Bachelor Thesis

Nesting behavior and disturbances in Yaniklar, Turkey

Nistverhalten und Störungen in Yaniklar, Türkei

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KURZFASSUNG

Caretta caretta ist eine der sieben Arten der Meeresschildkröten, die in einem Zyklus von 2 bis 3 Jahren an ihren Geburtsstrand zurückkehrt, um dort ihre eigenen Eier abzulegen. Zu beobachten sind mehrere einzelne Nistphasen, die charakteristisch für jede Schildkrötenart sind. Am Strand von Yaniklar in der Türkei wurden im Juli 2012 sechs adulte Meeresschildkröten beobachtet, die einzelnen Phasen mit einer Stoppuhr gemessen und analysiert. Da hier auch der Tourismus zu finden ist, werden die scheuen Tiere häufig bei der Eiablage gestört. Nur eine von den sechs Unechten Karettschildkröten zeigte ein komplettes Ethogramm einer nistenden Meeresschildkröte, die anderen fünf Tiere wurden wahrscheinlich durch anthropogenen Einfluss gestört und kehrten zurück in das Meer ohne Eier zu legen. Daher ist es wichtig, die Touristen sowie auch die Einheimischen über die Lebensweiße dieser Tiere zu informieren und zu erklären wie man sich in der Zeit der Eiablage verhält, bzw. Schilder aufzustellen, um wichtige Verhaltensregeln für die Menschen an den Nistplätzen deutlich zu machen. Dadurch könnte ein respektvoller Umgang mit der Natur zustande kommen und somit auch eine stressfreie Eiablage der *Caretta caretta* gewährleistet werden.

ABSTRACT

Caretta caretta is one of the seven species of sea turtles. The females return in a cycle of 2 to 3 years to their beach of birth to lay their own eggs. Nesting activity is divided into particular phases, which are characteristic for each sea turtle species. On the beach of Yaniklar in Turkey in July 2012, six adult female sea turtles were observed. The individual phases were timed with a stopwatch and analyzed. Due to a range of human activities, mostly related to tourism, the animals are apparently frequently disturbed during egg laying. Just one of the six observed female loggerheads showed the complete ethogramm of a nesting sea turtle; the other five animals returned to the sea without digging a nest. This makes it important to inform the tourists and the local residents about sea turtles and to explain how to behave during the nesting season. Signboards can help to show the correct behavior for visitors on the nesting areas. The goal is a respectful interaction with nature and consequently a stress-free egg deposition.

INTRODUCTION

The loggerhead sea turtle, *Caretta caretta*, inhabits warm, temperate and subtropical areas, including the Mediterranean Sea. In two- to three-year cycles, the females come back from the foraging areas to the region of their birth (philopatry) and select the best nesting site to lay their eggs in clutches on the beach. In this study we observed two different beaches on the Turkish southwest coast in Yaniklar near the city Fethiye. Here, the nesting season is between June and mid-August. Nesting of the loggerhead sea turtle takes place at night and involves stereotypical action patterns in a fixed sequence. Bustard et al. (1975) described the nesting behavior in different phases, which were modified for this study:

(1) Ascent to the beach, (2) Walking over the beach, (3) Digging a body pit, (4) Digging an egg chamber, (5) Oviposition (6) Fill the egg chamber, (7) Camouflaging, (8) Return to surf. Between these stages, turtles also tend to make pauses. According to Heilman and Elowson (1992) there are three types of breaks: The "Postrate pause", when the turtle emerges, the head horizontal pause, and the head raised pause. The whole behavior of the sea turtles varies between species and even among single individuals.

Nesting beaches tend to be sandy, wide open and fronted by a flat approach from the sea. The correlations between successful nesting attempts and environmental measures such as sand temperature, moisture content, as well as physical and chemical characteristics are very important to understand the behavior of these animals. Commonly, 10-75% of the nesting attempts are unsuccessful and in the majority of cases without an observable reason (Dodd 1988). The cues that discourage nesting could also encompass the inconsiderate actions of tourists and local residents, for example artificial light from the bars and hotels, loud music, garbage and people on the beach, including those making bonfires and barbecuing during nesting time. (Ehrhart et al.1996) In this study an effort is made to evaluate the behavior of the adult female sea turtles that have emerged on the beach and to examine the potential external influences. The goal is to learn more about how to promote the successful nesting of sea turtles.

METHODS

The study site was a beach on the southwest coast of the Turkey, at a small village named Yaniklar near Fethiye. Two beach sections were observed from late June to mid-July. The first beach zone is named Akgöl and is about 1.5 km long. It is also a popular tourist region The shoreline is characterized by many sandy places, but also zones with pebbles. The vegetation is very scanty and about 30 to 40 m away from the sea.

The second part of the beach named Yaniklar is divided in two sections – a touristic and a natural part. The first section contains two big hotels named here in short Tuana and Botanika, where many sunbeds and umbrellas are positioned on the beach. During daytime many people lie on the beach, swim or do water sport activities such as jet skiing.

The second section is a long stretch without any tourism. It is about 4 km long and has mostly a steep approach to the sea, whereby the initial pebbly substrate is followed by a sandy strip; 10 to 20 m from the sea the vegetation begins. This part has no hotels and few artificial lights; nonetheless, the city Fethiye is visible from the beach at night because of its strong light pollution (Fig. 8). Large sections of this beach are rarely visited by tourists. At the end of the beach facing Calis and Fethiye, however, is a section visited by beach-goers, named the "Karatas beach or Small Beach", where people come during daytime to swim.

The turtles were observed at night between 22:00 and 2:00, relying on moonlight for illumination. Both beaches were patrolled, excluding the so-called picnic area of the beach of Yaniklar.

The observers patrolled side by side in short distances to each other to check the whole beach width to increase the chance to see a turtle. If a turtle emerged onto the beach, the observers sat or lay on the sand to minimize disturbances. At this time a stopwatch was switched on to characterize, classify and note the behavior of the female turtle. Until she began laying her eggs into the nest, the observers remained at least 10 m away. Only one of six turtles laid eggs. At this time, when the eggs are falling into the sand cavity, it was possible to approach the animal: the turtle won't stop nesting at this stage.

When the turtle started to return to the sea, the carapace width and length were measured with a tape rule and a caliper. On the next day the length of the tracks, the number of body pits, and potential incomplete egg chambers were noted and sketched. (Fig. 2- 6)

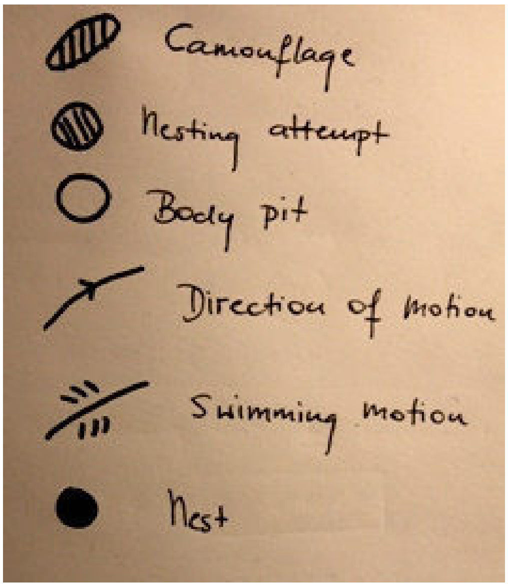

Fig. 1: Legend of the sketched drawings of the nesting behavior of the single turtles
Abb. 1: Legende der skizzierten Zeichnungen des Nistverhaltens der einzelnen Schildkröten

At most, five people in dark clothing (to minimize the contrast) went on these monitoring patrols. Flashlights were used only when measuring the animals.

RESULTS

On the nightshifts from 7 July to 14 July, six turtles emerged, one on the beach of Yaniklar and 5 on the beach of Akgöl. Only one of them showed the complete ethogramm of an egg-laying turtle. Draft versions of the track shapes and the behavior were drawn.

1. Site: Akgöl on 7 July 2012; Time: 00:50

The time of emergence from the water and the time spent wandering over the beach was not determinable because she was laying eggs at the time of sighting. The timetable therefore begins at the act of oviposition. The beach was very sandy, with no stones.

Tab. 1. Duration of nesting phases of sea turtle number 1
Tab. 1. Dauer der Nistphasen der Meeresschildkröte Nummer 1

PHASE	**TIME (min)**
Lay eggs	19.0
Close egg chamber	6.3
Camouflage	18.1
Return to the surf	2. 5
	Total: 46. 3

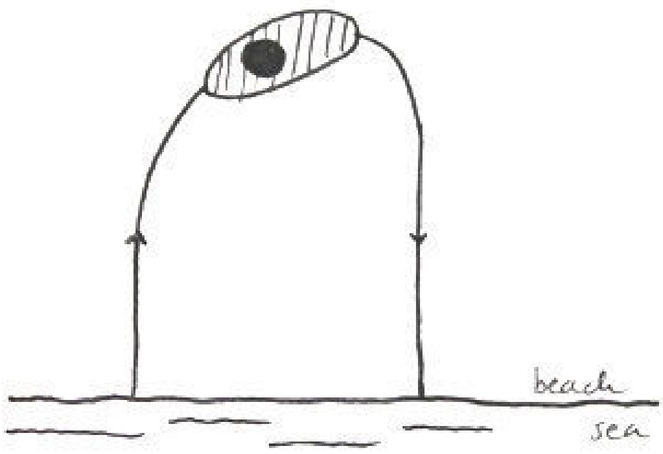

Fig. 2: Track shape and nesting behavior of loggerhead sea turtle number 1
Abb. 2: Spur und Nistverhalten der Unechten Karettschildkröte Nummer 1

Table 1 shows that the turtle needed 46.3 min for the monitored nesting behavior.
The distance she crawled was 38.2 m and the nest distance to the sea was 13.7 m. Other features were the U-shaped track and the large camouflage area, for which she needed 18.1 min. (Fig. 2) The nest received the number A4.

2. Site: Akgöl on 9 July 2012; Time: 00:20

This was the first turtle observed that did not lay eggs. She made five successive body pits, whereby the fourth one was a nesting attempt (based on the characteristic movements of the hindlimbs) (Fig. 11). After 17 minutes she stopped digging and made a head raised pause of 1.5 min (Tab. 2). At the same time some plastic bags and a plastic bottle were blown by because of the wind. She turned around, crawled 2 m, making a last body pit on the way back to the sea as she was leaving the beach.

Tab. 2. Duration of nesting phases of sea turtle number 2
Tab. 2. Dauer der Nistphasen der Meeresschildkröte Nummer 2

PHASE	**TIME(min)**
Ascent to the beach	2.5
Body pits (3)	9.4
Attempt to dig an egg chamber	5.0
Break	1.5
Body Pit	3.1
Return to the surf	1.3
	Total: 24

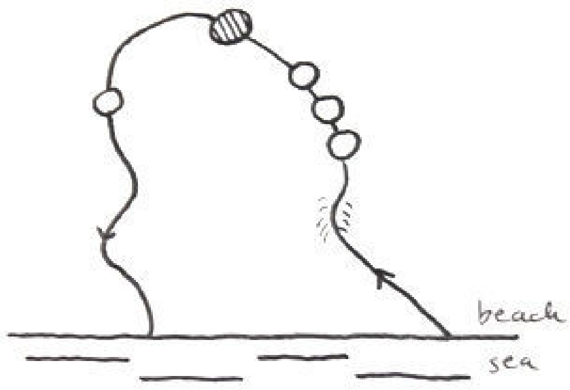

Fig. 3: Track shape and nesting behavior of loggerhead sea turtle number 2

Abb. 3: Spur und Nistverhalten der Unechten Karettschildkröte Nummer 2

For the first three body pits the female took 9.45 min. Fig. 1 shows that there were three contiguous body pits. The mean time required for a body pit was 3.15 min. (Tab. 1). The total distance crawled was 46.1 m.

3. Site: Yaniklar on 9 July 2012; Time: 10:45 pm

The beach was very stony with some sandy spots in between. After 6.5 min this turtle made the first body pit; after several seconds she made another one, after which she went back to the water. There were no recognizable disturbances at that time. Total distance crawled way length was 43.5 m (Fig. 4).

Tab. 3. Duration of nesting phases of sea turtle number 3

Tab. 3. Dauer der Nistphasen der Meeresschildkröte Nummer 3

PHASE	**TIME (min)**
Ascent to the beach	6.5
Break	1.2
Body pit	3.5
Body pit	3
Return to the surf	2.5
	Total: 17.5

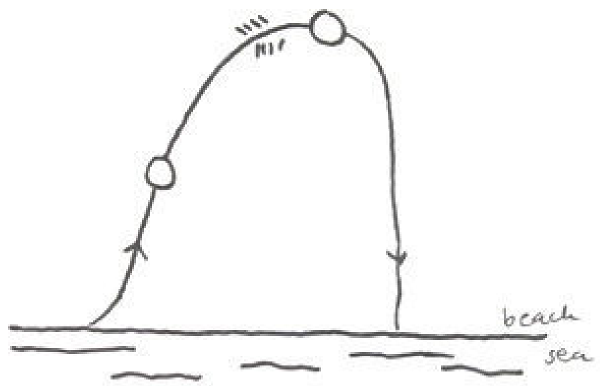

Fig. 4: Track shape and nesting behavior of loggerhead sea turtle number 3
Abb. 4: Spur und Nistverhalten der Unechten Karettschildkröte Nummer 3

4. Site: Akgöl on 10 July 2012; Time: 1:15

The substrate was very course here, with big stones, no sand. The turtle crawled to the vegetation zone. The closest hotel, Tuana, was 100 m away. She made one nest-digging attempt, but stoppedg because of plant roots, garbage and dead plants (Fig. 5). The total path was 63.3 m. After the attempt, she went back to the ocean. At the time of emergence, two persons were sitting on the beach near the turtle's point of emergence.

Tab. 4. Duration of nesting phases of sea turtle number 4
Tab. 4. Dauer der Nistphasen der Meeresschildkröte Nummer 4

PHASE	**TIME (min)**
Ascent to the beach	9.1
Attempt to dig egg chamber	11.3
Return to the surf	5.5
	Total: 26. 3

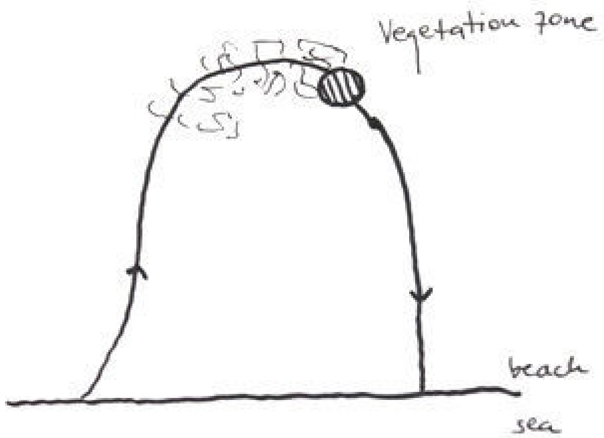

Fig. 5: Track shape and nesting behavior of the loggerhead sea turtle number 4
Abb. 5: Spur und Nistverhalten der Unechten Karettschildkröte Nummer 4

5. Site: Akgöl on 11 July 2012; Time: 0:10

This turtle was discovered on her way up the beach. At this time the distance to the sea was about 10 m. She crawled a few meters, then stopped. At the same time, 5 young people came with the lights of their mobile phones turned on. Talking and hearing music, they passed by the emerging turtle. Immediately the turtle turned around and went back to the sea. The time on the beach was at most 7 minutes, and the distance to the beach and back to the sea overall amounted to 29.3 m. There was no body pit or attempt to make a nest. This was the only turtle that went back along the same track she made when she came out of the water.

6. Site: Akgöl on 14 July 2012; Time: 1:00

The ascending turtle initially crawled more or less parallel to the waterline to make one body pit, then wandered straight ahead into the dark vegetation zone. There she stayed for a long pause (> 8 min). At the same time a car, with its lights turned on, arrived on the middle of the beach with at least 4 occupants. These people were very noisy and listening to loud music. The turtle turned around and went back to the sea. The overall distance crawled was 63.3 m. The substrate consisted mostly of pebbles with some sandy places.

Tab. 5. Duration of nesting phases of sea turtle number 6
Tab. 5. Dauer der Nistphasen der Meeresschildkröte Nummer 6

PHASE	TIME (min)
Ascent to the beach	4. 5
Body pit	2
Pause	8. 2
Return to the surf	4. 2
	Total: 19.3

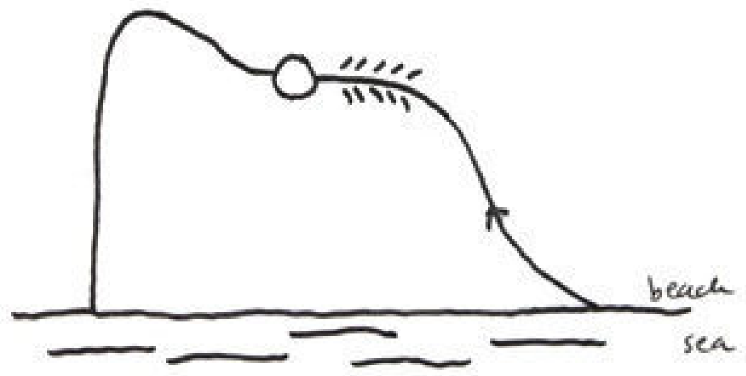

Fig. 6: Track shape and nesting behavior of the loggerhead sea turtle number 6
Abb. 6: Spur und Nistverhalten der Unechten Karettschildkröte Nummer 6

Based on these 6 cases of emerging female turtles, the behavior is very different for each individual. Wandering over the beach and making body pits (Fig. 10) did not take much time, but apparently the decision to dig a nest took a lot of time (Tab. 7).

As shown in Table 6, those turtles that did not nest successfully wandered an average of 49.1 m in 18.9 min. In contrast, the nesting turtle (Tab. 1 & Fig. 2) covered 38.2 m in 47.35 min.

Tab. 6: Time and distance of the "unsuccessful" sea turtles
Tab. 6: Distanz und Zeit der „erfolglosen" Meeresschildkröten

Turtle No.	**Distance (m)**	**Time (min)**
No. 2	46.1	24
No. 3	43.5	17.5
No. 4	63.3	26.3
No. 5	29.3	7
No. 6	63.3	19.3
	Mean value: 49. 1	Mean value: 18.9

Tab. 7: Mean value of the single phases of behavior exhibited by the six sea turtles
Tab. 7: Mittelwert der einzelnen Phasen der sechs Meeresschildkröten

PHASE	**TIME (min)**
Ascent to the beach	6. 4
Make Body Pit(s)	3
Attempt to dig an egg chamber	8. 2
Break	4.1
Return to the surf	3.3

DISCUSSION

According to other studies there is a considerable proportion of nesting failure, but in the most cases no disturbances were obvious to the observers (Hailman & Elowson 1992). In order to promote successful nesting, it is important to determine the reasons why female sea turtles abandon a nesting effort.

In this study just one of six sea turtles laid eggs and showed the whole spectrum of nesting behavior as described in other studies. In the literature, nesting turtles needed a mean value of about one hour on land (Johnson et al. 1996). The nesting loggerhead turtle (Nr. 1) in this study took 19 minutes for the egg-laying process itself. Her camouflage time of 18.1 minutes was longer than reported in Hailman & Elowson (1992), where the mean value was 12.6 min. Camouflage, as the name implies, has the function of covering the body pit the turtle made after she refilled the egg chamber with sand. A long camouflaging time could mean that the female wanted to hide the nest very well. This individual did not finish the nest quickly despite the short distance between the observers (three persons) and the turtle. No flashlight was used, except during the egg laying, when the observer stayed behind the loggerhead turtle (Fig. 6).

The second *Caretta caretta*, which emerged on 9 July, showed a very special behavior. After emerging on the sandy part of Akgöl beach, she tested the substrate by making three successive body pits. The fourth pit was very deep, indicating that this was an attempt to dig an egg chamber. Going back to the sea, she made a final body pit. In this case it is possible that litter on the beach could have caused her return: this litter rolled by because of the strong breeze on this night. In most turtles, the path back to the sea is very straight, without additional body pits. In this case, however, the turtle hesitated and return path was more winding . I interpret litter to be the reason for abandonment, i.e. marine debris can influence the decision to go back to the sea. Checking the substrate is one of the first behavioral actions when female loggerheads ascend the beach. By making body pits, she checks the texture and determines whether that particular place is suitable to dig the nest.

Turtles number 3 and 4 chose beaches with very stony, hard ground. Those beach sections were also very steep, so the females extended their path to the vegetation zone to find a proper place. In both cases, especially in number 4, plant roots hampered the digging activity. Furthermore, in case number 4, two beach goers were sitting near the emerging turtle; nevertheless, she continued to go up the beach.

Turtles number 5 and 6 showed just a few of the described nesting behaviors and went immediately back to the sea when the beach-goers appeared. This particular event shows the effect of anthropogenic disturbance very well. Beyond seeing moving objects on the beach, they may be able feel the vibrations when approached. Adult turtles have few enemies, but the nests are very vulnerable. The threats include predators such as foxes, jackals or wild boars that have specialized their foraging to find recent nests. These two turtles wandered a mean distance of 32.8 m in 13.19 minutes. This is much faster than the other turtles (Tab. 2 to Tab. 4). One interpretation is that the disturbance by the people has a big influence on turtle behavior, especially when there are lights such as from mobile phones or even from a car.

In conclusion, the durations of the individual behavioral phases (Table 7) are mostly comparable with recent studies (Hailman and Elowson 1992). Clearly, it is very important to avoid disturbances: many are preventable, for example cars on the beach (Fig. 9) or people walking on the seashore after about 10 p.m. and making bonfires. Based on the density of nests, Akgöl is an optimal beach for *Caretta caretta* females. This calls for special protection of this area. Finally, both tourists and local residents should be given more information about how to live in harmony with the loggerhead turtles during these 3 months of nesting.

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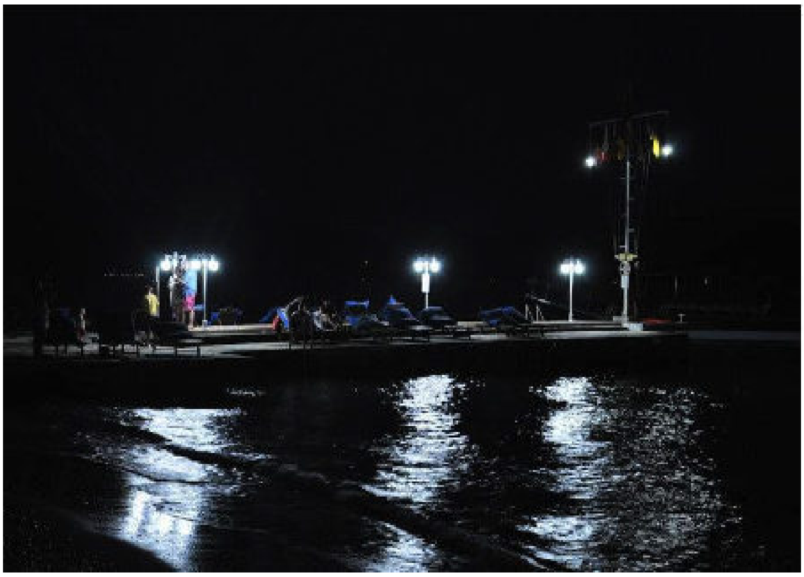

Fig.7: Artificial Light by the footbridge of the hotel “Tuana” on the Beach Yaniklar
Abb. 7: Zusätzliches Licht durch den Steg des Hotels “Tuana” auf dem Strand von Yaniklar
(Photo: M. Stachowitch)

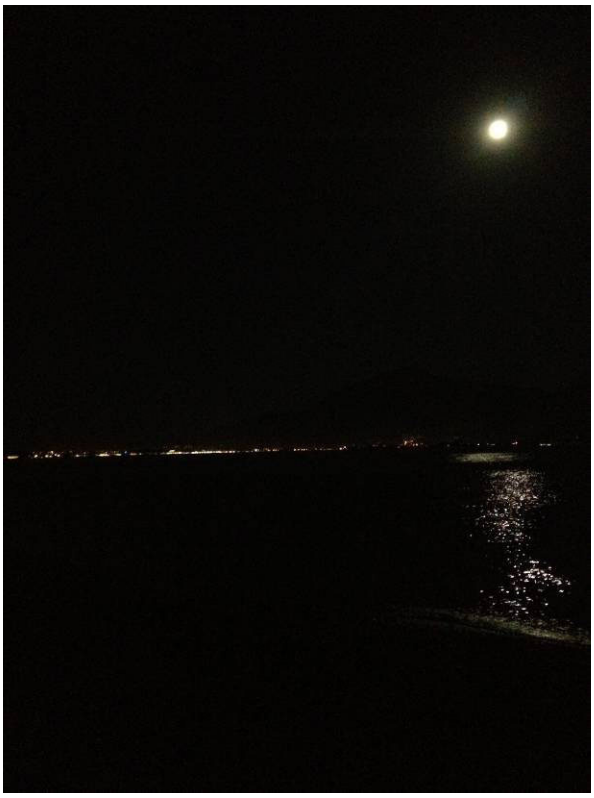

Fig. 8: Lights of the city Fethiye; visible from the beach Yaniklar
Abb. 8: Licht der Stadt Fethye; sichtbar vom Strand Yaniklar
(Photo: G. Gimpl)

Fig. 9: Cars on the beach part Akgöl
Abb. 9: Autos auf dem Strandabschnitt Akgöl
(Photo: M. Stachowitch)

Fig. 10: Track shape of loggerhead turtle (with bodypit)
Abb. 10: Spur einer Unechten Karettschildkröte (mit Bodypit)
(Photo: G. Gimpl

Fig. 11: Nesting attempt on the beach Yaniklar
Abb. 11: Nistversuch auf dem Strand Yaniklar
(Photo: G.Gimpl)

Bachelor Thesis

Threats to the seaward orientation of *Caretta caretta* hatchlings on a Turkish nesting beach

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KURZFASSUNG

Wenn Meeresschildkröten im Schutz der Nacht die Nesthöhle durchbrechen, begeben sie sich auf direktem Wege zum hellsten Punkt. Unter natürlichen Bedingungen liegt dieser Punkt über dem Meer. Dabei wenden sie sich von dunklen Silhouetten, welche durch die dahinterliegenden Dünen und die Vegetation hervorgerufen werden, ab. Diese seewärts gerichtete Bewegung wird vor allem über visuelle Reize gesteuert. Daher kann künstliches Licht, wie jenes von Häusern, Restaurants oder Hotels, zu einer massiven Störung dieser nächtlichen Orientierung führen. Die Folgen sind Fehlorientierungen die zum Tode führen können.

Diese Studie quantifiziert und analysiert die Effekte von anthropogen verursachten Lichtern sowie Fahrzeugspuren. Versucht wird herauszufinden, unter welchen Bedingungen Hatchlinge die direkte Richtung zum Meer verfehlen. Hierfür wurden Hatchlingspuren an einem Niststrand in der Türkei, Fethiye, welches ein SEPA (Special Environmental Protection Area) ist, untersucht.

Die Ergebnisse zeigen, dass Hatchlinge sehr wohl von künstlichem Licht beeinflusst werden, und zwar führt Lichtverschmutzung zu einer Desorientierung. Jedoch schafften es 408 von 441 untersuchten Hatchlingen das Meer zu erreichen. Fahrzeugspuren üben ebenso einen negativen Einfluss auf die seewärts gerichtete Orientierung aus. Daher ist der Schutz von Niststränden ein ganz besonderes Anliegen wenn es um die Erhaltung dieser gefährdeten Spezies geht.

ABSTRACT

When sea turtle hatchlings emerge from their nest chamber, they immediately start to crawl towards the brightest point, which under natural conditions is the horizon over the sea, and away from darker silhouettes. This seaward orientation is mostly directed through visual cues. Thus, artificial lighting such as lights from houses, restaurants or hotels can lead to a major deviation in this nocturnal orientation. The consequences for the hatchlings are disorientation that can lead to mortality.

This study quantifies the effects of human-caused lighting and vehicle track depressions. The aim was to determine the circumstances under which hatchlings fail to reach the sea directly.

Hatchling tracks were therefore documented on a nesting beach in Turkey, Fethiye, which is also a SEPA (Special Environmental Protection Area).

The results show that hatchlings responded to artificial lights by major disorientation, although 408 of 441 observed hatchlings still managed to find their way to the sea. Vehicle track depressions also contributed to failure in seaward orientation. This calls for better protection of sea turtle nesting beaches in order to ensure the survival of these endangered species.

Key words: *Caretta caretta*, orientation, light pollution, disorientation, vehicle tracks, Mediterranean

INTRODUCTION

Sea turtle hatchlings emerge – guided by sand temperature changes – mostly in the secure darkness at night (Witherington et al. 1990). When they break through the sand surface they almost immediately start to crawl towards the usually brighter horizon over the sea; this brightness is caused by the reflexion of the stars and the moon on the water surface. They tend to avoid darker silhouettes which are created by the dunes and vegetation behind the beach. Light intensity, light color, direction, polarization and the wavelength of the light play an important role in visual orientation. Experiments have shown that Loggerhead Turtles (*Caretta caretta*) move less toward yellow light with a wavelength of 560-600 nm, a phenomenon also known as xanthophobia (Lutz & Musick 2007). Although the most important cue is visual orientation, sea turtle hatchlings also use non-visual orientation cues such as the beach slope to find the ocean (Salmon et al. 1992).

Light pollution caused by artificial light sources can be a major threat to hatchlings because it leads them away from the sea towards the vegetation (Tuxbury & Salmon 2005). During this incorrect migration they can be predated, become stuck in the vegetation or die due to hyperthermia on the following day. Thus it is important to make an effort and to reduce light pollution in combination with restoring the dunes on sea turtle nesting beaches (Tuxbury & Salmon 2005) such as Fethiye.

Another major threat to sea turtle hatchlings as well as adult sea turtles is vehicles on nesting beaches. Hatchlings and adults can get run over by vehicles and female adults can get disturbed during nesting, leading to "false crawls" (Nester 2006). Heavy vehicles can affect the density of the sand and make it more compact. As a result, hatchlings are unable to escape from the nest chamber and die. Deep vehicle tracks can impede their movement by manipulating the seaward orientation, leading them into the dunes or on long crawls parallel to the waterline. This increases the time they spend on the beach as well as the energy input (Lamont et al. 2002).

Of the three sea turtle species that can be found in the Mediterranean – the loggerhead sea turtle (*Caretta caretta*), the Green turtle (*Chelonia mydas*) and the leatherback sea turtle (*Dermochelys coriacea*) – *Caretta caretta* is the most common. Nonetheless, it is still listed as "endangered" on the Red List of the IUCN.

The aim of this study was to determine the degree of disorientation of hatchlings by keeping records of the tracks and their course. This is one way of assessing the effects of human disruption. Hatchling tracks were therefore documented, counted and measured. Additionally, light measurements were taken to assess the strength of the light pollution and the consequences for the hatchlings.

MATERIAL AND METHODS

Fethiye, which is situated in the south-western part of Turkey in the Aegean region, is one of the key nesting beaches of the loggerhead sea turtle *Caretta caretta* in the Mediterranean. The beach is divided into three parts: Çaliş, Yaniklar and Akgöl. Our study was conducted in Yaniklar and Akgöl and started from Onur Camp, next to Yonca Lodge and surrounded by two major hotels: Majesty Club Tuana Park and Lykia Botanica. In Yaniklar the substrate was sand with cobbles at some sites. In Akgöl there was mainly sand where the nests were located.

The hatchling tracks were documented during morning shifts, which started at 6:00 a.m., later in the season at 6:15 or 6:30 a.m., and lasted 2 to 3 hours. For this purpose two students inspected the beach in Akgöl and Yaniklar and looked for hatchling tracks. Akgöl ("short-way") is approximately 1.6 km long, whereas Yaniklar ("long-way") is about 3.7 km long and leads to the other nesting beach in Çaliş. One student walked at the waterline, the other scanned the landward side of the beach. A measuring tape was used to document the hatchling tracks. The measurements were taken within a radius of 5 m around the nest. This area was divided into 8 sectors that were marked by eye (Fig. 1). Sectors 1, 2, 3 and 4 were directed seawards, sectors 5, 6, 7, and 8 faced landwards. Sector 1 marked the angle 0-45°, sector 2 the angle 45-90°, sector 3 90-135°, sector 4 135-180°, sector 5 180-225°, sector 6 225-270°, sector 7 270-315° and sector 8 315-360°. Sectors 2 and 3 marked the shortest way to the ocean.

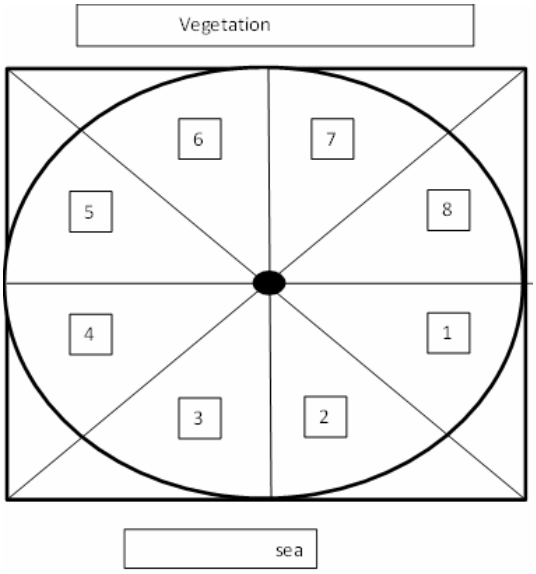

Fig.1: The arrangement of the 8 sectors; the nest is represented by the black dot in the middle

Fig.1: Die Anordnung der 8 Sektoren; das Nest wird durch den großen schwarzen Punkt in der Mitte repräsentiert

Twelve nests were examined over a period of 5 weeks, from 12 August to 14 September. Seven nests were located in Yaniklar, 5 nests in Akgöl. The distance to sea ranged from 14.0 m to 42.3 m. Due to the changing members of the shifts, the documentation of the selected nests could not be done every day continually. The intention was to select nests from both beaches, Yaniklar und Akgöl, in order to compare both sites. In Yaniklar, nests were observed at the beginning (3 nests), the middle (3 nests) and the end of the beach (1 nest). The selection in Akgöl was done randomly based on the date of emergence. Here, one nest was located directly in front of Yonca Lodge.

The data were then transferred into datasheets which contained the following information: the number of hatchling tracks in each sector, number of hatchling tracks reaching the sea in each sector, total length of the hatchling tracks and the distance of the nest to the sea. Additionally the number of "predated" hatchlings, the number of hatchlings "dead due to sun heat" and the number of "disorientated hatchlings that still reached the sea" were evaluated. In the case that a hatchling track crossed two or more sectors, the last sector was taken as that defining the track orientation. At some sites, where the final strip of the beach was covered with cobbles, it was not possible to see and therefore measure the full distance of the hatchling tracks to the sea. There, the distance to the cobbles was determined. To compare this distance with the distance covered by other hatchlings to the sea, the values of the deviations are expressed as percentages (Figs. 2, 3 and 4).

If vehicle tracks were found next to a selected nest, the vehicle track depth was measured. If hatchlings crossed the track or crawled inside it because of disorientation, the lengths of the hatchling tracks in the vehicle track were measured.

To check the efficiency of the track counts, all nests were excavated 4-5 days after the last hatchling emergence. Empty shells as well as dead hatchlings stuck in the nest chamber were counted and embryonic stages were determined.

Additionally to counting and measuring the hatchling tracks, light measurements were taken to quantify the light pollution (as a potential cause of disorientation). A photometer (Gossen, Mavolux-digital, Germany) was used for this purpose. The light measurements were conducted at following 4 sites: Y3, which was situated directly in front of a café, at a site called the “camping area”, at the beach in front of Onur Camp and at the end of the “short way” in Akgöl. At the beach at Onur Camp, light readings were taken during new moon, during full moon and when the moon was absent. For this purpose the photometer was placed approximately 1.5 m above the sand.

The data was then transferred into EXCEL. All diagrams and tables were done with EXCEL. The mean track length, the maximum and minimum track length and the standard deviation were calculated.

RESULTS

Twelve nests were documented in total: 7 nests in Yaniklar and 5 in Akgöl.

Results Yaniklar 2012

Tab.1: Hatchling tracks analyzed in Yaniklar. Percentage values were calculated by dividing hatchling track lengths by the straight distance of the nest to the sea. Slash: no data collected.

Tab.1: Hatchlingspuren Yaniklar. Die Prozent wurden dabei durch das Dividieren der Hatchlingspurlänge durch die Nest-Meer Distanz ermittelt. Schrägstrich: Werte nicht dokumentiert.

Nest	Emerging date	Number of tracks	mean hatchling track length (m)	distance to sea (m)	distance to cobbles (m)	%	max. track length (m)	min. track length (m)	S.D.
Y2	27.08.	20	45.4	26.0	/	174	102.5	25.0	31.0
	28.08.	7	32.0	26.0	/	123	56.5	26.9	12.6
	29.08.	14	9.4	26.0	/	36	26.6	0.4	6.9
	31.08.	1	45.5	26.0	/	175	45.5	45.5	/
	01.09.	1	26.2	26.0	/	101	26.2	26.2	/

Nest	Emerging date	Number of tracks	mean hatchling track length (m)	distance to sea (m)	distance to cobbles (m)	%	max. track length (m)	min. track length (m)	S.D.
Y3	18.08.	8	18.1	/	4.1	442	55.2	4.3	23.0
	19.08.	5	no data	/	4.1	no data	no data	no data	/
	21.08.	3	5.6	/	4.1	137	7.8		1.9
Y4	24.08.	25	14.5	/	14.1	103	14.7	14.2	0.2
	25.08.	21	14.0	/	14.1	100	14.4	7.0	1.6
	26.08.	1	14.2	/	14.1	101	14.2	14.2	/
Y5	27.08.	22	20.6	21.0	/	98	22.4	20.5	0.4
	28.08.	11	21.4	21.0	/	102	23.3	21.1	0.6
	29.08.	4	24.8	21.0	/	118	27.6	22.0	3.2
	30.08.	5	23.2	21.0	/	110	25.4	21.8	1.5
	31.08.	6	22.7	21.0	/	108	22.7	22.7	0.0
	01.09.	3	22.8	21.0	/	108	24.4	21.7	1.4
Y6	04.09.	8	6.1	/	6.1	101	6.6	4.9	0.8
	09.09.	6	6.2	/	6.1	102	6.2	6.2	0.0
YS3	28.08.	21	16.9	16.8	/	100	18.0	16.6	0.4
	29.08.	10	15.2	16.8	/	90	17.8	8.5	3.1
	31.08.	5	15.1	16.8	/	90	11.5	9.1	3.3
	01.09.	3	17.2	16.8	/	103	17.5	17.0	0.3
	03.09.	7	18.3	16.8	/	109	21.0	17.0	1.9
	06.09.	1	1.7	16.8	/	10	1.7	1.7	/
YS42	26.08.	10	21.6	15.0	/	144	65.0	4.4	25.7

Y2

Nest Y2 hatched from 27 August to 1 September. 29 tracks were measured totally and the number of empty shells at excavation was determined to be 45. Hatchling tracks were measured on all four emerging days. The mean track length of all emerging days ranged from 9.4 m to 45.5 m, whereas the maximum track length was measured on the 1st day of emergence with a length of 102.5 m (Tab. 1). The straight distance to the sea was 26.0 m. Hatchlings moved mainly in sectors 2 and 3 (45-135°), but also in sector 1 (0-45°) and sector 4 (135-180°) (Appendix). Of a total of 43 hatchlings, 8 did not reach the sea; 7 became completely disorientated but were still alive.

Y3

Y3 hatched from 18 August to 21 August. In total, 23 hatchling tracks and 30 empty shells were counted. This study recorded 16 hatchling tracks on the 2nd, 3rd and 4th day of emergence. The mean track lengths to cobbles ranged from 5.6 m to 18.1 m and the maximum track length was 55.2 m (Tab. 1) and led to a café. These values can be compared to the straight distance to the cobbles, namely 4.1 m. Twelve hatchlings moved in sectors 2 and 3 (45-135°), 4 tracks deviated and crossed Sector 6, 7 and 8 (225-360°) (Appendix) and died on their way. On the 2nd day of emergence, hatchling tracks were not measured because other students conducted the recording.

Y4

This nest hatched from 24 August to 26 August. 47 hatchling tracks were measured and a total number of 53 empty shells counted. Hatchling tracks were documented on all 3 emerging days. Mean track lengths of 14.0 to 14.5 m were determined (Tab. 1) and the distance to the cobbles was 14.1 m. All tracks were oriented in sectors 2 and 3 (45-135°) (Appendix) and showed no deviation.

Y5

Nest Y5 hatched from 27 August to 1 September. 51 tracks were measured and 75 empty shells were counted. The documentation of the hatchling tracks took place on all 6 emerging days. A mean track length of 20.6 to 24.8 m was calculated. The maximum track length of 27.6 m and a minimum of 20.5 m were determined (Tab. 1) which approximates the distance to the sea. The hatchling tracks were located in sectors 2 and 3 (45-135°), whereas one hatchling deviated and moved in sector 4 (135-180°) on the 2nd day of emergence (Appendix). Four hatchlings out of 51 did not reach the sea.

Y6

Y6 hatched from 1 September to 9 September. 45 tracks and 80 empty shells were counted in total. Hatchling tracks were measured on the 3rd and 6th day of emergence (a total of 14 tracks). The mean track length as well as the contrast between maximum length and minimum length varied only minimally (Tab. 1). The distance to the cobbles was 6.1 m. The hatchlings moved in sectors 1, 2 and 3 (0-135°) and showed no major deviations; the 2 distracted hatchlings moving in sector 1 (0-45°) as well as one hatchling moving in sector 3 (90-135°) died on their way (Appendix).

YS3

YS3 hatched from 28 August to 6 September. In total, 41 tracks were measured and 87 empty shells were counted. Hatchling tracks were documented on all 6 emerging days. The mean track length ranged from 15.1 m to 17.2 m except for 1.7 m where the hatchling had been predated (Tab. 1). The distance to the sea was 16.8 m. Most hatchlings moved in sectors 2 and 3 (45-135°); only 2 tracks deviated from the direct path and were found in sector 1 (0-45°). Forty-five hatchlings were able to reach the sea; 2 hatchlings did not and died on their way.

YS42

YS42 hatched on two days, on 25 and 26 August. Here, 14 tracks and 91 empty shells were counted in total. The documentation and measurement of the hatchling tracks took place on the 2nd day of emergence, where 10 tracks were measured. The mean track length was 21.6 m, whereas the difference between minimum and maximum track length was large – approximately 60 m (Tab. 1); the straight distance to the sea was 15.0 m. The hatchling tracks were distributed in the sectors 1, 2 and 3 (0-135°): only 3 of the 10 hatchlings reached the sea. The rest of them deviated from the direct path to the sea and probably died (Appendix) because the tracks ended abruptly and bird tracks were found nearby.

Fig. 2 shows the mean deviation of each nest in percent. Nests Y4, Y5 and Y6 show rather small deviation rates, whereas nest Y3 shows high deviation rates over 280%.

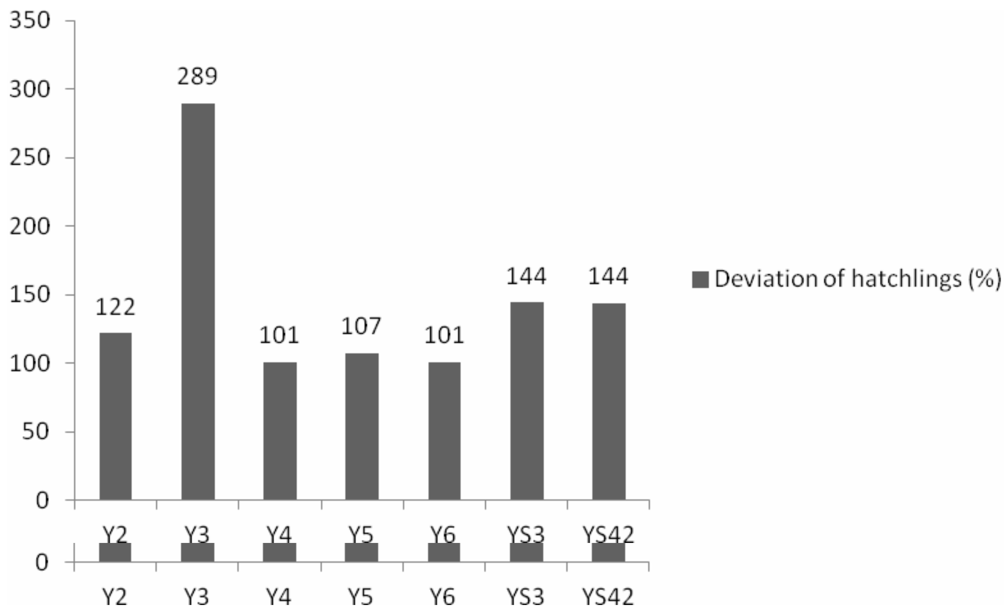

Fig.2: Deviation of hatchling tracks in Yaniklar from the direct path to the sea (distance to the sea is considered to be 100%)

Abb.2: Fehlorientierung der Hatchlinge in Yaniklar vom direkten Weg zum Meer. Die Distanz zum Meer wird als 100% angesehen

Results Akgöl 2012

Tab.2: Hatchling tracks analyzed in Akgöl. Percentage values were calculated by dividing hatchling track lengths by the straight distance of the nest to the sea. No data were collected when marked with a slash. (n.d.: no data)

Tab.2: Hatchlingspuren Akgöl. Die Prozent wurden dabei durch das Dividieren der Hatchlingspurlänge durch die Nest-Meer Distanz ermittelt. Die durch einen Schrägstrich gekennzeichneten Werte wurden nicht dokumentiert. (n.d.: keine Daten)

Nest	Emerging date	number of tracks	mean hatchling track length (m)	distance to sea (m)	distance to cobbles (m)	%	max. track length (m)	min. track length (m)	S.D.
A1	16.08.	40	28.1	15.8	/	178	28.1	28.1	/
	18.08.	8	23.4	15.8	/	148	23.4	23.4	/
	19.08.	5	23.2	15.8	/	147	23.2	23.2	/
A4	25.08.	25	16.7	n.d.	/	n.d.	22.1	15.5	1.7
	26.08.	3	16.8	n.d.	/	n.d.	16.8	16.8	/
A5/A6	22.08.	42	27.8	15.0	/	186	41.1	20.9	6.9
	24.08.	15	20.0	15.0	/	133	34.6	14.9	5.6
	25.08.	6	23.5	15.0	/	157	35.1	17.6	6.2
	26.08.	22	21.0	15.0	/	140	21.0	21.0	/
A9	30.08.	25	30.9	34.0	/	91	41.1	1.0	12.3
	31.08.	3	34.7	34.0	/	102	44.6	25.3	9.7
AS18	01.09.	15	11.9	/	11.5	103	11.9	11.9	0.2
	02.09.	3	11.6	/	11.5	101	11.6	11.6	/
	03.09.	1	11.7	/	11.5	102	11.7	11.7	/

A1

This nest hatched from 16 August to 24 August. In sum, 54 tracks and 77 empty shells were counted. Hatchling tracks were documented on the 1st, 2nd and 3rd day of emergence. At this time, 53 tracks were measured. The mean distance ranged from 23.2 m to 28.1 m which is as well the maximum and minimum track length (Tab. 2). The distance to sea was 15.8 m. All 53 hatchlings moved in sectors 1 and 2 (0-90°) and reached the sea (Appendix).

A4

The nest A4 hatched from 25 August to 26 August. Sixty-nine hatchling tracks and a total number of 78 empty shells were counted. The observation on the 1st and 2nd day documented 28 tracks with a mean track length of approximately 17 m (Tab. 2). Most of the tracks (25) were observed on the 1st day of emergence and all hatchlings moved in sectors 1 and 2 (0-90°)

(Appendix) and reached the sea despite deviation towards the Hotel Lykia Botanica and its jetty. As data acquisition was done by different students the direct distance to the sea was not measured.

A5 and A6

As nest A5 and A6 were very close (approximately 0.4 m) to each other, the observation and measurement of the hatchling tracks could not be done strictly separately. Thus, the hatchling tracks intersect each other and were counted as coming from one nest. The excavation was done separately. The nests hatched from 22 August to 26 August. A total number of 87 tracks were observed. The total number of empty shells in A5 was 74 and 54 in nest A6. This study measured 85 of 87 hatchling tracks on the 1st, 3rd, 4th and 5th day of emergence. The mean hatchling track lengths varied between 20.0 m and 27.8 m, whereas the maximum track length was 41.1 m (Tab. 2). The distance to the sea was 15.0 m. Hatchlings passed sectors 1 and 2 (0-90°) and all except 2 individuals reached the sea (Appendix).

A9

The nest A9 hatched on 2 days, from 30 August to 31 August and was observed on both days. 28 tracks were measured and 28 empty shells were counted in total. The mean length showed small variance, the difference between maximum and minimum (40.1 m) was higher (Tab. 2); the distance to sea was 34.0 m. Hatchlings moved mainly in sectors 1 and 2 (0-90°), 4 tracks deviated and crossed sectors 7 and 8 (270-360°) (Appendix): 2 of them still reached the sea, 2 hatchlings probably died on their way because their tracks ended abruptly.

AS18

This nest hatched from 1 September to 3 September. The total hatchling track number was 19 and the number of empty shells was determined to be 42. Hatchling tracks were documented on all emerging days (Tab. 2). Hatchling tracks did not deviate and moved straight to the sea in the sectors 2 and 3 (45-135°) (Appendix). All hatchlings were able to reach the sea.

Fig. 3 shows the mean deviation of each nest in percent. Nests A1 and A5/A6 show rather similar deviation rates over 150%, whereas the values of the other 2 nests were around 100%, which means that hatchling ran straight to the sea.

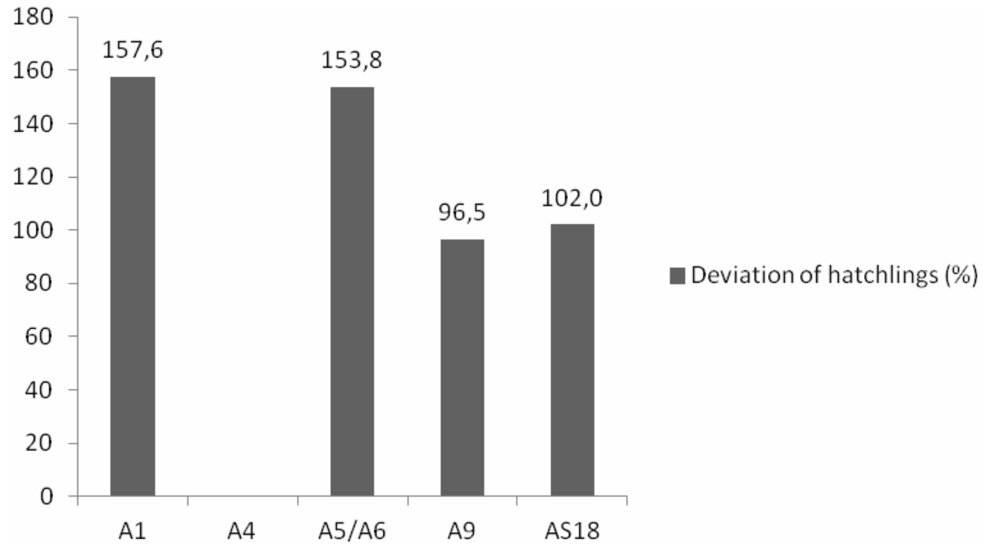

Fig.3: Deviation of hatchlings in Akgöl. Distance to sea is considered as 100% including predated hatchlings

Abb.3: Fehlorientierung der Hatchlinge in Akgöl. Die Distanz Nest-Meer wird als 100% angesehen, wobei die Spur der zu Tode gekommenen Hatchlinge mitberücksichtigt wird

When comparing the deviation rates of Akgöl and Yaniklar, Yaniklar shows higher values of 140-145%, whereas Akgöl stays at 125-130% (Fig. 4).

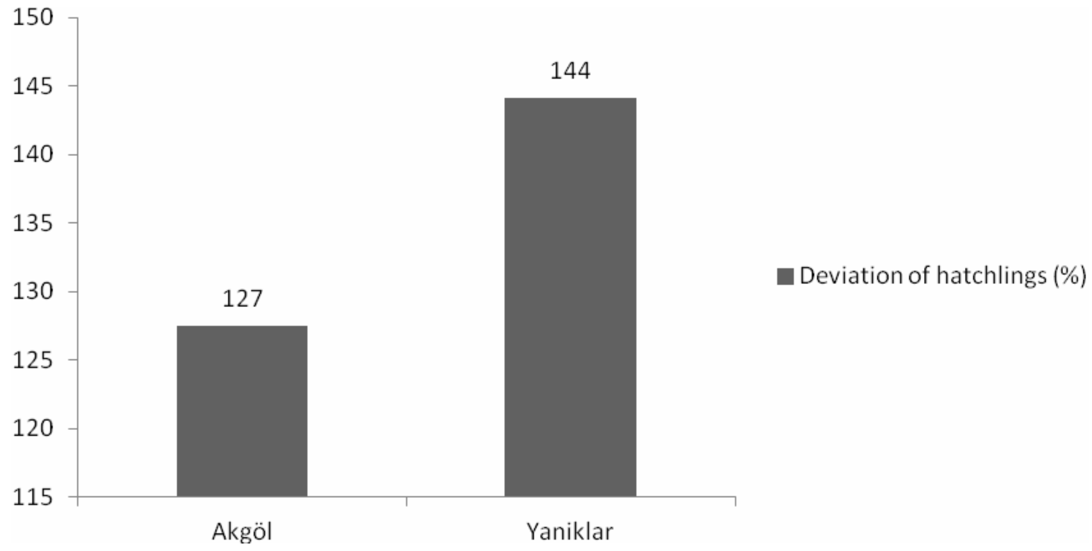

Fig.4: Comparison in the deviation of hatchling tracks in Akgöl and Yaniklar; mean deviation rates were calculated in percent, with distance to sea considered as 100%

Abb.4: Vergleich zwischen der Fehlorientierung der Hatchlinge zwischen Akgöl und Yaniklar, der Mittelwert wurde dabei in Prozent ermittelt, die Nest-Meer Distanz wurde dabei als 100% angesehen

Results vehicle tracks

Fig. 5 shows how far hatchlings from nest Y2 crawled in vehicle tracks. One the first day of emergence, the track lengths were generally longer but hatchlings crawled long distances in vehicle tracks, especially tracks 3-6 (Fig. 5). The vehicle track depths from 4 different vehicle tracks ranged from 5, 6, 7, 8, 9, 12, 13, 14 up to 16 and 21 cm.

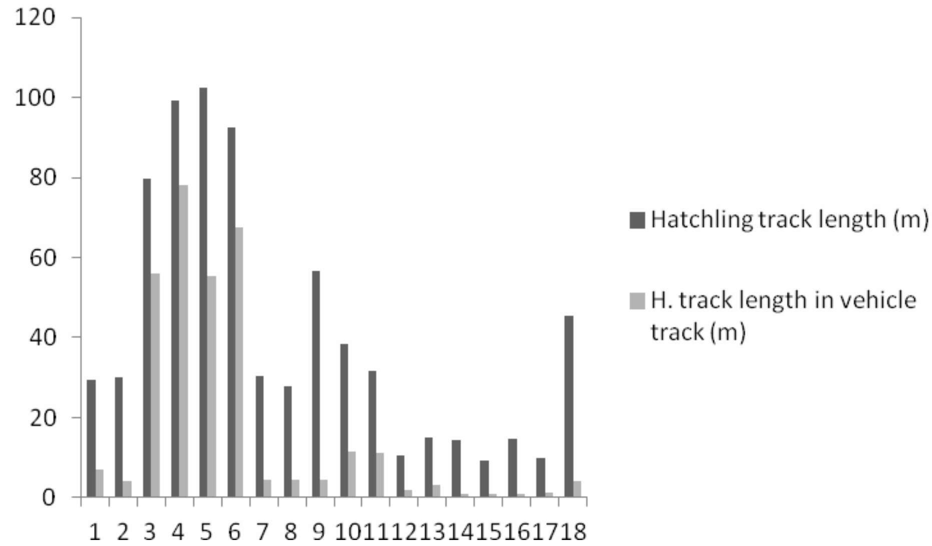

Fig. 5: Nest Y2 from 27, 28, 29 and 31 August; 1-8 show tracks from 27 August, 9-11 from 28 August, 12-17 from 29 August and 18 from 31 August

Abb.5: Nest Y2 vom 27., 28., 29. und 31. August; 1-8 zeigt Spuren vom 27. August, 9-11 vom 28. August, 12-17 vom 29. August und 18 vom 31. August

Light measurement

Parallel to hatchling track measurements, light measurements were taken. Tab. 3 shows that the measurements in the direction of Çalis show higher values, whereas the values facing the sea show lower light intensities.

Tab.3: Light measurements (/: no nest nearby at time of measurement)

Tab.3: Lichtmessungen (/: kein Nest in der Nähe zum Messzeitpunkt)

Date	Time	Location	Moon	Direction	Light intensity (lx)	approximate distance to nest (m)	Remarks
21.08.	22:00	Onur Camp	1/8	Sea	0.4	/	
				Çalis	0.7	/	
				Tuana	0.6	/	
30.08.	22:55	Onur Camp	full	Sea	0.0	/	
				Çalis/Moon	0.5	/	
				Tuana	0.0	/	
31.08.	22:00	Onur Camp	full	Sea	0.1	/	
				Çalis/Moon	0.6	/	
				Tuana	0.1	/	
02.09.	22:00	AS18	7/8	Sea	0.1	5	
				Çalis	0.1	10000	
				Yonca Lodge restaurant	0.2	5	7 lights, 5 candles, 2 lights at bar
				Yonca Lodge path	0.2	5	6 lights
07.09.	22:00	Y3		Sea	0.4	42	
				Çalis	0.5	5000	
				Cafe 2	0.5	50	1 big light, 8 lights in cafe, 1 parking lamp, 6 colored lights on path to cafe
10.09.	21:00	A8		Sea	0.3	10	
				Çalis	0.4	10000	
				Vegetation	0.3	20	

DISCUSSION

As hatchling orientation is primary directed by visual cues, photopollution plays an important aspect in the conservation biology of sea turtles (Witherington 1992). The general trend on the beach Fethiye suggests that one part of the beach (Yaniklar) can be considered as more or less natural, whereas the other one (Akgöl) is more impacted based on the greater deviations of hatchling tracks.

Compared to Yaniklar, Akgöl is under more anthropogenic pressure according to the longer and more severely deviated hatchling tracks (Fig. 3). One reason for this situation could be the photopollution caused by the artificial lightning on the jetty of the Hotel Majesty Club Tuana (Tab. 3). All hatchling tracks in Akgöl, except for 12, were found in sectors 1 and 2 (0-90°) (see Appendix), which is directed towards the jetty. A similar phenomenon was first observed in 2011 by Randa (2011). The exception to this general trend in Akgöl is nest AS18. This nest was located directly in front of Yonca Lodge. Here, hatchlings moved without an exception directly towards the sea (Tab. 2). The brighter horizon over the sea leads them away from darker silhouettes directly towards the sea (Witherington et al. 1990). In contrast, artificial lighting directs them away from the sea, often leading to mortality (Peters & Verhoeven 1994). In 2011, most hatchlings from a nest in front of this Lodge crawled directly away from the sea into the lodge's grounds. As most of the major hotels (and the lodge) have declared that they wish to help protect sea turtles, many lights are apparently being turned off after midnight to reduce light pollution and thus the distraction of nesting females or hatchlings in the later season. However, hatchlings that emerge before midnight could still be attracted by these lights. Therefore, lights should be eliminated throughout the night to increase the effectiveness of conservation. That would have reduced the number of disorientated hatchlings (33 of the total of 441) that did not reach the sea.

Yaniklar beach appears to face less artificial lighting. Nonetheless, two cafes are situated at the end of the beach (Café 1 and Café 2). Here, we observed major deviations at nest Y3 (Tab. 1). Four hatchlings deviated directly towards the lights of the café, where they either got predated or died due to hyperthermia (pers. observation). The remaining 16 individuals moved directly to the sea. My interpretation is that Café 2 also turned out their lights later in the night.

Another major threat to sea turtles is vehicles on nesting beaches. Nests Y2 and YS42 were both affected by cars during hatchling emergence, leading to disorientation. Vehicle tracks of 5-10 cm depth may halt hatchling seaward movement, and tracks that are 10-15 cm deep may significantly impede hatchling movement as they are unable to crawl out of the depression (Lamont et al. 2002). The vehicle tracks observed in Yaniklar were up to 21 cm in depth. Here, hatchlings moved distances up to 100 m before attempting to go seaward (Fig. 5). Some even fell over on their backs when crawling into the depressions (Appendix).

It is important to realize how vulnerable the orientation of sea turtle hatchlings can be when affected by light pollution or vehicle depressions. Beyond the conservation efforts regarding the fishery industries (e.g. reducing by-catch, for example by using TEDs (Turtle Excluder Devices)), it is crucial to preserve sea turtle nesting beaches and to find a balance between the tourism industry and conservation that allows the entire nesting process to proceed without disturbance.

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APPENDIX I

Fig.6: Nest Nr. Y2 with hatchling tracks and hatchling (Photo: A. Kristic)

Abb.6: Nest Nr. Y2 mit Hatchlingspuren und einem Hatchling

Fig.7: Hatchlings during emergence in the early morning (Photo: A. Kristic)

Abb.7: Hatchlinge während des Schlüpfens am frühen Morgen

Fig.8: Hatchlinge on their way to the sea (Photo: A. Kristic)

Abb.8: Hatchlinge am Weg zum Meer

Fig.9: Overturned hatchling attempting to right itself in the pebble zone (Photo: A. Kristic)

Abb.9: Hatchling, der zwischen den Steinen hängen blieb

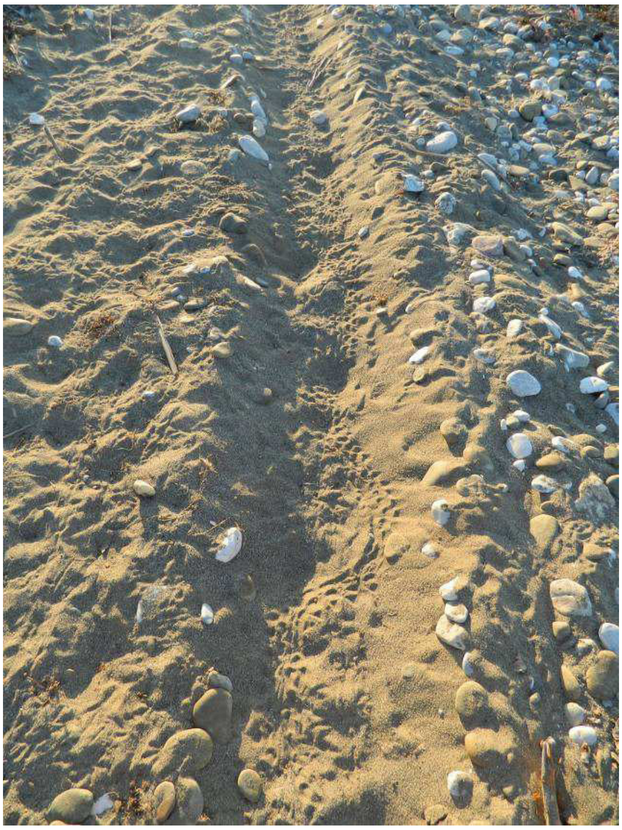


Fig.10: Hatchling tracks in vehicle tracks (Photo: A. Kristic)

Abb.10: Hatchlingspuren, die in Fahrzeugspuren verlaufen

Fig.11: Hatchling lying on its back in a vehicle track depression (Photo: A. Kristic)

Abb.11: Hatchling, der am Rücken in einer Fahrzeugspur liegt

APPENDIX II

Tab.4: Nest data of Y2. r.t.s.: reached the sea

Tab.4: Nest Daten von Y2

27.08.		total tracks	r.t.s.	died on way	stuck between an obstacle	disorientated, but still reached the sea
	sector 1	2		2		
	sector 2	13	13			
	sector 3	5	3	2		
	sector 4					
	sector 5					
	sector 6					
	sector 7					
	sector 8					
28.08.						
	sector 1					
	sector 2	2	2			
	sector 3	4	3	1		
	sector 4	1	1			
	sector 5					
	sector 6					
	sector 7					
	sector 8					
29.08.						
	sector 1					
	sector 2	7	6			4
	sector 3	3	2	1		2
	sector 4	4	2	2	1	
	sector 5					
	sector 6					
	sector 7					
	sector 8					
31.08.						
	sector 1	1	1			1
	sector 2					
	sector 3					
	sector 4					
	sector 5					
	sector 6					
	sector 7					
	sector 8					

01.09.		total tracks	r.t.s.	died on way	stuck between an obstacle	disorientated, but still reached the sea
	sector 1					
	sector 2	1	1			
	sector 3					
	sector 4					
	sector 5					
	sector 6					
	sector 7					
	sector 8					

Tab.5: Nest data of Y3

Tab.5: Nest Daten von Y3

18.08.		total tracks	r.t.s.	died on way	stuck between an obstacle	disorientated, but still reached the sea
	sector 1					
	sector 2	6		6		
	sector 3	2		2		
	sector 4					
	sector 5					
	sector 6	1			1	
	sector 7	1			1	
	sector 8	1			1	
19.08.						
	sector 1					
	sector 2					
	sector 3	4		4		
	sector 4					
	sector 5					
	sector 6					
	sector 7					
	sector 8	1			1	
21.08.						
	sector 1					
	sector 2	2		2		
	sector 3	1		1		
	sector 4					
	sector 5					
	sector 6					
	sector 7					
	sector 8					

Tab.6: Nest data of Y4

Tab.6: Nest Daten von Y4

24.08.		total tracks	r.t.s.	died on way	stuck between an obstacle	disorientated, but still reached the sea
	sector 1					
	sector 2	16	16			
	sector 3	9	9			
	sector 4					
	sector 5					
	sector 6					
	sector 7					
	sector 8					
25.08.						
	sector 1					
	sector 2	7	7			
	sector 3	14	13	1		
	sector 4					
	sector 5					
	sector 6					
	sector 7					
	sector 8					
26.08.						
	sector 1					
	sector 2					
	sector 3	1	1			
	sector 4					
	sector 5					
	sector 6					
	sector 7					
	sector 8					

Tab.7: Nest data of Y5

Tab.7: Nest Daten von Y5

27.08.		total tracks	r.t.s.	died on way	stuck between an obstacle	disorientated, but still reached the sea
	sector 1					
	sector 2	9	9			
	sector 3	13	13			
	sector 4					
	sector 5					
	sector 6					
	sector 7					
	sector 8					

28.08.		total tracks	r.t.s.	died on way	stuck between an obstacle	disorientated, but still reached the sea
	sector 1					
	sector 2	6	5	1		
	sector 3	4	4			
	sector 4	1	1			
	sector 5					
	sector 6					
	sector 7					
	sector 8					
29.08.						
	sector 1					
	sector 2	2	1	1		
	sector 3	2	1	1		
	sector 4					
	sector 5					
	sector 6					
	sector 7					
	sector 8					
30.08.						
	sector 1					
	sector 2	4	4			
	sector 3	1	1			
	sector 4					
	sector 5					
	sector 6					
	sector 7					
	sector 8					
31.08.						
	sector 1					
	sector 2	6	6			
	sector 3					
	sector 4					
	sector 5					
	sector 6					
	sector 7					
	sector 8					
01.09.						
	sector 1					
	sector 2					
	sector 3	3	3	1		
	sector 4					
	sector 5					
	sector 6					
	sector 7					
	sector 8					

Tab.8: Nest data of Y6

Tab.8: Nest Daten von Y6

04.09.		total tracks	r.t.s.	died on way	stuck between an obstacle	disorientated, but still reached the sea
	sector 1	2		2		
	sector 2					
	sector 3	6	4	1	1	
	sector 4					
	sector 5					
	sector 6					
	sector 7					
	sector 8					
09.09.						
	sector 1					
	sector 2	4	4			
	sector 3	2	2			
	sector 4					
	sector 5					
	sector 6					
	sector 7					
	sector 8					

Tab.9: Nest data of YS3

Tab.9: Nest Daten von YS3

28.08.		total tracks	r.t.s.	died on way	stuck between an obstacle	disorientated, but still reached the sea
	sector 1					
	sector 2	8	8			
	sector 3	13	13			
	sector 4					
	sector 5					
	sector 6					
	sector 7					
	sector 8					
29.08.						
	sector 1					
	sector 2	4	4			
	sector 3	6	6			
	sector 4					
	sector 5					
	sector 6					
	sector 7					
	sector 8					

31.08.		total tracks	r.t.s.	died on way	stuck between an obstacle	disorientated, but still reached the sea
	sector 1					
	sector 2	3	2	1		
	sector 3	2	2			
	sector 4					
	sector 5					
	sector 6					
	sector 7					
	sector 8					

Tab.10: Nest data of YS42

Tab.10: Nest Daten von YS42

26.08.		total tracks	r.t.s.	died on way	stuck between an obstacle	disorientated, but still reached the sea
	sector 1	5	3	2		
	sector 2	3		3		
	sector 3	2		2		
	sector 4					
	sector 5					
	sector 6					
	sector 7					
	sector 8					

Tab.11: Nest data of A1

Tab.11: Nest Daten von A1

16.08.		total tracks	r.t.s.	died on way	stuck between an obstacle	disorientated, but still reached the sea
	sector 1	23	23			
	sector 2	17	17			
	sector 3					
	sector 4					
	sector 5					
	sector 6					
	sector 7					
	sector 8					
18.08.						
	sector 1	3	3			
	sector 2	5	5			
	sector 3					
	sector 4					
	sector 5					
	sector 6					

18.08.		total tracks	r.t.s.	died on way	stuck between an obstacle	disorientated, but still reached the sea
	sector 7					
	sector 8					
19.08.						
	sector 1					
	sector 2	5	5			
	sector 3					
	sector 4					
	sector 5					
	sector 6					
	sector 7					
	sector 8					

Tab.12: Nest data of A4

Tab.12: Nest Daten von A4

25.08.		total tracks	r.t.s.	died on way	stuck between an obstacle	disorientated, but still reached the sea
	sector 1					
	sector 2	23	23			
	sector 3	2	2			
	sector 4					
	sector 5					
	sector 6					
	sector 7					
	sector 8					
26.08.						
	sector 1	1	1			
	sector 2	2	2			
	sector 3					
	sector 4					
	sector 5					
	sector 6					
	sector 7					
	sector 8					

Tab.13: Nest data of A5/A6

Tab.13: Nest Daten von A5/A6

22.08.		total tracks	r.t.s.	died on way	stuck between an obstacle	disorientated, but still reached the sea
	sector 1	36	34	2		
	sector 2	6	6			
	sector 3					

22.08.		total tracks	r.t.s.	died on way	stuck between an obstacle	disorientated, but still reached the sea
	sector 4					
	sector 5					
	sector 6					
	sector 7					
	sector 8					
24.08.						
	sector 1	13	13			
	sector 2	2	2			
	sector 3					
	sector 4					
	sector 5					
	sector 6					
	sector 7					
	sector 8					
25.08.						
	sector 1	4	4			
	sector 2	2	2			
	sector 3					
	sector 4					
	sector 5					
	sector 6					
	sector 7					
	sector 8					
26.08.						
	sector 1	3	3			
	sector 2	19	19			
	sector 3					
	sector 4					
	sector 5					
	sector 6					
	sector 7					
	sector 8					

Tab.14: Nest data of A9

Tab.14: Nest Daten von A9

30.08.		total tracks	r.t.s.	died on way	stuck between an obstacle	disorientated, but still reached the sea
	sector 1	11	11			
	sector 2	10	10			
	sector 3					
	sector 4					
	sector 5					
	sector 6					

30.08.		total tracks	r.t.s.	ied on way	stuck between an obstacle	disorientated, but still reached the sea
	sector 7	2		2		
	sector 8	2	2			
31.08.						
	sector 1					
	sector 2	3	3			
	sector 3					
	sector 4					
	sector 5					
	sector 6					
	sector 7					
	sector 8					

Tab.15: Nest data of AS18

Tab.15: Nest Daten von AS18

01.09.		total tracks	r.t.s.	died on way	stuck between an obstacle	disorientated, but still reached the sea
	sector 1					
	sector 2	11	11			
	sector 3	4	4			
	sector 4					
	sector 5					
	sector 6					
	sector 7					
	sector 8					
02.09.						
	sector 1					
	sector 2	1	1			
	sector 3	2	2			
	sector 4					
	sector 5					
	sector 6					
	sector 7					
	sector 8					
03.09.						
	sector 1					
	sector 2	1				
	sector 3					
	sector 4					
	sector 5					
	sector 6					
	sector 7					
	sector 8					

APPENDIX III

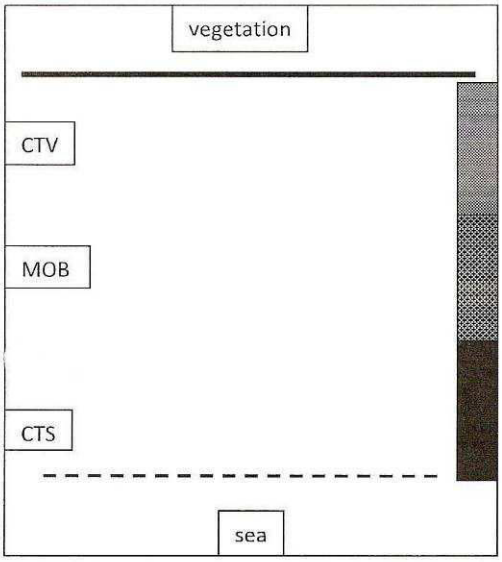
HATCHLING ORIENTATION 2012

Site: Akgöl Beach   Nest Number: A4   Nesting Date: 7.7.2012

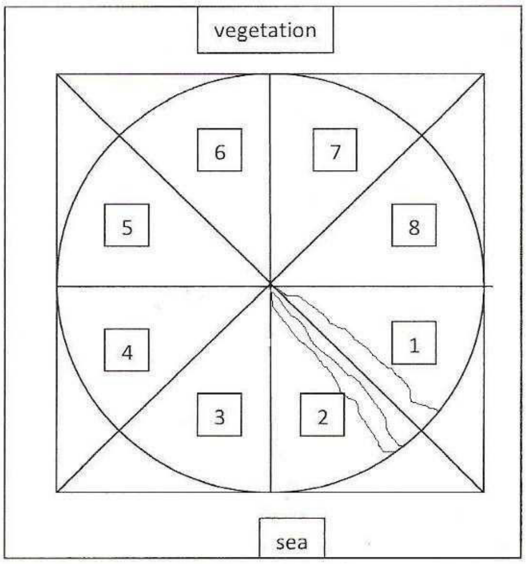
Date of Emergence: 26.08.2012   GPS coordinates: /

Artificial Light Sources: Hotel Majesty Club Tuana - jetty, Calis

Nest Site:



Hatchling Dispersal Pattern:



Sector	Total tracks	Hatchling reached the sea	Hatchling died on the way to the sea (Died because of the sun, killed by predators)	caught by an obstacle	Hatchling completely disorientated (didn't reach the sea but still alive)
1	1	1			
2	2	2			
3	0				
4	0				
5	0				
6	0				
7	0				
8	0				

Remarks: track length: 16.8 m (to sea)

Fig.12: datasheet: nest A4, 26 August 2012

Abb.12: Datenblatt: Nest A4, 26. August 2012

Bachelor Thesis

Temperature measurements in *Caretta caretta* nests at Yaniklar and Çaliş Beach in Fethiye, Turkey

Temperaturmessungen in *Caretta caretta*-Nestern auf den Niststränden von Yaniklar und Çaliş in Fethiye, Türkei

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Aspired academic title
Bachelor of Science (BSc.)

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KURZFASSUNG

Die Unechte Karettschildkröte (*Caretta caretta)* nistet im Mittelmeerraum an diversen Stränden von Zypern, Griechenland, der Türkei und Israel. Die adulten Weibchen erreichen die Niststrände nachts, gehen dort an Land, suchen einen geeigneten Nistplatz und fangen an, eine Eihöhle zu graben um danach dort ihre Eier zu legen. Da die Nesttemperatur über das Geschlecht der Meeresschildkröten entscheidet, ist es interessant welche Temperaturen tatsächlich während der Inkubation in den Nestern herrschen, um vorherzusagen wie die Geschlechterverteilung in zukünftigen Populationen aussieht. In dieser Arbeit wurden batteriebetriebene Temperaturmessgeräte, Tiny Tags (Gemini Data Logger, UK), in die frisch gelegten Nester hinzugefügt um die Temperaturen zu messen. Nebenbei wurden sie auch in selbstgemachte, künstliche Ei-Höhlen gelegt, um sie später vergleichen zu können. Dieser Vorgang wurde auf 2 verschiedenen Niststränden gemacht um mögliche Temperaturunterschiede gegenüberzustellen. Die Resultate zeigen, dass auf beiden Stränden die Lufttemperatur im Mittelwert ähnlich bis gleich war. Die Nesttemperatur jedoch war im Durchschnitt am Strand in Çaliş mindestens um 3°C höher als in Yaniklar. Mögliche Gründe dafür könnten unter anderem der manipulierte Sand in Çaliş sein, also die physikalischen Faktoren und die Gegebenheiten des Strandes.

ABSTRACT

The Loggerhead Turtle (*Caretta caretta)* breeds at different Mediterranean beaches such as in Cyprus, Greece, Turkey and Israel. The adult females reach the nesting beaches at night and crawl onto the beach, searching for a place to dig a self-made egg clutch and to lay their eggs inside. Because the nest temperature is very important for the sex differentiation of the sea turtles, it is interesting to know the entire nest temperature of a whole incubation period during a summer to predict the sex distribution of the population in the future. In this work, battery-powered data loggers were used as temperature measurement devices (Tiny Talk Data Loggers, Gemini, UK). These devices were added to the nests and to artificial nests to compare the data. This work was done at two different beaches to compare the measured data. Although the mean air temperature of the two beaches Çaliş and Yaniklar were very similar, the mean nest temperature in Çaliş were about 3°C higher than in Yaniklar. One reason could be that the sand at Çaliş beach is more manipulated then elsewhere in Fethiye. Accordingly, the environment and the physical factors that play a role in the sea turtle nesting and development processes could also be a reason for temperature differences of the sand.

INTRODUCTION

The *Caretta caretta* population counts 5000 individuals in the Mediterranean Sea, making it the most frequent sea turtle here (Demetropoulus & Hadjichristophorous 1995). Although the loggerhead sea turtle *Caretta caretta* inhabits the whole Mediterranean Sea, its nesting beaches are mostly in the eastern areas. One country with very important nesting sites is Turkey. In Turkey there are 14 nesting beaches for *Caretta caretta* (Bolton & Witherington 2003). Three of them – Dalyan, Patara and Fethiye – are Specially Protected Areas (SPAs) within the Barcelona Convention (Figs. 1 and 2).

As in most reptiles, in *Caretta caretta* the sex of individuals is defined by the temperature during the incubation period. This phenomenon is termed temperature sex determination (TSD) (Mrosovsky & Pieau 1991). If the mean environmental temperature of the eggs is higher than 29°C, more females will develop. If the temperature is lower than 29°C, more males will develop. A constant pivotal temperature between 28.6°C and 29.7°C leads to a sex ratio of 1:1 in a nest (Mrosovsky 1994).

Mrosovsky and Yntema (1980) state that the middle third of the incubation period therefore governs sex determination during the development process. This is a very thermo-sensitive time during the incubation period.

Temperature changes and the difference between day and night serve as a buffer, so that the mean constant pivotal temperature should not go beyond the ideal mean temperature, leading to a balanced sex ratio. Temperature also controls the duration of the incubation period. The warmer the environment, the shorter the incubation period. The mean incubation period of *Caretta caretta* is between 49 and 72 days (Le Buff Jr. 1990).

The embryonic developments, the incubation period, the sex ratio, along with environmental factors such as the water use efficiency or the gas exchange also depend on the temperature (Ackerman 1997). In general the beach temperature is around the pivotal temperature, making it important to measure and estimate variations in the local beach temperatures during the incubation period.

The temperature measurements in nests and at beaches are a very important part of the monitoring and conservation work on sea turtles. Good data make it possible to predict sex ratios of populations in the future and to potentially determine disturbances related with temperature changes (Kaska et al. 1998).

Finally, anthropogenic influences on nesting beaches can alter incubation environments and affect both hatchling success and hatchling characteristics.

MATERIAL AND METHODS

The present study involved battery-driven data loggers (Tiny Tags) of the company Gemini Data Loggers Ltd., UK (Figure 3). These data loggers are temperature measurement devices and they were programmed to take one temperature measurement every 72 minutes. They were provided by the University of Vienna. One device can collect up to 1800 data points and measure from -40°C to +80°C. They have an accuracy of +/-0.2°C between 0° C and 80°C. Six Tiny Tags were buried in summer 2012 from July to August, 3 in Çaliş Beach and 3 in Yaniklar to better compare the results of these beaches.

The intention was to find fresh nests with similar environments, i.e. nearly the same distance to the sea, the same depth, the same diameter and nearly the same nesting date.

Before burying the Tiny Tags, they were housed in 35mm film canisters and then wrapped with duct tape to protect them.

Çaliş:

Three data loggers were buried in Çaliş:

Tiny Tag V was buried in C1, a real nest,

Tiny Tag VI was buried in an "artificial egg chamber" a few meters away from C1. An artificial egg chamber is a simulated nest to produce the same nest conditions.

Tiny Tag II was also buried in an artificial nest, next to the wall of the promenade in Çaliş beach. More information is provided in Table 1.

Yaniklar:

Three data loggers were buried in Yaniklar Beach, nearly 40 minutes walk from Çaliş Beach.

Tiny Tag I in TII, an artificial nest in Akgöl, the western part of Yaniklar Beach.

Tiny Talk IV in nest Y2, a real nest, and

Tiny Tag 3 in TIII, an artificial nest, a few meters away from Y2.

More information is provided in table 2.

Every day in the morning, at noon and in the evening, air temperatures of the beach sites were measured with a thermometer. Also the data from the meteorological station in Fethiye (FETH) was taken for comparisons.

Tab. 1: Tiny Tag nest data of Çaliş
Tab. 1: Tiny Tag Nestdaten von Çaliş

nest number	**C1**	**TVI**	**TII**
depth at the top of the eggs	28cm	30cm	30cm
bottom of the egg chamber	no data	55cm	50cm
diameter of the egg chamber	no data	30cm	30cm
nest distance to the sea	26.3m	24.8m	21cm
wet zone (along the distance to the sea)	1.5m	1.6m	2.3m
moist zone (along the distance to the sea)	4.1m	1.6m	2.3m
dry zone (along the distance to the sea)	20.7m	23.1m	16.4m
substrate	fine sand	fine sand	fine sand
Tiny Talk starting date	07.07.2012 06:55	24.07.2012 14:10	24.07.2012 15:05
Tiny Talk removal date	28.08.2012 16:41	28.08.2012 16:35	28.08.2012 16:30
duration of the measurement in the nest	52 days 9h 46m	35 days 2h 25m	35 days 1h 25m
Tiny Talk number	TV	TVI	TII

Tab. 2: Tiny Tag nest data of Yaniklar
Tab. 2: Tiny Tag Nestdaten von Yaniklar

Tiny Talk number	TIV	TIII	TI
nest number	Y2	TIII	TI
depth at the top of the eggs	30cm	30cm	23cm
bottom of the egg chamber	58cm	50cm	43cm
diameter of the egg chamber	24cm	28cm	21.5cm
nest distance to the sea	24.2m	23.5m	20.55m
wet zone (along the distance to the sea)	1.4m	1.2m	1.4m
moist zone (along the distance to the sea)	1.5m	2.3m	3.2m
dry zone (along the distance to the sea)	21.3m	20m	15.95m
substrate	fine and coarse-grained sand	fine and coarse-grained sand	fine sand
Tiny Talk starting date	08.07.2012 18:40	08.07.2012 19:00	22.07.2012 19:45
Tiny Talk removal date	07.09.2012 05:00	07.09.2012 05:10	23.08.2012 13:12
duration of the measurement in the nest	60 days 10h 20m	60 days 10h 10m	31 days 17h 27m

RESULTS

Air temperature measurements:

The air temperatures in figure 1 were measured by the meteorological station of Fethiye (FETH). The measurements were done in the shadow every day at 12:00 from the beginning of July to the end of September and the mean temperature during these three months was 35.6°C. The highest temperature was 42.1°C on 15.7.2012 and the lowest temperature was 29.2°C on 13.9.2012.

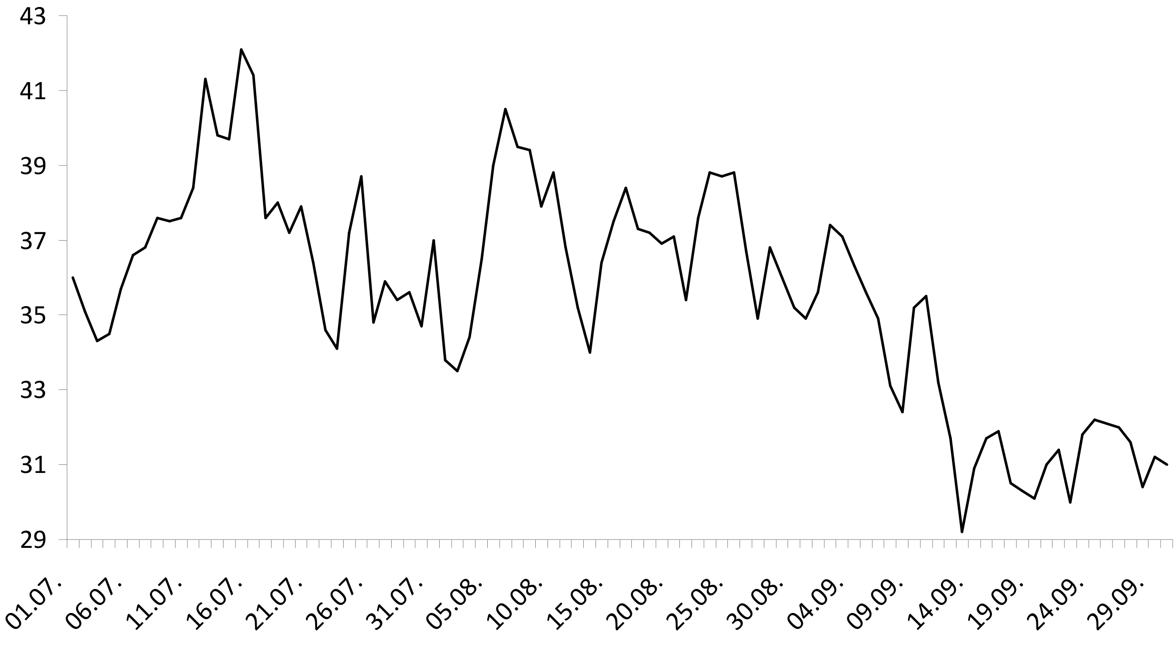

Fig. 1: Maximum air temperature measurement by the meteorological station of Fethiye (FETH) in 2012. The y-axis shows the temperature in °C and the x-axis shows the timeline.
Abb. 1: Die Maxima der Lufttemperaturmessungen der meteorologischen Station von Fethiye (FETH) im Jahr 2012. Die Y- Achse zeigt die Temperatur in °C und die X- Achse zeigt die Zeitachse.

The air temperatures at the beaches were measured by the students in Yaniklar and Çaliş every day in the morning, at noontime and in the evening with a digital temperature thermometer. The thermometer in Çaliş was occasionally inaccurate, so the beach temperatures of Çaliş are incomplete, because the thermometer described definitely unrealistic degrees. Figure 2 shows the beach temperature at Çaliş and Figure 3 the beach temperature at Yaniklar.

The mean beach temperature at Çaliş (all measurements) was 29.8°C. The highest peak was on 6.8.2012 at 12:00 with 50.5°C. The lowest air temperature measurement was on 27.7.2012 at 22:00 with 20°C.

The mean temperature of Yaniklar (all measurements) was 29.6°C, just 0.2°C less than in Çaliş. The highest peak was on 16.7.2012 at 12:00 with 51.8°C. The lowest measurement was on 11.9.2012 at 22:00 with 14.4°C.

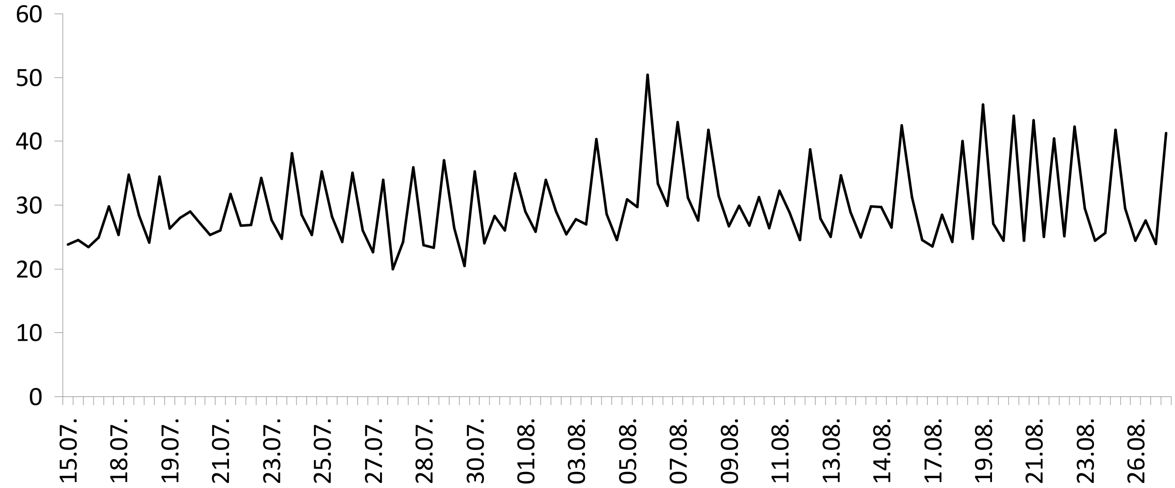

Fig. 2: The air temperature at the beach of Çaliş between 15.7.2012 and 27.8.2012. The y- axis describes the temperature in °C and the x- axis the timeline. Measurements were taken 3 times a day, but the statistic is incomplete because of device errors.
Abb. 2: Die Lufttemperatur von Çaliş Beach zwischen 15.7.2012 und 27.8.2012. Die Y- Achse beschreibt die Temperatur in °C und die X- Achse beschreibt die Zeit. Die Messungen wurden 3 mal täglich durchgeführt, aber die Statistik ist wegen Geräteproblemen unvollständig.

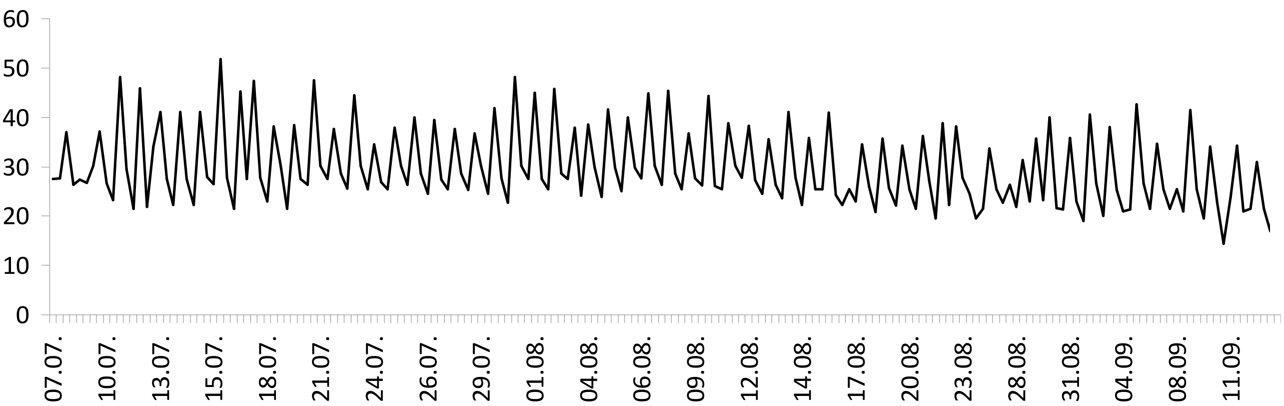

Fig. 3: The air temperature at the beach of Yaniklar between 7.7.2012 and 13.9.2012. The y- axis describes the temperature in °C and the x- axis the timeline. Measurements were taken 3 times a day, but the second half of the statistic is subtotal because of measuring gaps.
Abb. 3: Die Lufttemperatur vom Strand von Yaniklar zwischen 7.7.2012 und 13.9.2012. Die Y- Achse beschreibt die Temperatur in °C und die X- Achse die Zeit. Die Messungen wurden 3 mal täglich durchgeführt, aber die Statistik ist aufgrund von Messlücken in der zweiten Hälfte unvollständig.

The highest temperature measurement by FETH (15.7.2012 with 42.1°C in shadow) corresponded closely with the highest temperature measurement of Yaniklar on 16.7.2012 at 12:00 with 51.8°C

Nest C1 in Calis Beach:

Tiny Tag 5 was buried on 7.7.2012 at 6:55 in C1, 1 day after the nesting date. The nest data is provided in Table 1. The average temperature here was 33.5 °C during the period between 7.7. 2012 and 28.8.2012, i.e. 52 days. Figure 4 shows the temperature of this natural nest during the whole incubation period. In the following figures (Figs 4-11) the x-axis shows the time line and the y-axis shows the temperature in Celsius. In C1 the highest temperature was measured on 9.8.2012 (36.5 °C), which was in the middle third of the period. The mean temperature of the middle third of the incubation was 34.1 °C. The lowest temperature, which was measured at the end of the period, prior to removal, was between 30 °C and 30.5 °C. The overall trend in the temperature curves at the beginning shows a gradual increase until the highest peak.

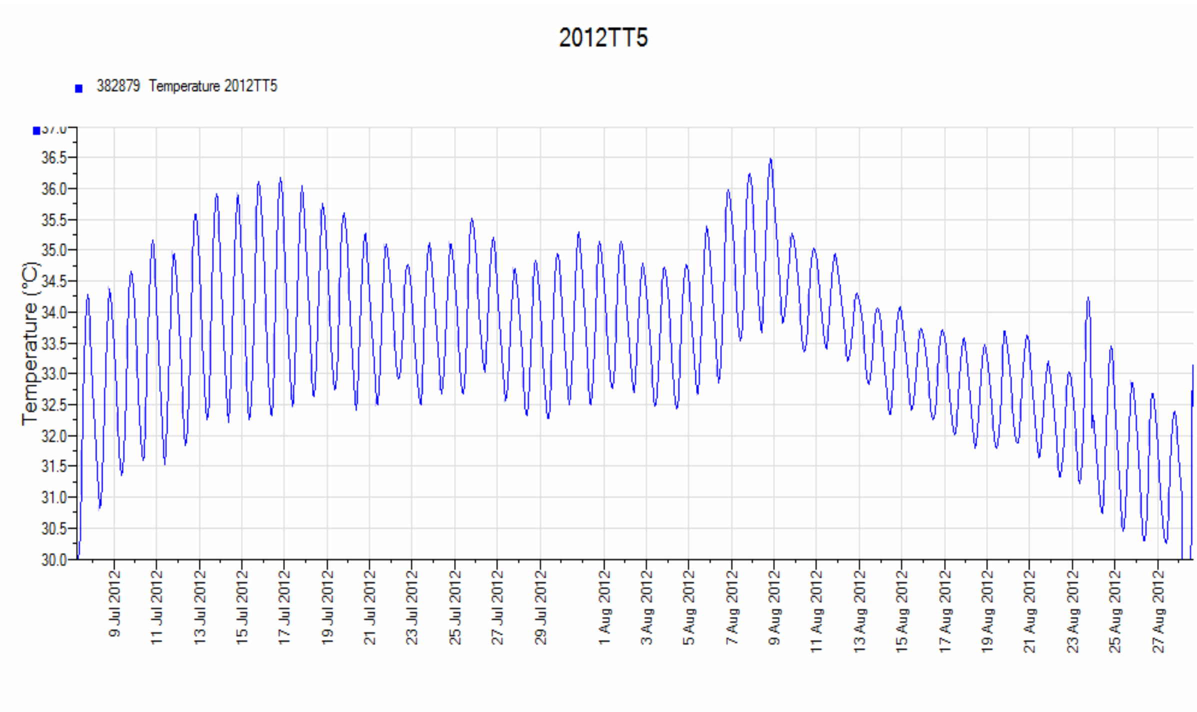

Fig. 4: Temperature measurement of C1
Abb. 4: Temperaturmessung von C1

"Artificial nest" T VI in Çaliş Beach:

Tiny Tag number VI was buried on 24.7.2012 at 14:10 into an artificial nest close to C1. The nest data are presented in Table 1. The mean temperature here was 33°C along the period between 24.7.2012 at 14:10 and 29.8.2012 at 16:35, i.e. 35 days. Figure 5 shows the temperature curve during the period. This "artificial nest" was made as a control for the data of the measurements of C1. An overlay of these 2 nests is shown in Figure 10. The highest measured temperature was 35.2°C, coinciding with the highest temperature in C1. On every day, the values in the artificial nest were consistently lower than in C1, and the trends also corresponded precisely.

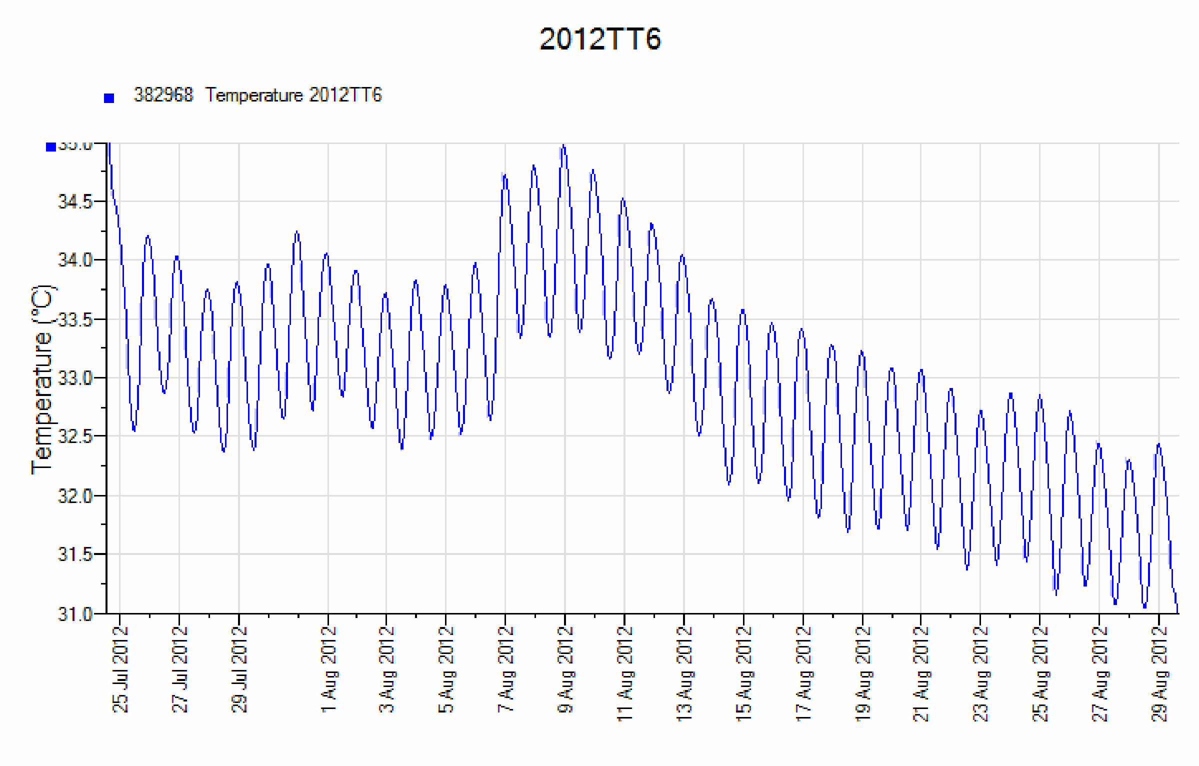

Fig. 5: Temperature measurement of T VI
Abb. 5: Temperaturmessung von T VI

"Artificial nest" T II in Çaliş Beach:

Tiny Tag number II was buried on 24.7.2012 at 15.05 into an "artificial nest" close to the Çaliş Beach promenade, 0.9m from the promenade wall. The nest data is listed in table 1. Figure 6, which shows the temperature during the measurement period, points to a defect of the Tiny Talk data logger and the data is unusable. For example, there are time periods which have the same temperature during 2 or 3 days. This is unrealistic. In former years in the sea turtle reports of Çaliş and Yaniklar, Tiny Talk number II also showed unrealistic parts (Stachowitsch, Fellhofer & Lambropoulos, 2011 and 2009). Here, in Figure 6, the mean temperature is 24.1°C and the maximum temperature measured is 27.7°C during the period between 24.7.2012 and 28.8.2012 (35days).

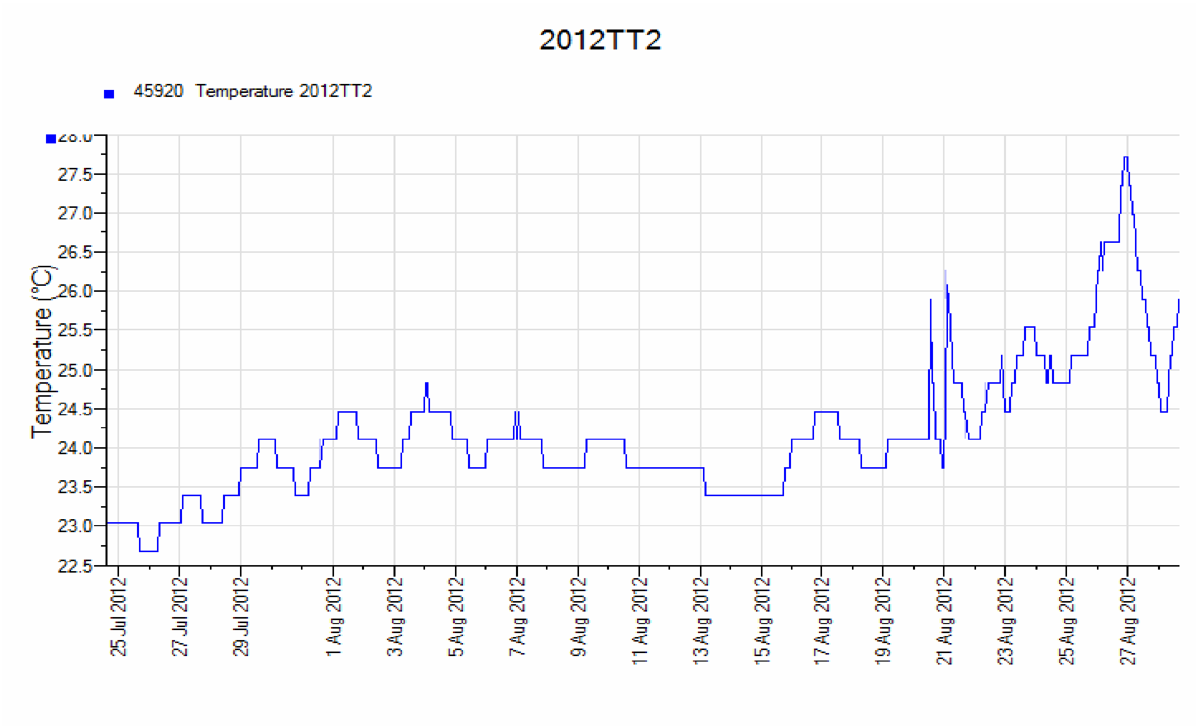

Fig. 6: Temperature measurement of T II
Abb. 6: Temperaturmessung von T II

Nest Y2 at Yaniklar:

This nest was found on 4.7.2012; the exactly nesting date is unknown. Tiny Tag number IV was buried here on 8.7.2012 at 18:40. More nest information is in Table 2. The mean temperature of Y2 was 29.8°C between the date 8.7.2012 and 7.9.2012 (60 days). The highest temperature in this period was 31.3°C and the lowest was 27.8°C. The highest peak here also corresponds to the highest peak of the measurement of FETH. The date on which the highest temperature was measured in this nest also closely corresponds to the date of the highest measurements by FETH. The temperature measurement is shown in Figure 7. If we consider that this period illustrates the incubation period of the nest, then the middle third part would have had a mean temperature of 30.5°C. Figure 15 shows a photo of Y2.

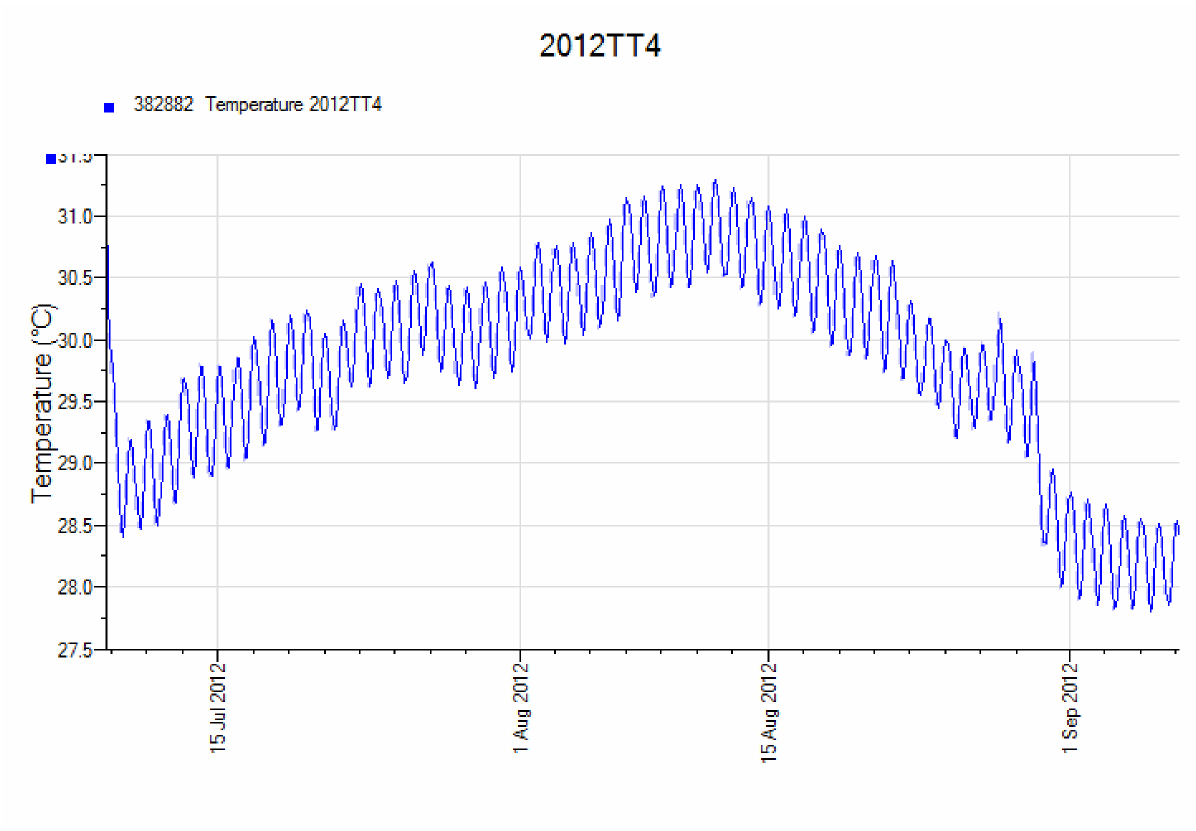

Fig. 7: Temperature measurement of Y2
Abb. 7: Temperaturmessung von Y2

"Artificial nest" T III of Yaniklar:

Here, the Tiny Tag was buried on 8.7.2012 at 19:00 till 7.9.2012. It was buried in an artificial egg chamber a few meters next do Y2 to compare and control the data. An overlay is these 2 nests is shown in Figure 11. The mean temperature of T III between this period was 29.6°C, just 0.2°C less than the mean temperature of Y2. The temperature data are shown in Figure 8. The highest temperature measured here, is also at the same time period as in Y2. Figure 12 shows a photo of T III.

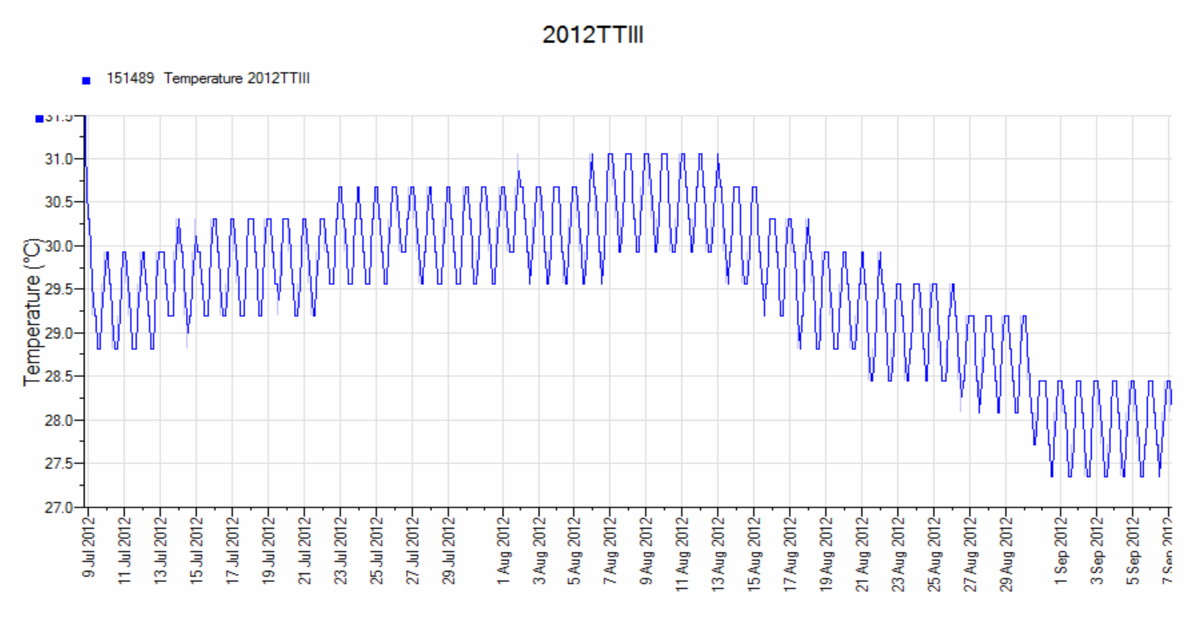

Fig. 8: Temperature curve of TIII
Abb. 8. Temperaturmessung von TIII

"Artificial nest" TI in Yaniklar/ Akgöl:

Tiny Talk I was also buried in Yaniklar, but at another beach part, in Akgöl (Fig. 13). It was buried on 22.7.2012 at 19: 45 until 22.8.2012. As evident in Figure 9 the temperature curve is different than the other two nests of Yaniklar. The mean temperature in this period is 30.6°C and the highest temperature measured is 32.5°C during the days 22.7 to 28.7, much higher than in the other two nests in Yaniklar. The trend shows that the temperature goes down constantly during this period.

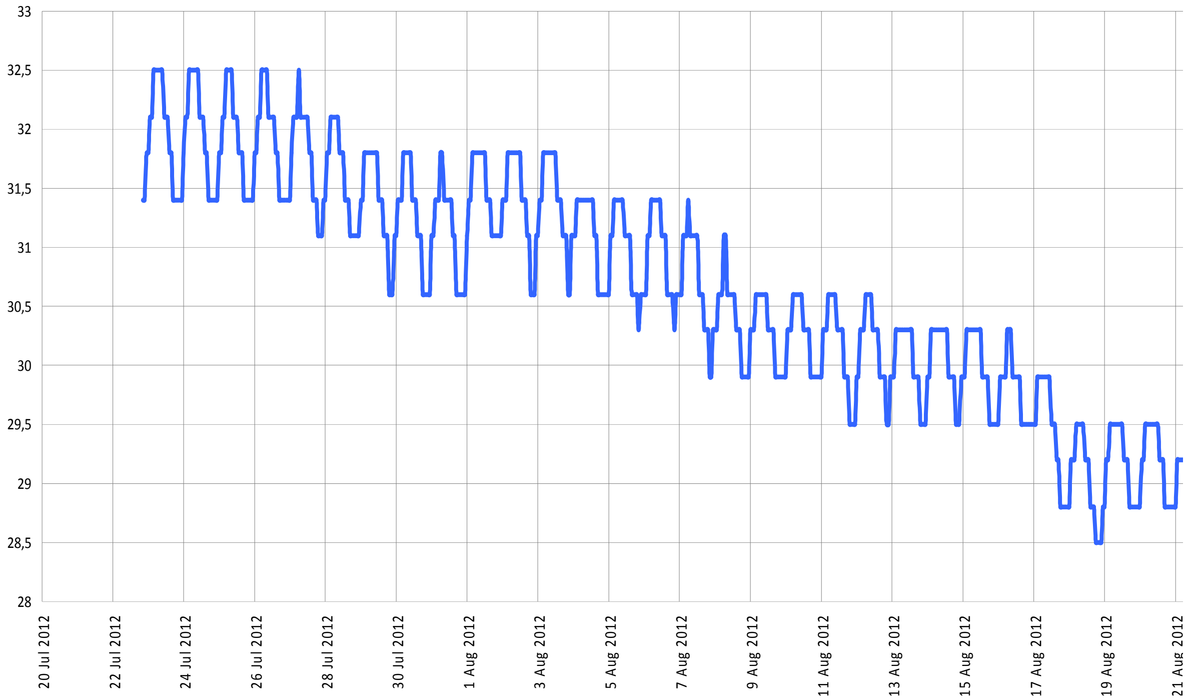

Fig. 9: Temperature measurement of TI
Abb. 9: Temperaturmessung von TI

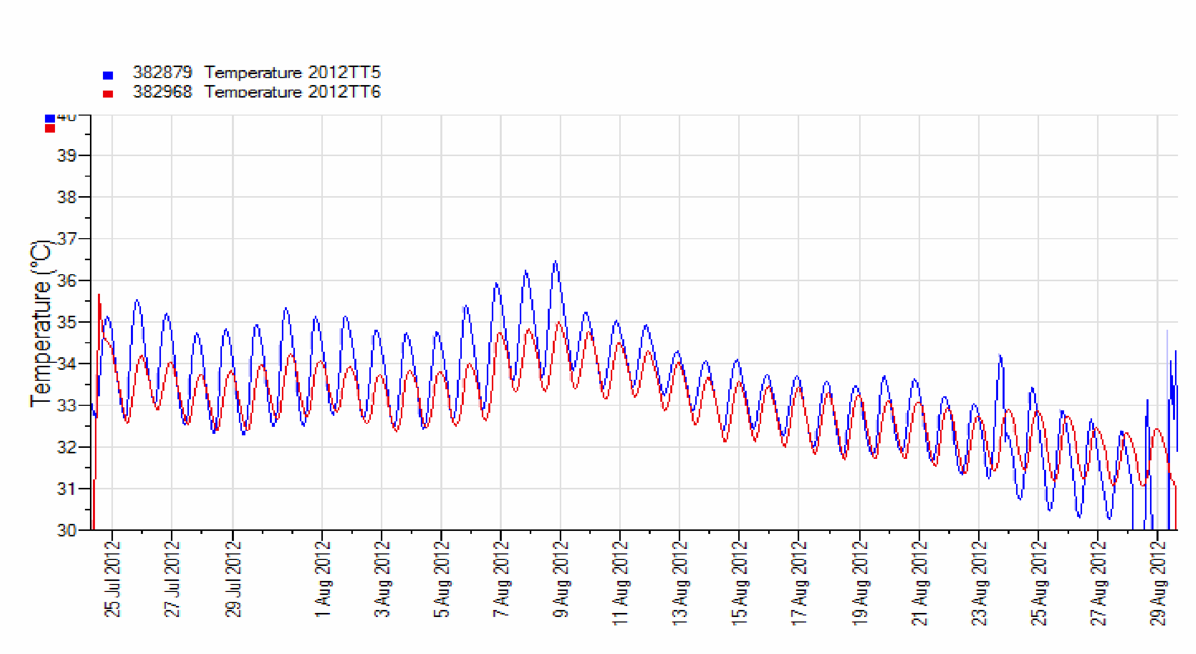

Fig. 10: Overlay of C1 and the "control nest" T IV, C1= blue; T VI = red
Abb. 10: Vergleich von C1 und dem "Kontrollnest" T IV, C1 = blau; TVI = rot

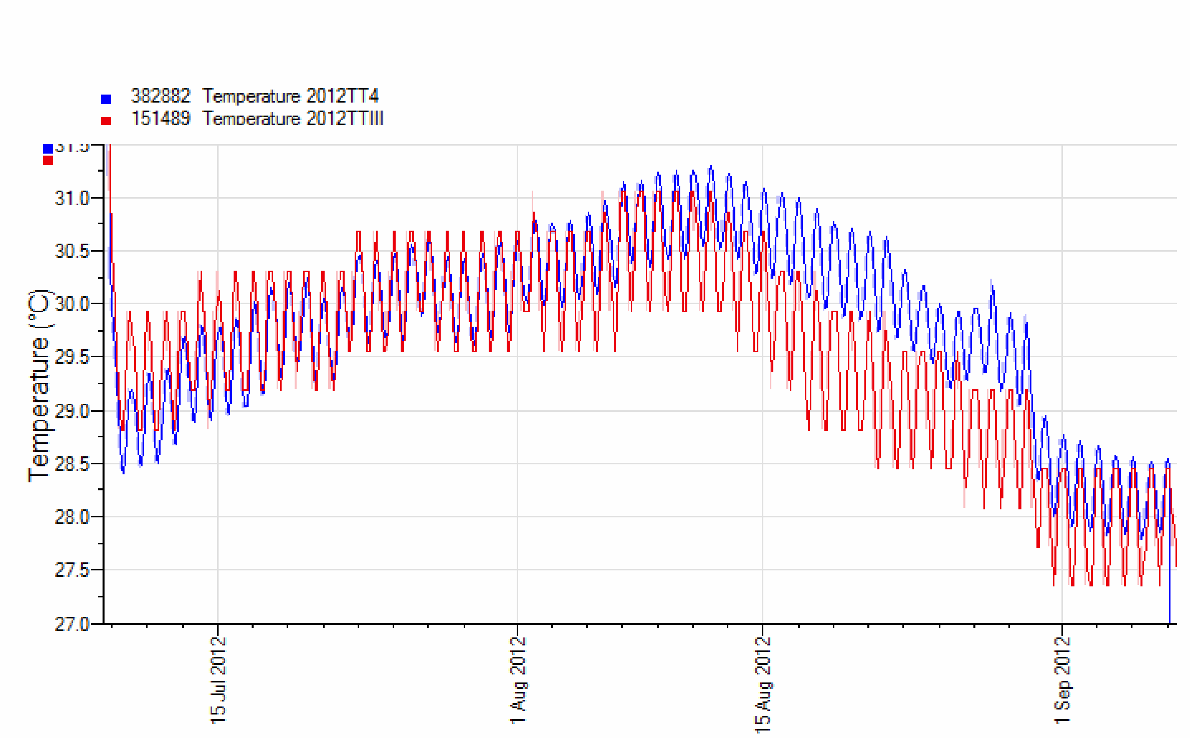

Fig. 11: Overlay of Y 2 and the "control nest" T III, Y2= blue; T III= red
Abb. 11: Vergleich von Y2 und dem "Kontrollnest" TIII, Y2= blau; T III = rot

DISCUSSION

Comparing the measurements of all nests and of all "artificial nests" it reveals that in general the nest temperatures in Çaliş were higher than in Yaniklar. The nest temperature, furthermore the pivotal temperature, is highly controlled by the environmental beach temperatures and the local climate (Mrosovsky 1994). Here, the mean air temperature of Çaliş beach was very similar to the air temperature of Yaniklar. In Çaliş the mean air temperature was 29.8 ° C and the mean air temperature of Yaniklar was 29.6°C. Interestingly, however, the nest temperatures in Çaliş beach were warmer than in Yaniklar. The mean temperature of C1 (figure 4) was 33.5°C and the mean temperature of T IV (Fig. 5) was 33°C. The data of T II is useless, because of technical failures of the Tiny Talk. Once again it has to be said, that all Tiny Tags were laid in nests or artificial nests, which all had quite the same depth.

The mean temperature of all Yaniklar measurements of the Tiny Tags was 30°C, i.e. 3 degrees colder than in Çaliş, although the air temperatures were almost the same.
The nest temperature depends on many factors like the exchange of gases and water, conditions of the beach sand, humidity, water potential, salinity, physical structure of the

beach and the local weather, climate and air temperature (Ackerman 1997). It is also been demonstrated that the variation of beach albedo (Limpus 1983) and movements of water, like tides (Ackerman, 1985), cause thermal differences. All nests and artificial nests in this work had a similar depth, diameter and nest distance to the sea (Tables 1, 2), which are additional physical factors that control the nest temperature. The reason why the nest temperatures in Çaliş were higher could be that the physical structure is different. The whole Çaliş beach (figure 14) is more manipulated and artificially delimited (promenade wall) than the beach of Yaniklar. There are more hotels and more tourism. Also, the gradient of the beach is much higher. Such conditions could make the sand compacter and could alter the gas and heat exchange of the nests.

The incubation period of nests is correlated with the temperature. The higher the temperature, the shorter the incubation period (Ackerman 1997). Loggerhead turtles have an incubation period of 49 to 72 days (Le Buff, 1990). This work shows that the incubation period of C1 (52 days) in Çaliş is shorter than Y2 of Yaniklar (60 days), maybe because of the higher temperature at Çaliş beach and the higher nest temperature of C1.

The middle third of the incubation period is the most important time for the temperature sex determination (TSD) (Mrosovsky & Yntema 1980). The threshold for a sex ratio of 1:1 is between 28°C and 30°C (Ackerman 1997). The average temperature of the middle third of C1 is 34.1°C. This would mean that solely females developed in C1, because the average temperature of the middle third is much higher and the whole mean temperature of the period is 33.5°C; Mrosovsky and Yntema (1980) state that only females will develop if this temperature exceeds 31°C. The constant pivotal temperature of 29°C with a standard deviation of 1.77°C initiates a balanced sex ratio (Paukstits & Janzen 1990). The average temperature along the middle third of the incubation period of Y2 is 30.5°C. After Paukstits and Janzen and their standard deviation, Y2 could develop a balanced sex ratio.

Kaska (1998) described that in Çaliş more males were developed, but maybe the air temperatures were different at this time and this factor plays an important role for the nest temperatures.

Ackerman (1997) also reported that the thermal tolerance range for sea turtle embryos incubated at constant temperature falls between about 25- 27°C and 33- 35°C and is about 10 degrees wide. In C1, at about 24 measurement points the temperature was higher than 35°C, some even higher than 36°C. So, according to Ackerman, the embryos could not tolerate these temperatures. Note, however, that the embryos were not constantly overexposed to these temperatures because the temperatures fluctuate during the incubation period.

Previous measurement data of Yaniklar in 2009 (Höfle & Mangold) show that the mean temperature of 5 nests of Yaniklar was 30.1°C, nearly the same as in 2012, i.e. only 0.1°C more.
The average temperature of the nests in Yaniklar and Akgöl in 2010 (Bauer) was 31.5°C, which is 1.5°C higher than this year. In 2010 there was also the highest measured air temperature of the last 3 years (30.03°C).
According to the measurement data of Pontiller in 2011 in Çaliş, one nest had an average temperature of 32.2°C. It seems that in Çaliş the nest temperatures could be generally higher than in Yaniklar.
Beyond all of these data and these facts, it should be kept in mind that the temperatures fluctuate inside the egg chamber. Moreover, there are differences between the top of the eggs and the bottom of the eggs of 0.3°C to 1.4°C (Kaska 1989). Finally, the nest temperature rises by 9.6°C during the incubation period (Kaska 1989) because of internal metabolic heating (Bustard & Greenham 1968).
Turkey is a very important country for sea turtles to nest, not just for *Caretta caretta.* All species of sea turtles are officially listed as threatened or endangered (CITES, Convention of International Trade in Endangered Species of wild flora and fauna). The Loggerhead Turtle has the status "endangered" (IUCN) and is therefore also at the red list.
It is very important to protect these species and to conduct projects and field courses like the present one by the universities in Pamukkale and Vienna, because these animals play an important role in marine ecosystems.

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I thank Dr. Yakup Kaska, University of Pamukkale, Turkey and Doz. Dr. Michael Stachowitsch, University of Vienna, Austria. They supervised the field course and made this research possible. Furthermore I thank Marie Lambropoulos, Christine Fellhofer, Evelyn Rameder, BSc. and all my fellow student colleagues from Austria and from Turkey for the support and the help during this important field course.

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APPENDIX

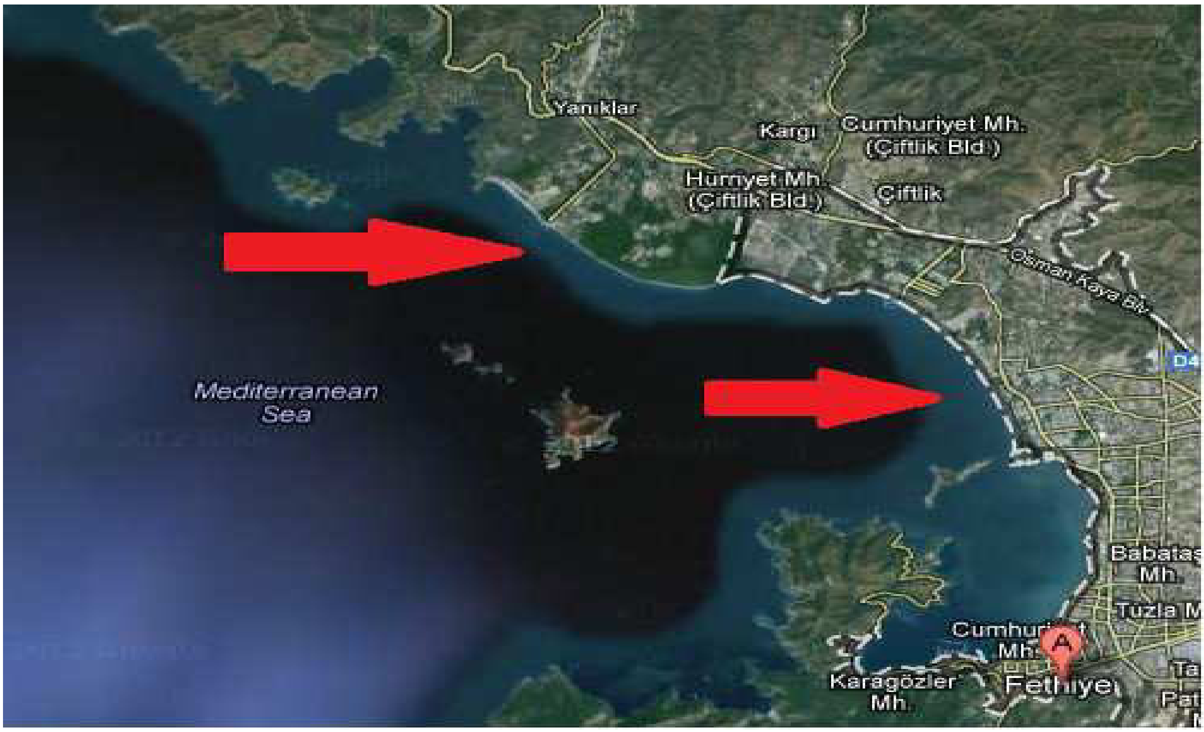

Fig. 1: Upper arrow shows Yaniklar, lower arrow shows Çaliş Beach (Google Maps 2012)
Abb. 1: Obere Pfeil zeigt Yaniklar und der untere zeigt Çaliş Beach (Google Maps 2012)

Fig. 2a: ←West Turkey

Fig. 2 a&b: Nesting beaches of the loggerhead sea turtle (Google Maps 2012)
Abb. 2: Niststrände der Unechten Karettschildkröte und der Grünen Meeresschildkröte (Google Maps 2012)

Fig. 2b: → East Turkey

Fig. 3: Tiny Tags with batteries and capsules (photo: C. Bialek.)
Abb. 3: Tiny Tags mit Kapseln/ Hüllen

Fig. 12: "Artificial nest" T III at Yaniklar (photo: C. Bialek)
Abb. 12: "Künstliches nest" T III in Yaniklar

Fig. 13: Yaniklar, Akgöl side of the beach. Note coarse substrate (photo: G. Gimpl)
Abb. 13: Yaniklar, Akgöl- Seite des Strandes

Fig. 14: Çaliş Beach. Note promenade wall on right (photo: S. Prader)
Abb. 14: Çaliş beach mit der Strandpromenade rechts

Fig. 15: Nest Y2 at Yaniklar, marked by semi-circle of stones (photo: C. Bialek)
Abb. 15: Nest Y2 von Yaniklar, markiert mit einem Halbkreis aus Steinen

Bachelor Thesis

Light pollution along the beach promenade in Çalış, Turkey, in 2012

Lichtverschmutzung an der Strandpromenade in Çalış, Türkei

Sabrina Wagner

Aspired academic title

Bachelor of Science (BSc)

Vienna, October 2012

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KURZFASSUNG

Lichtverschmutzung bleibt ein großes Problem in Çalış, da der Strand mit samt seiner Promenade sehr stark touristisch genutzt wird und sich viele Bars und Restaurants niedergelassen haben die allesamt stark beleuchtet sind. Da dies ein Niststrand der Unechten Karettschildkröte *Caretta caretta* ist, sollte dieses Problem reduziert oder besser gelöst werden. Das künstliche Licht ist eine starke Störungsquelle für alle adulten Schildkröten die zu dem Strand kommen um ihre Nester zu legen und dann wieder den Weg ins Meer zu finden. Weiteres ist es die Ursache für die Desorientierung der geschlüpften Hatchlinge in der Nacht.

Um die Lichtverschmutzung festzustellen wurden die Lichter der Promenade gezählt und die Lichtintensität mit einem Lux-Messgerät vor den Lokalen und vor den Nestern gemessen.

2012 wurden 1013 Lichter gezählt, im Vergleich zum vorigen Jahr blieb dieses Anzahl konstant. Der höchst gemessene Lux-Wert war 57 lux mit einem Lux-Mittelwert aller Restaurants und Bars von 14,07. Die 7 gefundenen Nester an der Promenade befanden sich eher am westlichen Teil der nicht so stark beleuchtet war. Trotzdem befanden sich 2 Nester in Gebieten mit hoher Lichtintensität(>20lux). Eine mögliche Erklärung dafür ist, dass die Lichter zu der Zeit als die Schildkröte an Land ging, schon abgedreht waren oder es der letzte Versuch für sie war, ein Nest zu machen. Weitere 3 Nester fern weg der Promenade befanden sich an einem dunklen Abschnitt des Strandes.

Zusätzlich wurden verschiedenen Strategien zur Verringerung der Lichtverschmutzung ausgearbeitet. Die beste Lösung – auch wenn unrealistisch - wäre es, die Lichter abzudrehen. Andere Strategien zur Verringerung wären die Anzahl der Lichter, die Höhe der Laternen, die Helligkeit der Lampen zu reduzieren oder als Lichtschutz Bäume/Sträucher vor der Promenadenwand zu pflanzen.

Um die Situation in Çalış zu verbessern wären gezielte Gesetze und entsprechende Kontrollen nötig. Zusätzlich sollten die Einheimischen und Touristen in Form von Vorträgen, Hinweistafeln oder direkt am Hotel über die Probleme am Strand und der Meeresschildkröten informiert werden. Denn nur zusammen können wir einen wichtigen Schritt machen um die Lichtverschmutzung zu verringern oder gar den Strand für die Schildkröten lichtfrei zu machen.

ABSTRACT

The investigation area Çalış is a very popular destination for tourists from all over the world. The local residents have therefore built restaurants, bars and shops along the beach promenade which are partially very strongly illuminated in the evening and night time.
Although this beach is a Special Protected Area because it is a nesting site of the loggerhead sea turtle *Caretta caretta*.
Most species of sea turtles such as the loggerhead are nocturnal nesters; artificial lighting of nesting beaches represents an environmental modification that disrupts visual cues. To a turtle that has not yet emerged to nest, a brightly lit beach may signify daylight and thus inhibit nesting. Light pollution is a major disturbance for the adult female turtles, but is also a problem for the hatchlings. Artificial lights disrupt the hatchlings when they crawl from their nest to the sea.
This study is designed to show whether the adults nest directly in front of artificial lights of bars, restaurants etc. or whether they prefer darker locations.
The promenade, which is about 1.5 km long, was subdivided into 74sections. Each section corresponds to one building, e.g. a restaurant or a bar. The intensity of light from every section was measured with a lux meter and the lights were counted and compared with the number of lights from 2011. In 2012 along the promenade of Çalış the total sum of counted lights was 1013; compared to 2011, this was a reduction of only 2 lights. The mean lux value was 14.07 lux, with the highest measured being 57 lux. There were two nests in front of highly lit bars. One potential explanation is that, the lights may have already been turned off (i.e. late at night/early morning) when the turtle came to the beach. Alternatively, the female may have found no better (significantly darker) place to lay her eggs. Overall, 4 of the 7 nests along the promenade were at darker sites.
Additionally, strategies to reduce the light pollution were elaborated. The best solution would be to turn off all the lights, although this is clearly unrealistic. Other strategies would be to reduce the number of lights, the height of the lanterns and the light intensity, or to plant vegetation between the beach and the promenade. This is illustrated with figures.
But without official regulations and adequate controls, the light pollution will become an increasing problem for the sea turtles on Çalış beach. The low number of nests in 2012 and the very low number of hatchlings reaching the sea underline this message. It is also

important to inform the tourists and the local residents to make a step into a future with less light on one of the nesting beaches of the sea turtle *Caretta caretta.*

INTRODUCTION

In the time since Europeans began migrating across the oceans of the world, sea turtle populations have declined. Since tourism has become a big business and the fisheries have become globalized, all sea turtles are threatened with extinction.

Light pollution is one of the negative effects tourism brings, not only for the turtles but also for nocturnal animals such as insects, birds, amphibians, reptilians, bats and human being-s. The Consequences for human are industrial disease and insomnia; animals suffer on disorientation, disturbed forage, modified predator-prey relationship and disturbed social interactions.

Artificial lighting is also a very strong source of disturbance along beaches, with the beach in Çalış serving as a prime example.

The investigation area Çalış is a very popular destination for tourists from all over the world. The local residents have therefore built restaurants, bars and shops along the beach promenade. Most of these are strongly illuminated in the evening and night time. Although this beach is a special protected area because it is a nesting site of the loggerhead sea turtle *Caretta caretta*.

Critical sea turtles behaviors affected by light pollution include the selection of nesting sites by adult turtles and the movement off the beach by hatchlings and adults (Witherington, 2003). On this beach the activities of tourists and sea turtles are conspicuously intertwined. Sea turtles spend very little of their lives on beaches, but their activities there are crucial for the survival of the next generation. Because most species of sea turtles such as the loggerhead are nocturnal nesters, artificial lighting of nesting beaches represents an environmental modification that disrupts visual cues. To a turtle that has not yet emerged to nest, a brightly lit beach may signify daylight and thus inhibit nesting (Witherington, 1992).

The various factors for nesting include where the female turtle emerges, where on the beach it begins digging, whether or not the nesting attempt is abandoned, what stage is reached before abandonment, and the directness of orientation on the return crawl. This variation in nesting behavior affects successes in egg deposition, in hatchling production and in the seaward return of the adult (Witherington, 1986).

Sea turtles select a nest site by deciding where to emerge from the surf and where on the beach to put their eggs. The most clearly demonstrated effect of artificial lighting on nesting is deterrence from emerging from the water. Evidence for this has been given by Raymond (1984b). Witherington (2003), also noted that the reason why artificial lighting deters nesting is because turtles perceived it as daylight, which may suppress nocturnal behavior. Once on the beach, sea turtles select a place to make a nest. In the field experiments by Witherington (1992), artificial lightning had no effect on how far from the dune sea turtles placed their nests. Nest placement on the beach may depend most heavily on nonvisual cues such as temperature gradients (Stoneburner and Richardson, 1981) or sand conditions.

After a sea turtle has camouflaged (closes and “hidden” the nest by casting sand, principally with front-flipper strokes) her nest, she orients herself toward the sea and returns there. Experiments with blindfolded immature green turtles indicate that they rely on vision to find the sea. It is therefore not surprising that interference by artificial light creates problems in finding their way back to the sea. In the lighted-beach experiments described by Witherington (1992), few nesting turtles returning to the sea were misdirected by lighting; however, those that were (four green turtles and one loggerhead) apparently spent a long time wandering in search of the ocean. Therefore, not all turtles became disrupted by brightness. Adult turtles attempting to return to the sea after nesting are not misdirected nearly as often as are hatchlings emerging on the same beaches (Witherington 2003).

Light pollution is a major disturbance for the adult turtle, but it is also a problem for the hatchlings. Artificial lights disrupt the hatchlings when they crawl from their nest to the sea (Tuxbury & Salmon, 2005). After the hatchlings emerge onto the sand surface, they also orientate by visual cues but, unlike adults, they perceive all the lights in the “cone of acceptance”. The cone of acceptance is about 180° wide horizontally and -10° up to -30° wide vertically. They crawl towards the brightest horizon, which should be the sea. Normally the moon and the stars reflect on the sea so that the brightest horizon is seawards but the strong lighting from the promenade disrupts this orientation of the hatchlings.

Witherington (1997& 2003) lists some strategies to handle light pollution. One solution is to reduce the power of the light by using lower wattage. Another solution is to use yellow, low-pressure sodium vapour lights: they seem to affect nesting turtles less than light from other sources. Finally, one can plant higher dune vegetation or construct higher dune profiles. A more recent strategy is to reduce the light duration by installing motion-detectors.

Salmon (2003) also elaborated strategies to solve the photo pollution problem. First, the unnecessary lights should be turned off. Second, the wattage should be reduced. Third, the lights should be redirected and focused to the places where they are needed or on the ground by using shields. Fourth, the upward-directed lights designed for decoration should be eliminated. Fifth, alternative light sources should be used; this includes lights with certain wavelengths which are less disruptive to sea turtles. Finally, new constructions should incorporate the latest light management technology.

The purpose of this bachelor thesis is to document the light pollution based on the light intensity along the promenade in Çalış and to determine whether there is a connection between well-lit areas and the position of the nests on the beach. A final task was to document whether the light pollution has increased based on the data from earlier years.

MATERIAL AND METHODS

The monitored area in Çalış is the promenade between an ice cream parlor on the eastern end (facing Fethiye) and Caretta-Beach Bar on the western end. The documentation started on the eastern end. This area, which is about 1.5 km long, was subdivided into 74 sections.

Each section corresponds to one building, e.g. a restaurant or a bar. Data were collected between 09:43 p.m. and 11.04 p.m. on 28 July 2013 when most of the lights were on.

The intensity of light at every section was measured with a lux meter and the lights were counted and compared with the number of lights in 2011. This was simplified by using a photo catalog with the same sections from 2011. To determine the number of lights every visible light source, based on the promenade, was counted. For every section the illumination was quantified in an about 4m wide area measured from the seaward promenade edge towards the restaurants.

The number and the position of the nests in front of the promenade were taken from the data sheets filled out by the students during the summer of 2012.

2012 was the first year in which the intensity of the lights along the promenade were measured. The total number of the counted lights was compared with earlier years going back to 2005. The figures were drawn in Microsoft Excel. The lux values were measured twice, on separate evenings between 9:00 p.m. and 11:00 p.m., in Table 1 lists the average from both.

To create a new catalogue of all bars and restaurants on the promenade, photos were taken between 9:43 p.m. and 11:04 p.m. on 28 July 2012. Camera angles varied slightly due to space restriction on the promenade. The light intensities on the images do not necessarily reflect actual brightness. This makes the lux values from each section important. Strategies to reduce light pollution were elaborated. Demonstrative illustrations were designed using the computer software Paint.

RESULTS

In 2012 along the promenade of Çalış the total sum of counted lights in the 72 sections was 1013. The mean lux value was 14.07 lux, with the highest measured value of 57 lux. The highest value was measured at a tiny ice cream stand with 4 large lights on it (Fig.1). This is a relatively small number of lights, but serves as a good example that the number of lights itself does not necessarily reflect the light intensity.

Table 1 lists the sections, their number of lights in 2011 and 2012, and the lux values sorted in descending order. The strongest illumination in one section was 57 lux, followed by 52 lux measured just 3 sections away. Two sections had a very little illumination, i.e. less than 2 lux. Half of the sections had more than 11 lights per section. Half of the nests were in front of sections with more than 20 lux.

Tab. 1: Lux values (in decreasing order) and number of lights at the different bars and restaurants (“sections”) in 2011 and 2012 and the nests(2012) in the corresponding section of the beach
Tab. 1: Lux-Stärke und Summe der Lichter der verschiedenen Lokale 2011 & 2012 und die davor liegenden Nester

Section number	Name	lux	sum 2012	sum 2011	nest
15.	ice cream p. simsek	57	4	-	
12.	ice cream p. deniz	52	8	-	
28.	Pioneer Travel	41	11	8	
27.	Cafe Soul	33	18		
30.	Red Tattoo	32	24	22	
38.	Turkish Bazar	29	13	13	CS1(8 lux)
40.	Taxi Office	28	4	2	
33.	Serkul 1	27	34	17	
31.	Souvenirs	26	22	22	
32.	Seaside Travel	26	18	18	
52.	Senkul Tourism	25	-	-	
59.	Secil Clothing	25	10	10	
53.	La Testi	22	7	7	
39.	Focus Travel	21	13	17	CS2(3 lux)
43.	Mado	21	10	17	

14.	Hotel Simsek	20	16	-	
41.	Cafe Green	20	10	12	
54.	Merhaba	20	10	14	
42.	Çalış Bazar	19	15	17	
60.	Secil Market	19	10	12	
22.	Orient Express	18	17	-	
34.	Serkul 2	18	33	21	
1.	ice cream palour	17	4	-	
13.	Deniz Beach	16	6	-	
55.	Clothing Shop	16	20	20	
25.	Moussaka	15	15	-	
29.	La Casa	15	26	8	
37.	The Palms Beach	15	23	23	
56.	Lilys Steak House	15	15	15	
5.	Rest. Mutlu	14	29	-	
21.	Da Vinci	14	11	-	
26.	Bambu Rest&Bar	14	25	-	
35.	Georges	14	18	16	
16.	Hotel Berlin	13	16	-	
19.	Bella Mama	12	25	-	
20.	Turkish Chinese	12	27	-	
23.	Eylül Optik	12	17	-	
49.	Info Travel	12	7	7	
36.	Eyna	11	10	18	
58.	Günes Hotel	11	17	17	CS7 (3 lux)
2.	Haslam Misir 1	10	3	-	
4.	Rest. Gadiri	10		-	
24.	Nil Restaurant	10	15	-	
11.	Anna Bar	9	40	-	
17.	Hotel Eröz	9	16	-	
62.	Seketur Hotel	9	7	7	
10.	Manas Park-lounge	8	14	-	
70.	Behame	8	13	8	
71.	Hotel Dolphin	8	10	11	CS4
74.	Caretta-Beach Bar	8	>61	-	C1+CS5
3.	Haslam Misir 2	7	3		
44.	jewelry shop	7	3	3	
61.	Tattoo	7	-	-	
73.	Hotel Letoon	7	44	32	
18.	Kassaba	6	20		
45.	painter	6	2	2	
51.	Rose Cafe&Rest.	6	19	19	
57.	Çalış Beach Rest.	6	12	15	
72.	Malhun Rest.	6	8	17	
7.	jewelry shop	5	5		

46.	glas former	5	2	-	
48.	Okyanus	5	15	15	
6.	House	4	4		
50.	1905 Pub	4	22	17	
63.	Sim Bar	4	23	23	
8.	Hamsi Cafe	3	18		
9.	Manas Park	3	8		
47.	lighthouse	3	15	15	CS3 (1 lux)
69.	Turkuaz Market	3	6	7	
65.	Keyif Cafe	2	11	11	
66.	Maya Cafe	2	11	8	
68.	Hotel Ceren	2	16	25	
64.	Caretta Info-Desk	1	2	3	
67.	Cinar Bar	1	8	11	
			1013		

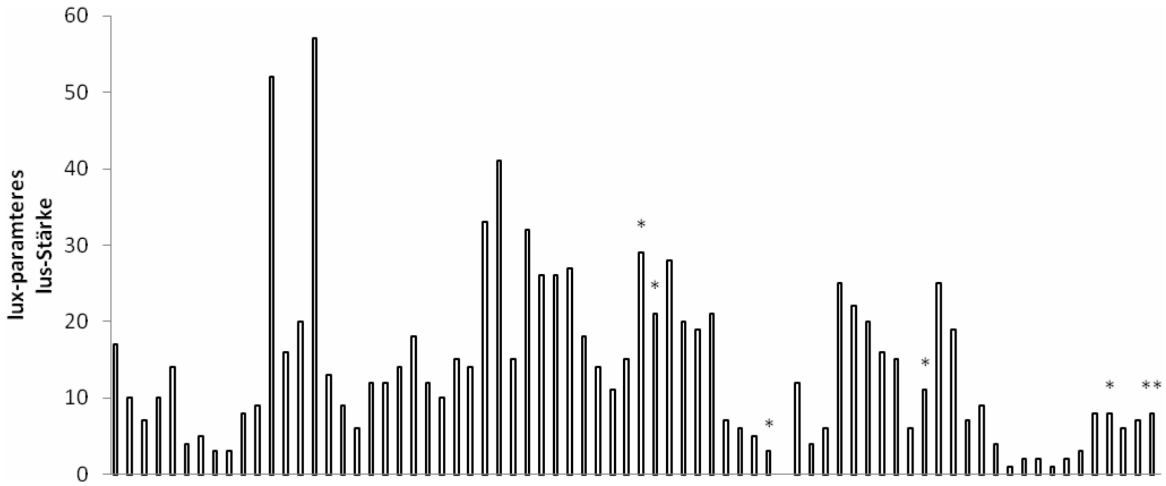

Fig. 2: Light intensity (lux) in each section: the sections with nests are marked with a star, 2 stars for a section with 2 nests
Abb. 2: Intensität der Lichter in den jeweiligen Abschnitten, Abschnitte mit Nestern, sind mit einem oder zwei (für 2 Nester) Sterne markiert

The distribution of lights is clearly visible in Fig. 2. Dividing the promenade into two sectors, with and without nest, yields another perspective. The first half had 603 lights (sections 1-37) with less luminosity and 2 sections with a very high light intensity but without a nest. The mean value was 17 lux per section. The other half had 410 lights (sections 37-73) and a mean value of 11.26 lux with all 7 nests. There were 3 more nests which are not shown in the figure; these 3 where in an area outside the promenade.

Compared to last year (2011) the number of lights has not significant changed. More importantly, since 2005 the number of lights has risen continuously, except in 2008 (Fig. 3), with the last two years showing peak values.

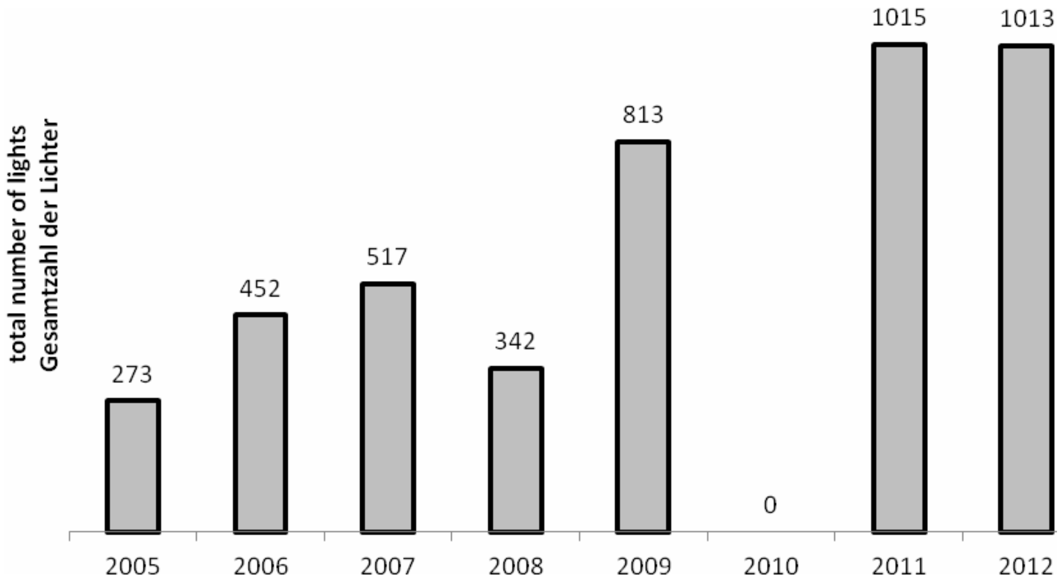

Fig. 3: Total number of lights in Çalış from 2005 to 2012 (2010: no data)
Abb. 3: Gesamtzahl der Lichter in Çalış von 2005 bis 2012 (2010: keine Daten)

This year, a promenade catalogue is also was produced (Appendix 1) in which all the bars and restaurants are listed from the eastern end to the western end of the promenade. This catalogue, with the photographs of each section, provide an overview of all the bars, restaurants, travel agencies and other shops on the promenade in Çalış. The photos give an impression of the lights closest to the beach and it will help future students to better orientate themselves and to compare their data.

DISCUSSION

At sea level in a clear full moon night and under natural conditions 0.25 lx can be measured (Janicek & Deyoung,1987, Spudis, 1999). Light pollution is a serious problem in Çalış and this is very well shown by the lux-values.

There were 17 restaurants with more than 20 lights. A good example is the Caretta-Beach Bar. It had more than 61 lights. Surprisingly there were 2 nests in front of this the bar. One explanation is that the light intensity was relatively low, just 8 lux. Another explanation might be that this was the last section measured and it is already at least 15 m away from the main promenade. The 2 nests were CS5 (Çalış secret 5) and C1 ("Çalış 1"). The latter is the only not-secret nest, i.e. the university students were on site when the adult turtle emerged. According to the students who watched the turtle coming out to nest at the Caretta-Beach Bar, the lights were dimmed but not entirely turned off, so there was some level of light pollution was present at the time. The hatchlings from these two nests still had their problem by sea finding but the light pollution must be low enough for the adult turtles to come out on the beach or the lights were turned off.

CS1 was in front of a very strongly lighted spot with 29 lux; the 2 measurements on the beach shoed that light intensities of 8 lux still reached the nest. Therefore this nest experienced the highest light pollution. Unfortunately it is a so-called secret nest, so the time when the turtle emerged from the water is unknown. The same valid for CS2 and CS7: these secret nests were located in front of strongly lighted hotels (> 10 lux). In those cases, the female may have come out from the sea at a time when most of the bars and restaurants had already turned off their lights. Another explanation for these nesting places can be sand condition, which plays an important role in nest side selection.

Despite the strong light pollution, the hatch-success was good. The number of hatchlings emerging and successfully reaching the sea from nests CS1, CS2 and CS7 were 35, 46 and 94, respectively.

These examples are conform with the theory off Witherington (1992) and Stoneburner (1981), which implies that artificial lightning had no effect on how far from the dune sea turtles placed their nests because nest placement on the beach may depend most heavily on nonvisual cues such as temperature gradients and sand conditions.

Accordingly, this nest sites in Çalış must have had good conditions for nesting.

Note, however, that in 2012 the lowest number of nests ever were recorded in Çalış, and one plausible explanation is the increasing light pollution

For several years now, the lanterns along the promenade have been modified with a small shield that partially blocks the light from shining on the beach (Fig. 4). Without this shield the light would shine directly on the beach. This is an admirable strategy against light pollution but the lights remain strong and are positioned very close to the beach. A better solution would be to use lower lights, direct the light even better with louvers, louvered step lighting or wall-mounted downlighting along the promenade wall (Figs 5-7).

Also, special light bulbs such as low-pressure sodium vapor lamps (Witherington & Bjorndal, 1991) can be used. These are expensive, but the affect nesting turtles less than light from other sources. The chance for voluntary use of such lamps is minimal, but compromises could be found if there is a will to reduce light pollution.

Another problem is the menu shields in front of almost every bar or restaurant (Fig.9). Clearly, these light sources are not easy to remove because every restaurant is in competition with the others, and very strong and colorfully lit menu shields help attract tourists. One solution for this problem would be to plant native vegetation in front of the promenade wall. Another would be to raise the wall. Since visitors like to walk along the promenade and look out to the sea; the wall should not be too high.

It is very difficult to quantify all sources of light pollution here. On the promenade some vendors sold toys that light up, others sold laser pointers. Such items can also contribute to light pollution. The promenade itself is not the only problem: elsewhere in Çalış, where the other 3 nests were found, a lot of light pollution is produced by the people who picnic and celebrate there. In this case, public education and public relations work could help.

The other monitored beach, Yaniklar, had many more nests than Çalış. One potential explanation is light pollution. There is less artificial light at night in Yaniklar beach and so the turtles may feel more attracted to this beach than to the bright lights in Çalış (Fig. 8)

Every year the students from the universities hold presentations in several restaurants and bars about the life of and risk to sea turtles, especially to *Caretta caretta*.

That is one step forward for because the tourists and owners are made aware of the problem After all, the demand determines the supply.

All strategies against light pollution will be unsuccessful if there are no laws to govern such matters or if the laws are not controlled. For example, the presence of mobile and semi-mobile sales booths (Fig.10) directly on the promenade should be forbidden. These could easily be moved further away from the wall along the beach.

More signs could be put up to inform the people about the special protected area and how to behave in such areas. The local residents should be better informed about the problems on the beach in Çalış and the solutions should be designed together.

The hotels could play an important role by not only promoting the sea turtles as an attraction but by better informing the tourists.

In conclusion, light pollution is a problem on the promenade of Çalış. There are suitable strategies to combat the light pollution, but these require regulations and controls. Otherwise light pollution will continue to be a problem for the sea turtles on Çalış beach. The few nests and the low number of hatchlings reaching the sea are a warning sign and a call for action.

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Fig. 1: ice cream parlour, light intensity: 57 lux (Photo: M. Stachowitsch)
Abb. 1: Eisstand, Lichtintensität: 57 lux

Fig. 4: Lantern on the beach of Çalış with beach-facing part partially shielded (Photo: B. Böswart)
Abb. 4: Laterne mit Abschirmung am Strand von Çalış

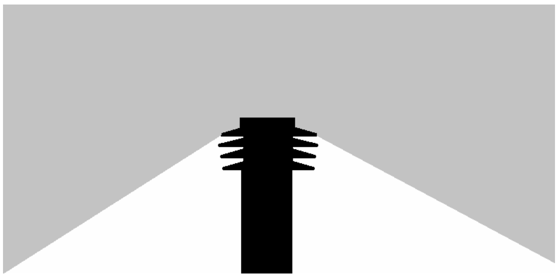


Fig 5: lighting bollard with louvers (Photo: B. Witherington)
Abb 5: Lamppfosten mit Blenden

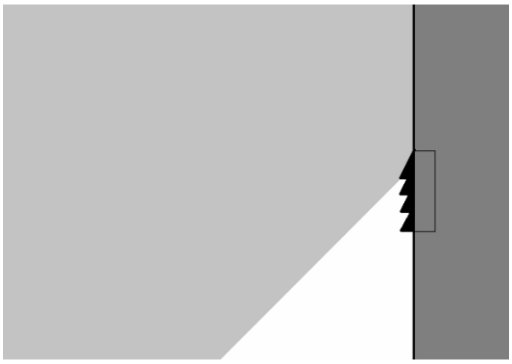


Fig 6: louvered step light (Photo: B. Witherington)
App 6: Wandlampe mit Blenden

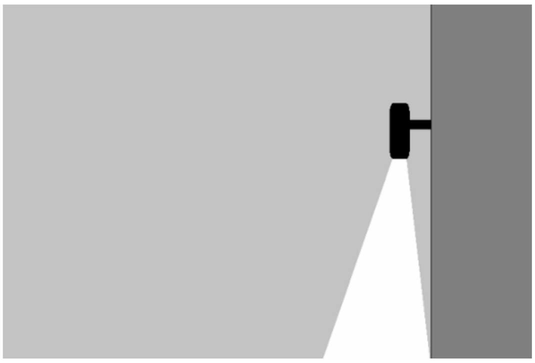


Fig. 7: wall-mounted down lighting (Photo: B. Witherington)
Abb. 7: nach unten gerichtete Wandlampe/Leuchte

Fig. 8: View from Yaniklar to Çalış (Photo:Gerald Gimpl)
Abb. 8: Sicht von Yaniklar auf Çalış

Fig. 9: restaurant with menu shield 15 lx(Photo: M.Stachowitsch)
Abb. 9: Restaurant mit Menüschild 15lx

Fig. 10: semi-mobile sale boot (Photo: M.Stachowitsch)
Abb. 10: halb-mobiler Verkaufsstand

Bachelor Thesis

Sea turtle strandings in Fethiye (Turkey) in summer 2012

Gestrandete Meeresschildkröten in Fethiye (Türkei) im Sommer 2012

Gratia Kautek

Aspired academic title
Bachelor of Science (BSc)

Vienna, October 2012

Studies number / Studienkennzahl: A033 630

Matriculation number / Matrikelnummer: 0802426

Department of Marine Biology

Supervisor: Doz. Dr. Michael Stachowitsch

ZUSAMMENFASSUNG

Die Unechte Karettschildkröte (*Caretta caretta*) ist eine der drei gefährdeten Meeresschildkrötenarten im Mittelmeer. Neben der Grünen Meeresschildkröte, *Chelonia mydas*, und der Lederschildkröte, *Dermochelys coriacea*, die alle durch menschliche Ausbeutung bedroht sind, erleidet auch die Unechte Karettschildkröte jährlich einen starken Rückgang in der Populationsgröße. Im gesamten Mittelmeerbereich werden vermehrt Daten von gestrandeten Meeresschildkröten gesammelt, um mehr Informationen über saisonale Verbreitung, Lebensgeschichte, sowie Sterblichkeit der gefährdeten Meeresschildkrötenarten zu erhalten. Während des Sea Turtle Field Course im Sommer 2012 der Universität Wien in Zusammenarbeit mit der Universität Pamukkale in Fethiye, Türkei, wurden Daten von gestrandeten Meeresschildkröten in Yaniklar, Çaliş und der Stadt Fethiye erhoben. In Nacht- und Morgenschichten wurden die Strände von Teilnehmern des Projektes abgegangen und gefundene Kadaver durch Körpervermessungen und Untersuchungen identifiziert und analysiert. Vier tote Unechte Karettschildkröten (*Caretta caretta*) wurden dabei entdeckt. Zwei von ihnen wurden im Hafen von Fethiye angeschwemmt, eine weitere am Strand von Çaliş und das Skelett eines zersetzten Meeresschildkrötenkadavers wurde am Strand von Yaniklar aufgefunden. Die erläuterten Todesursachen schienen repräsentativ für zwei der stärksten Bedrohungen der Meeresschildkröte im Mittelmeer, die Langleinenfischerei und die zunehmende Verschmutzung des Meeres durch Plastikmüll.

ABSTRACT

The Loggerhead sea turtle (*Caretta caretta*) is an endangered species in the Mediterranean and elsewhere. Similar to the two other endangered species, the Green sea turtle (*Chelonia mydas*) and the Leatherback sea turtle (*Dermochelys coriacea*), the Loggerhead sea turtle is facing many threats through human exploitation and has been suffering population declines every year. Stranding and bycatch data are progressively being collected all over the Mediterranean, providing important information about seasonal distribution, life history and mortality of the species. During the Sea Turtle Field Course in summer 2012 by the University of Vienna in collaboration with the University of Pamukkale in Fethiye, Turkey, data on sea turtle strandings in Yaniklar, Çaliş and Fethiye town were collected. The project‘s participants monitored the beaches during night and morning shifts, identifying and analyzing stranded sea turtles by body measurements and carcass investigation. Four dead Loggerhead sea turtles were detected. Two of them were found onshore in Fethiye harbour,

one carcass stranded on Çaliş beach and one skeleton of a decomposed sea turtle carcass was found on Yaniklar beach. The death causes seemed to be representative for two key threats for marine turtles in the Mediterranean, longline fishing and marine plastic pollution.

INTRODUCTION

The Mediterranean Sea represents an important habitat for marine mammals and sea turtles. Tropical and subtropical sea turtle species such as the Loggerhead sea turtle and the Green sea turtle use this area for foraging and nesting. The Loggerhead (*Caretta caretta*) is one of the seven threatened marine turtle species worldwide. Due to its long life cycle, wide distribution and its omnivorous diet the Loggerhead sea turtle faces many threats that seriously reduce its population. Like for other large-sized marine organisms, human exploitation has become the main risk and the main cause of all sea turtle species being endangered. Boat collisions, ingestion of debris, and chemical pollution are potential threats (Lutcavage et al. 1997), but the available data clearly indicate that fishing has become the largest cause of mortality.

The Loggerhead, the Green (*Chelonia mydas*) and the Leatherback sea turtle (*Dermatochelys coriacea*), the latter representing the largest species in body size, are protected under the Convention for the International Trade in Endangered Species (CITES). The IUCN (International Union for the Conservation of Natural Resources; The World Conservation Union) classified the Loggerhead and the Green sea turtle as endangered (Marine Turtle Specialist Group 1996; Seminoff 2004), the Leatherback as critically endangered. The protection and conservation of sea turtles in the Mediterranean is therefore a key issue and is gaining importance.

Long-term studies and data collection from coastal countries around the Mediterranean have concluded that the Loggerhead population is already declining here. This conclusion is mainly based on data collected via strandings. Stranding-data can provide valuable information about geographic ranges, seasonal distribution and life history as well as massive mortalities of the marine vertebrates in nearshore areas. The latter can support estimates of the abundance of marine species. (Tomás et al. 2003; Witt et al. 2007)

Whereas the nesting and migration areas of the Green sea turtle is confined to the Eastern Mediterranean coastlines (Kasparek et al. 2001), the migration routes of the Loggerhead extend through almost the whole Mediterranean Sea from the Strait of Gibraltar in the west to the Aegean Sea. Each year, thousands of strandings and bycatch are reported here; the Loggerhead represents the majority of cases.

Due to the improving effectiveness of the stranding network in the Mediterranean, the availability of more accurate data is increasing year by year (Panagopoulos et al. 2001). The annual augmentation of stranding data should be considered in long-term studies on the abundance of marine vertebrates in order to prevent inaccuracies.

Most of the strandings seem to occur in the Western Mediterranean, along the Spanish south coast. Reports from 1989 to 2000 detected about 415 dead Loggerheads along the eastern Spanish coast (Tomás et al. 2001). Greece reported that around the same time, 1080 sea turtles had stranded, whereby 957 were Loggerheads (Panagopoulos et al. 2001). Very early reports from Israel show sea turtle strandings totalling more than 15,000 individuals in the years 1952 to 1965 (Margaritoulis 2001). Mortality causes are mainly fishing activities such as entanglement in fishing gear but also the swallowing of marine debris like plastic (Tomás 2001). Therefore the true number of killed sea turtles needs to be determined using far more information than mere stranding data provide. In 2000, for example, Spain counted the number of bycatch in the longline fishing industry and concluded a number of more than 29,000 sea turtles for that year alone (Camiñas et al. 2001).

Also along the Turkish Mediterranean coast, which represents one of the most important nesting habitats of Green and Loggerhead sea turtles, almost every year stranded cadavers of these species and also of the Nile Soft-shelled turtle (*Trionyx triunguis)* have been recorded. During the summer, the Turkish beaches bordering the Aegean Sea around Fethiye are being monitored by university projects and courses in which important data on locally nesting sea turtles are collected.

In the following study, stranding data of the beaches around Fethiye were taken by students from the University of Vienna and the University of Pamukkale (partly within the 2012 Sea Turtle Field Course). Dead Loggerhead sea turtles were found washed ashore on Yaniklar beach, Çaliş beach and Fethiye harbour. Through these new observations and a necropsy of one stranded carcass, important data were added to the annual reports, updating the investigations on Loggerhead fatalities and mortalities on the western Turkish Mediterranean coast.

MATERIAL AND METHODS

During summer 2012 (July – September) the 2 beaches Yaniklar and Çaliş were monitored by participants of the Sea Turtle Field Course. Both beaches were observed during morning shifts, which extended 6am to 8am in Çaliş and until 10am in Yaniklar. Night shifts took place from 10pm to 2am at night. 2 to 4 persons walked along the beach side by side in a row perpendicular to the waterline, scanning up to 10 m ahead and about 2-4 m wide. 1 person carried a backpack containing a field data booklet, a torch, a measuring tape, a red light, a walkie-talkie, a pencil, a permanent marker, a tape, spare nest signs and ropes for fixation, a metal sand probe and tags. A large wooden caliper was carried by a second person. In Çaliş, the person walking along the upper side of the beach used the red light to better see in the shade of the promenade wall. The monitoring in the morning shift started from the eastern end of the promenade westwards up to Çaliş tepe. During the nightshift the beach was monitored only up to the Surf Café where a break of about 15 minutes was taken before heading back to the starting point.

In Yaniklar, 2 people monitored the beach from the camp to Karatas Beach - the so-called "small beach" and back, whereas another 2 walked simultaneously along the beach of Agköl during morning shift. In nightshifts, beaches were inspected twice by 3 people each. 1 person walked along the waterside, 1 in the middle of the beach and 1 along the vegetation-side and the beach was only monitored till the so-called "lonely tree". Each person had a different duty either measuring nests and adult turtles, illuminating the working process with the torch or taking notes. In Agköl the reversal point from which the second shift started was about 500m away from the camp.

From mid-July on, the team members additionally carried a bucket with a dark cloth as a cover for collecting hatchlings found during shifts.

When a stranding of an adult turtle was sighted the rest of the team was informed via walkie-talkie. In Çaliş beach the investigation needed to be conducted quickly in order to reduce the presence of tourists. The dead animal was recorded and the species identified. All data were recorded in the field data booklet. One person took pictures of the posterior, anterior and dorsal view of the turtle. Another person measured the body size using a measuring tape (curved body length/width) and caliper (straight body length/width). All measurements and documentations were then noted in a data sheet (see appendix). All carcasses were removed after inspection and transported onto/into a thick plastic bag.

For the necropsy the carcass was placed onto a clean cover with its carapace facing down. All persons involved wore gloves and face masks during the whole procedure. Instruments used for the necropsy were metal scissors, scalpels and a knife (further instruments recommended but not used in this study are blunt scissors, pointed scissors, hemostatic forceps, forceps without teeth, blunt probes, and a syringe (Wyneken 2001)). Plastic jars and glass jars were used to collect specific organs or samples for further studies.

The details about turtles that stranded outside the observation area were taken from the respective observers (e.g. the Fethiye Coast Guard Harbour). Upon hearing of a public sighting, 2-4 team members were sent to the sighting location for inspection. The species identification and other data were taken as described above.

RESULTS

In Yaniklar, Çaliş and Fethiye during the observation period in summer 2012, a total of 4 stranded dead sea turtles were recorded. 2 were found onshore in Fethiye harbour. 1 carcass was stranded along the shore on Çaliş beach and 1 dried, skeletonized carcass was found on Yaniklar beach. 3 of the 4 were identified as Loggerhead sea turtle *Caretta caretta*, the 4th one was assumed to be one. The dead sea turtles are presented individually below.

<u>The 4 dead sea turtles</u>

1. On 3 July 2012 at about 9am, a skeletonized sea turtle carcass was found onshore Yaniklar beach during morning shift by students of the University of Vienna (Fig. 2.0-2.2). This individual was a female according to the necropsy. The carcass was completely deteriorated and only bones had remained. The straight carapace length was about 50 cm. Some of the bones had holes in them whose diameter would correspond to that of a bullet.
The skull was found two weeks later on 19 July 2012 at the same location by the same students. The left side of the skull was broken and crushed in.

2. On 3 July 2012 at about 3.30pm, a stranded dead sea turtle was found onshore at Fethiye harbour by the Fethiye Coast Guard Community (Fig. 3.0 -3.2). Two team members from the University of Pamukkale (M. Azmaz and F. Polat) identified the carcass as a female Loggerhead sea turtle (*Caretta caretta*). The animal did not have any visible tags. The straight carapace measurements were 64 cm long (straight carapace length, SCL) and 52 cm wide (straight carapace width, SCW). The curved carapace measurements were 73 cm in length (curved carapace length, CCL) and 65 cm in width (curved carapace width, CCW). The body did not show any abnormalities or wounds but a few epibionts (12) on top of carapace (Fig. 3.0). A fishing line entangled in the larynx of the animal was found after opening the beak (Fig. 3.2).

3. On 9 July 2012 at about 4pm, a third dead stranded sea turtle was found onshore at Fethiye

harbour by the Fethiye Coast Guard Community (Fig. 4.0 – 4.3). Two observers of the University of Pamukkale (M. Azmaz and E. Gedik) identified the carcass as a female Loggerhead sea turtle (*Caretta caretta*). The sex was determined by tail length (Fig. 4.3). No visible tags were found attached to the body. The curved carapace measurements were 69cm in length (CCL) and 58cm in width (CCW). The straight carapace measurements were not recorded. The carcass did not show any wounds or abnormalities but many epibionts (29) on top of the carapace (Fig. 4.0). Through opening the beak a plastic bag was found stuck inside the animal's esophagus (Fig. 4.2).

4. On 12 July 2012 at 10:25pm another dead stranded sea turtle was found ashore on Çaliş beach in front of Hotel Idee during nightshift by students of the University of Vienna and University of Pamukkale (Fig. 5.3). The species was identified as a Loggerhead sea turtle (*Caretta caretta*). The sex was estimated as female by tail length and necropsy (Fig. 5.2 and 7.0). The body did not have any visible tags attached and did not show any wounds or abnormalities but some epibionts (21) on top of the carapace (Fig. 5.0 -5.1). The straight carapace measurements were 65cm in length (SCL) and 57cm in width (SCW). The curved carapace measurements were 75cm in length (CCL) and 66cm in width (CCW).

The necropsy of the stranded Loggerhead sea turtle of 12 July, from Çaliş beach, took place on 13 July around midday (Fig. 6.0) and was processed by F. Polat, E. Şeker and a Master student from University of Pamukkale. The inner organs did not show any specific wounds or abnormalities. The sex was determined female due to visible ovipositor, ovaries and small claws on the front flippers.
A swallowed plastic item was seen when opening the beak (Fig. 6.1). When turning the esophagus inside out a plastic bag of about 50cm length (Fig. 6.2) appeared. The plastic bag was laced with many small holes with about the size of $1cm^2$.

Within the last 12 years a total of 30 dead sea turtle strandings were recorded in Fethiye, Çaliş and Yaniklar. This is an annual average of 2.5 recorded strandings per year. The 4 strandings this year increased the annual average to 2.6 per year. Most of the stranded turtles including the ones from 2012 with an identified sex were female (68%); the sex was not identified of 31% of the strandings. Most of the dead sea turtles were found in Çaliş (60%). Fethiye and Yaniklar had fewer strandings (20% each) excluding the two live sea turtles found in Fethiye harbour in 2000 and 2007. The turtles whose approximate age had been able to be determined

(56%) were 72% adult and 28% juveniles. The most common cause of death was injuries through collision or other blunt force trauma (71%), followed by death through ingestion of a fish hook (12%) and marine debris (12%). Only one individual was killed by entanglement in a fishing net (6%). (Tab. 1)

Tab. 1: Dead and severely injured adult turtles found in Çaliş (C) and Yaniklar (Y) during the last 12 years (CC = Caretta caretta, CM = Chelonia mydas, TT = Trionyx tringuis, f = female, m = male, n.d. = not determined, a = adult, j = juvenile)
Tab. 1: Tote Schildkröten gefunden in Çaliş (C) und Yaniklar (Y) in den letzten 12 Jahren (CC = Caretta caretta, CM = Chelonia mydas, TT = Trionyx tringuis, f = weiblich, m = männlich, n.d. = nicht aufgenommen, a = adult, j = juvenil)

Year	**Species**	**Site of find**	**Date of find**	**Sex**	**Age**	**Injuries**	**Probable cause of death**
2000	*CC*	*F*	*31.07.-31.08.*	*f*	*a*	*still alive with injuries of the head*	*injured by a blunt object*
2001	CC	C	n.d.	f	a	swallowed fish hook	fish hook
2002	CC	F	n.d.	n.d.	n.d.	very decomposed, age and sex unknown	n.d.
2003	CC	Y	04.09.	m	n.d.	decomposed and gnawed, especially in the skull area	n.d.
	CM	F	n.d.	f	n.d.	bursted carapace; broken flipper	ship propeller
2004	CM	C	24.08.	m	j	small right hind limb; raw parts of bottom slide of throat	caught in a fisherman's net, drowned
	CC	F	late June	n.d.	n.d.	carapace torn open	ship propeller
2005	no dead turtles recorded						
2006	CC	C	June	f	a	right hind limb missing, perhaps hereditary	n.d.
	CC	C	19.08.	f	a	front extremity and eye missing	n.d.
	CC	C	25.08.	n.d.	n.d.	back part of body missing	n.d.
	CC	Y	July	m	n.d.	head and body skeletonized, hole in skull	ship propeller
	CM	C	Sept.	f	j	one eye missing	n.d.
	TT	C	August	n.d.	n.d.	no external injuries	n.d.
2007	CC	C	07.08.	m	a	head injuries, decomposed	maybe collision with boat
	CM	C	05.08.	f	j	head injuries; parts of the flipper missing	maybe killed by a human
	CM	C	02.09.	f	j	carapace torn open, injury extending down to the plastron	ship propeller
	CM	F	04.09.	m	a	still alive! No external injuries; unable to dive	alive
2008	CC	Y	02.07.	m	n.d.	scars on top of head, cut on the side of the body, carapace damaged	maybe boat accident

Tab. 1: Dead and severely injured adult turtles found in Çaliş (C) and Yaniklar (Y) during the last 12 years (CC = Caretta caretta, CM = Chelonia mydas, TT = Trionyx tringuis, f = female, m = male, n.d. = not determined, a = adult, j = juvenile)

Tab. 1: Tote Schildkröten gefunden in Çaliş (C) und Yaniklar (Y) in den letzten 12 Jahren (CC = Caretta caretta, CM = Chelonia mydas, TT = Trionyx tringuis, f = weiblich, m = männlich, n.d. = nicht aufgenommen, a = adult, j = juvenil)

Year	**Species**	**Site of find**	**Date of find**	**Sex**	**Age**	**Injuries**	**Probable cause of death**
	CC	C	04.07.	f	n.d.	n.d.	n.d.
	CC	C	15.07.	m	n.d.	fishing line around neck, 80% of carapace missing	n.d.
	CC	F	30.07.	n.d.	n.d.	n.d.	n.d.
2009	CC	C	04.08.	f	a	left flipper entangled with a fishing net, fishing hook	n.d.
	CM	C	05.08.	f	n.d.	n.d.	n.d.
2010	CC	Y	21.07.	f	a	decomposed	maybe strike on the head
	TT	C	16.08.	n.d.	n.d.	hole in the carapace	ship propeller
2011	CC	C	24.07.	n.d.	a	decomposed, cuttings on carapace, head, three flippers and tail missing	boat collision
	CC	Y	27.07.	n.d.	a	hole in the carapace, head missing	maybe strike on the head
	TT	C	June	n.d.	n.d.	decomposed, carapace injuries	n.d.
2012	CC	Y	03.07.	n.d.	j	decomposed, smashed head, holes in bones	maybe killed by a human
	CC	F	03.07.	f	a	swallowed fish hook	fish hook, drowned
	CC	F	09.07.	f	a	swallowed plastic bag	plastic bag, starvation
	CC	C	12.07.	f	a	swallowed plastic bag	plastic bag, starvation

DISCUSSION

In summer 2012, the participants of the Sea Turtle Field Course in Fethiye, Turkey, recorded another year with a high level of sea turtle strandings. After three years with relatively few strandings, the number of killed individuals rose again to a maximum value recorded in the past (Fig. 1). The reports from preceding 13 years of observation showed an average stranding rate of 2.3 per year. The four sea turtles killed this year indicates ongoing human impacts on sea turtles along the coastline of Fethiye.

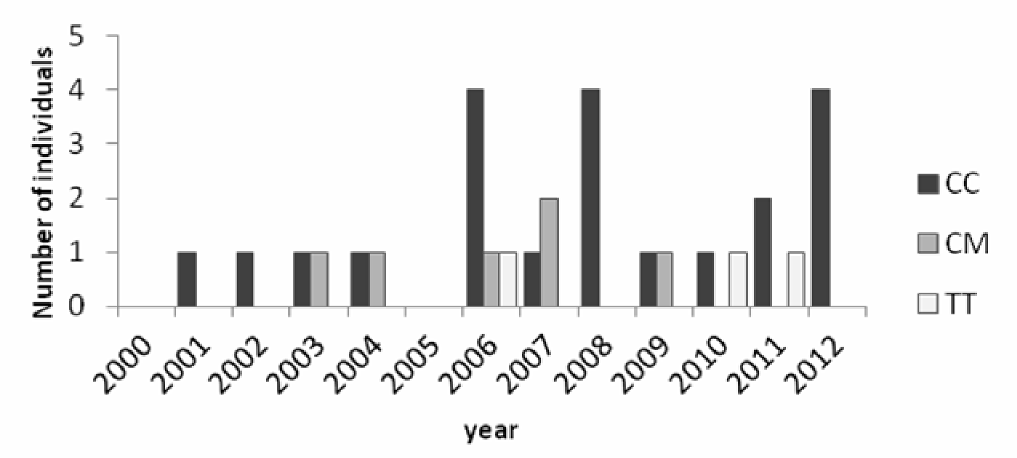


Fig. 1: Sea turtle strandings in Fethiye, Çaliş and Yaniklar observed by participants of the Sea Turtle Project (CC= Caretta caretta, CM=Chelonia mydas, TT=Trionyx tringuis).

Abb. 1: Gestrandete Meeresschildkröten in der Region Fethiye, Çaliş und Yaniklar, die von Teilnehmern des Sea Turtle Projects aufgefasst wurden (CC= Caretta caretta, CM=Chelonia mydas, TT=Trionyx tringuis)

This report of 2012 compared to reports of the 12 years before, the cause of death by swallowed marine debris occurred in Fethiye for the first time this summer (Fig. 1). The Sea Turtle Rescue Centre in Dalyan reported that no death caused by debris ingestion had been observed within the last three years (Kaska 2011).

The bones found on the beach of Yaniklar (nr. 1. in results) seem to be the remains of a stranded Loggerhead sea turtle that had faced a severe blunt trauma. Such injuries in which bones and even the skull breaks can occur in collisions with a boat or other fast vessel which the turtle cannot avoid quickly enough. Such collisions that affect the head can kill the animal immediately, damage to other body parts can impair the animal's mobility and foraging activities which can lead to a slow death.

The holes found in the bones might have come from gun shots or harpoons. The sea turtle might have accidently been entangled in fishing gear and shot thereafter. The time of death was probably months before the observation of the carcass as most of the body was already decomposed and skeletonized, but a more accurate estimate is not possible.

The second stranding observed in Fethiye harbor is a Loggerhead carcass (nr. 2. in results) that had been washed ashore after floating in the water for a longer time. Due to the missing scales on head and flippers the time of death must have occurred much earlier. The fishing line hanging out of the animal's esophagus shows that the animal swallowed a fish hook, perhaps from longline fishing gear.

Fishing activities in the Mediterranean, especially longline fishing, represents a key threat for sea turtles (Gerosa & Casale 1999). Casale (2008) estimates that over 50 000 sea turtles are killed by fishing activities such as longline fishing, set netting and trawlers around the

Mediterranean every year. A high bycatch rate occurs in the western Mediterranean where a migration route of many Loggerhead sea turtles from the Strait of Gibraltar passes through dense fishing areas (Camiñas, Valeiras 2001; Camiñas & De la Serna 1995, Laurent et al. 2001). Lewison et al. (2004) show that the Mediterranean is a global hotspot for longline fishery interactions with Loggerhead sea turtles. In the year 2000 alone, the authors estimated that 60 000 to 80 000 Loggerhead sea turtles were captured in pelagic longline fisheries in the Mediterranean. Further west, around Italy, turtles face another dense longline fishing area where the highest swordfish numbers are captured in the Mediterranean (Dominici et al. 2001). Studies by Dominici et al. (1994-2001) have estimated that about 1000 to 4700 loggerheads are directly impacted by these longline fisheries every year.

Trawlers represent another sea turtle-threatening fishing technique in which thousands of sea turtles are caught and killed (Casale et al. 2001). Reports from Tunisian trawlers, for example in the year 1992, list a bycatch of 2000 to 2500 loggerheads (Bradai 1992).

In Turkey, longline fishing belongs to one of the oldest fishing techniques and is still carried out all along the Mediterranean coast from Istanbul to Iskenderun (Akyol, Ceyhan 2011). In Fethiye, longlining started in the 1970s and since 1986, fishermen have been using drifting longlines in the deeper zones (fisherman: O. Somyürek, pers. comm.). Around 40 fishing boats deploy their longlines every year from December to May off Kuşadası, Gökova and Yeşilova Bays and in the open seas off Fethiye. The stranded female loggerhead in Fethiye harbour (nr. 2. in results) might have gotten entangled with one of these longlines after swallowing the hook with the bait. As the soak time of longline bait is usually many hours, bycaught turtles rarely survive the entanglement because they are unable to reach the surface to breath. If this individual drowned that way the fishermen might have cut off the line to release the carcass back into the sea. Another potential scenario is that the turtle survived the entanglement and either broke free or was cut free by the fishermen with the hook still stuck in its throat. Unfortunately, little is known about post hooking-mortality, the likelihood that a turtle hooked by longline gear will die after release (Tomás et al. 2008), but a few assessments are available (Chaloupka et al. 2004). Studies by Casale et al. (2007) propose a post-hooking mortality of over 30%. Ingesting a fish hook and a fishing line could lead to fatal gut pathologies and intussusception that can be lethal (Oros et al. 2005). As there was no dissection of the stranded female loggerhead (nr. 2. In results) we were unable to detect any further internal injuries or pathologies. Studies by Carreras et al. (2004) and Camiñas et al. (2006) state that pre-release mortalities in the western Mediterranean have been found to be very low and most turtles are captured alive.

Another potential fatal threat for Mediterranean sea turtles is pollution. The third and the fourth stranding that occurred in Fethiye were both adult female loggerheads that had swallowed a plastic bag. Loggerheads are omnivorous and prey on different small benthic fauna including crustaceans, molluscs and jellyfish (Carr 1952). As a swimming jelly fish in the water resembles a floating plastic bag a predator can mistake it for prey and swallow it with disastrous consequences.

The stranded carcass (nr. 3. in results) found in Fethiye harbour showed no visible injuries or abnormalities on its body. The high amount of epibionts (barnacles) on top of the carapace indicates that this female had been foraging in nutrient-rich water (Frick et al. 2004). The nutrient status and food content of the water may coincide with its state of pollution. This is because marine debris and pelagic microorganisms such as zooplankton float passively with the water current.

The stranded female loggerhead found on Çaliş beach (nr. 4. in results) must have died in the nearshore area based on the condition of the carcass. The carapace crack between marginal and lateral scutes on the left side of the body may have resulted from the bloating of the dead body, a stage of decomposition (Fig. 5.1).

The Mediterranean Sea is one of the most polluted seas on the planet. Marine debris is increasingly being recognized as having major consequences for the ocean ecosystem and wildlife. It has become one of the main causes of mortality in marine mammals, sea turtles, seabirds, fish and benthic biota. According to the United Nations Joint Group of Experts, an estimated 80% of the marine debris pollution is land-based and 20% ocean-based waste (Sheavly 2007). 60-80% of all marine debris consists of plastic (Derraik 2002). This waste is mainly dumped into the sea or washed from the beaches into the sea (Strebinger 2011). Most sea turtles that have ingested marine debris seem to be juveniles; this may be explained by their indiscriminate pelagic feeding strategy (Bjorndal 1997).

Ingestion of plastic items such as bags can cause a variety of health problems, including intestinal occlusion, asphyxia, malnutrition, starvation or ulcerations (Strebinger 2011). Most of plastic items a sea turtle swallows pass through the digestive tract (Tomás 2002), but due to the structure of the turtles' esophagus the ingestion of soft material like a plastic bag can lead to obstruction. The plastic bag inside the esophagus of the second dead Loggerhead found in Çaliş (Nr. 2.) originated from a transport wrapping of a machine (identified by F. Polat). It showed many holes that were most likely formed by the papillae (Fig. 6.2). The sharp, keratinized papillae inside the esophagus of a sea turtle point inwards towards the stomach

(Wyneken 2001); this orientation is a main reason for an obstruction of the digestive tract via debris ingestion. Whether the two female stranded loggerheads died due to starvation cannot be determined, but the necropsy of the second stranding did not show any internal abnormalities (Fig. 6.0; 6.1; 5.2).

All four dead loggerheads, which were found on only a relatively small zone around Fethiye, illustrate that juveniles as well as foraging females are threatened. Through several notifications of locals as well as tourists we have to assume that our sightings are only a fractional amount of the total sea turtle strandings that occur around Fethiye. The mortality rate of sea turtles in this area must consequently be higher than illustrated in this report.

Within the last 13 years, only in 2006 and 2008 the same amounts of strandings were observed (Fig. 1) by Sea Turtle Project members. As opposed to 2008, when the same number of dead loggerheads was found (4 individuals), the cause of death this year could be more clearly identified (Fig. 1). The finding that the dead individuals included a juvenile and foraging females should be a cause for concern: the conservation of marine sea turtles in Turkey should not focus merely on the hatchlings but also on juveniles and the nesting females. As only 1 of 1000 hatchlings is estimated to survive to adulthood, reaching maturity at the age of 10 to 30 years, it is clear that protection of large juveniles as well as mature females is a priority for population management and the survival of the species (Bjorndal 1999; Crouse et al. 1987; Kaska 2011).

The lack of information about the sea turtle populations in the Mediterranean is a major problem in management and calls for further research and more data collection. New information should go beyond merely counting nests on beaches but include monitoring turtle behaviour and physical development as well as migratory behaviour.

Bycatch in fisheries needs to be reduced in order to protect the Mediterranean loggerhead population because it represents the main cause of death. This would entail introducing stricter rules regarding the fishing industry but with consideration of the fishermen's standard of living and income.

Clearer protection laws and more control in the Special Protected Areas are needed and should be gone about by the government.

Management of marine pollution has become a priority concern in marine wildlife conservation. The pollution of the Mediterranean Sea in particular continues to be a problem that needs to be tackled and reduced in order to protect wildlife. Public awareness about the present pollution problem needs to be increased by educational efforts in order to raise every person's sense of responsibility and reduce the waste.

Beach clean-up organizations should be sponsored and supported by businesses and the government; such events should be conducted in more areas to reduce pollution coming from the beaches and simultaneously raise public awareness.

Finally, efforts should be made to not just reduce the total number of sea turtle fatalities but to protect each individual sea turtle, such as is being done at the rescue center in Dalyan (see contribution by Ullmann in this volume). One lost adult sea turtle means the loss of generations of hatchlings. Such protection efforts can be crucial for the survival of the species as a whole.

Dead or injured sea turtles 2012

Observer: ……………………………….. Stranding date and time: ………………

Species: *Caretta caretta*- loggerhead turtle □
Chelonia mydas- Green turtle □
Trionyx triunguis – Nile softshell turtle □
Other:…………………………….

Stranding location: Offshore (beach) □ Inshore (sea, lake, river) □
Descriptive Location:…………………………………………………

Sex: undetermined □ Male □ Female □

How was sex determined: necropsy □ tail length (adult only) □

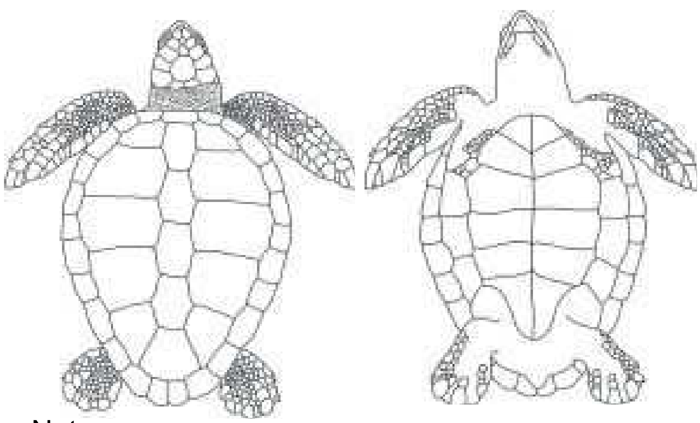
Condition: 1 alive □
2 fresh dead □
3 decomposed □
4 dried carcass □
5 skeleton bones only □

Tags: Checked for tags? Yes □ no □ Tagnumber:……………………………...
Tag location:……………………………………………………………..............
Return adress:………………………………………………………………………

Carapace measurements: SCL ………………….. SCW………………………….
CCL …………………… CCW………………………….

Photos taken? Yes□ no□
Nr. of photos:

Mark wounds/abnormalities on diagrams and describe. Please also note if no wounds or abnormalities are found.



□ holes/ wounds made by gun
□ deformations
□ cuttings
□ missing parts
□ gear or debris entanglement
□ propeller damage
□ others:

Notes:

Fig. 2.0: Dried bones (a. Hyoplastron, b./d. pectoral girdle, c. lower jaw) of a Loggerhead sea turtle (*Caretta caretta*) on Yaniklar beach, Fethiye (photo: E. Hollergschwandtner on 9 July 2012).
Abb. 3.0: Die getrockneten Knochen (a. Hyoplastron, b./d. Schultergürtel, c.Unterkiefer) einer Unechten Karettschildkröte (*Caretta caretta*) am Strand von Yaniklar, bei Fethiye.

Fig. 2.1: Dried bones (a.carapace piece with four ribs, b./d. Hyoplastron, c. Hypoplastron) of a Loggerhead sea turtle (*Caretta caretta*) on Yaniklar beach, Fethiye (photo: E. Hollergschwandtner on 9 July 2012).
Abb. 2.1: Die getrockneten Knochen (a.Stück eines Carapax mit vier Rippen, b./d. Hyoplastron, c. Hypoplastron) einer Unechten Karettschildkröte (*Caretta caretta*) am Strand von Yaniklar, bei Fethiye .

Fig. 2.2: The lower jaw of a Loggerhead sea turtle (*Caretta caretta*) found on the beach of Yaniklar (photo: E.Hollergschwandtner on July 9th, 2012).
Abb. 2.2: Der Unterkiefer einer Unechten Karettschildkröte (*Caretta caretta*), der am Strand von Yaniklar, bei Fethiye, gefunden worden war.

Fig. 3.0: Carapace view of a stranded female Loggerhead sea turtle (*Caretta caretta*) in Fethiye harbour (Photo taken by M. Azmaz on July 3rd, 2012).
Abb. 3.0: Carapax Ansicht der gestrandeten weiblichen Unechten Karettschildkröte (*Caretta caretta*) im Hafen von Fethiye.

Fig. 3.1: Plastron of stranded female Loggerhead sea turtle (*Caretta caretta*) in Fethiye harbour (Photo taken by M. Azmaz on July 3rd, 2012).
Abb. 3.1: Plastron der gestrandeten weiblichen Unechten Karettschildkröte (*Caretta caretta*) im Hafen von Fethiye.

Fig. 3.2: Swallowed fishing line in the esophagus of stranded female Loggerhead sea turtle (*Caretta caretta*) in Fethiye harbour (Photo taken by M. Azmaz on July 3rd, 2012).
Abb. 3.2: Verschluckter Fischergarn im Ösophagus der gestrandeten weiblichen Unechten Karettschildkröte (*Caretta caretta*) im Hafen von Fethiye.

Fig. 4.0: Carapace of the stranded female Loggerhead sea turtle (*Caretta caretta*) in Fethiye harbour (Photo taken by E. Gedik on July 9th, 2012).
Abb. 4.0: Carapax der gestrandeten weiblichen Unechten Karettschildkröte (*Caretta caretta*) im Hafen von Fethiye.

Fig. 4.1: Left side view of the stranded female Loggerhead sea turtle (*Caretta caretta*) in Fethiye Harbour (Photo taken by E. Gedik on July 9th, 2012).
Abb. 4.1: Linke Seitenansicht der gestrandeten weiblichen Unechten Karettschildkröte (*Caretta caretta*) im Hafen von Fethiye.

Fig. 4.2: Swallowed plastic bag in larynx of the stranded female Loggerhead sea turtle (*Caretta caretta*) in Fethiye harbour (Photo taken by E. Gedik on July 9th, 2012).
Abb. 4.2: Verschluckte Plastiktüte im Larynx der gestrandeten weiblichen Unechten Karettschildkröte (*Caretta caretta*) im Hafen von Fethiye.

Fig. 4.3: Back view of ovipositor of the stranded female Loggerhead sea turtle (*Caretta caretta*) in Fethiye Harbour (Photo taken by M. Azmaz on July 9th, 2012).
Abb. 4.3: Rückansicht auf den Ovipositor der gestrandeten weiblichen Unechten Karettschildkröte (*Caretta caretta*) im Hafen von Fethiye.

Fig. 5.0: Carapace of the stranded female Loggerhead sea turtle (*Caretta caretta*) on Çaliş beach, Fethiye (Photo taken by M. Azmaz on July 12th, 2012).
Abb. 5.0: Carapax der gestrandeten weiblichen Unechten Karettschildkröte (*Caretta caretta*) am Strand von Çaliş, Fethiye.

Fig. 5.1: Left side of the stranded female Loggerhead sea turtle (*Caretta caretta*) on Çaliş beach, Fethiye (Photo: M.Azmaz on July 12th, 2012).
Abb. 5.1: Linke Seitenansicht der gestrandeten weiblichen Unechten Karettschildkröte (*Caretta caretta*) am Strand von Çaliş, Fethiye.

Fig. 5.2: Back view of ovipositor of the stranded female Loggerhead sea turtle (*Caretta caretta*) on Çaliş beach, Fethiye (Photo: M.Azmaz on July 12th, 2012).
Abb. 5.2: Rückenansicht auf den Ovipositor der gestrandeten weiblichen Unechten Karettschildkröte (*Caretta caretta*) am Strand von Çaliş, Fethiye.

Fig. 5.3: The stranded female Loggerhead sea turtle (*Caretta caretta*) on Çaliş beach, Fethiye (Photo: S. Birngruber on July 12th, 2012).

Abb 5.3: Die gestrandete weibliche Unechte Karettschildkröte (*Caretta caretta*) am Strand von Çaliş, Fethiye.

Fig. 6.0: The open carcass with inner organs (a. intestinal gland, b. heart, c. liver, d. fat, e. ovipositor, f. left back flipper) of the stranded female Loggerhead sea turtle (*Caretta caretta*) from Çaliş beach, Fethiye, during necropsy (Photo: G. Kautek on July 13th, 2012).
Abb. 6.0: Der geöffnete Kadaver mit den inneren Organen (a. Darm, b. Herz, c. Leber, d. Fettgewebe, e. Ovipositor, f. hintere linke Extremität) der gestrandeten weiblichen Unechten Karettschildkröte (*Caretta caretta*) vom Strand Çaliş, Fethiye, während der Sektion.

Fig. 6.1: The open mouth of the stranded female Loggerhead sea turtle (*Caretta caretta*) from Çaliş beach, Fethiye, with the swallowed plastic bag inside the esophagus, during necropsy (Photo: G. Kautek on July 13th, 2012).
Abb. 6.1: Das geöffnete Maul der gestrandeten weiblichen Unechten Karettschildkröte (*Caretta caretta*) vom Strand Çaliş, Fethiye, mit der verschluckten Plastiktüte im im Ösophagus, während der Sektion.

Fig. 6.2: The plastic bag after taken out of the esophagus of the stranded female Loggerhead sea turtle (*Caretta caretta*) from Çaliş beach, Fethiye, during necropsy (Photo: G. Kautek on July 13th, 2012).
Abb. 6.2: Die Plastiktüte nachdem Herausnehmen aus dem Ösophagus der gestrandeten weiblichen Unechten Karettschildkröte (*Caretta caretta*) vom Strand Çaliş, Fethiye, während der Sektion.

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Bachelor Thesis

Marine debris: Meso-litter on Yaniklar beach (Turkey)
Two beach sections, one big problem

Meeresverschmutzung: Meso-litter in Yaniklar (Türkei)
Zwei Strandabschnitte, ein großes Problem

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KURZFASSUNG

Schätzungsweise treiben rund 290 Milliarden kleine Abfallteile im Mittelmeer, wobei hier der Hauptanteil bei Plastikabfällen liegt. Zum einen wird Abfall an den Küsten und Stränden hinterlassen, welcher dann durch Wind ins Wasser gelangt und zum anderen Abfälle, die von Schiffen, der Fischereiindustrie und vielen anderen Fabriken durch Flüsse ins Meer gelangen. Anfangs handelt es sich in der Regel um größere Abfallfragmente, welche über die Zeit und durch mechanische Einflüsse wie Wellengang oder UV-Strahlung in kleinere Teilchen zerkleinert werden. Viele Müllsorten, vor allem Kunststoff, kann biologisch nicht vollständig abgebaut werden und wird daher immer weiter transportiert.

Diese Arbeit wurde im Rahmen des Meeresschildkröten Projekts *(Caretta carett*a) von der Universität Wien in Zusammenarbeit mit einer türkischen Universität (Pamukkale) an den Stränden von Yaniklar und Akgöl (Fethiye, Türkei) durchgeführt. Diese Strände sind Nistgebiete für die Unechte Karettschildkröte (*Caretta caretta*). Im Zeitraum von 4. August bis 8. September 2012 wurde überprüft wie sich diese zwei Strandabschnitte bezüglich der Häufigkeit und Verteilung des Meso-litters (Fragmente in einer Größe von 1 mm bis 75 mm) unterschieden. So wurden bei beiden Strandabschnitten jeweils 2 Transekte abgesteckt. Pro Transekt wurden separat fünf 1-m^2-Quadrate ausgemessen. Beginnend bei der Vegetation bis zur Gezeitenzone wurden die Probequadrate mithilfe zweier Siebe unterschiedlicher Porengröße (2 mm und 4 mm) besiebt. Mit Lupe und Pinzette wurde der Müll in dieser Größenordnung ausselektiert und in beschriftete Probebehälter gegeben. An beiden Strandabschnitten gibt es Unterschiede in den einzelnen Transekten bezüglich der Gesamtstückanzahl und der Variabilität der verschiedenen Stoffklassen. Aufgrund von Wind und Wellengang kann der Müll weiter in das Strandinnere gelangen. Anhand des Gezeitenzyklus kann man auch deutliche Unterschiede an angeschwemmtem Material erkennen. Insgesamt wurden bei allen Transekten zusammen und deren beprobten Quadrate 3 verschiedene Stoffklassen in hoher Dominanz bezüglich ihrer Stückanzahl gefunden: Styropor (280), organisches Material (223) und Plastik (71). Das organische Material wurde von Besuchern zurückgelassen und daher als Müll bezeichnet.

Meeresverschmutzung ist ein globales Problem und beeinflusst somit auch die Biodiversität mit negativen Auswirkungen. Viele Meerestiere, z.B. Meeresschildkröten oder Seevögel, werden durch die Einnahme von Kunststoff-Fragmenten geschädigt oder getötet. Manche dieser Tiere, wie die Meeresschildkröten die an diesen Stränden nisten, sind vom Aussterben bedroht und ihr Verschwinden hätte schädliche Folgen auf das Ökosystem.

ABSTRACT

Approximately 290 billion small litter items are currently floating in the Mediterranean Sea. Most of this litter is plastic. There are two main sources for this waste: Firstly it is left on the coasts and beaches by humans, and then enters the water due to the wind and waves; secondly, waste is thrown into the water from ships, by the fishing industry and enters the ocean via rivers. The initially often large fragments of litter get broken into smaller particles over time by mechanical influences such as wave motion or by UV radiation. Especially plastic litter cannot be degraded completely biologically and so can be transported over great distances.

This study was undertaken during a conservation and research field course to the beaches of Yaniklar and Akgöl (Fethiye, Turkey) in order to help protect the nesting beaches of the loggerhead turtles (*Caretta caretta*). In cooperation with a Turkish university (Pamukkale), students from Vienna monitored the adult turtles and their nests. During the period from 4 August to 8 September, two sections (Yaniklar and Akgöl) of one beach were surveyed in order to determine the abundance, weight and distribution of meso-litter (items ranging in size from 1 mm to 75 mm). On both parts of the beach, two transects were laid. Along each transect, five 1-m^2 sections were investigated. Starting with the section bordering the vegetation down to the intertidal zone next to the sea, the quadrats were sieved with two different mesh sizes (2 mm and 4 mm). Using a magnifying glass and tweezers, the collected debris was sorted out and placed into labeled sample bags. On both parts of the beach, distinct differences in total number of items and the variability of different material groups. Due to

wind, litter can be transported ashore. As a result of the tides, there is a visible difference in washed up materials.

Altogether three dominant material groups (related to their number of items) were recorded in all transects and their sections: styrofoam (280), organic material (223) and plastic (71). Beach visitors left organic matter on the beach and this was counted as litter.

Marine pollution is a global problem that adversely affects biodiversity. A variety of marine animals such as sea turtles and seabirds are affected by the ingestion of plastic fragments. Many of these animals are in danger of extinction, which would impact the whole ecosystem.

INTRODUCTION

"Once upon a time" a net was thrown into the sea and was lost. This net consisted of plastic and styrofoam, and was overgrown with bivalves, and after a long period afloat, it arrived on a beach somewhere. In the following years, it was joined by many other plastic fragments, styrofoam pieces, plastic bottles and other items. These occurrences raise the questions: Why does this happen? What has happened during the last years with this litter? Why does litter come ashore? And why is there so much more litter on the beach now?

The Mediterranean Sea, which covers some 2.5 million km^2, is an enclosed sea with only one opening for water exchange, the 14-km-wide Strait of Gibraltar (Blue Plan, 1987). During the past two to three decades, tourism in the Mediterranean has increased dramatically. For many countries in the Mediterranean region, tourism is an extremely important economic pillar, which is needed to improve, or partially compensate for, their trade deficits. This demand has resulted in numerous environmental problems, for example the increasing amount of litter left-behind. This increase in development of the tourist industry is visible on every beach. There are various sources where litter can come from. These include factories, fishing vessels, river outflows etc. Like many anthropogenic impacts on natural systems, it is one that, despite widespread recognition of the problem, is still growing. Even if stopped immediately, the impacts will persist for centuries (Mato et al., 2001). Marine litter has been defined as solid materials of human origin that are discarded at sea or reach the sea through waterways or domestic and industrial outfalls (National Academy of Sciences, 1975).

One of the most critical types of litter will be described here. Within just a few decades since mass production of plastics products commenced in the 1950s, plastic debris has accumulated in terrestrial environments, in the open ocean, on shorelines of even the most remote islands and in the deep sea (Barnes et al., 2009). The worldwide production of plastics is still rising. The main reason for this increase is the advantageous characteristics of plastics. It is lightweight, strong, durable and cheap (Laist, 1987). All these aspects make plastic suitable for the manufactures of a very wide range of products. The same properties also explain why plastics are a serious hazard to the environment (Pruter, 1987; Laist 1987). Plastics are synthetic organic polymers, which are derived from the polymerisation of monomers extracted from oil or gas (Derraik, 2002; Rios et al.; Thompson et al., 2009b). Microorganisms use them as transporters, that's one of the reasons why plastic cannot be naturally degraded.

Marine debris can be classified according to size and according to composition, e.g. paper, metal, plastic, netting, etc (Ribic et al., 1992). Most debris takes a long time to degrade completely. The more natural or organic the material composition of the item is, the less time it takes to degrade. Such a degradation depends on many factors including material type, size and thickness, temperature, wave action, exposure to sunlight and location (e.g. on the beach, floating at sea).

Larger debris can wash up on shores or get broken up into smaller pieces that fish and other organisms often mistake for food. As garbage continues to pour into our oceans, our waters are becoming an ever-increasing reservoir of litter (Gramentz, 1988).

The boundaries for size categories for litter vary from study to study. Identification of sizes should be mentioned and defined clearly at the beginning of each study. It is important to consider this factor when comparing own results with those from other studies. Recently, Andrady (2011) suggested adding the term "meso-plastics" to scientific nomenclature, to differentiate between small plastics visible to the human eye and those only discernible using microscopy (Cole et al., 2011). This study will differentiate only between macro- and meso-litter. Here, I will refer to meso-litter as litter ranging from 1 mm to 75 mm. Litter smaller than 1 mm is inconsequential to this study. However, anything larger than the above-mentioned sizes will be described as macro-litter.

In general, meso-litter moves in a different way than macro-litter in the sea. The distribution of macro-litter can often be explained by the currents and wind, while the mechanisms that drive the distribution of meso-litter are less well-known and are possibly influenced by particle aggregation or animal activities. Whilst macro-litter has been the focus of environmental concern for some time, meso-litter should warrant the same amount of observation. Human activities have led to an increase in pollution, which in turn has caused a decline in biological diversity (Derraik, 2002). Meso-litter significantly affects the environment and impacts on the biodiversity in the sea and ashore. An increasing load of especially mesoplastic debris is being dispersed over long distances. When they finally settle in sediments, they may remain for centuries (Hansen, 1990; Ryan, 1987b; Goldberg, 1995, 1997). This is one of the reasons why plastics are a serious hazard to the environment. The accumulation of debris can inhibit the gas exchange between the overlying water layers and the pore water layers of the sediments. The resulting hypoxia or anoxia in the benthos then interferes with normal ecosystem functions, and could alter the make-up of life on the sea floor (Goldberg, 1994).

Mesoplastics are found worldwide in water, sand and sediment on the ocean floor. Floating plastic particles often resemble food to many marine species, including the fish we eat. The contaminants they contain, such as plasticizers and solvents have been linked to cancer and hormone disruption. On the shore, the litter that washes up is much more than an eyesore. It can also be dangerous to animals and children and it costs millions of euros in both cleanup operations and loss of tourism revenue. Coastlines accumulate plastic litter from both terrestrial and marine sources: terrestrial sources of litter will typically dominate close to urban areas, sites of tourism and near river outflows, whilst marine debris will be deposited along shorelines when caught in nearshore currents (Ryan et al., 2009).

The ingestion of litter (mainly plastic) by organisms, especially sea turtles, sea birds and fish affects their health and causes injuries and death. When these pieces and fragments of litter are eaten by wildlife, they cannot always be passed through their digestive tracts. This leads to malnutrition and starvation. Most of these plastics are used consumer products (e.g. bottles, caps, containers, etc.) that have been carelessly discarded. Such big pieces or fragments are not biodegradable. This means that once they are present, they can affect the marine ecosystem for decades or even centuries (Gramentz, 1988).

MATERIAL AND METHODS

Pre-observations

Before beginning with the research, a concept was written in order to determine the most useful method and the exact materials needed for the field work. This also provided an opportunity to become acquainted background information and literature.

Study site

The research area was at Yaniklar beach in Fethiye in southwest Turkey. Fethiye is designated as a Special Environment Protection Area (SEPA) and is well-known as a tourist destination where many holiday resorts, restaurants and bars are located (Ilgaz, 2007; Yerli, 1996). The beach is divided into two sections: Yaniklar and Akgöl. In 2012 from 4 August until 8 September, data from these two beaches were collected. These beaches adjoin each other, so they are, in essence, two parts of a larger beach.

Yaniklar beach is about 4.5 km long and has a width of between 50 m and 80 m (Fig. 12). After the first few meters of the intertidal zone, pebbles, stones and vegetation remains (branches, twigs and leaves) are present between 5 m to 15 m from the water edge. Behind this area, fine sand is the dominant substrate. Wetlands, steppe vegetation and large patches of amber forests are located inland behind the beaches. Small streams open in different parts of the beach and marshy sites are present in the forest (Özdemir, 2006). In the eastern part of Yaniklar there are camping sites, bars and a hotel complex (Lykia Botanica Hotel), which features deck chairs, umbrellas, wooden walkways, volleyball courts, small bars, lights at night, artificially planted bushes and trees.

This beach was chosen because at the end of the tourism zone (Lykia Botanika), there is a more or less natural beach. In this case, natural fdoes not necessarily mean clean. Litter is typically visible from the vegetation to the intertidal zone. The research will show the abundance of meso-litter within two transects along this section of beach.

Akgöl beach is about 1.0 km long and is about 55 m at its narrowest (Türkozan, 2000) (Fig. 13). Sand is the dominant substrate of the small part of the beach in the west. This area is almost the only part of the beach, where fine sand is present.
The lower beach in the intertidal zone also consists of sand (ca. 2 m). The rest of the beach consists of sand mixed with pebbles up to 2 cm in diameter, also termed as cobbles. Towards the east, cobbles dominate. Behind the beach, agricultural areas reach further inland. The eastern most part of the beach, where sand is the dominant substrate, is a popular recreational area for local day visitors, who contribute to the pollution of the beach. Although it is forbidden to do so, tourists and day visitor's camp at the beach, have barbecues and bonfires, some also go fishing and spearfishing. It is easy to distinguish the litter left behind by visitors. This part of the beach is used primarily as a picnic area. For the study, these two areas provide a useful comparison between a more natural beach section and a beach more frequently used by visitors.

The study

In the first week, preliminary observations in the field were used to determine which method would be the best strategy for collecting samples. The first step was to note the sand texture along the width and length of the beaches. Furthermore, the different zones of the beach needed to be described, beginning from the vegetation and ending at the intertidal zone.

In this study, the amount of meso-litter was recorded. This sampling technique involved collecting and identifying litter items, in a systematic approach, along a specified stretch of coastline (Ryan et al., 2009). This method was the least complicated of the available techniques to conduct the survey, requiring little logistical planning and relatively low costs (MCS, 2010). The technique was used in the present to detect pieces of litter, usually on the surface of sediments by the naked eye. It started by setting-out a transect beginning at the

bordering vegetation and extending down the beach until it reached the intertidal zone (Fig. 14). The length of the transect was measured with a tape measure. Within a transect-length, five separate 1 m^2 sections were defined. The numbering started from the section bordering the vegetation and ended at the intertidal zone. The quadrat bordering the vegetation was labeled with a small letter “a”. The following quadrats (from vegetation to intertidal zone) were labeled “b”, “c”, “d”, “e”. Quadrat “c” was located exactly in the middle of the transect-length. Quadrat “b” was midway between quadrat “a” and “c”. The last quadrat (“e”) was located at the intertidal zone. Quadrat “d” was situated midway between quadrat “c” and “e”. Altogether there were five numbered quadrats within one transect.
For measuring a quadrat exactly, a second tape was required for having valid boundaries. Each quadrat was marked with reeds or stones (Fig. 15). Finally in each part of the large beach, Yaniklar and Akgöl, 2 transects wern laid along the width of the beach. The five 1 m^2 quadrats were placed along these transects.

This study focused mostly on abiotic material, which means non-living items. This includes all kinds of plastics (for example plastic pellets), styrofoam (ranging from individual spheres to small fragments), pieces of fishing nets, glass, metals and many other abiotic materials. There was also a large amount of organic material (nutshells, garlic remains etc) in Akgöl (the picnic area – see below) too. This area represents an exception, because the nutshells were obviously left by visitors. This kind of litter also changes in the general appearance of the beach. Everything that is not naturally part of the beach is described here as litter.

Through sieving every single quadrat of each transect, meso-litter was separated from the samples (sand, stones, dead plant and animal materials etc) at two different mesh sizes (2 mm and 4 mm) (Figs. 16 & 17). Using a shovel, the substrate was sieved to a depth of 5 cm (Fig. 18). In some quadrats it was not possible to sieve down to 5 cm depth because at that depth the sandy substrate was wet. Such sand did not pass through the sieve. The material retained in the sieve was collected and sorted, while that passed through was discarded. The use of sieves with different mesh sizes allows categories of meso-litter to be distinguished.

Visual Sorting and Separation: The method used was based on visual examination of the taken samples. Careful visual sorting of retained material in the sieves with the help of a magnifying glass was necessary to separate biotic (animals and plant parts, seagrasses, etc) from abiotic (plastics, glass, styrofoam, etc) materials. Meso-litter was carefully sorted out using tweezers and placed into labeled plastic bags. For example, the code: Y; TR 1; c indicates: Y=Yaniklar beach, TR 1=Number of transect (in this case, the first one) and c is the quadrat "c" (in the middle of the transect).

In this study, a lot of plastic was found at the high tide line. For this reason, one extra square meter (designated "x") was sieved in this zone independent of the other transects. The aim was to find so-called plastic-pellets again in this extra quadrat. These samples were not weighed and measured but the number of items was counted. The results will be discussed below.

Figs. 19 & 20 show the location of the two transects in Yaniklar beach and Fig. 21 demonstrates the laid transects in Akgöl beach.

Post-observations

Weighting, measuring and counting the collected garbage was not possible in the field camp, in part because of the wind and the very light weight of the collected items. Therefore, the quantification was continued in a laboratory at the Department of Marine Biology, University of Vienna. From each sampled quadrat, all single fragments or pieces were weighed using a calibrated scale with a measurement precision of ± 0.001 g, (Sartorius AG; Fig. 22). Thereafter the longest length of the items was measured using an electronic caliper with a measurement precision of ± 0.1 mm (Fig. 23) to determining size. The number of items per square meter was established.

Importantly, some items could not be weighed individually because they were too light (< 0.001 g). These were summarized within their respective material class, i.e. glass, metal, styrofoam, plastic etc. Mean values were then calculated for each of these groups. Every fragment of piece that weighed > 0.001 g was measured separately.

A camera was used to document key aspects of the methodology. All photos without references were taken by the author.

The data were compiled, evaluated and illustrated using Microsoft Office Excel 2007.

RESULTS

The below-mentioned figures illustrate every single transect and each quadrat on Yaniklar and Akgöl beach. Here all values can be compared together. Then an overview of the number of pieces, the distribution and the composition is given. Starting on Yaniklar beach:

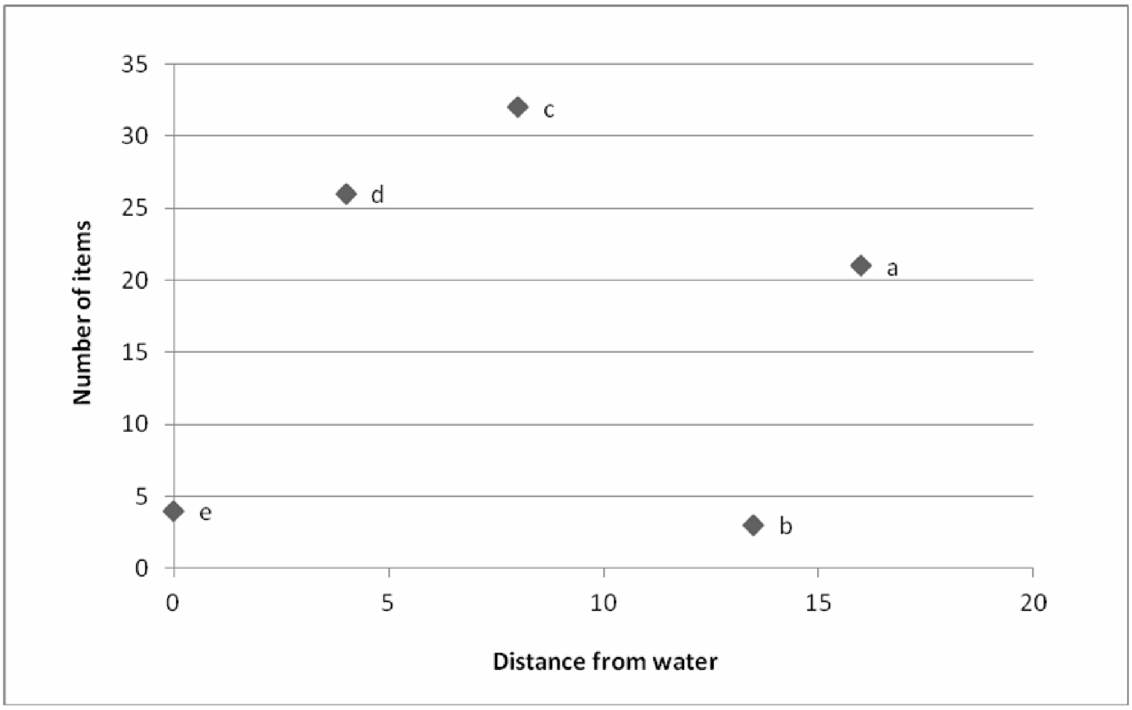

Fig. 1: Meso-litter items along transect 1 for each quadrat (a-e)

Abb. 1 : Anzahl an Stücken entlang des Transektes 1 für jedes Quadrat (a-e)

At transect 1 (Fig. 1) on Yaniklar beach, the distribution and the composition of litter is in the surveyed area was very heterogeneous. Quadrat "c" had the highest number of particles sieved along this transect.

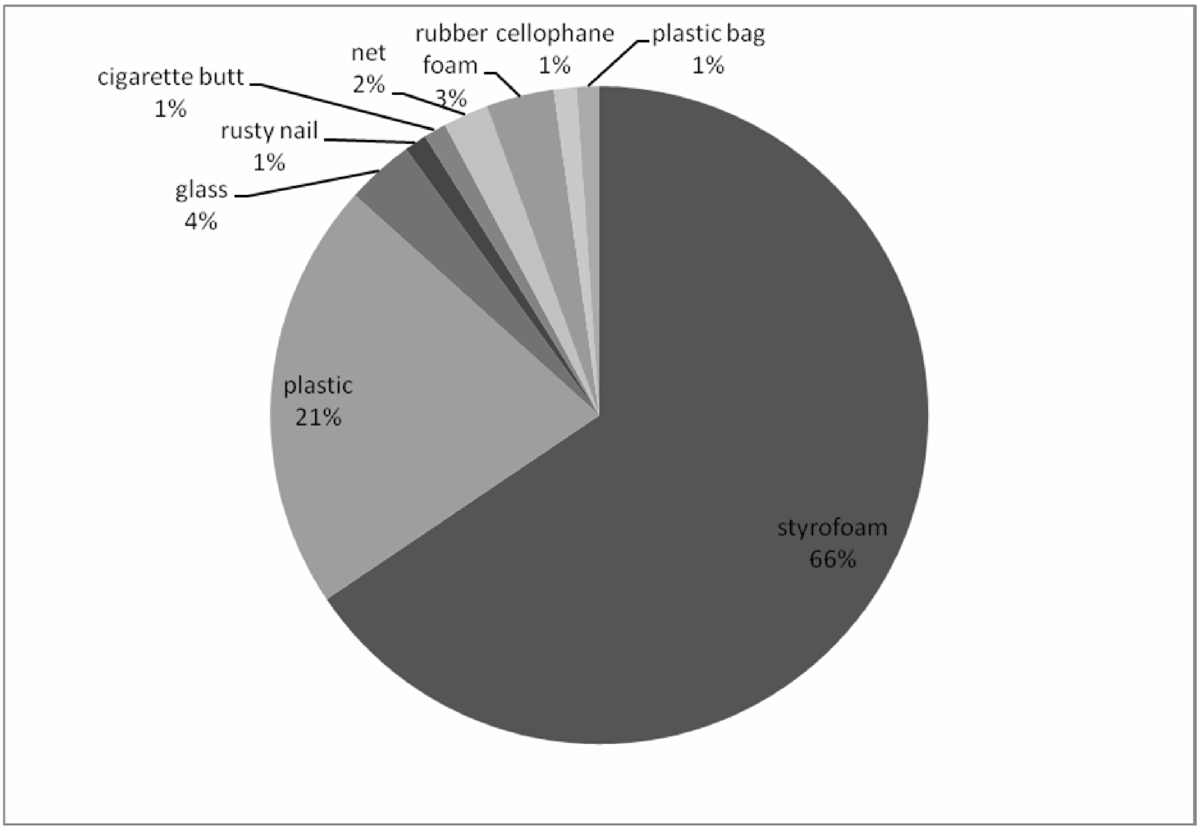

Fig. 2 : Total percentage of meso-litter of transect 1 in Yaniklar beach

Abb.2 : Überblick vom Gesamtprozentsatz des Meso-litters vom Transekt 1 von Yaniklar

We can differentiate between a lot of different material groups in this transect. Clearly, the dominant items are styrofoam, plastic and glass. The less frequent material groups such as plastic bag, cellophane, cigarette butts and rusty nail had less than three items here. Note that this figure shows the total amount of all particles in the whole transect and not the distribution over every single section. Within a section, the distribution of particles varies between the litter types.

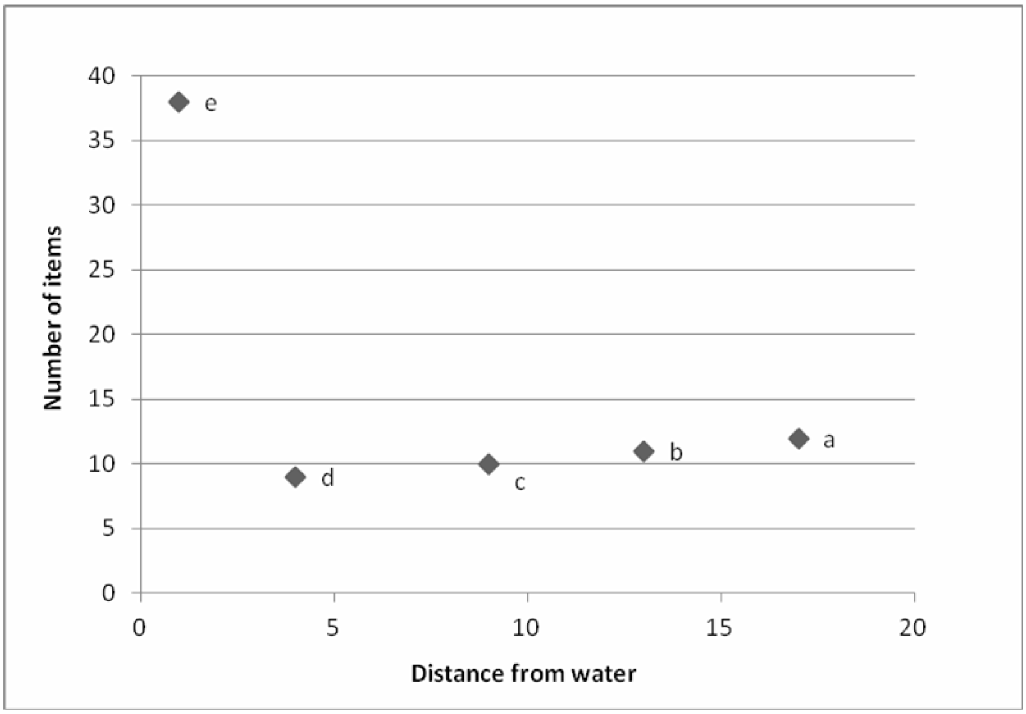

Fig. 3: Meso-litter items along transect 2 for each quadrat (a-e)

Abb. 3 : Anzahl an Stücken entlang des Transektes 2 für jedes Quadrat (a-e)

In contrast to the first transect (Fig. 1), the distribution of the total number of items clearly differed here. In the first three sections (a-c) styrofoam fragments made up the majority of the litter. Striking here was that styrofoam fragments (big and small ones) were distributed along the whole transect in every single quadrat. Section “e” of this transect showed the biggest difference when compared to other quadrats of this transect.

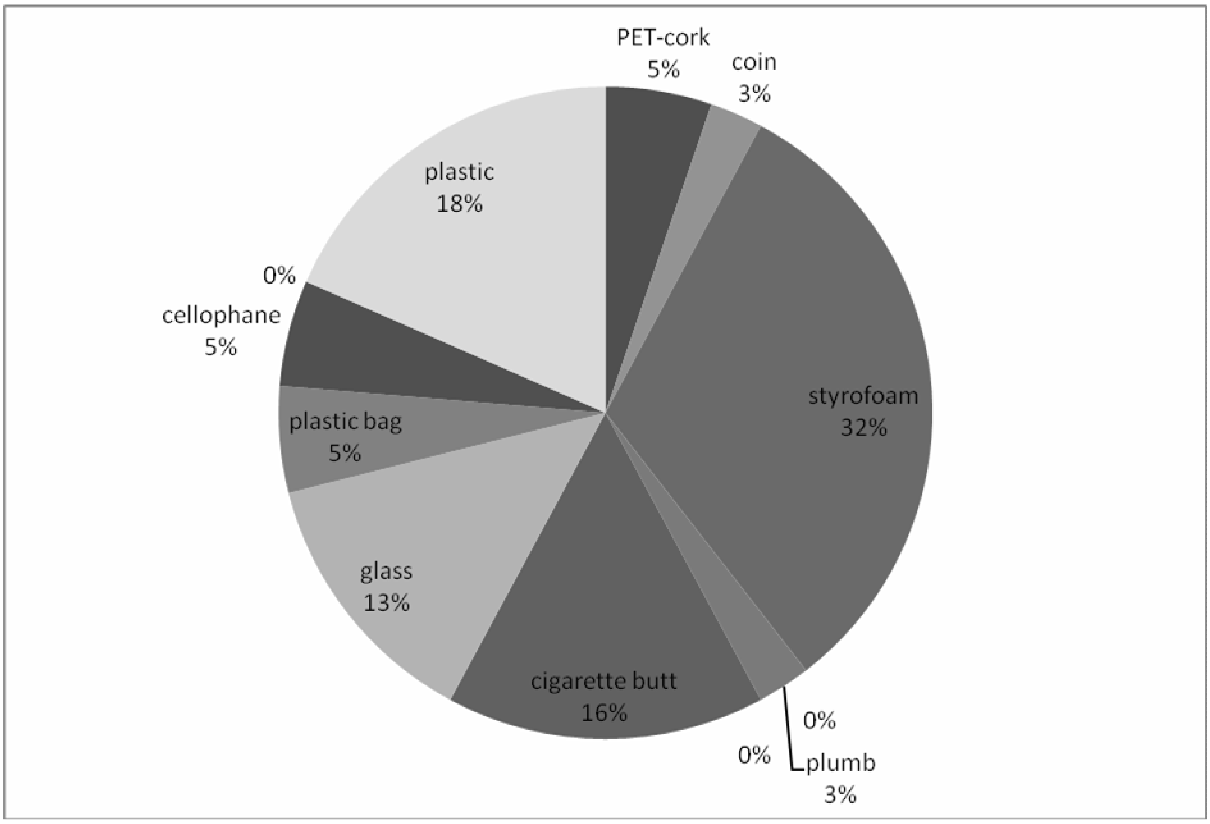

Fig. 4 : Total percentage of meso-litter of transect 2 in Yaniklar beach

Abb. 4 : Überblick vom Gesamtprozentsatz des Meso-litters vom Transekt 2 von Yaniklar

Figure 4 shows the presence of many different types of litter. The largest proportions are attributable to styrofoam, plastic and cigarette butts.

Tab. 1: Overview and occurrence of macro-litter in each transect per square meter section

Tab. 1 : Überblick und Vorkommen von Makro-Müll in jedem Transekt pro Quadratmeter

square meter	**transect 1**	**transect 2**
a	plastic bottle	/
b	/	/
c	sandal	/
d	can	plastic bottle
e	/	/

Above a size of 75 mm the litter was referred to as macro-litter. In general, the macro-litter was not collected but it was present. Therefore no measurements in weight and length were taken from these fragments.

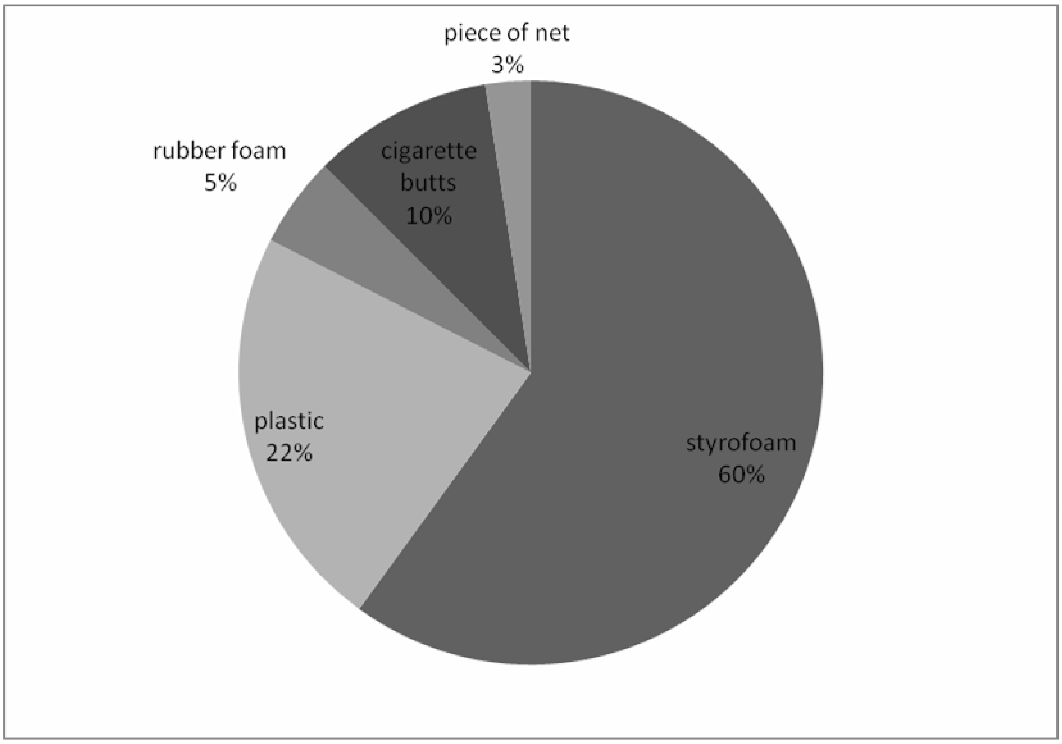

Fig. 5 : Total percentage of meso-litter of the extra quadrat in Yaniklar beach

Abb. 5 : Überblick vom Gesamtprozentsatz des Meso-litters vom seperaten Quadrat von Yaniklar

This extra quadrat chosen at Yaniklar was also very interesting. A piece of a net was found. It contained styrofoam, plastic and two little bivalves. The styrofoam and plastic items were counted for the survey, but the two bivalves were returned to the water.

The samplings on Akgöl beach were taken and sieved under same conditions:

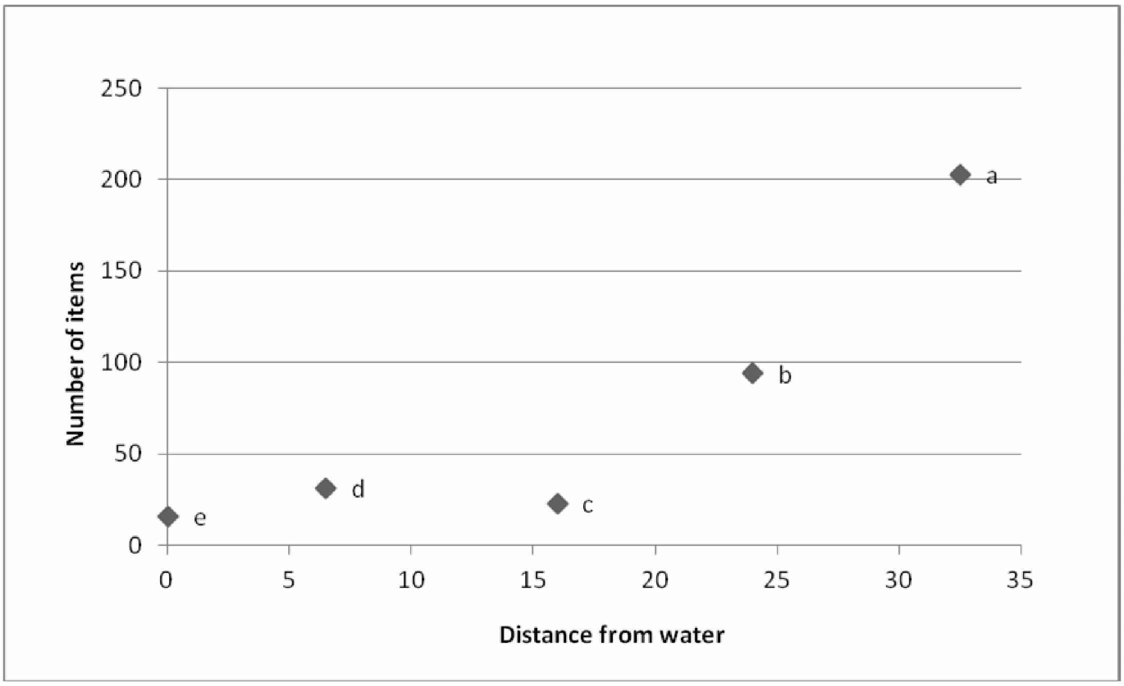

Fig. 6 : Meso-litter items along transect 1 in Akgöl for each quadrat (a-e)

Abb. 6 : Anzahl an Stücken entlang des Transektes 1 in Akgöl für jedes Quadrat (a-e)

In Fig. 6, the first section "a" shows a high abundance of various types of material, e.g. styrofoam, handkerchiefs, plastic, coal, biotic materials, cigarette butts, cellophane and many other materials (Fig. 7).

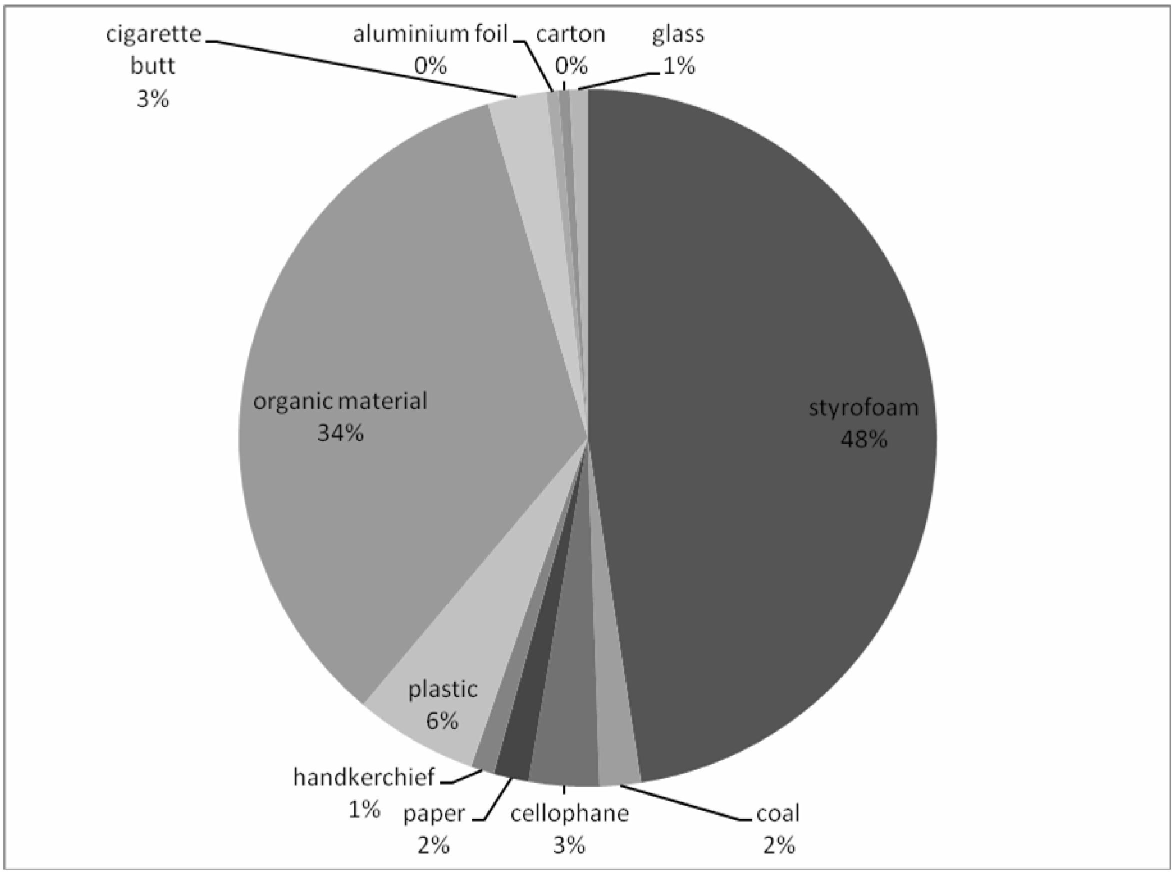

Fig.7 : Total percentage of meso-litter items of transect 1 in Akgöl beach

Abb. 7 : Überblick vom Gesamtprozentsatz des Meso-litters vom Transekt 1 von Akgöl

Fig. 7 shows the litter distribution over the whole transect. Interestingly, more than one third of the litter is organic matter. A different result would have been reached had the distribution been presented on a weight basis (grams). Illustrating the weight percentages from the different material groups, styrofoam for example would never have reached a percentage of 48% due to the light weights of the small items.

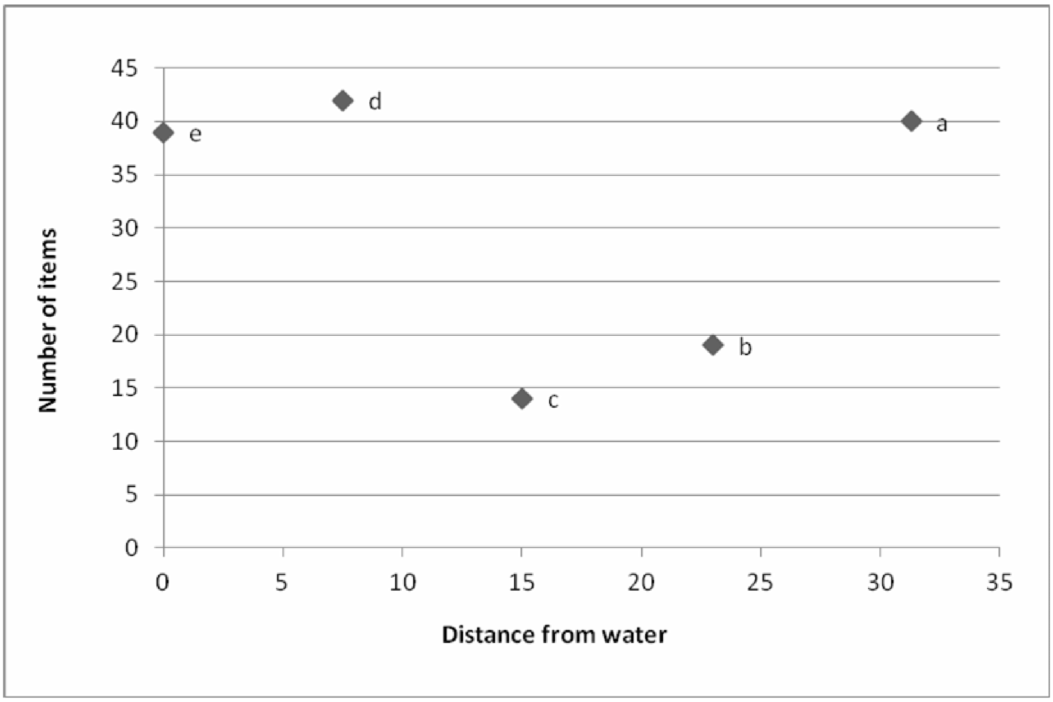

Fig. 8 : Meso-litter items along transect 2 in Akgöl for each quadrat (a-e)

Abb. 8 : Anzahl an Stücken entlang des Transektes 2 für jedes Quadrat (a-e)

The second transect in Akgöl again showed a different distribution of particles. Here sections “a”, “d” and “e” contained more items than “d” and “c”.

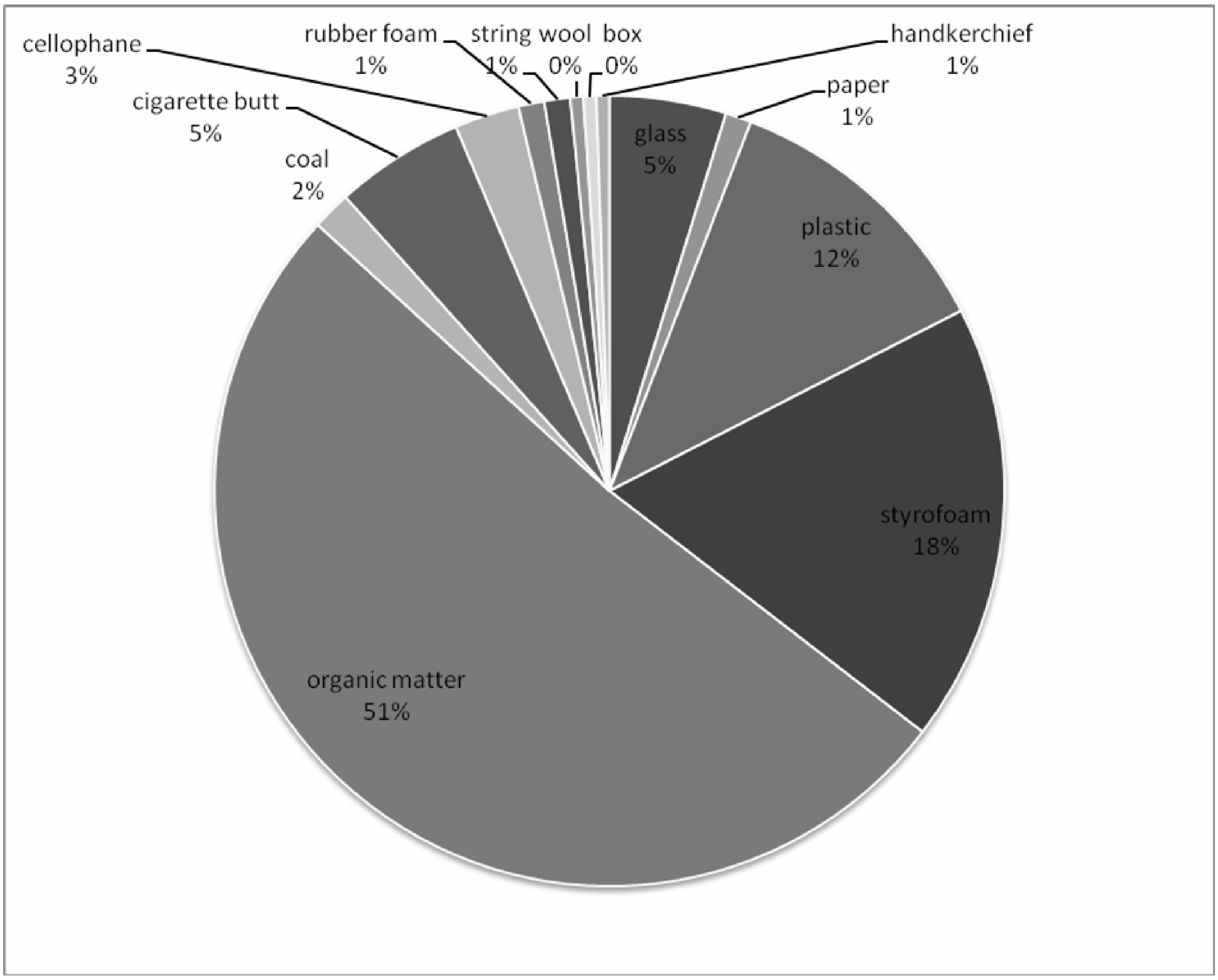

Fig.9 : Total percentage of meso-litter items of transect 2 in Akgöl beach

Abb .9 : Überblick vom Gesamtprozentsatz des Meso-litters vom Transekt 2 von Akgöl

Organic material makes up over 50% of the litter. This is followed by styrofoam and plastic (as already seen in other representations from this study. Many material groups as paper, handkerchief, coal, cigarette butt, wool and others were definitely left from visitors.

Tab. 2: Overview and occurrence of macro-litter in each transect per quadrat

Tab. 2 : Überblick und Vorkommen von Makro-Müll in jedem Transekt pro Quadratmeter

square meter	**transect 1**	**transect 2**
a	1 piece of sunshade	/
b	2 cans	/
c	/	1 towel
d	1 piece of sponge	/
e	shoe	piece of fishing net

Tab. 2 shows that macro-litter was present on both transects. Here, none of the illustrated macro-litter items were collected and measured. This table only shows the abundance of macro-litter.

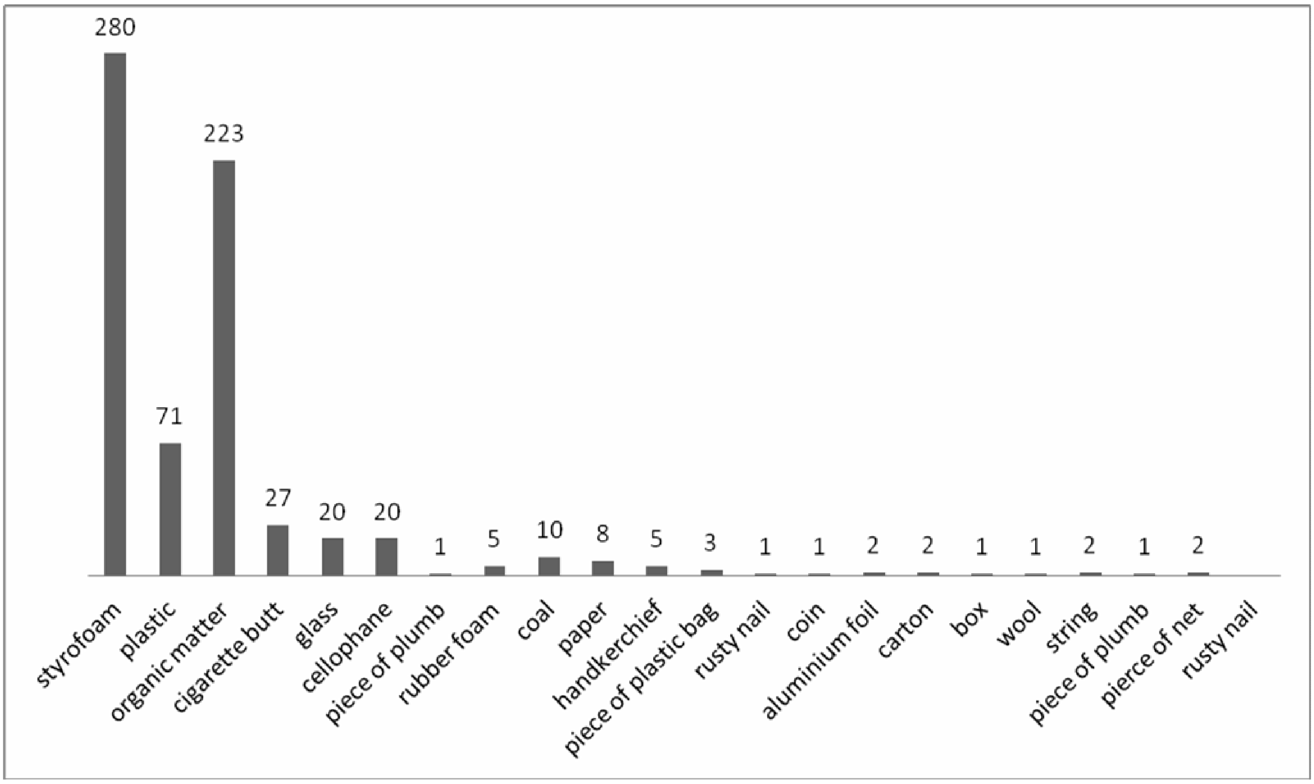

Fig. 10: Total number of items from all 4 transects together

Abb. 10 : Gesamte Stückanzahl von allen 4 Transekten zusammen

Fig. 10 shows the total distribution of litter for all sections of all transects. Finally, it shows the total number of litter items divided into single material groups.

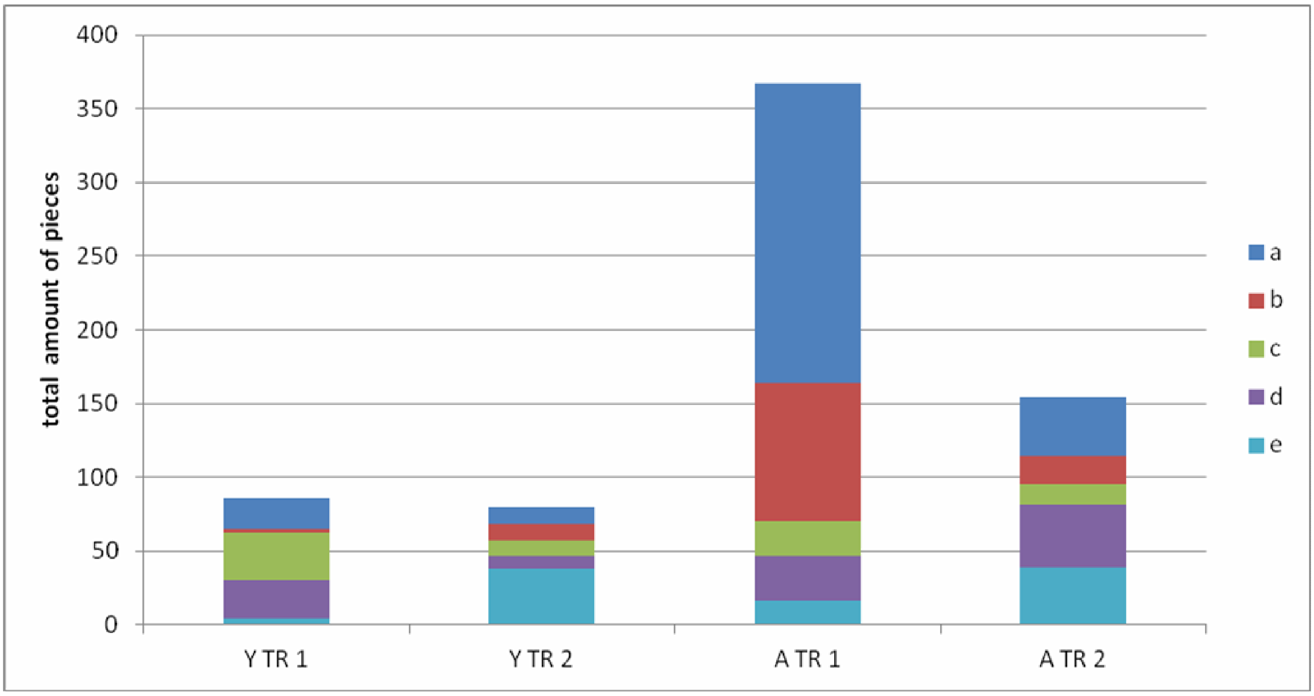

Fig.11 : Overview of abundance of the total amount of items of every transect and their separate quadrats (Y: Yaniklar, A: Akgöl, TR: transect)

Abb. 11 : Gesamtüberblick der Abundanz aller Stücke von jedem Transekt und deren Quadrate (Y: Yaniklar, A: Akgöl, TR: Transekt)

In order to better compare both beaches and their transects, Fig. 11 shows all transect with every single section colored differently.

DISCUSSION

During the past two to three decades, tourism in the Mediterranean has increased extremely. This development of the tourist industry is visible on every beach, and is also valid for the two beach zones in this study, Yaniklar and Akgöl. At the first glance, a beach may seems very clean and less polluted. A closer look often proves this first impression wrong. The results of this study show that many smaller items of waste are present and quantifies this pollution.

At transect 1 (Fig. 1) in quadrat “a” only styrofoam were recorded. These particles are easily blown away by the wind. While sampling transect 1 the tide was low, which might explain why there is less washed-up litter in the section “e”. Section “d” contained four pieces of plastic-pellets. Plastic pellets are the basic raw material of most industries (see below) (Fig. 24).

Due to the surface-volume ratio of round plastic-pellets, these small fragments are optimal sites for the growth of microorganisms. Even protozoa at the base of the food chain absorb toxins, which are then transferred to higher trophic level organisms. Due to fisheries, harmful substances return to the perpetrators of the waste problem, i.e. back to humans.

The pieces from styrofoam differed in both size and shape. Big complexes (Fig. 25), small crushed complexes and single round pieces of styrofoam were recorded (Fig. 26). Based on their small volume and low weight, these styrofoam items were probably transported by the wind.

In contrast to the first transect (Fig. 1), the distribution of the total number of pieces clearly differed in transect 2 (Fig. 3). In the first three sections (a-c) sytrofoam fragments made up the majority of the litter. Again, here the wind could have played a major role. In conclusion, sections a-d contained fewer debris items. Section “e” of transect 2 shows the biggest difference when compared to its counterpart in transect 1. The sample was taken mainly during high tide. During this phase of the tide cycle much material is washed ashore. In this study the highest concentration of plastic-pellets was found at the intertidal zone of the beach. One reason for this abundance may be that these plastic-pellets are heavier than styrofoam and therefore more difficult to transport to other parts of the beach by wind. Another example for wave motion and the subsequent onshore deposition were cigarette butts. It was observed that the filter paper of the cigarette butt has been dissolved and the filter itself was saturated with water.

In Fig. 4 less styrofoam were recorded. On this day, when samples were sieved at transect 2, the wind was stronger than usual. Light items were easily blown away by wind.

The main distribution mechanisms at Yaniklar beach are physical factors such as strong wave action and winds blowing inland. Although the beach is visibly littered, *Caretta caretta* still nests here. Tab. 1 shows that macro-litter can also be found here. These items can very often be barriers for sea turtles. The female lays her eggs in an egg chamber and then covers the nest to hide it. Dense marine debris may mean that a female can accidentally bury litter in the nest while camouflaging it. This may hinder the hatchlings from emerging. Fewer hatchlings reaching the sea lower the probability for the species to survive.

Abiotic materials such as plastics and styrofoam and also small animals are frequently found in such fishing nets floating on the surface. Macro-litter has the potential to carry a wide range of species and support the growth of many to reproductive viability (Gregory, 2009). At some point, much of these materials will be washed ashore. Stranded sessile animals attached to such nets then die.

The second beach, Akgöl is a typical picnic area and contained a different composition and abundance of meso-litter. The organic components such as the shells of seeds, garlic shells and a piece of sweet pepper (Fig. 27) were clearly left by visitors of the beach; all such items were counted as litter (Fig. 28). The pieces of coal probably stem from campfires on the beach, and the food remains from the accompanying barbeques, e.g. pieces of garlic shells. Some campfires were located next to the nests of *Caretta caretta*. Hatchlings that emerge from their nests here face a severe threat. Along the whole transect, seed remains were found. Organic matter can attract other animals, posing a predation threat to hatchlings.

Comparing this pie chart (Fig. 7) with those for the Yaniklar transects (Figs. 2 & 4) reveals a higher number of organic material and points to a greater presence of people on the beach.

The second transect in Akgöl (Fig. 8) again showed a different distribution of particles. Here sections “a”, “d” and “e” contained more than “b” and “c”. This could be because this transect was laid on the border of the picnic zone. The zone in the middle of this transect may have been used as a tourist pathway.

In this transect (Fig. 9) the plastic fragments differ a little bit from the ones found in other transects. One barrette (Fig. 29), two caps of plastic bottles and two pieces of a strap, probably from swimming goggles (Fig. 30). The rest are, like usual, smaller fragments which were crushed from bigger ones. In the whole transect, especially next to the high tide line, no plastic pellets were recorded. This might point to no regularity in the distribution of plastic-pellets. The pie chart gives a rough overview for a better comparison with the other sampled transects.

Beaches have a high oxygen availability and direct exposure to sunlight, so pellets will degrade rapidly, in time turning brittle, forming cracks and „yellowing“ (Andrady, 2011; Barnes et al., 2009). In this study the highest concentration of these plastic-pellets was found next to the intertidal zone. One of the most interesting results was that these pellets were found only in this zone of the beaches (expect transect 2, in Akgöl).

Tab. 2 shows that macro-litter was present on both transects. The shaft of the sunshade in transect 1 was stuck in the smooth sand. Visitors are typically unaware of the nests and such sharp objects my penetrate the nests and destroy already laid eggs. The shoe in quadrat "e" most likely was washed up because it seemed damaged. The towel in quadrat "c" from transect 2 is a typical sign for the presence of bathers, who for some reason failed to remove their own towel. Such left-behind items impact the environment and its inhabitants.

Fig. 10 shows all different material groups which were recorded during the sampling period. Lastly, Fig. 11 illustrates the information about the total number of pieces of all transects. It is easy to recognize which transect has most items. The high number of items on land correlates with the floating items in water..

The transects clearly reveal the underlying pollution with small-sized marine debris. This calls for improved awareness and concrete steps. Everybody should know that litter has a large negative impact on the environment and its biodiversity. Everyone should recognize this global problem, but this does not seem to be the case.

Hotels build lot facilities for tourists, creating many problems for *Caretta caretta* to emerge onto the beach, find suitable places for their nests, lay their eggs inside the nests and leave the beach back to the sea. Every year, more and more tourists come, making the beaches increasingly unsuitable as a nesting place for the sea turtles.

There are also great pieces of waste that prevent turtles to dig a nest and continue to look for suitable places. In this study, in every single transect macro-litter were found.

The impact of litter has many consequences for the whole ecosystem. Due to ingestion, sea turtles, seabirds or mammals and a large number of other marine species are harmed and/or killed by plastic debris. Importantly, many organisms are already endangered by other forms of anthropogenic activities (Derraik, 2002). Effects from the ingestion of plastics include blockage of gastric enzyme secretion, diminished feeding stimulus, lowered steroid hormone levels, delayed ovulation and reproductive failure (Azzarello and Van-Vleet, 1987).

The threats to marine life are primarily mechanical due to ingestion of plastic debris and entanglement in packaging bands, synthetic ropes and lines, or drift nets (Laist, 1987, 1997; Quayle, 1992). Sea turtles approach and attempt to eat all types of debris, including entangling material (Carr 1986, 1987).

When a dead adult turtle is washed ashore, it should examined by trained personnel from institutions that have permits to anatomically investigate the cadavers. One task is to look how much marine debris was consumed and could not be eliminated from the digestive tract. What can the average citizen do to ensure that less waste enters the sea? More trash cans, for example, could contribute to reducing waste at the beaches. Moreover, many institutions already conduct beach clean-ups, mostly using volunteers.

Not only sea turtles confuse litter with food; sea birds also eat debris instead of real nutrition. Birds collect plastic items to build their nests and as a result their young can become entangled. Ingestion of litter has a negative impact on the metabolism. Seabirds select specific plastic shapes and colors, mistaking them for potential prey items. Sea birds are also frequent victims of abandoned or lost fishing nets. Because most seabirds feed on fish, they are often attracted to fish caught or entangled in discarded nets or fishing lines. Many birds, including ducks, geese, cormorants and gulls, are also entangled in six-pack rings and other encircling pieces of marine litter. Of the world’s 312 species of seabirds, 111 species are known to ingest plastics. Between 700.000 and one million seabirds are killed by entanglement or ingestion each year. Plastic remains in their stomachs for long periods.

Marine pollution poses a threat to the marine biodiversity and is compounded by overfishing, climate change and other forms of anthropogenic disturbance. There is a need for more research in order to gain an accurate and meaningful assessment of litter and its influence.

The focus should be on long-term and large-scale monitoring: this problem must be considered globally because everyone is part of the process.

Education is a very powerful tool to address the issue, for example if it is discussed in schools. Youngsters can then share their knowledge with their families and friends. Enormous amounts of plastic waste have accumulated in the world's oceans. The amount is increasing because of the existing waste does not decompose easily. This calls for action – action by each and every one of us. It can be as simple as picking up your own litter, picking up other litter and telling others to do the same the next time you visit a beach.

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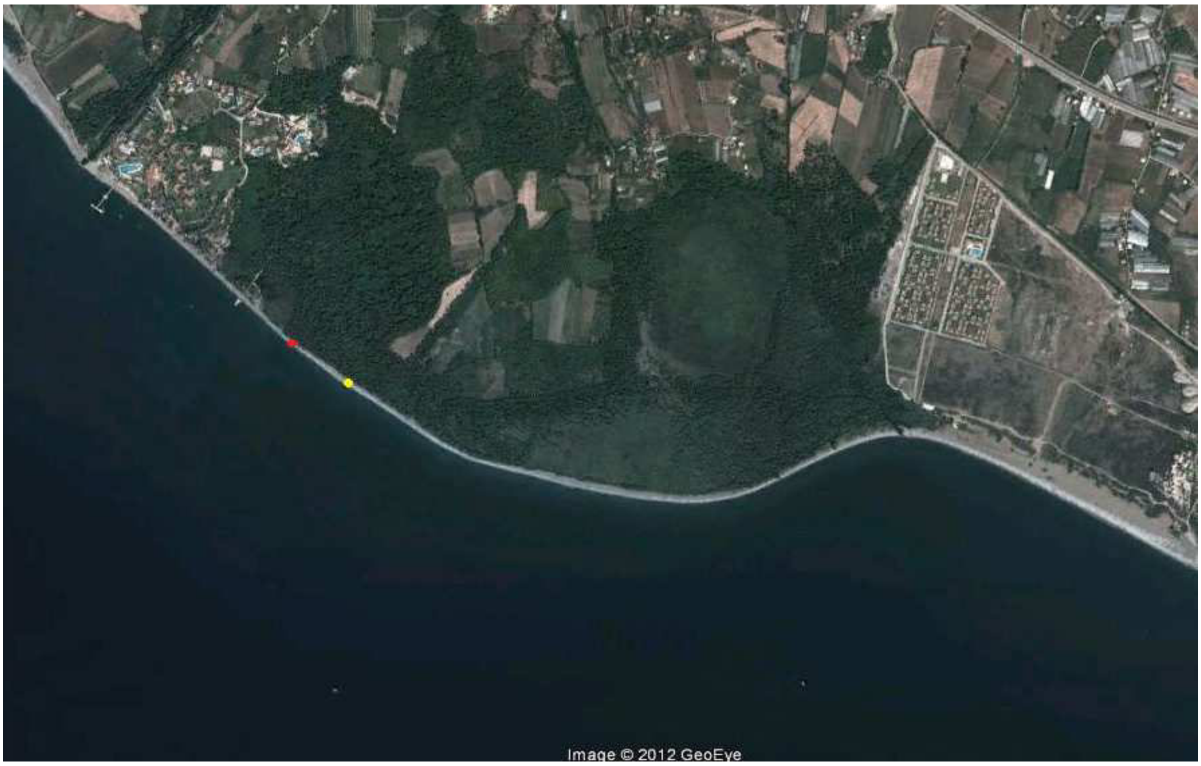

Fig. 12: View of Yaniklar beach; red point = transect 1; yellow point = transect 2 (2012; google.maps.com)
Abb. 12: Ansicht von Yaniklar; roter Punkt = Transekt 1; gelber Punkt = Transekt 2 (2012; google.maps.com)

Fig. 13: View of Akgöl beach; red line = transect 1; yellow line = transect 2 (2012; google.maps.com)
Abb. 13: Ansicht von Akgöl; rote Linie = Transekt 1; gelbe Linie = Transekt 2 (2012; google.maps.com)

Fig. 14: Transect (marked by tape measure) beginning at the vegetation (not visible) until the intertidal zone. Note marked quadrat (bottom)
Abb. 14: Transekt beginnend bei der angrenzenden Vegetation (nicht im Bild) bis zum Gezeitenbereich; Siehe gekennzeichnetes Quadrat (Boden).

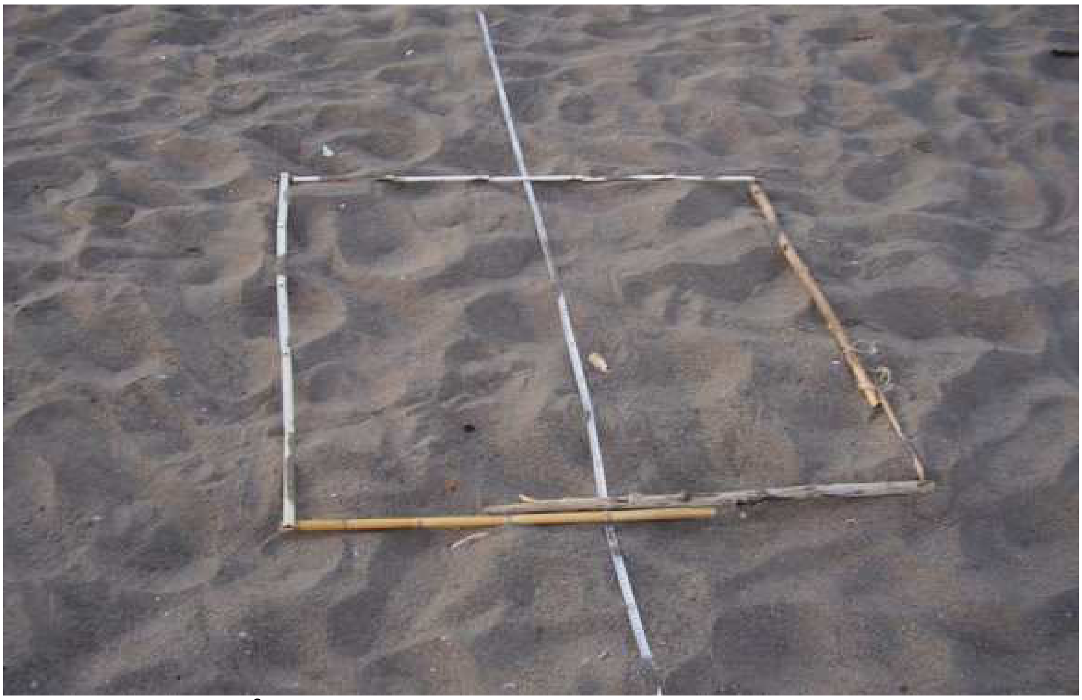

Fig. 15: A typical 1 m^2 quadrate along the transect (tape measure) delimited by reeds.
Abb. 15: 1 m^2 Quadrat entlang eines Transekts (Maßband), abgesteckt mit Schilfrohr.

Fig. 16: Quadrat with the two sieves used, prior to sieving
Abb. 16: Quadrat mit 2 Sieben.

Fig. 17: Sieve with 4 mm mesh size
Abb. 17: Sieb mit einer Siebweite von 4 mm

Fig. 18: The sieving proces: meso-litter is retained in the sieves.
Abb. 18: Das Sieben: meso-litter bleibt unter anderem im Sieb zurück.

Fig.19: Transect 1 at Yaniklar beach (16 m). In background, Hotel Lykia Botanik.
Abb. 19: Transekt 1 in Yaniklar (16 m). Im Hintergrund, das Hotel Lykia Botanik

Fig 20: Transect 2 at Yaniklar beach (17 m) (photo: I. Rabl)

Abb. 20: Transekt 2 in Yaniklar (17

Fig. 21: First (red: 32.5 m) and second (yellow: 31.3 m) transects at Akgöl beach
Abb. 21: Erstes (rot: 32,5 m) und zweites (gelb: 31,3 m) Transekt von Akgöl.

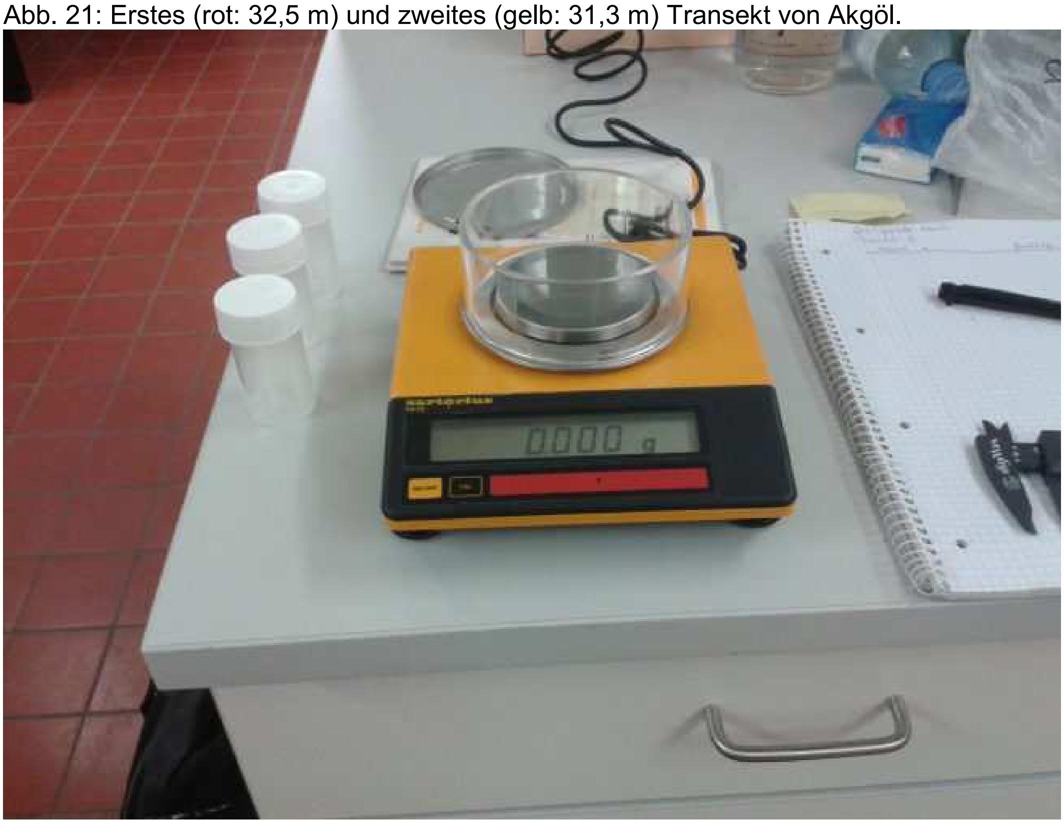

Fig. 22: Calibrated scale used to weigh every single item in the quadrats (Department of Marine Biology)
Abb. 22: Geeichte Waage zum Wiegen von jeden einzelnen Stück von jedem Quadrat (benutzt im Labor vom Department der Meeresbologie).

Fig. 23: The maximum lengths of the items were measured with an electronic caliper
Abb. 23: Die maximale Länge der Stücke wurde mit einer elektronischen Schiebelehre gemessen.

Fig.24 :Two plastic-pellets from the intertidal zone; these plastics are transported by wind and waves onto the beach
Abb. 24:Zwei Plastik-pellets von der Gezeitenzone; diese Plastik Stücke werden durch Wind und Wellen an Land transportiert.

Fig. 25: Single round styrofoam element – a common item in the samples
Abb. 25: Einzelne runde Styroporkügelchen – häufiges Stück in den Proben

Fig.26: Such larger pieces of styrofoam were found in every transect of both beach sections
Abb.26 : Solche größeren Styroporkomplexe wurden in jedem Transekt von jedem Strandabschnitt gefunden.

Fig.28 :All items(except nut shells) from quadrat “a” from transect 1 in Akgöl beach: styrofoam, coal, handkerchief, cigarette butts, plastic, cellophane, among others
Abb.28: Alle Stücke (außer Nussschalen) von Quadrat „a“ vom Transekt 1 in Akgöl: Styropor, Kohle, Taschentuch, Zigarettenstummel, Plastik, Zellophan neben weiteren Stücken

Fig. 29:Transect 2 at Akgöl beach: a barrette and a single styrofoam element
Abb. 29:Transekt 2 in Akgöl: eine Haarspange und ein einzelnes Styroporstück

Fig. 30: Different shapes and colors of plastic fragments from transect 2 of Akgöl beach next to the intertidal zone.
Abb. 30: Verschiedene Formen und Farben von Plastikstücken von Transekt 2 in Akgöl nahe der Gezeitenzone.

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Eva Schweiger
Judith Ullmann
Sabrina Wagner
Sarah Zauner

……………...............2012 Observer:……………………….………………

ADULT/NEST/TRACK

Date:………………. Time:………………..	Nest Nr.:…………..	Track Nr.: ……………..

Tag Nr.: [L / R] Straight measurements: SCL ……. SCW ……… Curved measurements: CCL ……. CCW ………. Epibionts …………………. Deformations……………….	Shape of track dry zone(1) moist zone(2) wet zone(3)	Total track length:……………….. Track width:……………………… Nr. of body pits: …………………. Nest Dist. to sea: ……………….. Beach zones 1:.…………………m (dry) 2:...……………....m (moist) 3:…………………m (wet) Hatchery Yes No

Exact position of the nest:

Notes: vegetation, substrate type (sand, pebbles > 2mm, cobbles > 64 mm)

.....................2012
HATCHING-DATA

Nest Nr:................. Nest Date:………………… Incubation Time:………………….. Observer:………………………………………

Emerging days	1	2	3	4	5	6	7	8	Total
Hatch date									
Hatch time (start)									
Number of tracks									
Hatchlings reaching the sea									
Predated hatchlings									
Predated eggs									
Dead due to sun/heat									

Other observations and remarks:

Nest excavation: Date:.......……………….. Time :……..……………. Observer:……………………………………………

Empty shells	
Hatchlings still living inside nest	
Dead hatchlings in nest	
Unfertilized eggs	
Total Nr. of fertilized eggs:	

Early-embryonic stage (<1 cm)	
Mid.-embryonic stage (>1 cm <2cm)	
Late-embryonic stag (> 2cm)	

Total Nr. of eggs	
Total Nr. of empty shells	
Total Nr. of hatchlings reaching the sea	

Depth: top eggs	
Bottom of chamber	
Diam. of chamber	
Nest dist. to sea	

Insects ets. in nest: