 nests. This occurs within 2 weeks. On Çalış beach, the number of eggs per nest ranges from 23 to 134 eggs (Stachowitsch et al., 2009). The nesting season in Turkey starts in late May. The incubation time of the eggs spans from 44 to 64 days. The hatchlings normally emerge at night and move towards the sea, which is usually brighter than the hinterland. If the illumination from the landward side of the beach is stronger, they would move there and not to the sea. The consequence is often death due to predation or exhaustion (Stachowitsch et al., 2007). To compare the data and to reveal trends in hatching success, it is important to document this process over a long time span.

MATERIAL AND METHODS

From 27 June to 19 September the nests on Çalış beach were monitored by eleven students from the University of Vienna. Therefore the beach was patrolled by two or three people in a morning-shift lasting from 6 am to 8 am. The route of the shift started at the esplanade beside Hotel Mutlu and extended to the rocks in 3 km distance beyond the municipal border. The same stretch was patrolled in a night-shift by 3 persons four times from 10 pm to 2 am, but only extending up to the Surf Café.

From mid-August, only the nests were controlled in the night-shifts (i.e. not the entire beach). From late June to mid- August the beach was searched for adult and juvenile tracks as well for sea turtles. After oviposition the females were measured and the exact position of the nest was noted.

The nests were shielded with triangular metal cages (Fig. 9) to prevent damage by predators. Every cage was labeled in three languages, i.e. Turkish, German and English to inform people on the beach that they were dealing with a sea turtle nest. In addition, plastic netting was attached to every cage; this netting could be moved up or down. Once the first hatchlings emerged, the plastic fence was lifted up approximately 10 cm to ensure the hatchlings could reach the sea. Before night-shift the fence was slid back into the lower position to prevent disorientated hatchlings from crawling in the wrong direction. These hatchlings were collected at regular intervals during the night and released into the sea at a dark beach-section.

Hatchlings found during the morning-shift were either released immediately into the ocean if the sand temperature was still low or they were held in a bucket filled with moist sand and covered with a wet towel in the camp during the day to release them that same night.

Hatchling tracks were counted and followed to find strayed or dead animals. Hatchlings were considered "predated" if their tracks abruptly stopped in the sand. Hatchlings were considered to have "reached the sea" if the tracks led to the sea. About 5 days after the last hatchling emerged, the nest was excavated. At this time the number of empty egg shells, dead hatchlings, hatchlings still living inside the nest, fertilized and unfertilized eggs were counted. Fertilized eggs were scaled in early, middle and late state. In a final step the nest measurements were taken, i.e. distance from sand surface to top eggs, depth of egg chamber and diameter.

RESULTS

In the 2009 season, 15 nests were laid at Çalış beach. The total number of eggs was 1117 and 949 eggs hatched (76%). A minimum of 665 hatchlings reached the sea. This number is calculated based on the hatchlings released by the students, because the track numbers alone were too unreliable as a source. The maximum number consists of the empty eggshells minus all dead hatchlings (either predated, death due to heat/sun) and amounted to 849 animals.

The average incubation time was 45.5 days.

In the 2009 nesting season, the most eggs were laid in nest number C3 (124), the fewest in C9 (55). The average number of eggs was 85.9, not including nest C8, which wasn't found – only tracks. Nest #4 is not shown here due to lack of data.

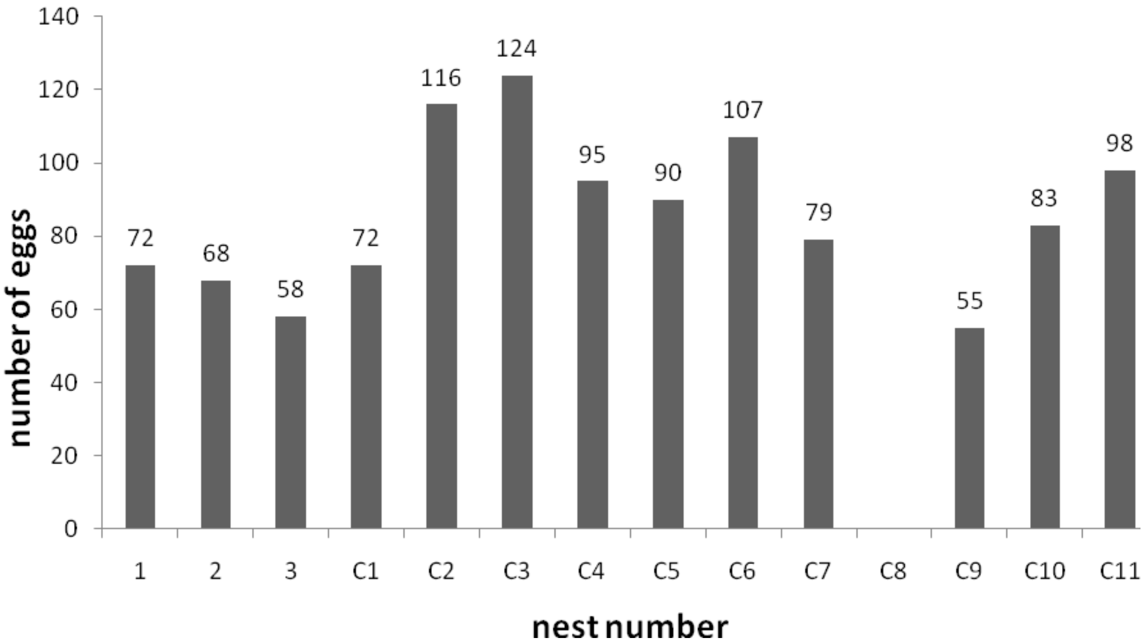

Fig. 1: Total number of eggs per nest (C-numbers refer to “secret nests”)
Abb. 1: Gesamtzahl der Eier pro Nest

Figure 2 compares the different development stages per nest. C6 and C7 didn’t have any “underdeveloped” eggs. C1 had the most dead embryos in the early stage (17), whereas C11 in the late stage (41). Nest #4 is not shown here due to lack of data.

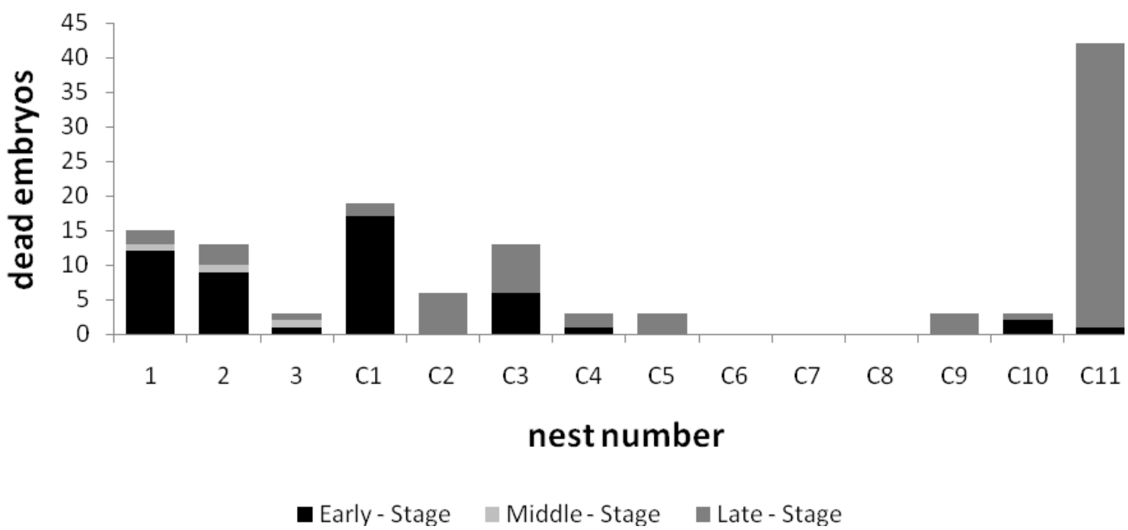

Fig. 2: Development stages of dead embryos per nest
Abb. 2: Entwicklungsstadien der toten Embryonen pro Nest

With a total of 1117 eggs, 2009 was the second most successful year after 1994 (1638 eggs). The lowest value was in 2003 – 381 eggs (Stachowitsch & Fellhofer, 2007, 2008).

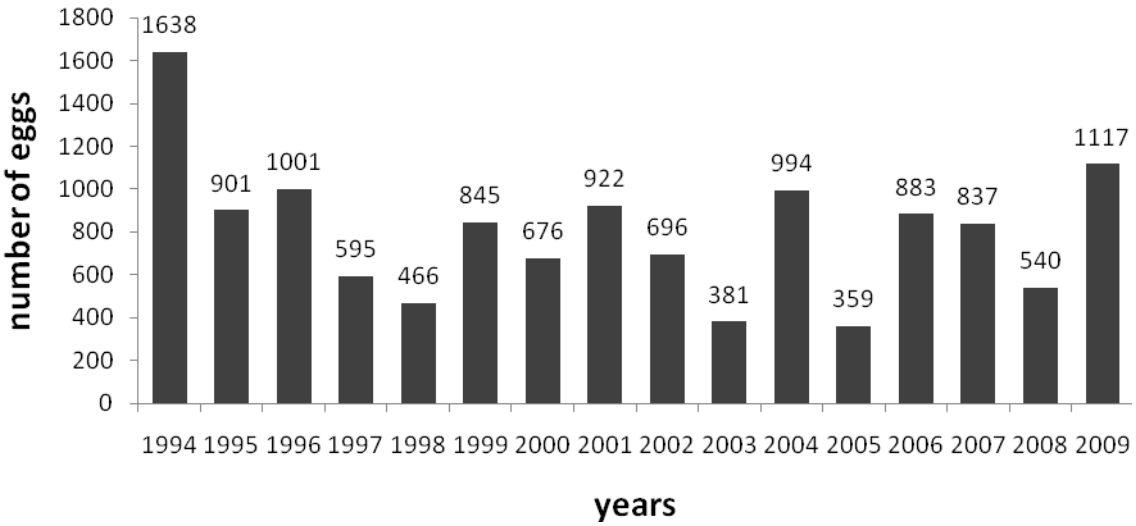

Fig. 3: Total number of eggs in Calış over 16 years.
Abb. 3: Anzahl der Eier pro Jahr in den letzten 16 Jahren.

The maximum success rate is calculated by empty eggshells minus dead hatchlings divided by the total number of eggs in the nest. The minimum number is equivalent to the hatchlings which were set free by students (and sometimes tourists) plus those found still living inside in the nest. Track numbers have not been used for reasons mentioned above. Nest #4 is not shown here due to lack of data.

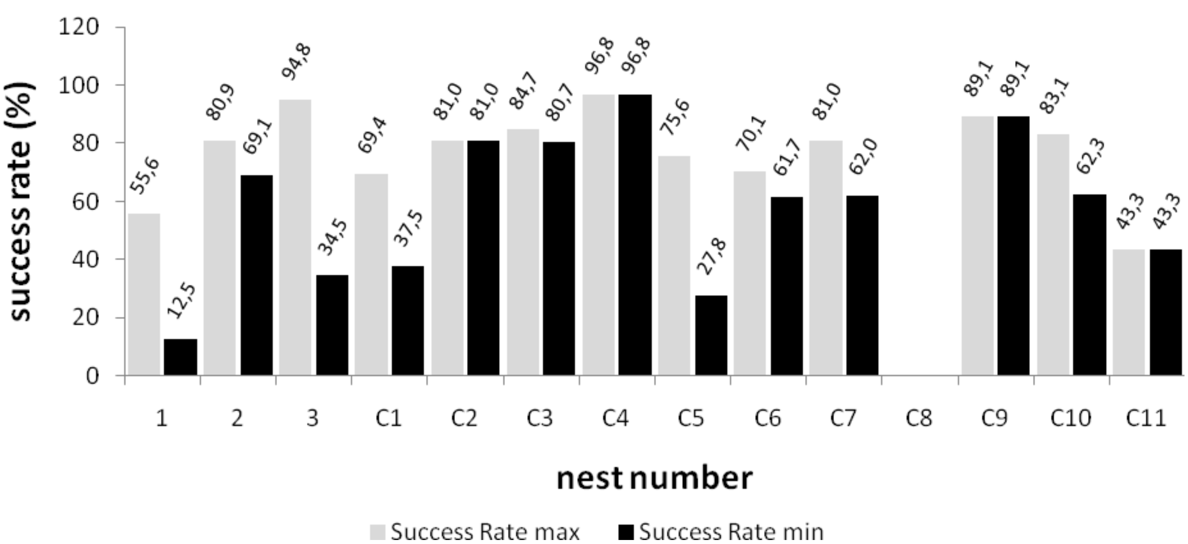

Fig. 4: Minimum and maximum success rates per nest in percent
Abb. 4: Minimale und maximale Erfolgsrate pro Nest in Prozent

849 hatchlings reached the sea in this season. This number was calculated by deducting the number of dead hatchlings (predated, due to sun/heat) from the number of empty eggshells. Although this value is higher compared to 2008, it is only ranked 6th place compared to the recordings over the last 13 years (Stachowitsch & Fellhofer, 2007, 2008).

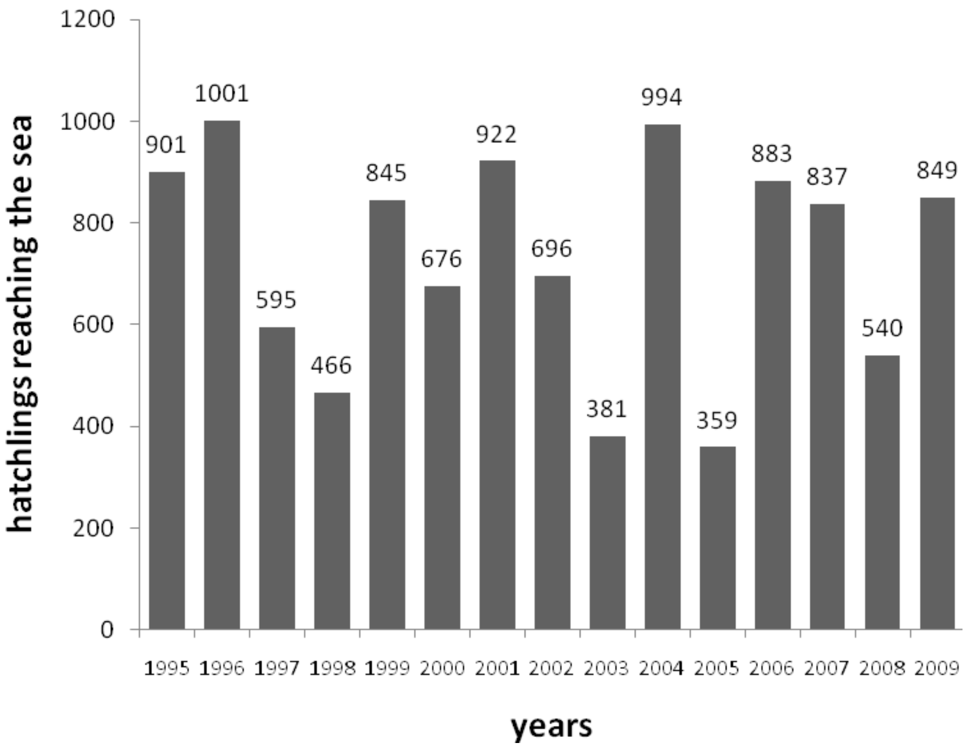

Fig. 5: Hatchlings reaching the sea per year
Abb. 5: Hatchlinge die das Meer erreicht haben pro Jahr

Based on the succes rate, however, 2009 had the highest rate since the start of the project. 76% of the animals reached the sea, topping even 2006 with a rate of 74.1% (Stachowitsch & Fellhofer, 2007, 2008).

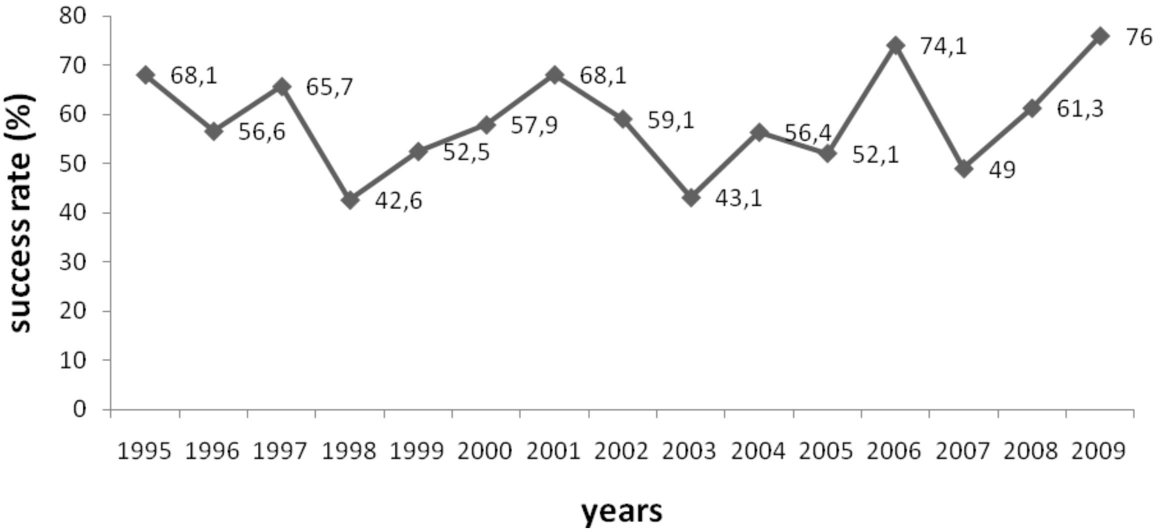

Fig. 6: Success rate in percent over the last 14 years
Abb. 6: Erfolgsrate der letzten 14 Jahre in Prozent

Nest #1 had the most unfertilized eggs (13), but the values are very low overall.

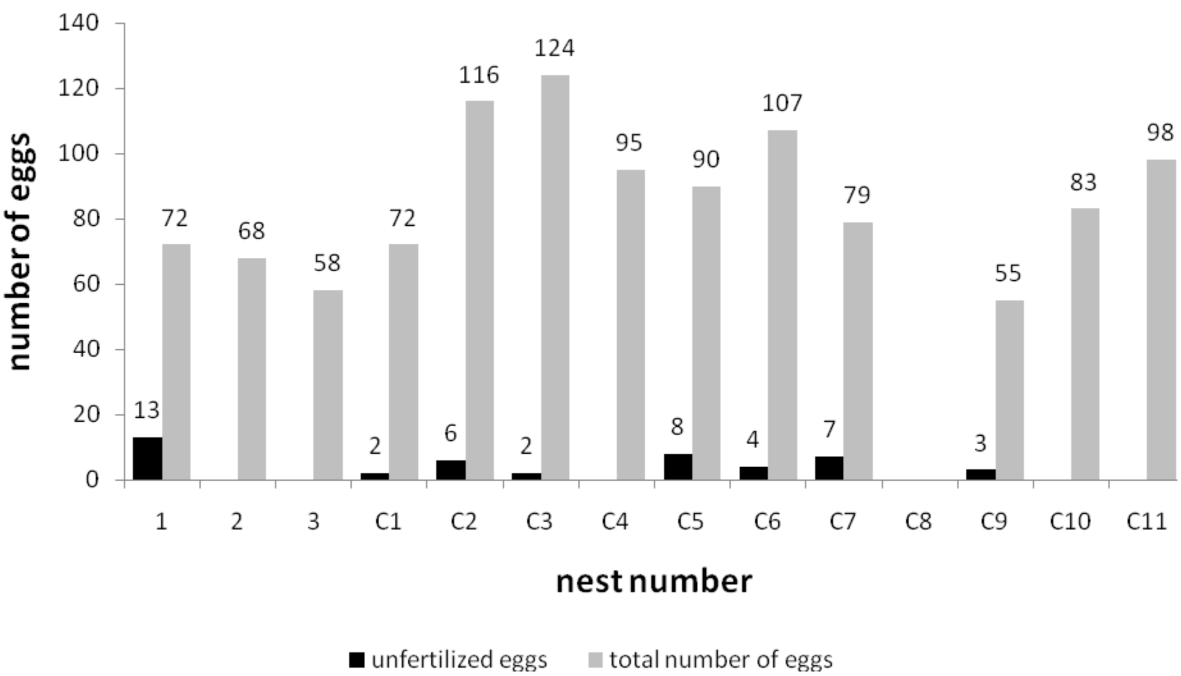

Fig. 7: Number of unfertilized eggs compared to total number of eggs
Abb. 7: Anzahl der unbefruchteten Eier verglichen mit der Gesamtzahl pro Nest

Details of the nests

Fifteen nests were laid in the 2009 season. The exact nest date is known only for 4, whereas the remaining 11 dates could not be determined because the nests were laid prior to the students' arrival or the respective adults were not observed.

Nest #1

This nest was laid on 09.07.2009 and hatched over a period of 3 days. The incubation time was 46 days. Initially, the nest was laid too close to the waterline. The nest was therefore moved several meters landwards (i.e. a hatchery was constructed). This was necessary to ensure a better hatching success. Three hatchlings hatched on 25.08.2009 at noon. Only 8 animals were counted reaching the sea, whereas the number of empty egg shells minus dead hatchlings yielded a total number of 40. The nest was excavated 5 days after the last hatchling emerged. Thirteen unfertilized eggs, 1 dead hatchling and 14 fertilized eggs in various stages of development were found.

Table 1: Excavation data and success rate of nest number 1
Tab. 1: Ausgrabungsdaten und Erfolgsrate von Nest 1

Total number of eggs	72	**Success rate (maximum)**
Total number of empty shells	44	55.6%
Total number of hatchlings reaching the sea	40	
Unfertilized eggs	13	
Fertilized eggs (dead embryos)	15	
Hatchlings still living inside nest	0	
Total number of dead hatchlings	4	
Total number of predated eggs	3	

Nest #2

The nest date was 10.07.2009 and the incubation time was 45 days. It hatched over 7 days and was excavated on 31.08.2009, yielding in a total number of 68 fertilized eggs. Nine of them were in an early, 1 in a mid and 3 in late embryonic stage. There were 24 living hatchlings inside the nest.

Table 2: Excavation data and success rate of nest number 2
Tab. 2: Ausgrabungsdaten und Erfolgsrate von Nest 2

Total number of eggs	68	**Success rate (maximum)**
Total number of empty shells	55	80.9 %
Total number of hatchlings reaching the sea	55	
Unfertilized eggs	0	
Fertilized eggs (dead embryos)	13	
Hatchlings still living inside nest	24	
Total number of dead hatchlings	0	
Total number of predated eggs	0	

Nest #3

This nest was laid on 14.07.2009 and the incubation time was 47 days. On 24 July, 10 eggs were found excavated near a sunshade with a strong indication of human interference. The hatching process was observed for one day only.

Table 3: Excavation data and success rate of nest number 3
Tab. 3: Ausgrabungsdaten und Erfolgsrate von Nest 3

Total number of eggs	58	**Success rate (maximum)**
Total number of empty shells	55	94.8 %
Total number of hatchlings reaching the sea	55	
Unfertilized eggs	0	
Fertilized eggs (dead embryos)	3	
Hatchlings still living inside nest	0	
Total number of dead hatchlings	0	
Total number of predated eggs	10	

Nest # C1

The nesting date is unknown. The hatching period ranged from 17 to 22 August. Here, 3 hatchlings were released into the sea by tourists. A total of 50 animals reached the sea.

Table 4: Excavation data and success rate of nest number C1
Tab. 4: Ausgrabungsdaten und Erfolgsrate von Nest C1

Total number of eggs	72	**Success rate (maximum)**
Total number of empty shells	51	69.4 %
Total number of hatchlings reaching the sea	50	
Unfertilized eggs	2	
Fertilized eggs (dead embryos)	19	
Hatchlings still living inside nest	0	
Total number of dead hatchlings	1	
Total number of predated eggs	0	

Nest # C2

This nest hatched over 8 days starting on 24 July and was excavated on 6 August. A total of 94 hatchlings reached the sea. We found 3 dead hatchlings infested with maggots during a check of the nest. A total of 116 eggs were counted.

Table 5: Excavation data and success rate of nest number C2
Tab. 5: Ausgrabungsdaten und Erfolgsrate von Nest C2

Total number of eggs	116	**Success rate (maximum)**
Total number of empty shells	104	81.0 %
Total number of hatchlings reaching the sea	94	
Unfertilized eggs	6	
Fertilized eggs (dead embryos)	6	
Hatchlings still living inside nest	10	
Total number of dead hatchlings	10	
Total number of predated eggs	0	

Nest # C3

This nest hatched over 8 days starting on 10 July and was excavated on 19 July, yielding a total of 124 eggs, with 109 empty egg shells. With 105 hatchlings reaching the sea, this nest was the most successful one in this season.

Table 6: Excavation data and success rate of nest number C3
Tab. 6: Ausgrabungsdaten und Erfolgsrate von Nest C3

Total number of eggs	124	**Success rate (maximum)**
Total number of empty shells	109	84.7 %
Total number of hatchlings reaching the sea	105	
Unfertilized eggs	2	
Fertilized eggs (dead embryos)	13	
Hatchlings still living inside nest	6	
Total number of dead hatchlings	4	
Total number of predated eggs	0	

Nest # C4

The hatching period ranged over 6 days starting on 5 August with 49 hatchlings, with 15 others having been released by tourists. Altogether, 83 hatchlings were released into the sea.

Table 7: Excavation data and success rate of nest number C4
Tab. 7: Ausgrabungsdaten und Erfolgsrate von Nest C4

Total number of eggs	95	**Success rate (maximum)**
Total number of empty shells	92	96.8 %
Total number of hatchlings reaching the sea	17	
Unfertilized eggs	0	
Fertilized eggs (dead embryos)	3	
Hatchlings still living inside nest	2	
Total number of dead hatchlings	9	
Total number of predated eggs	0	

Nest # C5

After a 6-day hatching period starting on 14 July, the nest was excavated on 20 July. Eight unfertilized eggs were found, 2 of them were conjoined. One of the hatchlings found in the nest was deformed. A total of 68 hatchlings reached the sea.

Table 8: Excavation data and success rate of nest number C5
Tab. 8: Ausgrabungsdaten und Erfolgsrate von Nest C5

Total number of eggs	90	**Success rate (maximum)**
Total number of empty shells	79	75.6 %
Total number of hatchlings reaching the sea	68	
Unfertilized eggs	9	
Fertilized eggs (dead embryos)	3	
Hatchlings still living inside nest	3	
Total number of dead hatchlings	11	
Total number of predated eggs	0	

Nest # C6

Starting on 25 July, over a period of 5 days, 75 hatchlings emerged and reached the sea. The first hatching day, with 55 counted animals, was the most successful one in this season. During a nest check, 23 hatchlings were found with severe injuries, perhaps due to a parasite infestation (swollen bodies, open wounds).

Table 9: Excavation data and success rate of nest number C6
Tab. 9: Ausgrabungsdaten und Erfolgsrate von Nest C6

Total number of eggs	107	**Success rate (maximum)**
Total number of empty shells	103	70.1 %
Total number of hatchlings reaching the sea	75	
Unfertilized eggs	0	
Fertilized eggs (dead embryos)	4	
Hatchlings still living inside nest	0	
Total number of dead hatchlings	28	
Total number of predated eggs	0	

Nest # C7

After a 5-day hatching period, 64 hatchlings reached the sea. A large stone in the nest blocked the way out, resulting in the death of 8 hatchlings before it was removed by the students. During the excavation a large number of insect larvae, e.g. Muscidae, acari and worms were found (Fig. 10).

Table 10: Excavation data and success rate of nest number C7
Tab. 10: Ausgrabungsdaten und Erfolgsrate von Nest C7

Total number of eggs	79	**Success rate (maximum)**
Total number of empty shells	72	81.0 %
Total number of hatchlings reaching the sea	64	
Unfertilized eggs	7	
Fertilized eggs (dead embryos)	4	
Hatchlings still living inside nest	0	
Total number of dead hatchlings	8	
Total number of predated eggs	0	

Nest # C8

An undetermined number of tracks were found in a beach bar, but the exact position of this nest could not be located.

Nest # C9

This nest hatched over a period of 5 days starting on 31.07.2009. Five days after the last emergence it was excavated, yielding 3 unfertilized eggs and 3 in a late embryonic stage.
A total of 49 hatchlings reached the sea.

Table 11: Excavation data and success rate of nest number C9
Tab. 11: Ausgrabungsdaten und Erfolgsrate von Nest C9

Total number of eggs	55	**Success rate (maximum)**
Total number of empty shells	49	89.1 %
Total number of hatchlings reaching the sea	49	
Unfertilized eggs	3	
Fertilized eggs (dead embryos)	3	
Hatchlings still living inside nest	0	
Total number of dead hatchlings	0	
Total number of predated eggs	0	

Nest # C10

The nest hatched from 1 to 8 of August. During a nest check on the 5th day, 7 hatchlings were found dead and maggot-infested. 69 hatchlings reached the sea.

Table 12: Excavation data and success rate of nest number C10
Tab. 12: Ausgrabungsdaten und Erfolgsrate von Nest C10

Total number of eggs	83	**Success rate (maximum)**
Total number of empty shells	80	83.1 %
Total number of hatchlings reaching the sea	69	
Unfertilized eggs	7	
Fertilized eggs (dead embryos)	3	
Hatchlings still living inside nest	4	
Total number of dead hatchlings	11	
Total number of predated eggs	0	

Nest # C11

The hatching started on 11 August and ended on 13 August. During the excavation on 17 August, a large number of pebbles and bigger stones were found within the nest, blocking the hatching-process and leading to a high number of incompletely developed eggs (1 early, 41 late embryonic stage). Despite a total number of 98 eggs, only 42 hatchlings reached the sea, which is equivalent to a maximum rate of only 43.3% (lowest success-rate of this season).

Table 13: Excavation data and success rate of nest number C11
Tab. 13: Ausgrabungsdaten und Erfolgsrate von Nest C11

Total number of eggs	98	**Success rate (maximum)**
Total number of empty shells	56	43.3 %
Total number of hatchlings reaching the sea	42	
Unfertilized eggs	0	
Fertilized eggs (dead embryos)	42	
Hatchlings still living inside nest	15	
Total number of dead hatchlings	14	
Total number of predated eggs	0	

Table 14: Summary of the hatchling data from Calış 2008
Tab. 14: Zusammenfassung der 2008 erhobenen Hatchling-Daten in Calış

Nest n°	Nest date	Incubation time	Hatchlings reaching the sea		Still living inside	Empty eggshells	Unfertilized eggs	Dead embryos	Dead hatchlings	Total n° of eggs
			MIN	MAX						
1	09.07.2009	46	9	40	0	44	13	15	4	72
2	10.07.2009	45	47	55	24	55	0	13	0	68
3	14.07.2009	47	20	55	0	55	0	3	0	58
4	06.08.2009	53	-	-	-	-	-	-	-	-
C1	secret	-	27	50	0	51	2	19	1	72
C2	secret	-	94	94	10	104	6	6	10	116
C3	secret	-	100	105	6	109	2	13	4	124
C4	secret	-	83	83	2	92	0	3	9	95
C5	secret	-	25	68	3	79	9	3	11	90
C6	secret	-	66	75	0	103	4	0	28	107
C7	secret	-	49	64	0	72	7	0	8	79
C8	secret									
C9	secret	-	49	49	0	49	3	3	0	55
C10	secret	-	55	69	4	80	0	3	11	83
C11	secret	-	42	42	15	56	0	42	14	98
Total		Ø 47.75	665	849	64	949	46	123	100	1117

Percent-wise, the total number of eggs in Çalış varies to the same extent as in Yaniklar and Akgöl combined.

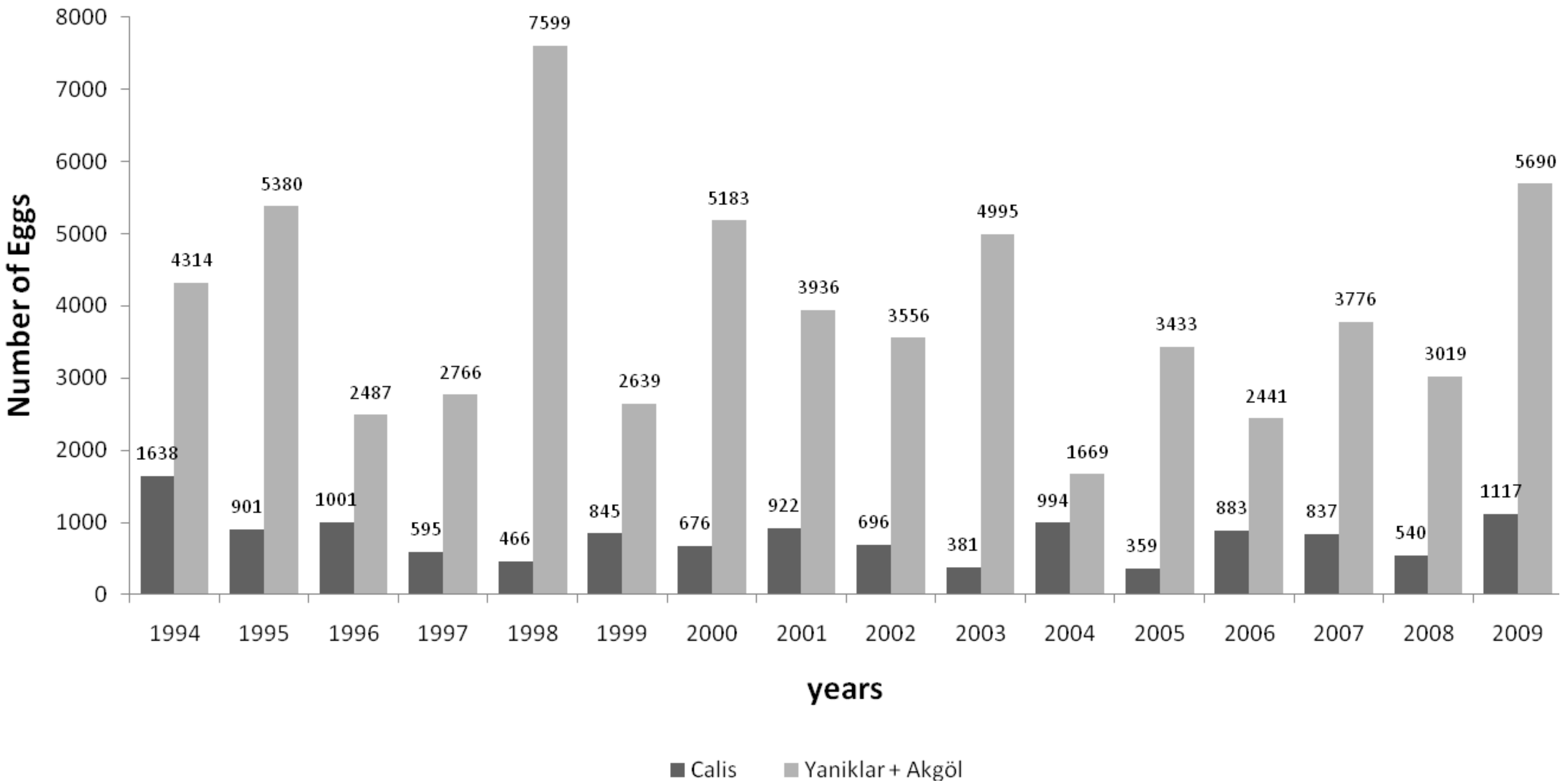

Fig. 8: Comparison of the total number of eggs between Çalış, Yaniklar & Akgöl
Abb. 8: Vergleich der Gesamteizahlen von Çalış und Yaniklar mit Akgöl

DISCUSSION

With a success rate of 76.01%, this nesting season was the most successful one in the whole 17-year project. Compared to the last 2 years, this year completes yet another 3-year cycle of increasing success rates. The years 1995, 2001 and 2006 also represent peaks of a more or less successful cycle.

Most animals hatched in July (479), followed by 468 in August.

849 hatchlings reached the sea, which is 309 more than last year. An important factor was fewer incompletely developed eggs. The only exception was nest C11, in which 41 embryos died in late and 1 died in the early stages of development. The many pebbles and other debris in the nest indicate a negative influence on the development, perhaps due to abnormal temperature fluctuations and insufficient ventilation.

In 4 nests on Çalış beach (C2 81%, C4 97%, C9 89%, C11 43%) the maximum and minimum success rates did not differ. This is a result of the proper placement of the protective cages this year and due to less predation and parasite infestation. Although the cages proved a good defense against animal predation, they couldn't help against human interference, i.e. in nest 3, 10 eggs were dug up and placed under an umbrella.

Eleven out of 15 nests were secret nests, which complicated the better monitoring of incubation times. The average incubation time was 47.8 days, which is 3.3 days less than in 2008.

An exception was nest number 4. It was laid very late in the season, on 06.08.2009. The nest hatched on 28.09.2009 when none of the students were present anymore. Fifty hatchlings were probably released into the sea by tourists, but no exact data are available.

Tourism is still increasing in Fethiye and therefore continuous to be the biggest threat to these animals. The so called "picnic area" located between the Surf Bar and the dolmuş bus station, an area approximately 1 km long, was not used as a nesting ground by the turtles this year. Reasons are the large number of people and their vehicles, which harden the sand and the left behind litter. The latter is an enormous problem for hatchlings trying to reach the sea, as they become entrapped or entangled by it and die (Decline of the sea turtles, causes and prevention, 1990).

As a result of construction projects, large amounts of sand are moved and removed, leaving big stones and other debris. This makes it more difficult for female turtles to dig their nests. At the same time, potential nesting areas vanish.

Fig. 9: Cage for nest protection
Abb. 9: Käfig für Nestschutz
Note position of plastic netting to allow hatchlings to make their way to the sea should they emerge during the day.
Photo: Nikolas Steurer

Fig. 10: Worm infestation of an egg
Abb. 10: Wurmbefall eines Eies
Photo: Nikolas Steurer

Fig. 11: Emerging hatchling
Abb. 11: Soeben geschlüpfter Hatchling
Photo: Carl Philip Kruspe

Fig. 12: Empty egg shells after excavation
Abb. 12: Leere Eierschalen nach einer Nestausgrabung
Photo: Carl Philip Kruspe

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Caretta Caretta hatchlings in Yaniklar 2009

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KURZFASSUNG

Das Meeresschildkröten-Naturschutzprojekt fand an der ägäischen Küste in der Türkei statt, welche in zwei Abschnitte unterteilt wurde: einerseits Yaniklar und Akgöl, andererseits Calis. Seit 1993 werden jeden Sommer die Brutaktivitäten von *Caretta caretta* von türkischen und österreichischen Studenten beobachtet und dokumentiert. Es werden dafür die Größe der Schildkröten, die Anzahl an gelegten Nestern und deren Position bezüglich der Distanz zum Meer und zur Vegetation, die Anzahl der gelegten Eier und der Bruterfolg in Datenblättern festgehalten. Anschließend wurden die gesammelten Daten mit denen aus vorherigen Jahren verglichen.

Im Jahr 2009 konnte eine Zunahme bezüglich der Nestanzahl und der Anzahl der gelegten Eier festgestellt werden. Bei Vergleichen mit Daten aus den Vorjahren lässt sich ein Auf- und Abwärtstrend abwechselnd erkennen (2009: 5690, 2008: 5480, 2007: 5901 gelegte Eier). Die Fertilität (Gesamtanzahl der Eier/befruchtete Eier) ist mit rund 98 % gleichgeblieben. Im Jahr 2009 betrug die Nestanzahl 77 Nester. Die maximale Anzahl von Hatchlingen, die das Meer erreicht haben, hat sich im Vergleich mit den Zahlen von 2008 erhöht, im Jahr 2007 hingegen war die maximale Anzahl von Hatchlingen noch höher (2009: 3417, 2008: 2990, 2007: 3776 Hatchlinge).

ABSTRACT

The research and conservation sea turtle project took place on the Aegean coast of Turkey and was divided into two sections: Yaniklar and Akgöl on the one hand, and Calis on the other hand. The nesting activities of *Caretta caretta* have been observed and documented by Turkish and Austrian students every summer since 1993.

The size of the turtles, the number of nests as well as their position concerning the distance to the sea and vegetation, the number of eggs and the success of the hatch were documented. The collected data were then compared with those taken in previous years.

In 2009, an increase in the number of nests and the total number of eggs (5690) was recorded. Comparing the previous data shows a fluctuation in the total number of eggs (2008: 5480, 2007: 5901 eggs). The fertility (fertilized eggs/total number of eggs) is about the same as last year (98 %). This year 77 nests were laid. The maximum number of hatchlings reaching the

sea increased compared to previous year, but was below the value of 2007 (2009: 3417, 2008: 2990, 2007: 3776 hatchlings).

INTRODUCTION

The *Caretta caretta* sea turtle project in Fethiye (Turkey) is based on a cooperation between universities in Turkey and the University of Vienna, and has taken place every summer since 1994 (Hofstädter and Wurth, 2007).

Generally, loggerhead sea turtles are still common in coastal tropical and subtropical waters although they are endangered. They can be found mainly along the North- and South American coasts, but their nesting areas are also located in Africa and the Mediterranean as well as areas of the western Pacific and the Indian Ocean (http://marinebio.org). Fethiye beach, where our research and conservation project took place, is an important Mediterranean nesting area for *Caretta caretta* (Türkozan et al., 2003). This year the beach of Yaniklar (near Fethiye) was observed by the Turkish and Austrian students from 27 June until 19 September.

Between May and August the female loggerhead sea turtles return every two to four years to the nesting beach to dig a nest. The number of eggs per nest varies not only between different species (80 to 120 eggs per nest), but also within a species. The hatching season starts in July and lasts until October (http://www.archelon.gr). The development of the eggs, the so-called incubation time, takes several weeks. In this time the embryo grows and develops into a fully formed organism. The incubation time is affected by several environmental factors such as temperature or humidity as well as levels of respiratory gases (Ackerman, 1997). After the hatchlings hatched they dig to the surface, which can take several days because oxygen is rare. To avoid heat and predation they come out of their nest during the night or in the early morning and move directly to the sea. Furthermore, they often hatch in batches (http://www.archelon.gr).

Caretta caretta is guided by phototaxis and photokinesis, which means that they are attracted by lights. In order to make their way to the sea it is necessary that there are no disturbing lights like street lights or lights from restaurants and bars. Otherwise they might be attracted to these lights and move in the wrong direction (Warren and Antonpoulou, 1990).

According to recent estimates, only one sea turtle in a thousand reaches adulthood and is therefore able to reproduce (http://www.archelon.gr).

All the nests in Yaniklar beach were monitored from 27 June until 19 September 2009. The nests were checked every day and data was taken. Our focus of interest was the number of nests and whether there are any preferred breeding sites on the beach, the hatching rate in relation to the unhatched or unfertilized eggs. In addition, we were interested if there is any correlation between the predation of nests by insects or the presence of fungus and the distance between nest and closest vegetation.

MATERIAL AND METHODS

Morning observation shifts started at about 06:00 AM with at least two students walking in each direction along the beach from the campsite. The beach to the right of the camp was Akgöl that to the left was Yaniklar beach. There was also one small beach section at the end of Yaniklar beach. During the shift the students kept an eye on hatchling tracks on the beach and inspected the nests, which were marked with a semicircle of stones (Fig.1). Moreover, we listed three different reference points and their distances to the nest position so that we could find the nest easily even without the stones if necessary. In that case the exact position of the egg chamber was found by using a metal rod (so-called shish).

Early in the season, two nests had to be relocated because their positions strongly decreased the chance of the hatchlings´ survival. For this purpose all the measurements (the depth to the top of the eggs, the depth to the bottom of the egg chamber, and the diameter of the nest) were reproduced in the new position. After that, the eggs were replaced into the new nest and reburied.

If hatchling tracks were found during the morning shift they were counted and followed to ensure that there no living hatchlings were left on the beach and to determine whether predation may have occurred (e.g. by birds). In case still living hatchlings were found on the beach, they were either released into the sea immediately or taken to the camp in a bucket filled with a few centimeters of wet sand (Fig.2). The bucket then was covered with paper and the hatchlings released that night (about 10:00 pm) on a dark section of the beach a few meters away from the waterline. While releasing them we used red lamps in order to keep the effect of light to a minimum. In our data such hatchlings were listed as hatchlings reaching the sea. Furthermore, we noted not only the number of tracks and hatchlings reaching the sea, but also predated hatchlings and hatchlings that died due to sun exposure (Fig.3). The empty egg-shells were also counted from the students (Fig.4). Concerning the nest control, we also removed stones inside the nest if necessary to ensure that the hatchlings were not inhibited in coming up to the surface. On the third day without additional tracks we checked the nest to see if any living eggs were left. Otherwise, one of the students excavated the nest carefully, and the other one wrote down the data (Fig.5).

Fig.1: A *Caretta caretta* nest marked with a semicircle of stones
Abb.1: Ein *Caretta caretta* Nest markiert durch einen Halbkreis aus Steinen (Foto: Sonnleitner Birgit)

Fig.2: Still living hatchlings were taken from the nest and put into a bucket, which was filled with a few centimetres of wet sand. The bucket was covered with paper and the hatchlings were released in the following night.
Abb.2: Lebende Hatchlinge wurden in einem Kübel auf ein paar Zenitmeter feuchten Sand aufbewahrt und mit Papier zugedeckt. Die Hatchlinge wurden in der folgenden Nacht freigelassen. (Foto: Sonnleitner Birgit)

Fig.3: *Caretta caretta* hatchling which died in the late-embryonic-stage.
Abb.3: Ein im spätembryonalen Entwicklungsstadium verstorbener *Caretta caretta* Hatchling. (Foto: Sonnleitner Birgit)

Fig.4: All the empty egg-shells from each nest were counted from the students.
Abb.4: Die leeren Eischalen wurden von jedem Nest gezählt und notiert. (Foto: Sonnleitner Birgit)

Fig.5: Excavation of a *Caretta caretta* nest on Akgöl beach. Gloves were used to handle the eggs and egg shells.
Abb.5: Ausgrabung eines *Caretta caretta* Nests am Strand von Akgöl. Es wurden für den Umgang mit den Eiern und den Eischalen Handschuhe verwendet. (Foto: Sonnleitner Birgit)

RESULTS

This year we had a total of 77 nests in Yaniklar and Akgöl (Y43 and A34). Almost half of them were laid unobserved in Yaniklar (20) and in Akgöl (16). Eleven nests hatched after the Austrian students left and were later excavated by our Turkish colleagues. One was lost because of high tides and rain (Akgöl No. 16) and one was still brooding because the nest was laid on 18.8.09 (Akgöl No. 18). These two were not included in the table (Tab. 1-3).
A total of 5690 eggs were documented, with 3262 eggs in Yaniklar and 2428 in Akgöl, of which 2% were unfertilized. Out of the fertilized eggs, 69.2 percent hatched, 15 percent died in the early embryonic stage; about the same number died in the mid and late stage or were predated (Fig.6).

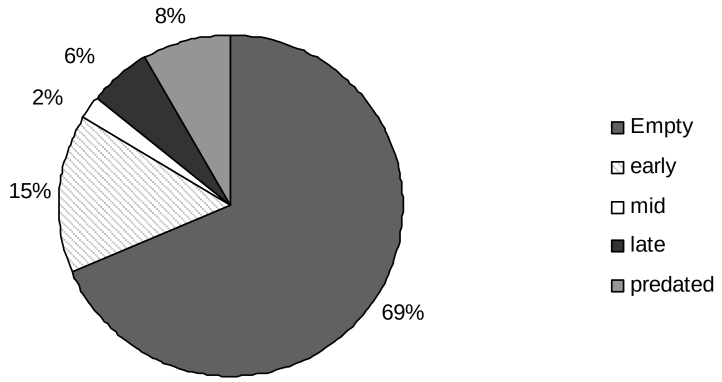

Fig. 6: Segmentation of the fertilized eggs in categories of the found embryo stage in percent.
Abb. 6: Aufteilung der befruchteten Eier in den gefunden Stadien in Prozent von der Gesamtzahl

Mainly Tenebrionidae and Acari predated the eggs, in Yaniklar more Tenebrionidae (58%) and in Akgöl more Acari (51%). Of all predated eggs, 90 % were from Yaniklar. Other predators were Oligochaeta and Muscidae, and fungi were also found. In 20 % of the predated eggs, two or more different predators were present. The early embryonic stage (304 eggs), followed by the late stage (66 eggs), was the primary target of the predators. A few eggs were lost due to birds, dogs, or human interference (e.g. digging).

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An average of 52 eggs hatched in each nest (standard deviation SD: ± 26). This yielded a total of 3841 empty egg shells (Yaniklar 2044, Akgöl 1797). The hatching rate, which relates the empty egg shells to the total eggs, in Yaniklar was 63 %, which was slightly lower than in Akgöl 74 %. The overall average was 67 %.

Only a small fraction of the hatchlings was found dead in the nest (369), or killed by the sun (16) or predation (39) (Fig.7). The number of hatchlings reaching the sea was between a minimum of 2540 (tracks + living hatchlings) and a maximum of 3417. The maximum was the number of the empty shells minus the dead hatchlings. In the nests Y7 and Y20, albino hatchlings (3) were found. One of them died during the excavation, the others were found dead. They showed deformations for example the eyes were located on the tip of the snout.

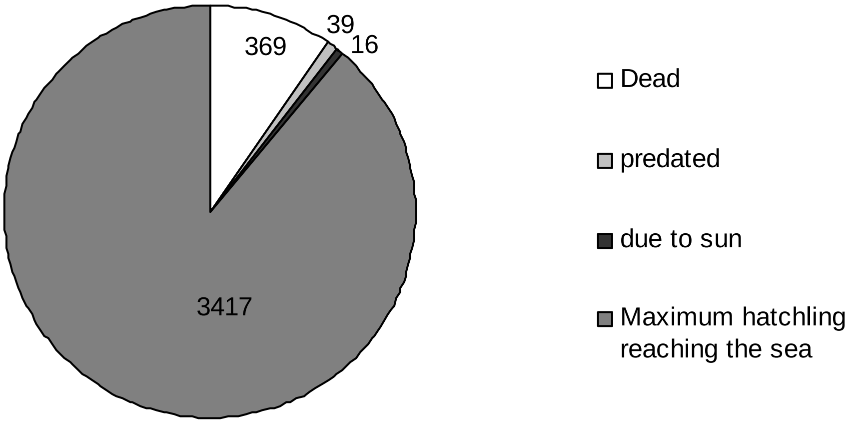


Fig.7: Number of dead hatchlings in the nest, predated hatchlings, hatchlings due to the sun and maximum of hatchling reaching the sea
Abb.7: Nummer der toten und gefressenen frisch-geschlüpften Junge im Nest, sowie der durch die Sonne/Hitze umgekommenen und derer die es ins Meer geschafft haben.

The hatch dates ranged from July to September, but more than half of the nests started in August with an average of five emerging days (SD: ± 3.47). The incubation time was a minimum of 43 days and a maximum of 66 days, overall 52.9 days (SD ± 6.24). Three nests in Akgöl took longer than 60 days (No. 1, 2, 8), all in the same area of the beach within three meters to each other (Tab. 1).
The average nest depth (bottom of the chamber) was 0.47 m (SD: ±0.09), with dry sand to

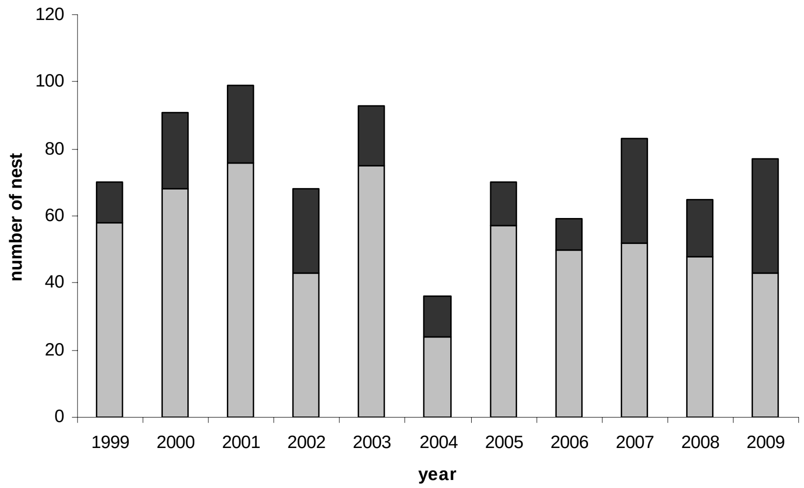
0.21 (SD: ±0.09) and wet sand to a further 0.26 meter (SD: ±0.08). The average distance to the sea in both beaches was 20 m, with a minimum of 5.7 and a maximum of 82.4 meters, both in Akgöl. The latter value was more than double the maximum in Yaniklar. In general the nests in Yaniklar were closer to the vegetation line and in Akgöl closer to the sea (Tab. 3).
At the end of the season several nests near the waterline were flooded by high tide, and after 11.9.09 it started to rain often. This made it hard to keep track of the nests, because the stone semicircles were washed away by the water.
The size of five female turtles was measured and compared with the number of eggs those turtles laid. No direct correlation was evident as the smallest laid almost as many as the biggest turtle (Tab. 4).

Table 4: Comparison between body size of the female and the total number of eggs.
Tab. 4: Vergleich zwischen der Körpergröße und der Anzahl der Eier.

Nest	Eggs	SCL	SCW	CCL	CCW	tagged
1	87	0.6	0.47	0.725	0.65	TR2202
13	66	0.65	0.5	0.67	0.61	TR808
15	82	0.69	0.53	0.71	0.64	No
18	68	0.74	0.54	0.78	0.71	TR806
14	92	0.79	0.59	0.85	0.76	No

DISCUSSION

Overall, we documented an increase of nests from 2008 to 2009, with a correlated increase in total number of eggs from 5480 to 5690, though not as high as in 2007 (5901 eggs). This shows a slight up and down every two years, as in 2006 only 59 nests were found (Fig.8).



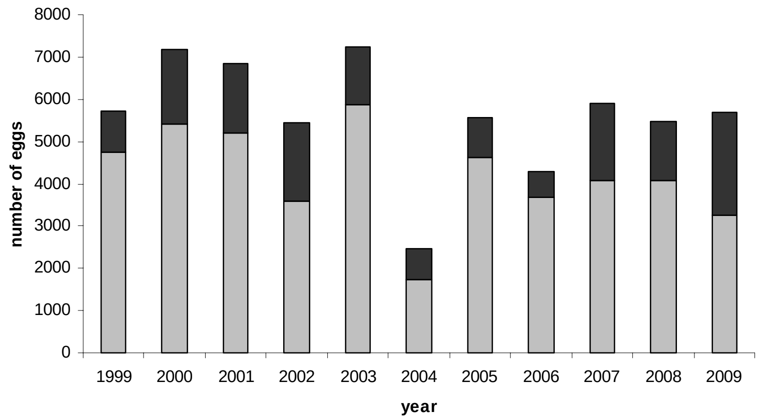


Fig.8: Number of eggs and nest over the last ten years. (Black: Akgöl ,grey: Yaniklar).
Abb.8: Anzahl der Eier und Nester in den letzten 10 Jahren. (Schwarz Akgöl, grauYaniklar).

The fertility in 2009 and 2008 is about the same (98 %). The hatching rate increased compared to 2008 as did the minimum and maximum number of hatchlings reaching the sea. This year was very similar to 2005 and again the slight upwards trend was seen even though the numbers were lower than 2007 (Fig.9). However, due to the rain at the end of the season and the high tide, we probably lost quite a few hatchlings due to the temperature drop inside the nests (see chapter “tiny talk”). Nest number 16 in Akgöl was completly lost because of the high tide.

This fluctuation over the last years may relate to the fact that females return every two to three years for mating, and the high peaks 1995, 1998, 2000 and 2003 may correspond to a synchronization of the females (Fig.9).

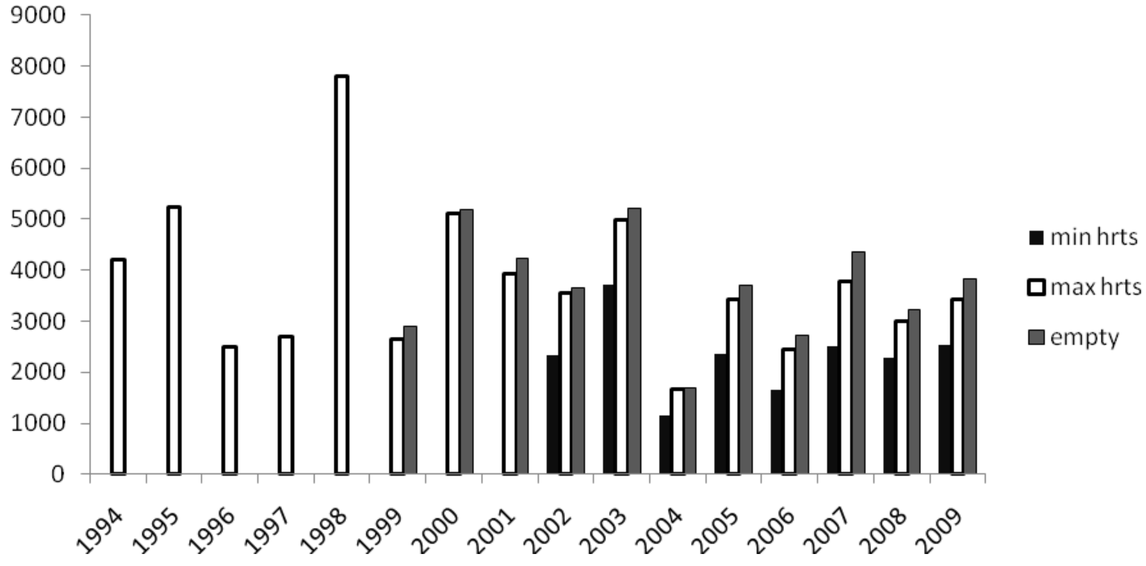


Fig.9: Comparison between the last sixteen years of the minimum and maximum hatchlings reaching the sea (min/max hrts) and the empty egg shells (empty).
Abb.9: Jahresvergleich der Minimum und Maximum Hatchlinge (hrts), die das Meer erreicht haben sowie der Leeren Eischalen(empty).

Nest A7 was a very interesting study object, because it was located on the shoreline. Tracks were hard to count since the tide erased all evidence, but 32 out of 84 eggs hatched, and probably all but one made it into the sea. The situation was similar to this nest for nest number 10 and 17 in Akgöl.

The body size of the female turtle and the egg number were not correlated, but this result must be treated with caution, because of the small number (n=5) and also the unknown number of how often the respective turtles had already laid a nest this season.

Big stones and dead hatchlings also clogged in several nests the neck of the chamber. This led to the death of hatchlings below.

Predation seems to be a bigger problem in Yaniklar than in Akgöl, as the numbers of the last few years show. This year about ten times more predated eggs were documented in Yaniklar than in Akgöl (13.03 % Yaniklar, 1.94% Akgöl).

One may think the shorter the distance to the sea, the higher the survival rate. Nonetheless nest 6 in Akgöl, for example, was the farthest away from the shoreline with 82.4 meters and still 100 % hatched and an estimated 90 % reached the sea.

As described in the last years the problems with vehicles running over nests by was a big issue, especially near Akgöl lake where cars repeatedly drove over about nine nests. We placed big stones to the land side of the nests to prevent cars from driving over them, but these were often removed by visitors. We also digged a ditch to prevent cars from driving on to the beach, but within three days these was filled up again.

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http://marinebio.org/species.asp?id=163 (19.10.09)

Table 1a: Nest data Akgöl: Total number of eggs laid, empty egg shells in the nest, minimum and maximum hatched turtles, incubation and emerging duration in days, important dates (when laid/nest date, when started hatching/hatch date, excavation). Standard deviation, minimum and maximum numbers. No data (nd).
Tab. 1a: Nestdaten Akgöl: Anzahl der gesamten Eier (total eggs) und leeren Eischalen (total empty) in jedem Nest. Minimal geschlüpfte Junge sind die gezählten Spuren plus die lebenden Junge im Nest, maximal geschlüpfte Junge leeren Eischalen weniger den toten am Strand sowie im Nest und der gefressenen. Inkubationszeit, Schlüpfdauer (emerging days) in Tagen und die verschiedenen Daten der Nester. Gesamtzahlen (Total), Mittelwert (Mean) und Standardabweichung (SD) sowie Minimum und Maximum sind angegeben. Keine Daten (nd).

Akgöl Nest No	Total Eggs	Total Empty	Hatchling reaching the sea min.	max.	Incubation time	Nest date	Hatch date	Excavation Date	Emerging days
1	85	71	42	58	61	20.06.09	20.08.09	02.09.00	6
2	61	59	54	54	66	22.06.09	29.08.09	12.09.09	11
3	70	49	40	49	52	22.06.09	13.08.09	17.08.09	1
4	64	51	14	51	47	27.06.09	13.08.09	17.08.09	1
5	58	55	44	54	55	28.06.09	22.08.09	04.09.09	10
6	84	84	59	75	52	28.06.09	19.08.09	23.08.09	1
7	92	69	38	66	49	29.06.09	17.08.09	24.08.09	4
8	71	62	25	62	63	04.07.09	05.09.09	10.09.09	3
9H1	87	70	42	67	48	04.07.09	21.08.09	28.08.09	4
10	76	33	30	30	nd	nd	nd	Nd	nd
11	60	53	34	43	50	10.07.09	29.08.09	07.09.09	6
12	98	79	41	79	45	10.07.09	24.08.09	02.09.09	5
13	73	57	41	57	46	11.07.09	26.08.09	31.08.09	1
14	66	0	0	0	nd	21.07.09	nd	17.09.09	nd
15	69	29	25	25	nd	22.07.09	nd	Nd	nd
17	72	15	10	10	nd	24.07.09	nd	Nd	nd
A1	84	75	63	71			23.07.09	02.08.09	8
A2	90	71	40	70			21.08.09	04.09.09	10
A3	80	65	20	27			07.08.09	15.08.09	4
A4	72	58	45	43			01.08.09	08.08.09	4
A5	90	87	29	39			24.07.09	30.07.09	4
A6	60	51	49	50			06.08.09	18.08.09	8
A7	84	32	11	31			12.08.09	01.09.09	5
A8	74	14	14	14			nd	06.09.09	nd
A9	110	98	95	97			17.07.09	19.07.09	1
A10	84	78	54	54			18.07.09	24.07.09	3
A11	86	81	70	81			26.07.09	03.08.09	4
A12	103	90	73	80			28.07.09	05.08.09	4
A13	41	38	33	37			30.07.09	08.08.09	2
A14	42	22	16	20			17.08.09	22.08.09	3
A15	64	58	52	51			24.08.09	31.08.09	4
A16	78	43	35	40			25.08.09	03.09.09	6
Total	2428	1797	1238	1585					
Mean	75.88	56.16	38.69	49.53	52.83				4.56
SD ±	15.64	23.95	20.46	22.66	6.99				2.85
Min.	41	0	0	0	45				1
Max	110	98	95	97	66				11

Table 1b: Nest data Yaniklar.
Tab. 1b: Nestdaten Yaniklar.

Yaniklar Nest No	Total Eggs	Total Empty	Hatchling reaching the sea min.	max.	Incubation time	Nest date	Hatch date	Excavation Date	Emerging days
1	87	73	57	73	56	30.05.09	02.07.09	10.08.09	14
2	90	39	29	37	59	19.06.09	17.08.09	27.08.09	6
3	77	71	42	65	59	19.06.09	07.08.09	15.08.09	4
4	63	14	10	13	58	24.06.09	21.08.09	03.09.09	9
5	86	61	54	51	56	25.06.09	20.08.09	31.08.09	8
6	88	41	23	29	46	29.06.09	14.08.09	21.08.09	4
8	58	44	27	44	43	04.07.09	16.08.09	21.08.09	2
9H1	75	56	14	54	57	01.07.09	27.08.09	03.09.08	5
10	50	29	19	29	54	01.07.09	24.08.09	03.09.09	7
11	95	58	32	54	49	03.07.09	21.08.09	28.08.09	4
12	68	13	7	4	47	10.07.09	26.08.09	02.09.09	3
13	66	64	64	64	nd	11.07.09	nd	Nd	nd
14	92	82	68	81	59	11.07.09	08.09.09	17.09.09	nd
15	82	7	5	7	52	11.07.09	01.09.09	06.09.09	2
16	81	53	43	51	46	11.07.09	26.08.09	03.09.09	5
17	52	8	8	8	57	14.07.09	09.09.09	15.09.09	6
18	68	37	17	30	49	16.07.09	03.09.09	09.09.09	3
19	59	14	13	13	nd	22.07.09	nd	Nd	nd
20	54	1	1	1	nd	23.07.09	nd	Nd	nd
21	50	32	32	30	nd	23.07.09	nd	Nd	nd
Y1	96	34	13	34			08.08.09	20.08.09	10
Y2	106	56	27	45			05.08.09	13.08.09	5
Y3	94	32	5	12			28.07.09	05.08.09	2
Y4	76	0	0	0			nd	06.09.09	nd
Y5	76	74	66	66			01.08.09	10.08.09	7
Y6	88	70	23	70			29.07.09	05.08.09	2
Y7	96	32	26	22			26.07.09	18.08.09	19
Y8	69	68	44	66			11.08.09	18.08.09	4
Y9	103	96	59	91			27.07.09	08.08.09	8
Y10	62	50	50	48			24.07.09	10.08.09	13
Y11	88	84	72	66			02.08.09	13.08.09	2
Y12	78	41	19	28			03.08.09	10.08.09	4
Y13	97	86	49	84			16.07.09	21.07.09	4
Y14	77	73	35	49			25.07.09	05.08.09	6
Y15	72	11	11	4			15.08.09	30.08.09	11
Y16	42	8	8	8			nd	Nd	nd
Y17	109	96	52	91			22.07.09	30.07.09	7
Y18	81	76	71	72			23.07.09	04.08.09	7
Y19	78	71	61	61			05.08.09	16.08.09	7
Y20	79	55	38	53			11.08.09	21.08.09	5
S1	88	77	63	68			21.07.09	25.07.09	4
S2	66	57	41	56			11.08.09	16.08.09	2
Total	3262	2044	1398	1832					
Mean	77.67	48.67	33.29	43.62	52.94				6.03
SD ±	16.25	27.38	21.91	26.61	5.48				3.80
Min.	42	0	0	0	43				2
Max	109	96	72	91	59				19

Table 2a: Egg and hatchling data Akgöl: unfertilized and fertilized eggs, dead embryos in early, mid and late stage, living and dead hatchlings in the nest, predated hatchlings and eggs, hatchlings due to the sun. Standard deviation, minimum and maximum numbers.
Tab. 2a: Ei und Hatchling Daten Akgöl: Unbefruchtete (unfertil.) und befruchtete (fertiliz.) Eier, tote Embryos im Früh- (early), Mittel- (mid) und Spätstadion (late), lebende und tote Hatchlinge im Nest, Hatchlingspuren (tracks), erbeutete (predated) Eier und Hatchlinge, an Hitze verstorbene Hatchlinge (due to sun). Gesamtzahlen (Total), Mittelwert (Mean) und Standardabweichung (SD) sowie Minimum und Maximum sind angegeben.

Akgöl Nest No	**Unfertil.**	**Fertiliz**	**Early**	**Mid**	**Late**	**Living hatchling**	**Dead hatchling**	**Tracks**	**Predated hatchling**	**Due to sun**	**Predated egg**
1	4	81	2		8	24	13	18			
2		61	1		1		5	41			
3	1	69	13	1				40			6
4	2	62	2	1	7			14			1
5	2	56	1					43	1		
6		84				22	9	37			
7		92	13	1	2	3	3	35			7
8		71	3		6	3		22			
9H1	5	82	3		7	1	2	42	1		2
10		76	36	2	5	1	3				
11		60	5	1	1	26	10	20			
12	7	91	7		5			41			
13	3	70	2		11			41			
14		66	56								10
15		69	34	1	4	4	4				
17		72	52		5	1	5				
A1		84	6		2	12	4	51			1
A2		90	10	6	3	2	1	38			
A3	2	78	11	1	1	6	38	12			
A4	2	70			12	15	10	32	4	1	
A5		90	3			12	48	26			
A6		60	3	6			1	49			5
A7		84	11	9	30		1	6			2
A8	4	70	45	1	10						
A9	1	109	10		1	1		97		1	
A10	1	83	2		3	36	24	21			
A11	1	85	2		2	1		69			
A12	2	101	8		3	43	8	32	2		
A13		41	3			9	1	21			
A14		42	1		6	2	1	12		1	11
A15		64		1	5	23	7	14			
A16	8	70	5	6	14	13	3	20			2
Total	45	2383	350	37	154	260	201	894	8	3	47
Mean	3.00	74.47	12.07	2.85	6.16	11.82	9.14	33.11	2.00	1.00	4.70
SD ±	2.20	15.18	15.97	2.82	6.14	12.31	12.28	19.41	1.41	0.00	3.71
Min.	1	41	1	1	1	1	1	6	1	1	1
Max	8	109	56	9	30	43	48	97	4	1	11

Table 2b: Egg and hatchling data Yaniklar.
Tab. 2b: Ei und Hatchlings Daten Yaniklar.

Yaniklar Nest No	Unfertil.	Fertiliz	Early	Mid	Late	Hatchling alive	Dead hatchling	Tracks	Predated hatchling	Due to sun	Predated egg
1	1	86	6	2	1	4		52			4
2	4	86	19	2	2	2	2	27			21
3	2	75	2		2	4	3	36		3	8
4	7	56	17			1	1	9			25
5	2	84	7	6	3	33	6	21	4		7
6	1	87	14	2	13	1	10	21	2		17
8		58	1	2	3	2		25			8
9H1	4	71	7	2			2	13			6
10		50	8	1	2			19			10
11	2	93	9	1		10	4	15			25
12	4	64	11	6	8	2	4	8	3	2	27
13		66	2								
14	2	90	5		3	52	1	16			
15	7	75	21	7	11			5			29
16	10	71	11	2			1	43		1	5
17		52	12	1	3	3		4			25
18	1	67	20	1	9	6	7	11			11
19		59	23	7	4	1	1				11
20		54	28	4	8						13
21		50	3		15					2	
Y1		96	43	2	3	1		12			14
Y2		106	9	1	7	5	8	20		3	33
Y3	8	86	20	4	13	1	20	4			14
Y4	4	72	57	3	1						11
Y5		76				43	8	53			2
Y6	1	87	16					23			1
Y7	1	95	52	3	6	7	2	20	8		4
Y8		69				3	2	34			1
Y9		103	4		3	3		53	4	1	
Y10	1	61	2	3	2	2	1	63		1	4
Y11	2	86	1		1	65	18				
Y12	3	75	8	13	3	4	13	15			10
Y13		97	8	1		4	1	45	1		2
Y14	2	75			4	6	24	28			
Y15		72		5	2	6	7	9			54
Y16	1	41	7	4	10						13
Y17		109	7		4	14	5	39			2
Y18	1	80			2	5	3	52	1		2
Y19		78	2			1	3	64	7		5
Y20	1	78	18	2	1	2	2	23			1
S1		88	3		8	22	9	39			
S2	1	65			8	11		31	1		
Total	73	3189	483	87	165	326	168	952	31	13	425
Mean	2.92	75.93	13.42	3.35	5.16	10.19	6.00	27.20	3.44	1.86	12.50
SD ±	2.55	16.18	13.47	2.73	3.99	15.83	6.13	17.31	2.60	0.90	11.67
Min.	1	41	1	1	1	1	1	4	1	1	1
Max	10	109	57	13	15	65	24	64	8	3	54

Table 3: Nest measurments in Yaniklar and Akgöl: nest diameter (diam), depth to bottom of the chamber, wet and dry part of the sand. Distance to the sea (dts) and to the vegetation (dtv) in meters.
Tab 3: Nestmaße von Yaniklar und Akgöl in Meter: Nestdurchschnitt (Diam.), Tiefe (bottom of chamber), Nasser (wet) und trockener (dry) Sandanteil der Tiefe, Distanz zum Meer bzw. zur Vegetation.

Yaniklar Nest No	Diam.	Bottom of chamber	wet	dry	dts	dtv
1	0.28	0.57	0.26	0.31	12.2	1
2	0.3	0.51	0.2	0.39	15.4	0.1
3	0.23	0.56	0.3	0.26	36.8	3
4	0.27	0.47	0.28	0.19	16.2	7.2
5	0.27	0.53	0.28	0.25	16.4	2.3
6	0.25	0.44	0.13	0.31	27.45	3.8
8	0,26	0,40	0,21	0,19	34,3	2.1
9H1	0.25	0.53	0.27	0.26	10.9	5.4
10	0.21	0.50	0.19	0.31	11.4	1.9
11	0.28	0.46	0.13	0.33	17.2	0.1
12	0.32	0.45	0.24	0.21	31.9	0.1
13	0.22	0.46	0.33	0.13	13.2	
14	0.27	0.39	nd	nd	14.5	3.7
15	0.19	0.43	0.18	0.25	17.1	11.5
16	0.23	0.47	0.25	0.22	34.7	2.1
17	0.24	0.40	0.4	0	13.8	14.2
18	0.22	0.48	0.34	0.12	18.1	4.2
19	0.19	0.48	0.3	0.18	19.8	
20	0.19	0.36	0.22	0.14	9.2	
21	0.21	0.48	0.26	0.22	18.5	
Y1	0.3	0.42	0.27	0.15	17.5	0.85
Y2	0.24	0.56	0.42	0.14	15.6	0.1
Y3	0.19	0.55	0.24	0.31	19.6	14.5
Y4	0.25	0.38	0.13	0.25	17.07	7
Y5	0.33	0.47	0.32	0.15	22.8	6.3
Y6	0.18	0.45	0.25	0.2	18.6	9.5
Y7	0.21	0.55	0.33	0.22	11	14
Y8	0.19	0.54	0.32	0.22	16.7	6.9
Y9	0.28	0.57	0.34	0.23	14.3	3.8
Y10	0.27	0.52	0.26	0.26	19.2	0.2
Y11	0.24	0.47	0.29	0.18	15.5	9.5
Y12	0.22	0.45	0.24	0.21	28.3	2.2
Y13	0.22	0.38	0.24	0.14	33.3	1.3
Y14	0.28	0.49	0.19	0.3	34.2	4.7
Y15	0.26	0.40	0.19	0.21	18.9	1.2
Y16	0.22	0.39	0.25	0.14	14.8	
Y17	0.23	0.44	0.24	0.2		0.4
Y18	0.24	0.48	0.29	0.19	16.2	
Y19	0.25	0.50	0.3	0.2	21.5	10.6
Y20	0.24	0.40	0.22	0.18	18.5	3.5
S1	0.21	0.39	0.19	0.2	22	
S2	0.21	0.49	0.29	0.2	22.2	19.1
Mean	0.25	0.48	0.26	0.22	20.17	5.25
SD ±	0.04	0.06	0.07	0.07	7.26	4.96
Min.	0.18	0.36	0.13	0	9.2	0.1
Max.	0.33	0.57	0.42	0.39	36.8	19.1

Akgöl Nest No	Diam.	Bottom of chamber	wet	dry	dts	dtv
1	0.25	0.35	0.18	0.17	9.2	27
2	0.28	0.41	nd	nd	6.29	21.6
3	0.19	0.47	0.27	0.2	19.2	4.8
4	0.26	0.47	0.36	0.11	5.7	14.2
5	0.26	0.56	0.22	0.34	10.1	
6	0.28	0.47	0.35	0.12	82.4	0,3
7	0.33	0.46	0.12	0.34	9.5	
8	0.23	0.45	0.39	0.06	7.7	14.6
9H1	0.23	0.43	0.31	0.12	16.5	6.6
10	0.2	0.44	0.28	0.16	11.2	
11	0.24	0.47	0.23	0.24	12.9	33
12	0.27	0.44	0.22	0.22	8.9	49
13	0.25	0.44	0.17	0.24	17.8	14.6
14	0.16	0.47	nd	nd	22	10
15	0.22	0.47	0.3	0.17	57	
17	0.2	0.43	0.27	0.16	7.4	
A1	0.28	0.95	0.3	0.65	27	
A2	0.2	0.46	0.34	0.12	8.7	
A3	0.25	0.55	0.26	0.29	14.1	28.3
A4	0.28	0.58	0.28	0.3	36	13.5
A5	0.2	0.51	0.29	0.22	36.2	
A6	0.25	0.42	0.29	0.13	12.7	
A7	0.24	0.28	0.28	0.01	6.4	6.8
A8	0.22	0.39	0.2	0.19	15.9	
A9	0.19	0.61	0.4	0.21	31.6	5.8
A10	0.21	0.49	0.3	0.19	21	
A11	0.19	0.52	0.29	0.23	14.3	16.8
A12	0.26	0.36	0.23	0.13	15.4	22.3
A13	0.28	0.40	0.22	0.18	17.2	
A14	0.28	0.20	0.05	0.15	21.2	0.2
A15	0.25	0.37	0.19	0.18	11.3	22.1
A16	0.18	0.42	0.2	0.22	53.5	5.6
Mean	0.24	0.46	0.26	0.20	20.20	15.86
SD ±	0.04	0.12	0.08	0.11	16.98	12.17
Min.	0.16	0.2	0.05	0.01	5.7	0.2
Max	0.33	0.95	0.4	0.65	82.4	49

Temperature measurements in *Caretta caretta* nests at Yaniklar beach in Fethiye

Ricarda Höfle & Alexandra Mangold

KURZFASSUNG

Die Niststrände der Unechten Karettschildkröte (*Caretta caretta*) befinden sich im Mittelmeer hauptsächlich an den Küsten Griechenlands, der Türkei, Zyperns und Israels. Die Schildkröten graben Löcher in den Sand, in die sie dann ihre Eier legen. Die Temperatur im Nest spielt bei der Entwicklung der Eier eine wichtige Rolle.

Fünf Tiny Talks wurden am Strand in Yaniklar (Fethiye/Türkei) in fünf Nester eingegraben. Tiny Talks sind batteriebetriebene Temperatur-Sensoren, die die Nesttemperatur während der Inkubationszeit kontinuierlich messen und aufzeichnen. Tiny Talk Nr. 1, 2, 4, 5 und 6 wurden in die Nester Nr. 8, 9, 10, 11, 12 eingegraben. Es wurden 20 Messwerte pro Tag festgehalten. Um die Temperatur in den Nestern mit der Umgebungstemperatur vergleichen zu können, wurde die Lufttemperatur an diesem Strand, sowie einem benachbarten Strand in Calis regelmäßig um 6:00 Uhr morgens, 12:00 Uhr mittags sowie 22:00 Uhr abends gemessen.

Obwohl der Sand die Lufttemperaturschwankungen zwischen Tag und Nacht puffert, besteht eine positive Korrelation zwischen Luft- und Nesttemperatur. Die Temperatur in einem Nest wird aber auch durch die Tiefe in der die Eier vergraben sind, die Beschaffenheit des Bodens und andere Faktoren wie zum Beispiel die Distanz zwischen Nest und Meer bestimmt. Unsere Ergebnisse zeigen, dass eine geringfügige Änderung dieser Parameter die Nesttemperatur verändern kann. Das wiederum beeinflusst die Inkubationszeit und andere Parameter die mit der Entwicklung der Eier zusammenhängen.

ABSTRACT

In the Mediterranean Sea the Loggerhead sea turtles (*Caretta caretta*) mainly nest along the coasts of Greece, Turkey, Cyprus and Israel. The female turtles dig holes on the beach, in which they lay their eggs. The temperature is important for the development of the eggs.

We placed five Tiny Talks in five nests at the beach in Yaniklar (Fethiye/Turkey). Tiny Talks are electronic continuous-temperature recorders which record the nest temperature in

programmable intervals during the incubation time. Tiny Talk 1, 2, 4, 5 and 6 were placed in nest number 8, 9, 10, 11 and 12, respectively. Each day each Tiny Talk made 20 measurements. To be able to compare the air temperature with the nest temperature, the air temperature at the beach in Yaniklar and at the neighboring beach in Calis was recorded at 6:00, 12:00 and 22:00.

Although most of the temperature fluctuations between night and day are buffered by the sand, there is a correlation between nest and air temperature. The temperature in the nest is also influenced by the depth of the eggs, the quality of the substrate and other factors like the distance to the sea. Our studies show that minimal changes of these factors can influence the temperature of the nest. The temperature influences the incubation time and other parameters associated with egg development.

INTRODUCTION

Although air temperatures at night and during the day differ strongly, the difference between night and day in *Caretta caretta* nests is less distinct. This is due to the buffering nature of the sand and is very important because nest temperature has a major influence on the development of the hatchlings and the hatching success. Whether hatchlings survive and fully develop depends on the temperature.

Sea turtles are reptiles. Their sex is not predetermined chromosomally like in human beings. Like other reptile species they have a temperature-dependent sexual determination (TSD). That means that the sex ratio is defined by the temperature during embryonic development (Hawkes et al., 2007). The average temperature during the middle third of the incubation period influences the sex ratio the most (Kaska et al., 1998).

The constant pivotal temperature of 28.6 – 29.7 ° C leads to a 50% male : female ratio of hatchlings (Kaska et al., 1998). Warmer temperatures produce more females and cooler temperatures more males.

The temperature in the nest remains relatively constant compared with air temperatures. But the temperature within the clutch isn’t all the same. At the top of the nest, temperatures are warmer than at the bottom. Therefore there is a variation in sex ratio within the clutch (Kaska et al., 1998).

The incubation time of *Caretta caretta* is determined by the temperature in the nest. Loggerhead turtle eggs incubate from about 40 to 60 days. Higher temperatures lead to shorter incubation time. Shadows of vegetation, umbrellas and towels, bad weather, a deep position of the nest and a short distance to the sea can decrease the temperature in the nest (Johnston, 2007) increasing the incubation time. According to Kaska et al. (1998) the mean temperature over the entire incubation period can be used to predict the date of hatching.

Thus, development of hatchlings, sex ratio, incubation time and hatching success are directly associated with the temperature in the nest. That's why research into temperature is very important.

MATERIAL AND METHODS

The two investigated beaches, Yaniklar and Calis, are located near Fethiye. We measured the temperature of the air at both beaches and the temperature of 5 nests at Yaniklar beach.

Nest temperature measurements

We measured nest temperature only at Yaniklar beach. We equipped 5 nests with so-called Tiny Talks. These are small electronic sensors which record the temperature at specified intervals; our Tiny Talks were programmed at intervals of 72 minutes, so they recorded 20 measurements a day. The Tiny Talks stopped automatically when they were full - after 1800 measurements. At 20 measurements per day, they recorded for 90 days. We used them from early July to late September.

The sensors were put into sealed plastic film capsules to prevent damage and keep out moisture. In order to be able to recognize when the temperature measurements in the nests began and ended, the Tiny Talks were stored before and after the measurements for several hours in the refrigerator. This yielded obvious negative peaks in the curve. In the morning after the egg deposition, we put the Tiny Talks onto the topmost eggs of the nests.

On 4 July, Tiny Talk 1 was put into nest number 11 and it recorded until 28 August. Tiny Talk 2 was buried on 25 July in nest number 8 and recorded until 17 September. Tiny Talk 4 measured the temperature of nest number 9 and Tiny Talk 5 of nest number 10. Both measured for 64 days from 2 July to 3 September. Tiny Talk 6 was put into nest number 12 on 11 July and measured the temperature until 2 September.

Air temperature measurement

We measured the air temperature at both beaches – Yaniklar and Calis. We measured the temperature every day at 6:00, 12:00 and 22:00, in Yaniklar from 6 July to 18 September and in Calis from 5 July to 4 September. We used a digital thermometer which was placed in the sun at the beach and not in the shade in the camp. Also the wind conditions were noted and, if visible, the phase of the moon.

The Tiny Talk data were downloaded with the program Logger Manager OTML (Orion Tiny Logger manager) and the software Tinytag Explorer – Version 4.6. Tables and graphics for the comparison of the data were constructed with Microsoft Excel.

Tab. 1: Übersicht der Tiny Talk Daten
Table 1: Overview of data and mode of Tiny Talks

Logger	TT 1	TT 2	TT 4	TT 5	TT 6
type	Orion Tinytalk 1	Tinytalk II - 40/75(125)°C	TK-4014	TK-4014	TK-4014
property	Temperature	Temperature	Temperature	Temperature	Temperature
serial number	30915	45920	382882	382879	382968
capacity	1800	1800	1800	1800	1800
title	2009TT1	2009TT2	2009TT4	2009TT5	2009TT6
interval	1h 12min	1h 12min	1h 12min	1h 12min	1h 12min
total measurements	1797	1800	1800	1800	1800
total measurements in nest	1101	1087	1260	1262	1060
first measurement in nest	04.07.2009	25.07.2009	02.07.2009	02.07.2009	11.07.2009
last measurement in nest	28.08.2009	17.09.2009	03.09.2009	03.09.2009	02.09.2009
temperature in nest (°C)					
min.	27	28.8	26.7	27.4	29.8
max.	32.9	31.1	30.8	29.9	34
average	30.4	30.1	29.1	28.9	32.0
nest information					
nest number	11	8	9	10	12
nest date	03.07.2009	04.07.2009	01.07.2009	01.07.2009	10.07.2009
hatch date	23.08.2009	16.08.2009	27.08.2009	24.08.2009	26.08.2009
incubation time	49	43	57	54	47
depth of top eggs	0.33	0.19	0.26	0.31	

Tab. 1: Übersicht der Tiny Talk Daten
Table 1: (Continue) Overview of data and mode of Tiny Talks

Logger	TT 1	TT 2	TT 4	TT 5	TT 6
total depth	0.46	0.4	0.53	0.5	
diametre of chamber	0.28	0.26	0.25	0.21	
distance to the sea	17.2	34.3	10.9	11.4	
hatchlings information					
total number of eggs	95	58	75	50	68
unfertilized	2	0	4	0	4
early embryo	9	1	7	8	11
mid embryo	1	2	2	1	6
late embryo	0	3	0	2	8
predated eggs	25	8	6	10	27
empty egg shells	58	44	56	29	13
dead hatchlings	4	0	2	0	9
max. number of hatchlings reaching the sea	54	44	54	29	4

RESULTS

Nest temperature

Figures 1-5 show the course of the temperature in the 5 nests equipped with Tiny Talks. In all nests, daily fluctuations are visible. In every nest the temperature was the lowest in July. The temperature increased constantly until the second half of August. At the last few days of August the temperature in the nests decreased.

Figure 1 shows the temperature course of nest number 11, recorded by Tiny Talk 1 from 4.7. to 28.8.2009. Temperature minimum was reached with 27.0 °C at the first day of the measurement and the maximum was reached with 32.9 °C at 24.8.2009 (fig. 1).

Figure 2 shows the temperature course of nest number 8, recorded by Tiny Talk 2. The measurements in the nest took place between 25.7. and 17.9.2009. Temperature minimum was reached with 28.8 °C at the beginning of the measurement and the maximum was reached with 31.1 °C between 7 and 17 September (fig. 2).

The course of the temperature in figure 3 was recorded by Tiny Talk 4 in nest number 9. Measurements extended from 2 July to 3 September. Temperature minimum was reached with 26.7 °C on 2 July and the maximum was reached with 30.8 °C on 21 August (fig. 3).

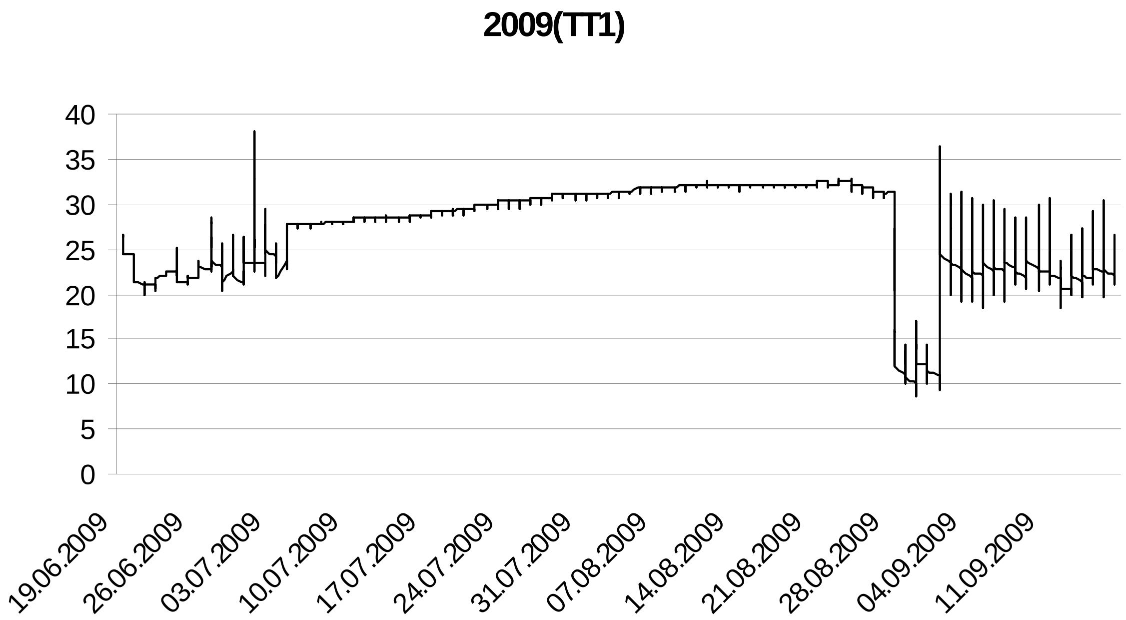

Abb. 1: Verlauf der Nesttemperatur von Nest Nummer 11 von Anfang Juli bis Ende August.
Fig. 1: Temperature course in nest number 11 from early July to late August.

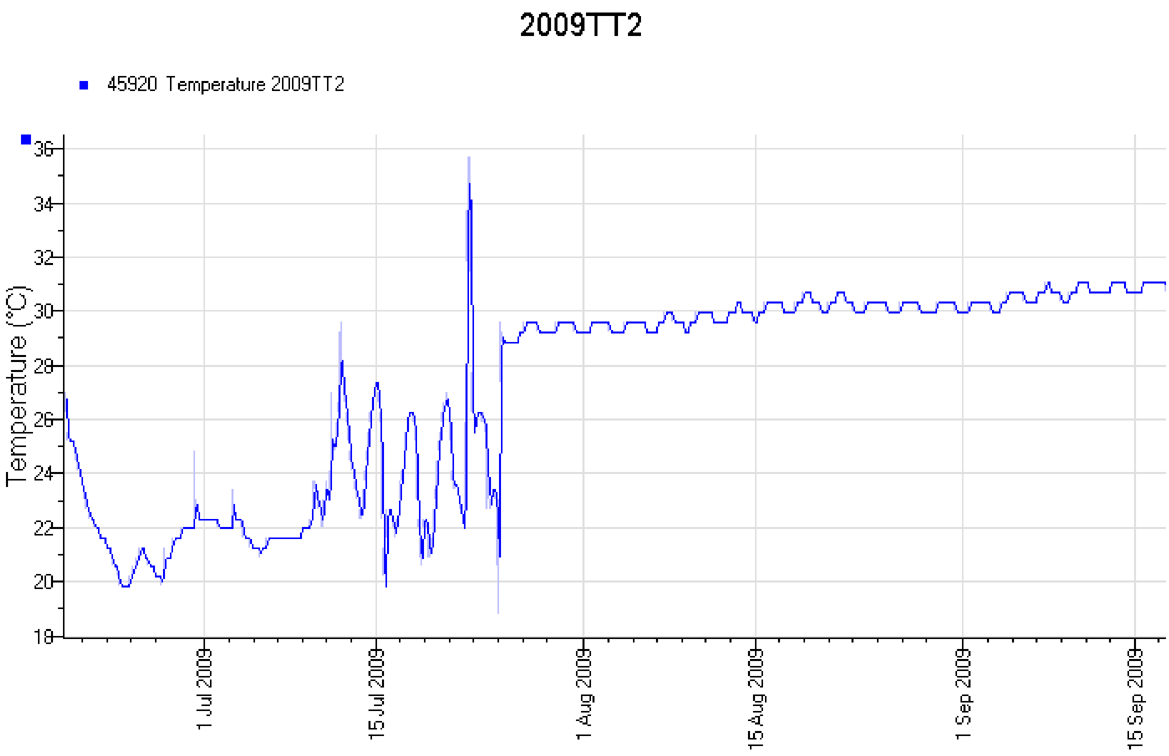

Abb. 2: Verlauf der Nesttemperatur von Nest Nummer 8 von Ende Juli bis Mitte September.
Fig. 2: Temperature course in nest number 8 from late June to mid-September.

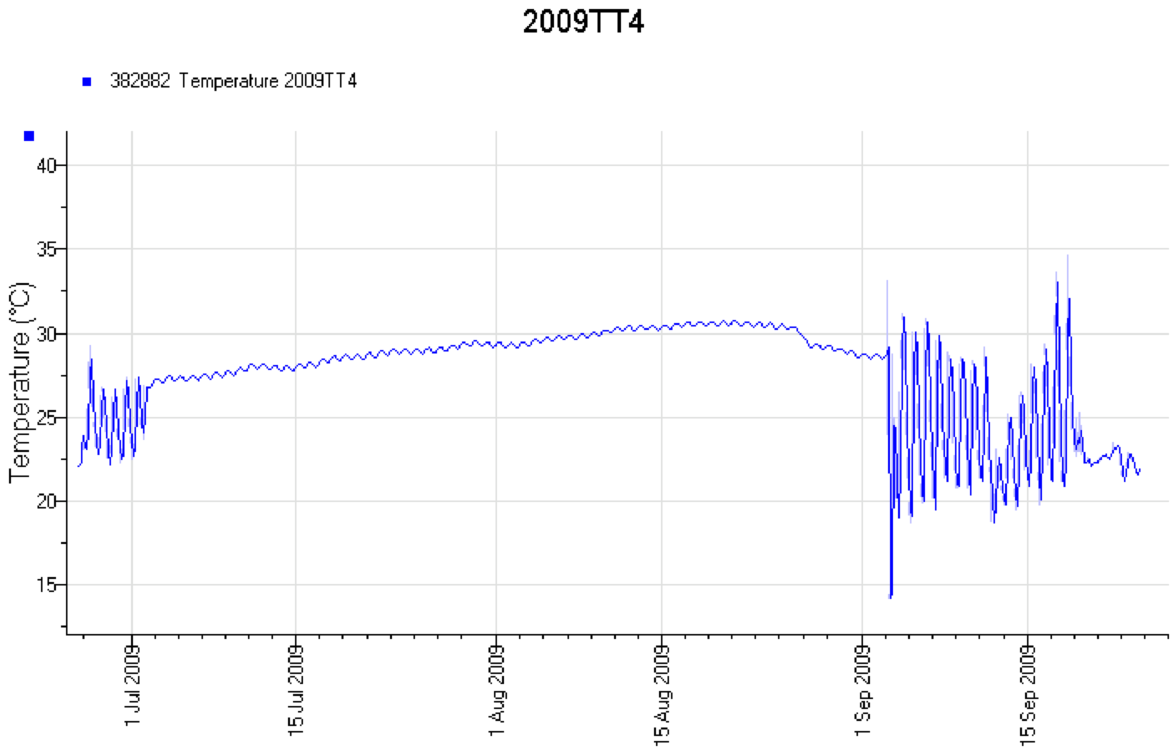

Abb. 3: Verlauf der Nesttemperatur von Nest Nummer 9 von Anfang Juli bis Anfang September.
Fig. 3: Temperature course in nest number 8 from early July to early September.

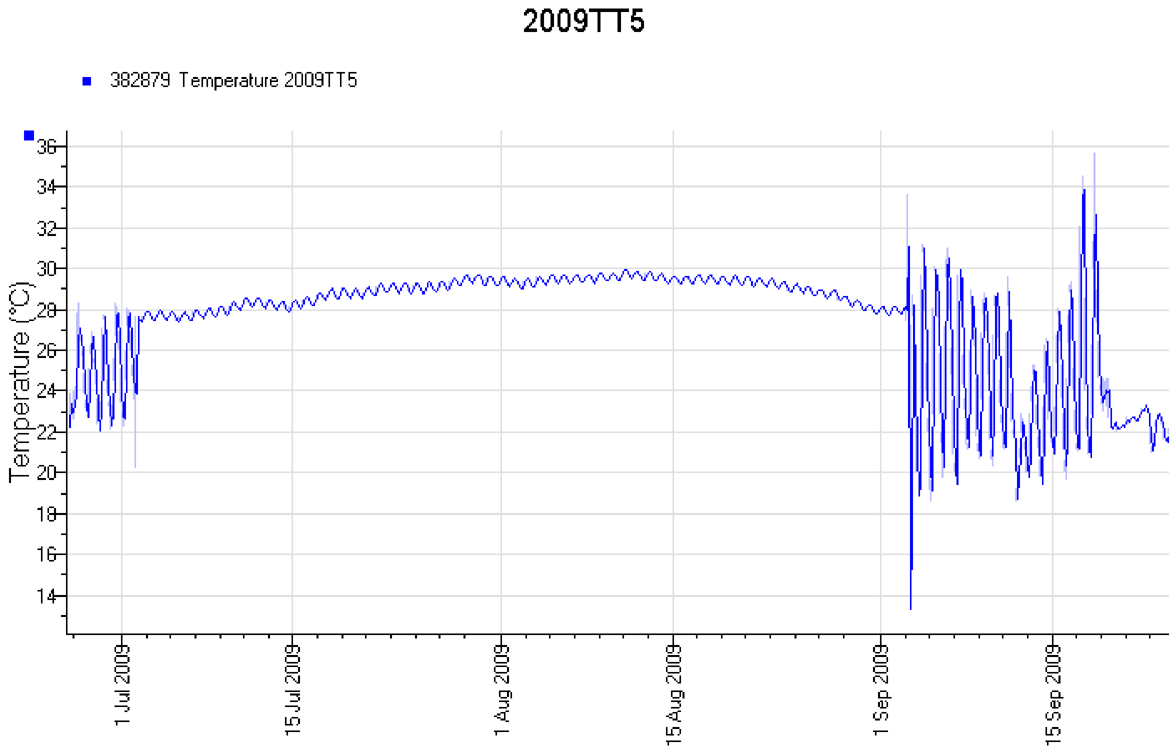

Abb. 4: Verlauf der Nesttemperatur von Nest Nummer 10 von Anfang Juli bis Anfang September.
Fig. 4: Temperature course in nest number 10 from early July to early September.

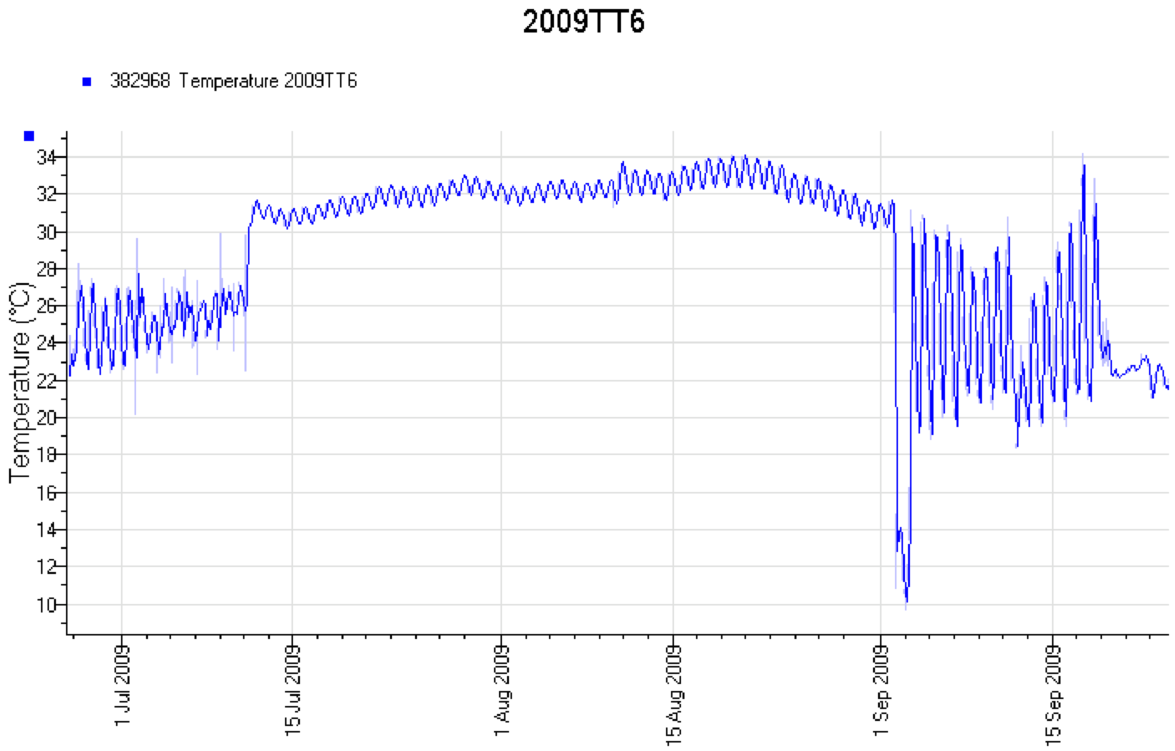

Abb. 5: Verlauf der Nesttemperatur von Nest Nummer 12 von Mitte Juli bis Anfang September.
Fig. 5: Temperature course in nest number 12 from mid-July to early September.

Figure 4 shows the temperature course of nest number 10, recorded by Tiny Talk 5. Measurements in the nest took place between 2 July and 3 September. Temperature minimum was reached with 27.4 °C at the first day of the measurement. The maximum was reached with 29.9 °C at 11 August (fig. 4).

The course of the temperature in figure 5 was recorded by Tiny Talk 6 in nest number 12. Measurements in the nest took place between 11 July and 2 September. Temperature minimum was reached with 29.8 °C at the end of August and the maximum was reached with 34.0 °C at 19 and 20 August (fig. 5).

Air temperature

The air temperature was measured at both beaches at 6:00, 12:00 and 22:00. See Annex 1 and 2 for the air temperature measurements, the wind strength and the phase of the moon. Annex 1 shows all data of Calis taken from 5 July to 4 September. Annex 2 shows all data of Yaniklar taken from 6 July to 18 September.

Figure 6 shows the course of air temperature at Yaniklar beach. The peaks result from the fluctuation during day. The higher values represent the measurements from 12:00, the lower ones represent the temperatures measured at 06:00. The measurements from 22:00 lie between these two values. The fluctuation between the average daily minimum (20.3 °C) and average daily maximum (41.3 °C) is about 21 °C. In July the temperature was high and relatively constant. On 26 July the maximum was reached with 47.4 °C. On 1 August temperature dropped somewhat for about one week. From mid-August to early September the temperature increased again and remained constant. From 8 September on, the temperature decreased again. The average value from July to mid-September was 28.6 °C.

Figure 7 shows the air temperatures at Calis beach. The fluctuation between the mean daily maximum (36.8 °C) and the mean daily minimum temperature (25.0 °C) is about 11.7 °C. The temperature course remained relatively stabile from July to mid-August. On 31 July and 1 August there was a short drop in temperature. At the end of August the temperature decreased. The maximum was reached with 45.4 °C on 11 July. The average value from July to September was 30.2 °C.

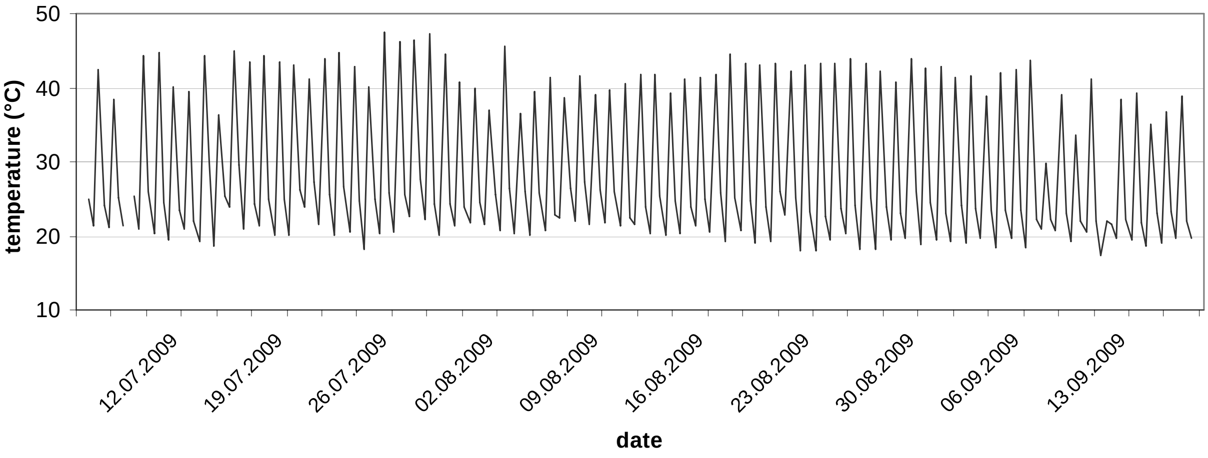

Abb. 6: Verlauf der Lufttemperatur in Yaniklar von Juli bis Mitte September.
Fig. 6: Course of the air temperature in Yaniklar from July to mid-September.

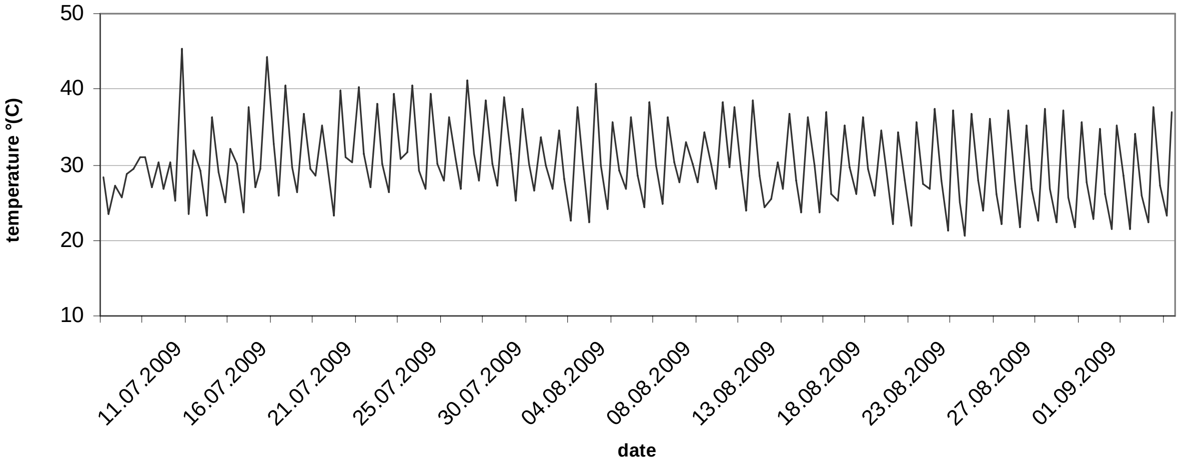

Abb. 7: Verlauf der Lufttemperatur in Calis während der Monate Juli, August und bis Mitte September.
Fig. 7: Course oft he air temperature in Calis during July, August and until mid-September.

Figure 8 compares the course of the air temperature at Yaniklar and Calis. At Yaniklar beach the temperature had stronger daily fluctuation than at Calis beach. In Yaniklar the fluctuation between the average daily minimum and average daily maximum was about 21 °C and in Calis it was about 11.7 °C. In Calis the average temperature of July, August and September is 30.2 °C and in Yaniklar it is 28.6 °C (tab. 2). On 1 August the temperature dropped at both beaches because the wind was stormy (black arrow in fig. 8).

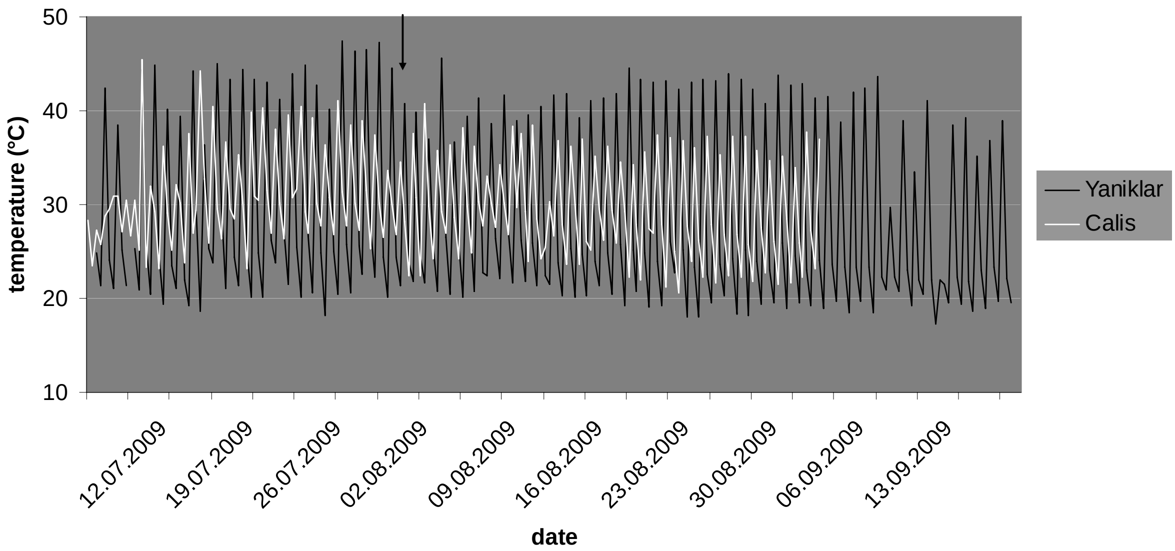

Abb. 8: Vergleich der Lufttemp. in Calis und Yaniklar. Schwarzer Pfeil zeigt einen Temperatureinbruch.
Fig. 8: Comparison of air temperatures in Calis and Yaniklar. Black arrow shows a drop of temperature.

In conclusion at Yaniklar beach the mean temperature is colder than at Calis beach and there is a stronger fluctuation during the day. Weather conditions like stormy wind influence the temperature at both beaches.

Tabelle 2: Vergleich der Temperaturdaten von Yaniklar und Calis
Table 2: Comparison of air temperature measurements at Yaniklar and Calis

	Yaniklar	Calis
maximum temperature / date	47.4 °C / 26.7.	45.4 °C / 11.7.
average temperature	28.6 °C	30.2 °C
average daily maximum	41.3 °C	36.8 °C
average daily minimum	20.3 °C	25.0 °C
mean fluctuation	21.0 °C	11.7 °C

Comparison of air temperature and nest temperature

Figure 9 combines the course of nest temperatures of Tiny Talk 2 (nest 8), 4 (nest 9), 5 (nest 10) and 6 (nest 12). The values from Tiny Talk 1 (nest 11) are not included because the data were downloaded with different software.

The temperature courses of Tiny Talk 4 (nest 9) and 5 (nest 10) were very similar. Tiny Talk 6 (nest 12) measured the highest temperatures. Nest 12 was therefore the warmest clutch, with an average temperature of 32.0 °C (tab. 1).

The comparison of the air temperature and the temperatures in the nests shows the correlation between the two. The temperature increased in July and dropped on 1 August because of stormy wind (black arrow in figure 8). Concurrently, the temperature in nests 8, 9, 10, 12 decreased on that day (black arrows in figure 9). In nest 11 the temperature neither decreased nor increased, i.e. it temporarily flattened before later continuing to climb (fig. 1).

Figure 10 shows a detail of the temperature course of nest number 9 in the night from 27 to 28 August. Although the temperature at night wasn't colder than on other nights, the nest temperature dropped about 1 °C. Interestingly exactly on this night the nest started to hatch.

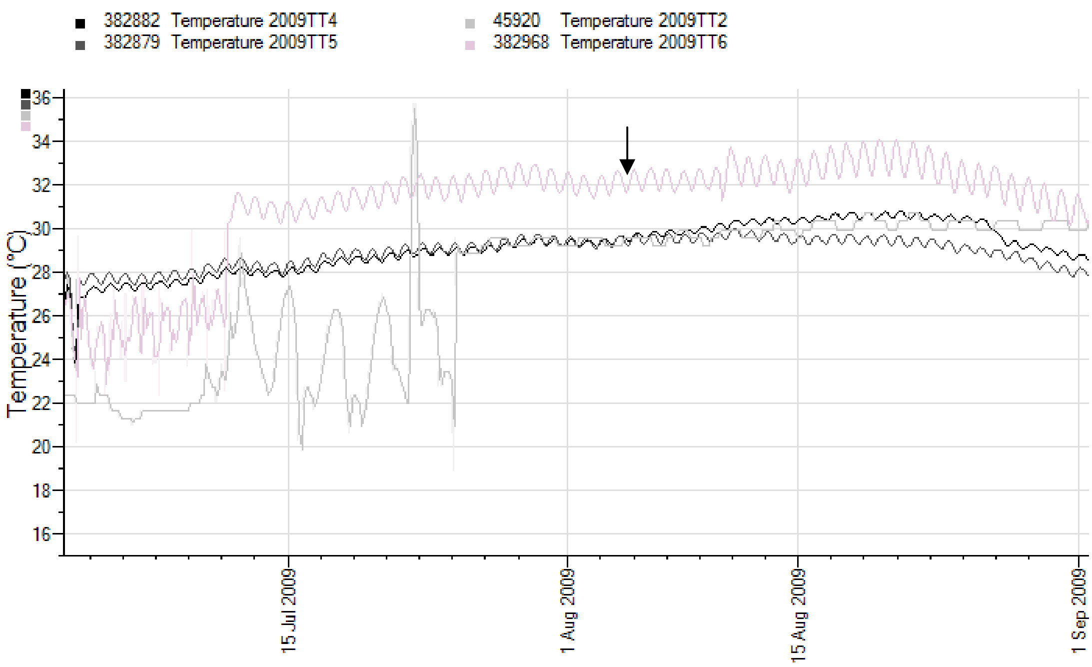

Abb. 9: Vergleich der Nesttemperaturen in Nest Nummer 8 (TT2), 9 (TT4), 10 (TT5) und 12 (TT6). Der schwarze Pfeil zeigt einen Temperaturabfall.
Fig. 9: Comparison of the nest temperatures in nest number 8 (TT2), 9 (TT4), 10 (TT5) and 12 (TT6). Black arrow shows a drop of temperature.

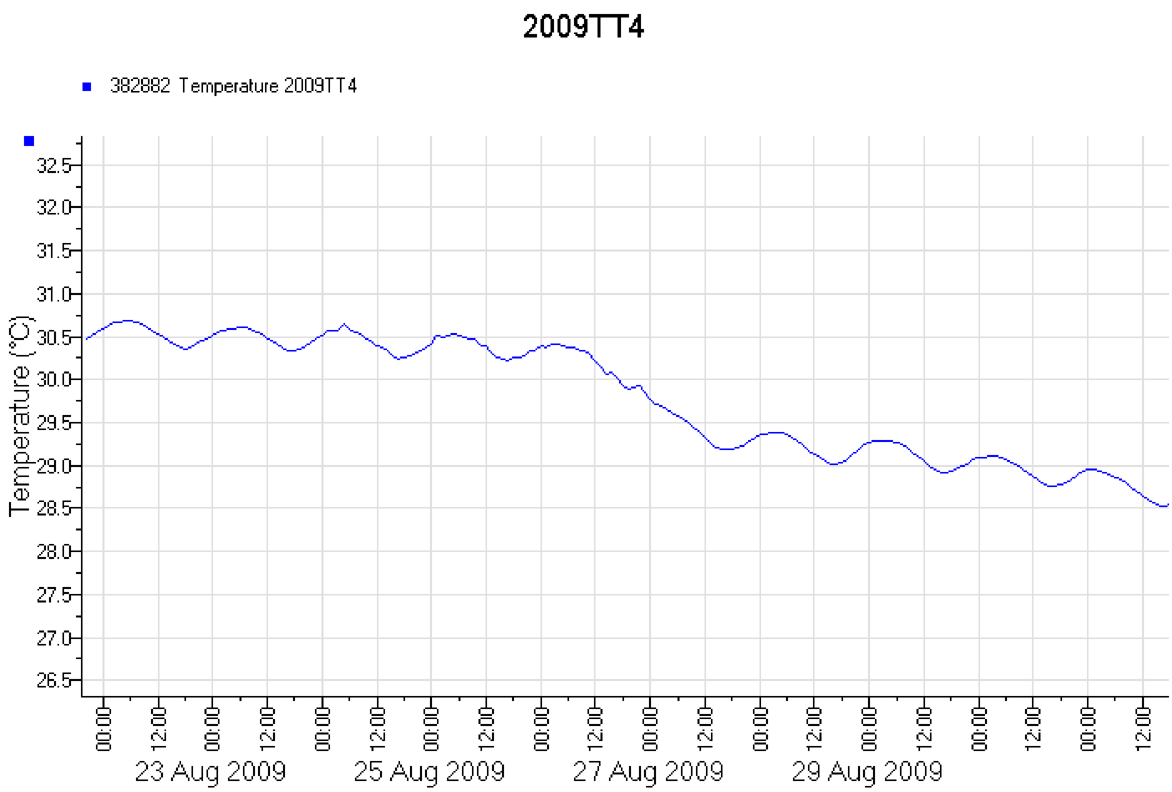

Abb. 10: Ausschnitt des Temperaturabfalls von Nest 9 (Tiny Talk 4) zum Zeitpunkt des Schlüpfens.
Fig. 10: Detail of the temperature drop in nest 9 (Tiny Talk 4) on hatching date.

Tab. 3: Übersicht der Durchschnittstemperaturen der Nester sowie die Inkubationsdauer.
table 3: Overview of the mean temperatures in nests and the incubation time.

nest	average Temperature (°C)	incubation time (days)
nest 10	28.9	54
nest 9	29.1	57
nest 8	30.1	47
nest 11	30.4	49
nest 12	32	47

We would expect that the higher the mean temperature in the nest, the shorter the incubation time, but such a correlation is difficult to examine based on only 5 sets of data. Nonetheless, a potential correlation is evident: nests with temperatures above 30°C had clearly shorter incubation times that those with temperature below 30°C (fig. 11).

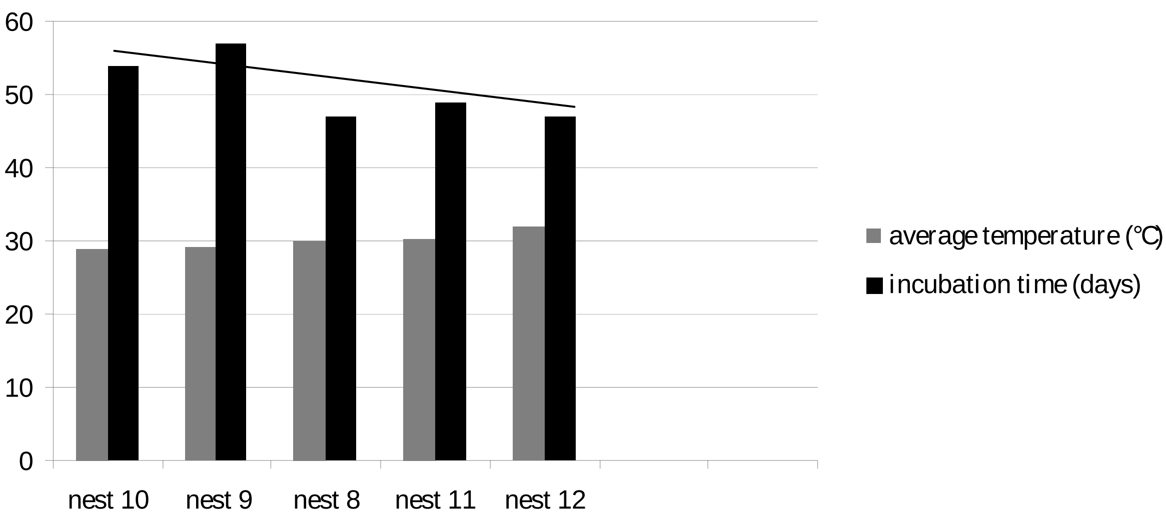

Abb.11: Trend zw. Durchschnittstemp. im Nest und Inkubationszeit (Trendlinie nach Augenmaß)
Fig. 11: Trend between mean nest temperature and incubation time (trend line fitted by eye)

DISCUSSION

Air temperature and the temperature in the nests correlate, although most of the temperature fluctuations are buffered by the sand. A representative example for this correlation is the measurements of 1 August. On this day the air temperature decreased by about 5 °C because of stormy wind. This caused a negative peak in the temperature courses of the nests.

According to Kaska et al. (1998) the mean temperature in the nest can be used to predict the date of hatching. Higher mean temperatures lead to shorter incubation times and lower mean temperatures cause longer incubation times. This is clearly evident in the comparison of nests number 9 and 12. In the former the average temperature was 29.1 °C and the incubation period lasted 57 days. In the later the average temperature was 32 °C and the incubation time lasted 47 days. Nests with temperatures above 30°C had clearly shorter incubation times that those with temperature below 30°C (table 3).

In comparing the location of the nests, we note that nests 9 and 10, which both were located on sandy substrate, were very similar in their incubation times and nest temperatures. The other nests (8, 11, 12) were situated on substrates more or less covered with vegetation. The plants may have influenced the depth of the nests, because in comparing the five nests, those in sandy ground (9,10) were placed deeper in the sand than the other nests (8,11,12). The depth of nests number 9 and 10 leads to a lower mean temperature and a longer incubation time (table 1).

Our study clearly reveals that air temperature significantly affects the development of hatchlings. That is why phenomena like Global Warming could have an enormous effect on the reproduction of thermally sensitive species like the loggerhead sea turtle. This makes research on this topic increasingly important.

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ANNEX

Anhang 1: Lufttemperaturmessungen, Windstärke und Mondphase in Calis.
Annex 1: Air temperature measurements, wind strength and moon phase in Calis.

Date	Time	Temperature	Wind	Moon
05.07.2009	22:05	28,4	calm	-1d full moon
06.07.2009	06:24	23,5	light	n.v.
06.07.2009	22:00	27,2	light	full
07.07.2009	06:18	25,7		n.v.
07.07.2009	22:01	28,8	light	+1d full moon
08.07.2009	06:00	29,5	calm	n.v.
08.07.2009	12:00	30,9		n.v.
08.07.2009	21:58	30,9	light	+2d full moon
09.07.2009	05:54	27,1	calm	n.v.
09.07.2009	21:56	30,4	calm	n.v.
10.07.2009	06:15	26,7	calm	n.v.
10.07.2009	22:06	30,4	light	3/4
11.07.2009	06:00	25,2	calm	3/4
11.07.2009	11:55	45,4	light	n.v.
12.07.2009	06:08	23,4	calm	2/3
12.07.2009	12:00	31,9	heavy	2/3
12.07.2009	21:54	29,3	light	n.v.
13.07.2009	06:07	23,2	calm	1/2
13.07.2009	11:58	36,2	heavy	1/2
13.07.2009	21:54	29,1	calm	n.v.
14.07.2009	06:06	25,1	calm	1/2
14.07.2009	12:06	32,1	calm	n.v.
14.07.2009	22:10	30,1	heavy	1/2
15.07.2009	06:11	23,8	light	1/2
15.07.2009	11:59	37,6	light	1/2
15.07.2009	21:59	27,0	light	n.v.
16.07.2009	06:17	29,4	light	1/2
16.07.2009	12:10	44,3	light	n.v.
16.07.2009	22:04	32,8	light	n.v.
17.07.2009	06:02	25,9	calm	1/2
17.07.2009	12:00	40,4	light	n.v.
17.07.2009	21:59	29,6	light	n.v.
18.07.2009	05:57	26,3	calm	new
18.07.2009	11:59	36,7	light	n.v.
18.07.2009	21:58	29,5	calm	n.v.
19.07.2009	05:58	28,5	calm	new
19.07.2009	11:58	35,3	light	n.v.
19.07.2009	22:10	30,1	calm	n.v.
20.07.2009	06:04	23,2	calm	n.v.
20.07.2009	12:30	39,8	light	n.v.
20.07.2009	21:58	30,9	calm	n.v.
21.07.2009	06:26	30,4	light	n.v.
21.07.2009	11:47	40,3	light	n.v.
21.07.2009	21:55	31,5	calm	n.v.
22.07.2009	06:14	27,0	calm	n.v.
22.07.2009	12:00	38,1	calm	n.v.
22.07.2009	21:57	30,2	light	n.v.

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23.07.2009	06:03	26,4	calm	n.v.
23.07.2009	11:55	39,5	light	n.v.
23.07.2009	21:55	30,8	calm	n.v.
24.07.2009	05:56	31,7	light	n.v.
24.07.2009	11:54	40,5	heavy	n.v.
24.07.2009	22:03	29,3	calm	n.v.
25.07.2009	05:53	26,9	calm	n.v.
25.07.2009	12:01	39,3	light	n.v.
25.07.2009	22:05	30,2	calm	1/4
26.07.2009	06:01	27,8	calm	n.v.
26.07.2009	11:46	36,4	light	n.v.
26.07.2009	21:58	30,8	calm	1/4
27.07.2009	06:05	26,8	calm	n.v.
27.07.2009	12:02	41,1	calm	n.v.
27.07.2009	22:00	31,4	light	1/2
28.07.2009	06:10	27,8	calm	n.v.
28.07.2009	12:00	38,5	light	n.v.
28.07.2009	22:05	30,1	light	1/2
29.07.2009	06:03	27,2	calm	n.v.
29.07.2009	12:00	39,0	light	n.v.
29.07.2009	21:57	31,5	calm	1/2
30.07.2009	06:20	25,3	calm	n.v.
30.07.2009	12:03	37,5	heavy	n.v.
30.07.2009	21:51	30,1	calm	1/2
31.07.2009	06:00	26,5	calm	n.v.
31.07.2009	12:00	33,7	light	1/2
31.07.2009	21:54	30,0	light	1/2
01.08.2009	05:42	26,8	calm	n.v.
01.08.2009	12:06	34,6	heavy	n.v.
01.08.2009	22:02	28,2	calm	1/2
02.08.2009	06:00	22,5	calm	n.v.
02.08.2009	12:15	37,6	light	n.v.
02.08.2009	22:01	30,7	calm	3/4
03.08.2009	05:41	22,4	calm	n.v.
03.08.2009	12:08	40,8	light	n.v.
03.08.2009	22:01	29,9	light	full
04.08.2009	06:00	24,2	calm	n.v.
04.08.2009	11:16	35,7	light	n.v.
04.08.2009	22:03	29,3	calm	full
05.08.2009	05:57	26,9	calm	n.v.
05.08.2009	12:10	36,4	light	n.v.
05.08.2009	22:00	28,6	calm	full
06.08.2009	06:01	24,3	light	full
06.08.2009	11:59	38,2	heavy	n.v.
06.08.2009	21:56	29,9	calm	full
07.08.2009	06:03	24,8	calm	full
07.08.2009	12:15	36,2	light	n.v.
07.08.2009	22:08	30,3	calm	full
08.08.2009	05:51	27,7	calm	full
08.08.2009	11:58	33,0	light	n.v.
08.08.2009	22:03	30,1	calm	n.v.

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09.08.2009	05:50	27,6	calm	full
09.08.2009	12:05	34,2	calm	n.v.
09.08.2009	22:04	30,2	calm	full
10.09.2009	05:57	26,8	calm	3/4
10.09.2009	12:05	38,3	light	n.v.
10.09.2009	22:00	29,7	calm	n.v.
11.08.2009	12:15	37,6	calm	n.v.
11.08.2009	22:00	29,2	calm	n.v.
12.08.2009	05:55	23,9	calm	1/2
12.08.2009	12:05	38,5	light	n.v.
12.08.2009	22:06	28,5	calm	n.v.
13.08.2009	05:55	24,3	calm	1/2
13.08.2009	12:00	25,4	calm	n.v.
13.08.2009	22:04	30,3	calm	n.v.
14.08.2009	05:59	26,7	calm	1/2
14.08.2009	11:58	36,8	light	1/2
14.08.2009	22:01	27,9	calm	n.v.
15.08.2009	05:55	23,7	calm	n.v.
15.08.2009	12:00	36,2	calm	n.v.
15.08.2009	21:58	30,0	calm	n.v.
16.08.2009	06:04	23,7	calm	1/4
16.08.2009	12:04	37,0	calm	1/4
16.08.2009	22:02	26,1	calm	n.v.
17.08.2009	06:07	25,2	calm	1/4
17.08.2009	12:04	35,1	light	n.v.
17.08.2009	22:02	29,6	calm	n.v.
18.08.2009	06:09	26,2	calm	new
18.08.2009	12:02	36,2	calm	n.v.
18.08.2009	22:00	29,4	calm	n.v.
19.08.2009	06:04	25,9	calm	n.v.
19.08.2009	12:01	34,6	light	n.v.
19.08.2009	21:59	29,2	calm	n.v.
20.08.2009	06:02	22,2	calm	n.v.
20.08.2009	12:02	34,2	calm	n.v.
20.08.2009	22:03	27,9	calm	n.v.
21.08.2009	06:05	21,9	calm	n.v.
21.08.2009	11:55	35,6	light	n.v.
21.08.2009	22:01	27,4	calm	n.v.
22.08.2009	06:03	26,9	calm	n.v.
22.08.2009	12:00	37,4	calm	n.v.
22.08.2009	22:00	27,9	calm	n.v.
23.08.2009	06:05	21,2	calm	n.v.
23.08.2009	12:01	37,1	calm	n.v.
23.08.2009	22:01	25,0	calm	1/4
24.08.2009	06:08	20,6	calm	n.v.
24.08.2009	12:10	36,8	calm	n.v.
24.08.2009	22:02	27,8	calm	n.v.
25.08.2009	06:20	23,9	calm	n.v.
25.08.2009	12:01	36,1	light	n.v.
25.08.2009	22:00	26,2	calm	n.v.

Anhang 1: Lufttemperaturmessungen, Windstärke und Mondphase in Calis.
Annex 1: Air temperature measurements, wind strength and moon phase in Calis.

26.08.2009	06:08	22,2	calm	n.v.
26.08.2009	12:15	37,2	light	n.v.
26.08.2009	21:57	27,9	light	1/2
27.08.2009	06:19	21,7	calm	n.v.
27.08.2009	11:58	35,3	light	n.v.
27.08.2009	22:01	26,8	calm	1/2
28.08.2009	06:09	22,5	calm	n.v.
28.08.2009	12:20	37,3	light	n.v.
28.08.2009	22:03	26,8	calm	1/2
29.08.2009	06:29	22,3	calm	n.v.
29.08.2009	13:00	37,2	calm	n.v.
29.08.2009	22:01	25,8	calm	3/4
30.08.2009	06:15	21,8	calm	n.v.
30.08.2009	12:10	35,7	calm	n.v.
30.08.2009	22:00	27,6	calm	3/4
31.08.2009	06:29	22,8	calm	n.v.
31.08.2009	12:10	34,7	light	n.v.
31.08.2009	22:00	26,1	calm	3/4
01.09.2009	06:20	21,5	calm	n.v.
01.09.2009	12:03	35,1	calm	n.v.
01.09.2009	22:06	28,5	calm	3/4
02.09.2009	06:58	21,6	calm	n.v.
02.09.2009	12:08	34,0	calm	n.v.
02.09.2009	22:01	25,9	calm	full
03.09.2009	06:32	22,3	calm	n.v.
03.09.2009	12:08	37,7	light	n.v.
03.09.2009	22:04	27,3	calm	full
04.09.2009	06:32	23,2	calm	n.v.
04.09.2009	12:27	36,9	light	n.v.

Anhang 2: Lufttemperaturmessungen, Windstärke und Mondphase in Yaniklar.
Annex 2: Air temperature measurements, wind strength and moon phase in Yaniklar.

Date	Time	Temperature	Wind	Moon
06.07.2009	22:00	24,9	calm	full
07.07.2009	06:00	21,4	calm	n.v.
07.07.2009	12:00	42,4	light	n.v.
07.07.2009	22:00	24,1	calm	full
08.07.2009	06:00	21,1	calm	full
08.07.2009	12:00	38,5	heavy	full
08.07.2009	22:00	25,1	calm	full
09.07.2009	06:00	21,4	calm	full
09.07.2009	12:00			
09.07.2009	22:00	25,3	light	3/4
10.07.2009	06:00	20,9		3/4
10.07.2009	12:00	44,4	light	3/4
10.07.2009	22:00	25,9	calm	3/4

Anhang 2: Lufttemperaturmessungen, Windstärke und Mondphase in Yaniklar
Annex 2: Air temperature measurements, wind strength and moon phase in Yaniklar

11.07.2009	06:00	20,4	calm	3/4
11.07.2009	12:00	44,8	heavy	3/4
11.07.2009	22:00	24,6	light	3/4
12.07.2009	06:00	19,4	calm	3/4
12.07.2009	12:00	40,1	heavy	3/4
12.07.2009	22:00	23,5	calm	3/4
13.07.2009	06:00	21	calm	3/4
13.07.2009	12:00	39,4	heavy	3/4
13.07.2009	22:00	21,9	light	3/4
14.07.2009	06:00	19,3	calm	3/4
14.07.2009	12:00	44,3	light	3/4
14.07.2009	22:00	30	light	1/2
15.07.2009	06:00	18,7	calm	1/2
15.07.2009	12:00	36,4	light	1/2
15.07.2009	22:00	25,3	calm	1/2
16.07.2009	06:00	23,8	calm	1/2
16.07.2009	12:00	45	light	
16.07.2009	22:00	29,6	heavy	n.v.
17.07.2009	06:00	21	calm	
17.07.2009	12:00	43,4	light	
17.07.2009	22:00	24,4	calm	n.v.
18.07.2009	06:00	21,3	calm	
18.07.2009	12:00	44,4	heavy	
18.07.2009	22:00	24,9	calm	n.v.
19.07.2009	06:00	20,1	calm	
19.07.2009	12:00	43,4	heavy	1/2
19.07.2009	22:00	24,9	light	
20.07.2009	06:00	20,2	calm	
20.07.2009	12:00	43	light	
20.07.2009	22:00	26,2	light	n.v.
21.07.2009	06:00	23,8	calm	n.v.
21.07.2009	12:00	41,2	calm	n.v.
21.07.2009	22:00	27,3	calm	n.v.
22.07.2009	06:00	21,5	calm	
22.07.2009	12:00	43,9	calm	
22.07.2009	22:00	25,5	light	n.v.
23.07.2009	06:00	20,1	calm	n.v.
23.07.2009	12:00	44,8	light	n.v.
23.07.2009	22:00	26,6	calm	n.v.
24.07.2009	06:00	20,6	calm	n.v.
24.07.2009	12:00	42,8	heavy	n.v.
24.07.2009	22:00	24,8	light	new

Anhang 2: Lufttemperaturmessungen, Windstärke und Mondphase in Yaniklar
Annex 2: Air temperature measurements, wind strength and moon phase in Yaniklar

25.07.2009	06:00	18,2	calm	n.v.
25.07.2009	12:00	40,2	light	n.v.
25.07.2009	22:00	25	light	n.v.
26.07.2009	06:00	20,4	calm	n.v.
26.07.2009	12:00	47,4	light	n.v.
26.07.2009	22:00	25,7	calm	1/4
27.07.2009	06:00	20,6	calm	1/4
27.07.2009	12:00	46,3	light	n.v.
27.07.2009	22:00	25,6	calm	1/4
28.07.2009	06:00	22,6	calm	1/4
28.07.2009	12:00	46,5	light	n.v.
28.07.2009	22:00	27,6	calm	1/2
29.07.2009	06:00	22,2	light	n.v.
29.07.2009	12:00	47,3	light	1/2
29.07.2009	22:00	24,4	calm	1/2
30.07.2009	06:00	20,2	calm	1/2
30.07.2009	12:00	44,6	light	1/2
30.07.2009	22:00	24,4	calm	1/2
31.07.2009	06:00	21,3	calm	n.v.
31.07.2009	12:00	40,7	light	n.v.
31.07.2009	22:00	23,8	calm	1/2
01.08.2009	06:00	21,8	calm	n.v.
01.08.2009	12:00	39,8	heavy	n.v.
01.08.2009	22:00	24,5	calm	3/4
02.08.2009	06:00	21,6	calm	n.v.
02.08.2009	12:00	36,9	light	n.v.
02.08.2009	22:00	25,6	calm	3/4
03.08.2009	06:00	20,8	light	n.v.
03.08.2009	12:00	45,6	calm	n.v.
03.08.2009	22:00	26,5	calm	3/4
04.08.2009	06:00	20,4	calm	n.v.
04.08.2009	12:00	36,6	light	n.v.
04.08.2009	22:00	25,9	calm	full
05.08.2009	06:00	20,2	calm	full
05.08.2009	12:00	39,4	heavy	full
05.08.2009	22:00	25,7	calm	full
06.08.2009	06:00	20,8	calm	full
06.08.2009	12:00	41,3	light	full
06.08.2009	22:00	22,8	calm	full
07.08.2009	06:00	22,5	calm	full
07.08.2009	12:00	38,7	light	full
07.08.2009	22:00	26,4	calm	full

Anhang 2: Lufttemperaturmessungen, Windstärke und Mondphase in Yaniklar
Annex 2: Air temperature measurements, wind strength and moon phase in Yaniklar

08.08.2009	06:00	22,1	calm	3/4
08.08.2009	12:00	41,6	light	3/4
08.08.2009	22:00	27,2	light	3/4
09.08.2009	06:00	21,6	calm	3/4
09.08.2009	12:00	39	calm	3/4
09.08.2009	22:00	26,2	calm	n.v.
10.08.2009	06:00	21,8	calm	3/4
10.08.2009	12:00	39,6	light	n.v.
10.08.2009	22:00	25,9	calm	n.v.
11.08.2009	06:00	21,4	calm	3/4
11.08.2009	12:00	40,5	light	3/4
11.08.2009	22:00	22,4	calm	3/4
12.08.2009	06:00	21,5	light	1/2
12.08.2009	12:00	41,7	light	1/2
12.08.2009	22:00	23,8	light	1/2
13.08.2009	06:00	20,3	calm	1/2
13.08.2009	12:00	41,8	light	1/2
13.08.2009	22:00	25,3	calm	1/2
14.08.2009	06:00	20,1	calm	1/4
14.08.2009	12:00	39,3	light	1/4
14.08.2009	22:00	24,7	light	1/4
15.08.2009	06:00	20,3	calm	1/4
15.08.2009	12:00	41,1	light	1/4
15.08.2009	22:00	23,9	calm	1/4
16.08.2009	06:00	21,3	calm	1/4
16.08.2009	12:00	41,4	light	n.v.
16.08.2009	22:00	24,9	calm	new
17.08.2009	06:00	20,5	calm	new
17.08.2009	12:00	41,8	light	new
17.08.2009	22:00	25,7	calm	new
18.08.2009	06:00	19,3	calm	1/4
18.08.2009	12:00	44,5	light	1/4
18.08.2009	22:00	25,2	calm	1/4
19.08.2009	06:00	20,8	calm	1/4
19.08.2009	12:00	43,3	light	1/4
19.08.2009	22:00	24,8	calm	1/4
20.08.2009	06:00	19,1	calm	1/4
20.08.2009	12:00	43,1	light	n.v.
20.08.2009	22:00	23,9	calm	n.v.
21.08.2009	06:00	19,3	calm	1/4
21.08.2009	12:00	43,2	light	1/4
21.08.2009	22:00	26	calm	n.v.

Anhang 2: Lufttemperaturmessungen, Windstärke und Mondphase in Yaniklar.
Annex 2: Air temperature measurements, wind strength and moon phase in Yaniklar.

22.08.2009	06:00	22,8	calm	n.v.
22.08.2009	12:00	42,3	light	n.v.
22.08.2009	22:00	25,1	calm	n.v.
23.08.2009	06:00	18,1	calm	n.v.
23.08.2009	12:00	43,1	light	n.v.
23.08.2009	22:00	23,3	calm	n.v.
24.08.2009	06:00	18,1	calm	n.v.
24.08.2009	12:00	43,3	light	n.v.
24.08.2009	22:00	22,6	calm	n.v.
25.08.2009	06:00	19,5	calm	1/4
25.08.2009	12:00	43,2	light	1/4
25.08.2009	22:00	23,7	light	1/4
26.08.2009	06:00	20,3	calm	1/4
26.08.2009	12:00	43,9	light	1/4
26.08.2009	22:00	24,2	calm	1/4
27.08.2009	06:00	18,3	calm	1/2
27.08.2009	12:00	43,3	light	1/2
27.08.2009	22:00	25,1	light	1/2
28.08.2009	06:00	18,2	calm	1/2
28.08.2009	12:00	42,3	light	1/2
28.08.2009	22:00	23,9	calm	1/2
29.08.2009	06:00	19,4	calm	1/2
29.08.2009	12:00	40,7	light	1/2
29.08.2009	22:00	23,1	light	1/2
30.08.2009	06:00	19,6	calm	1/2
30.08.2009	12:00	43,8	light	1/2
30.08.2009	22:00	25,9	calm	1/2
31.08.2009	06:00	18,9	calm	3/4
31.08.2009	12:00	42,7	heavy	3/4
31.08.2009	22:00	24,5	calm	3/4
01.09.2009	06:00	19,5	calm	n.v.
01.09.2009	12:00	42,9	light	n.v.
01.09.2009	22:00	23,1	calm	3/4
02.09.2009	06:00	19,2	calm	3/4
02.09.2009	12:00	41,3	heavy	3/4
02.09.2009	22:00	24,1	calm	3/4
03.09.2009	06:00	19	light	3/4
03.09.2009	12:00	41,5	light	3/4
03.09.2009	22:00	23,6	calm	full
04.09.2009	06:00	19,7	light	full
04.09.2009	12:00	38,8	light	n.v.
04.09.2009	22:00	23,4	light	full

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05.09.2009	06:00	18,5	calm	full
05.09.2009	12:00	41,9	light	full
05.09.2009	22:00	23,4	calm	full
06.09.2009	06:00	19,7	light	full
06.09.2009	12:00	42,4	light	full
06.09.2009	22:00	23,4	light	full
07.09.2009	06:00	18,5	light	3/4
07.09.2009	12:00	43,7	light	3/4
07.09.2009	22:00	22,3	light	3/4
08.09.2009	06:00	20,9	light	3/4
08.09.2009	12:00	29,7	light	3/4
08.09.2009	22:00	22,2	light	3/4
09.09.2009	06:00	20,8	calm	3/4
09.09.2009	12:00	39	heavy	3/4
09.09.2009	22:00	23,1	light	3/4
10.09.2009	06:00	19,3	light	1/2
10.09.2009	12:00	33,5	light	1/2
10.09.2009	22:00	21,9	calm	1/2
11.09.2009	06:00	20,5	calm	1/2
11.09.2009	12:00	41,1	calm	1/2
11.09.2009	22:00	21,9	light	1/2
12.09.2009	06:00	17,3	calm	1/2
12.09.2009	12:00	21,9	calm	1/2
12.09.2009	22:00	21,5	calm	1/2
13.09.2009	06:00	19,6	calm	1/4
13.09.2009	12:00	38,5	light	n.v.
13.09.2009	22:00	22,3	light	n.v.
14.09.2009	06:00	19,4	calm	n.v.
14.09.2009	12:00	39,3	calm	n.v.
14.09.2009	22:00	21,8	calm	n.v.
15.09.2009	06:00	18,6	light	n.v.
15.09.2009	12:00	35,1	calm	n.v.
15.09.2009	22:00	23	calm	n.v.
16.09.2009	06:00	19	calm	n.v.
16.09.2009	12:00	36,8	light	n.v.
16.09.2009	22:00	23,3	calm	n.v.
17.09.2009	06:00	19,7	calm	n.v.
17.09.2009	12:00	38,9	light	n.v.
17.09.2009	22:00	22,1	calm	n.v.
18.09.2009	06:00	19,6	calm	n.v.