SALAMANDRA 54(1) | 45–55 | 15 February 2018 | ISSN 0036–3375

Chelonia mydas and *Caretta caretta* nesting activity along the Mauritanian coast

Feitoumatt Lematt Hama[1,2,3,4], Christelle Dyc[1], Abdallahi Samba Ould Bilal[2,5], Moulaye Mohamed Wagne[2,6], Wim Mullie[2], Zein El Abidine Ould Sidaty[7] & Jacques Fretey[1,2]

[1)] Centre de recherches sur les tortues marines – Chélonée, 46260 Beauregard, France

[2)] Programme Biodiversité, Gaz, Pétrole (BGP), Deutsche Gesellschaft fur Internationale Zusammenarbeit (GIZ), Nouakchott, Mauritania

[3)] Croatian Institute for Biodiversity, Lipovac I., br. 7., HR-10000 Zagreb, Croatia

[4)] Biota j.d.o.o., Braće Radića 128/A., HR-43290 Grubišno polje, Croatia

[5)] Laboratoire d'Ecologie et Biologie des Organismes Aquatique (LEBOA), Institut Mauritanien de Recherches Océanographiques et des Pêches (IMROP), Mauritania

[6)] Laboratoire d'Etudes des Milieux Marins et Côtiers (LEMMC), Institut Mauritanien de Recherches Océanographiques et des Pêches (IMROP), Mauritania

[7)] Conservateur Parc National du Diawling, Mauritania

Corresponding author: Feitoumatt Lematt Hama, e-mail: lemattkate@gmail.com

Manuscript received: 8 February 2017

Accepted: 28 June 2017 by Philipp Wagner

Abstract. Our study on sea turtle nesting along the Mauritanian coast covers the period from June 2010 until October 2015 and provides the first evidence of occasionally high *Chelonia mydas* nest concentrations along the Mauritanian coast. Between 2010 and 2013, sea turtle nests were rarely observed suggesting that nesting events along the Mauritanian coast were sporadic and scattered. In September 2011, a nest of *C. mydas* on the beach near the Diawling National Park with 36 eggs was translocated to an enclosure at Mouily locality. This was the first attempt to establish an optimal translocation procedure along the Mauritanian coast. In October 2014, a total of 127 *C. mydas* nests or nesting activities were recorded of which 99 were closely inspected. The majority of the nests were located on the beach between 28 and 65 km south of Nouakchott. Embryos from most nests were estimated to be within 30 days of their emergence, but three were estimated to be at the start of their embryonic development. From August until October 2015, one *Caretta caretta* and 25 *C. mydas* nesting activities were recorded. Numerous tracks of African golden wolves, ghost crabs and humans were recorded around sea turtle nests suggesting predation and poaching activity on their eggs. During our study we noticed that sea turtles are readily captured and killed onshore and offshore by local fishermen and natives who still use their meat, fat and eggs for various purposes.

Key words. Mauritania, West Africa, Sea turtles, nesting season, temperature, predation.

Introduction

The Atlantic coast of Mauritania is the northernmost area of West Africa where the presence and nesting activity of several sea turtle species has been recorded. This gives it a possibly unique conservation importance (Fretey 2001). The existence of nesting activity of *Chelonia mydas* (Linnaeus, 1758) and *Caretta caretta* (Linnaeus, 1758) in Mauritania was previously mentioned by a number of authors (Pasteur & Bons 1960, Maigret 1975, Arvy & Dia1995, Arvy et al. 2000). Additionally, people from the native coastal population (called Imraguen) have observed nesting of three sea turtle species described as *C. mydas, C. caretta* and *Dermochelys coriacea* (Vandelli, 1761) (Maigret 1983, Mint Hama et al. 2013). However, available scientific data regarding sea turtle nesting along the whole Mauritanian coast is still scarce and fragmentary. Thus, more accurate and concrete data regarding the nesting season period, location of nesting sites and nesting activity along the Mauritanian coast are needed to grasp the true biogeographical importance of this area for different sea turtle species populations. Despite the fact that the Mauritanian government has ratified the CMS Memorandum of Understanding on Conservation Measures for Marine Turtles in the Atlantic Coast of Africa (MOU of Abidjan) in May 1999 and is involved in the Regional Conservation Program of the Marine and Coastal area of West Africa (PRCM), sea turtles and their nests are still being destroyed and poached

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along the entire Mauritanian coast. Additionally, sea turtle nests are easily exposed to numerous detrimental environmental conditions such as high (lethal) sand temperatures and substantial beach erosion caused by high sea tides. In many reptile species, and especially in turtles (Pieau 1975), the sex of an individual depends on the temperature conditions in the period of embryonic development which corresponds to the first stages of gonad differentiation. This developmental mechanism is referred to as Temperature-dependent Sex Determination or TSD. Previous studies show that substrate (sand) temperature is a crucial factor for sex determination of tortoises and sea turtle embryos during the thermosensitive incubation period (Yntema & Mrosovsky 1980, Mrosovsky & Pieau 1991, Lescure et al. 1985, Mrosovsky 1994). However, to the best of our knowledge, studies that analyse substrate (sand) temperature fluctuations at the sea turtle nesting sites along the Mauritanian coast have not yet been conducted. Therefore, the objectives of this study were to: 1) gather evidence of sea turtle nesting activity, 2) identify all sea turtle species that nest along the Mauritanian coast, 3) identify and monitor the main nesting sites, 4) collect substrate (sand) temperature fluctuation data at the identified sea turtle nesting sites during a 2-year period, and 5) record all of the possible sea turtle nest predation activities.

Materials and methods

Study protocol

Field work was conducted from June 2010 until October 2015 along the major part of the 754 km long Mauritanian coastline from Nouadhibou to Mamghar localities (Northern area), from Mamghar to PK28 localities (Central area) and from PK28 to N'diago localities (Southern area). Work was done using four-wheel drive vehicles and partially on foot. At the beginning of the study, an information gathering survey was conducted among fishermen and natives living in villages and seasonal camps in the Southern and Central areas (Fig. 1). Pictures of *C. caretta*, *C. mydas*, *Lepidochelys olivacea* (Eschscholtz, 1829), *Lepidochelys kempii* (Garman, 1880), *Eretmochelys imbricata* (Linnaeus, 1766), and *D. coriacea* species in their various life stages were shown to them with the goal of gathering information about the existence of particular sea turtle species, their nesting season and possible nesting sites.

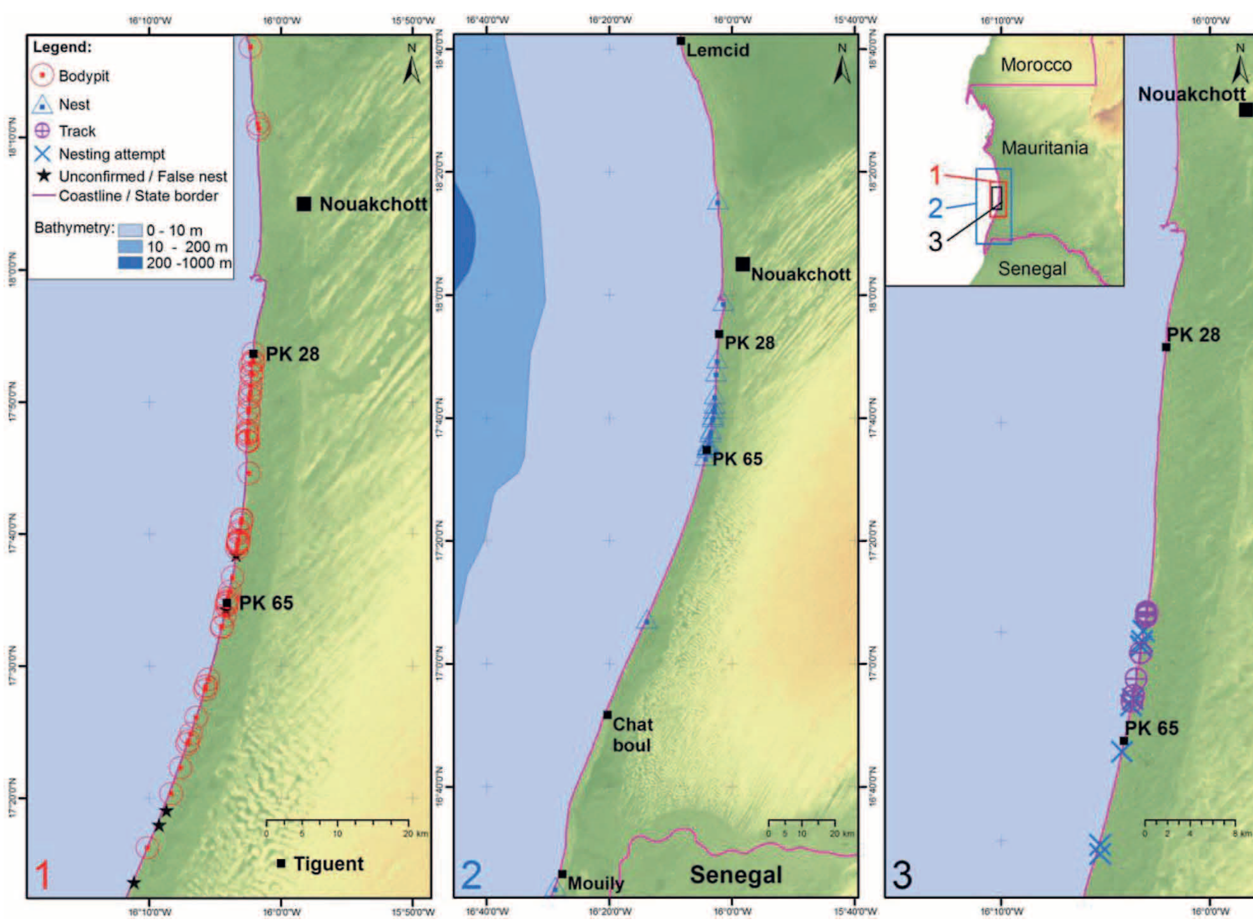

Figure 1. Map of the Mauritanian coast nesting area.

Identification of sea turtle nesting sites

After the optimal time period was identified, in relation with the daily tide (or sunset), routine beach patrols were done. Daily, we covered ~60 km of beach by vehicle and ~8 km of a randomly assigned transection on foot. As such, bodypits, possible nests and traces left by female turtles during the previous night were easily recognized. Nests and body pits were recorded by a GPS device and marked with a stick labelled with a unique code and an orange piece of tape for subsequent visual recognition. All marked sea turtle tracks were subsequently erased. *Chelonia mydas* nests were usually located by the existence of body pits they typically leave after their nesting attempts, because their locomotion tracks in the sand are often erased by wind within few days. All GPS data were recorded in WGS 1984 (World Geodetic System 1984) datum format and depict identified sea turtle nests, bodypits, nesting attempts, false nests and sea turtle tracks. Thus gathered data was used to design a distribution map using ArcGIS 10.2 (Esri 2013) software.

Translocation of a potentially threatened sea turtle nest

To protect sea turtle nests, we constructed a 3x3m fenced enclosure in the Mouily area in southern Mauritania (Fig. 1) to which all nests, potentially endangered by poaching, predation and erosion, could be translocated. This technique also allows for an easier and more accurate identification of the species because hatching can be easily monitored. The exact position of nests in the identified bodypits was established by gently probing every twenty centimetres using a thin iron rod. On the places where the sand was loosely packed, it was removed by hand until the eggs were uncovered. Nests were given identification numbers and were documented in detail. Eggs from the first identified nest were carefully removed from the nest pit and transported in a plastic container filled with sand in the same orientation in which they were positioned in the nest to the prepared enclosure. The position of the North was marked with a pencil on the egg membrane surface as to avoid potential disturbances in embryological development.

Substrate temperature measurement

Aiming to determine the precise nest substrate (sand) temperature fluctuations and subsequently predict the possible sex ratio in sea turtle nests located at Mouily locality, we placed Temperature Data Loggers (HOBO® Water Temp Pro v2) at two depths (30 and 50 cm) in different beach zones at three different sites (Fig. 2). Temperature recorders were placed in December 2012 and left to continuously measure the sand temperature until December 2014, when they were recovered. Temperature recorder devices took measurements in one hour intervals during each day. Each temperature recording device had an assigned code (i.e. AA, AB and AC). Devices AA and AC were placed at 30 cm depth whereas AB was placed at 50 cm depth. AB and AC were positioned 1,5 m apart from each other in the

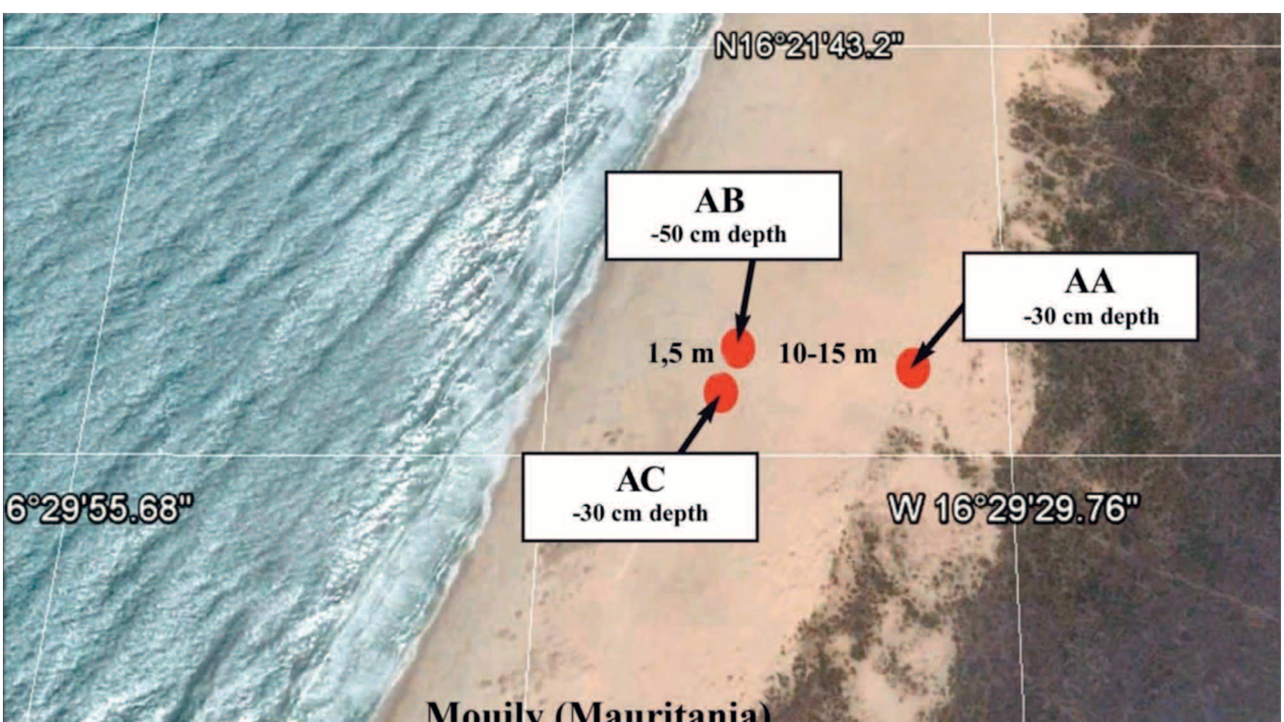

Figure 2. Location of AA, AB and AC temperature recorders on the Mouily beach.

centre of the Mouily beach, whereas device AA was positioned in the uppermost part of the beach, 10–15 m from both AB and AC. Devices AA, AB, and AC were placed to cover the whole potential sea turtle nesting beach zone (Fig. 2). Statistica 10 software was used to analyse gathered temperature data.

Incubation success ratio

To verify the presence of eggs, evaluate their condition, estimate the onset of a hatching event, and estimate the incubation success of the identified *C. mydas* nests, we excavated and collected data from ten random nests, and subsequently calculated the incubation success ratio using the following formula:

$$\text{Incubation success (\%)} = \frac{A}{B} \times 100$$

A = Total number of hatched egg membranes, hatching eggs, live newborns/hatchlings in ascension, dead newborns/hatchlings during the ascension

B = Total number of eggs/egg membranes

The presence of hatchlings that had possibly remained after ascension was also checked.

Results

Sea turtle survey

According to the interviewed fishermen and native Imraguen people, there were three different species of sea turtles nesting along the Mauritanian coast: *C. mydas, C. caretta* and *D. coriacea*. They reported their lifelong observations that these species nest in several places along the southern part of the Mauritanian coast, in particular at the localities PK28 and PK65 (28 km and 65 km south of Nouakchott respectively) as well as within the N'diago, Mouily, and Chott Boul areas (Fig. 1). They also reported numerous nesting attempts of *C. caretta* individuals. The latter species, due to its generally fearful nature, easily returns into the sea without laying eggs. The interviewed fishermen and natives also reported the existence of nesting activity in the Central and Northern Mauritania areas, at Rgueiba and Mamghar localities in the Banc d'Arguin National Park (PNBA) and in the area between and including M'Hejratt, Jreif, Balawakh and Lemcid. Interestingly, an old native Imraguen mentioned finding a *D. coriacea* nest at M'Hejratt locality. He explained in detail the duration of the incubation period and he made a drawing showing the approximate egg size which indicated that he had probably seen the excavated nest with eggs inside it. However, during our study we did not find evidence of sea turtle nesting activities at these localities. The interviewees mentioned poaching of sea turtle nests and adult individuals for various purposes despite the fact that the majority of them were aware of existing laws prohibiting such activities. For this reason people were often reluctant to answer questions regarding such activities, or they provided inconsistent information about sea turtles.

Chelonia mydas nesting activity

In the first year of our study we did not observe any sea turtle nesting activity. During 2011 (July 23rd – August 18th), we found one *C. mydas* nest between Chott Boul and Mouily localities containing 36 eggs and three body pits without eggs. In 2012 and 2013 no nests were found, but from August until October 2014, a total of 127 *C. mydas* nesting activities were recorded (Fig. 1), of which only 99 were closely inspected due to time constraints. Twelve of the inspected body pits were false nests with no evidence of sea turtle egg membranes or eggs. In the vicinity of 22 body pits, we found egg membrane remains indicating that hatching had already occurred. Most nests were found in the Central and Southern areas with the highest concentration between 28 and 65 km South of Nouakchott. All nests appeared to be between 30 days of age and their emergence with the exception of one nest around which female arrival-departure locomotion tracks were visible. North of Nouakchott city we observed female tracks (18°37'10" N, 18°37'20" W) and several old *C. mydas* nests (18°10'24" N, 16°01'24.96" W; 18°11'7.86" N, 16°01'27.90" W; 18°16'30.78" N, 16°02'11.94" W). Also, in that same area, we found one new *C. mydas* nest containing 95 eggs (18°17'24.30"N, 16°02'20.58"W) which dated from November 2014. According to our evaluation, the majority of these nests were probably dug between late August and early September. During the end of August and the beginning of September 2015, 25 nesting activities of *C. mydas* species were recorded at the beaches along the Mauritanian coast. The observed nesting activities included eleven cases of locomotion tracks (female arrival–departure tracks) without the presence of nesting attempts, and 14 body pits.

Translocation experiment

From the nest identified between Chott Boul and Mouily localities, all 36 eggs were translocated. In total, 26 individuals hatched and only three were killed by predators (*Ocypode cursor* [Linneaus 1758]). The remaining 23 were released and safely reached the sea (Fig. 3).

Incubation success ratio analysis

During the excavation of the located sea turtle nests, which aimed to estimate the incubation success rate, we found four dead *C. mydas* hatchlings in the position of ascension whereas 56 hatchlings were found dead within the nests. Only in three nests we encountered turtle embryos in their final incubation stage and one nest that contained 95 freshly laid eggs. In total, nine of ten randomly excavated *C. mydas* nests showed to have an incubation success ratio

Table 1. Incubation success ratio in 10 randomly excavated *Chelonia mydas* nests found during 2014. * Observation of one yolkless egg; ** Evidence of possible African golden wolf predation.

Nest number	Hatched egg membranes	Hatching eggs	Rotten eggs	Live newborns/ hatchlings in ascension	Dead newborns/ hatchlings during the ascension	Eggs without apparent development	Dead embryos at the end of incubation	Total number	Incubation success ratio (%)
1	69	4	11	–	1	–	–	85	87
2	75	4	–	–	–	–	–	79	100
3	64	4	2	2	4	2	1	79	94
4		106	–	–	–	2	–	108	98
5	105	–	–	–	–	2	–	107	98
6*	139	–		–	–	13	5	158	88
7**	3	–	19	–	–	–	3	25	12
8	99	–	19	–	–	5	6	129	77
9	64	–	2	4	–	2	4	76	89
10	139	–	–	5	–	14	45	203	71

≥ 71% (Fig. 4). Only one of the excavated nests showed a low incubation success ratio (12%) along with a high ratio of rotten eggs (76%; 19 of 25) and three dead embryos indicating suboptimal developmental conditions (Table 1).

Caretta caretta nesting activity

In August and September 2015, we recorded several nesting activities for this species (i.e. traces, nests and nesting attempts), which consisted of seven locomotion tracks without the presence of nesting attempts, two nesting attempts, and one identified nest.

Dermochelys coriacea nesting activity

We did not record locomotion tracks or any evidence (e.g. stirred sand area indicating a wide sweep after eggs-laying) which would indicate possible *D. coriacea* nests along the Mauritanian coast. However, we found stranded or captured and butchered individuals which will be reported elsewhere.

Substrate temperature analysis

A total of 17437 temperature data points were recorded during the two-year period (2012–2014). Devices AA, AB, AC were respectively placed at 30, 50, and 30 cm depth in the uppermost or centre beach zone and recorded temperatures that ranged from the minimum 8.9°C, 8.6°C, and 8.7°C in November 2014 to the maximum 48.9°C, 49.8°C, and 49.9°C in May 2013. Substrate temperature fluctuations from June to October were shown to be the smallest in comparison with other periods and seem to be optimal for the incubation of sea turtle eggs (Figs 5–7, Supplementary Tables S1–S3). During that period the mean substrate

Figure 3. *Chelonia mydas* juveniles hatched from the translocated nest and released at the beach between Chott Boul and Mouily locality (© M. Ba).

Figure 4. Nest with successful incubation during a hatching event (© J. Fretey).

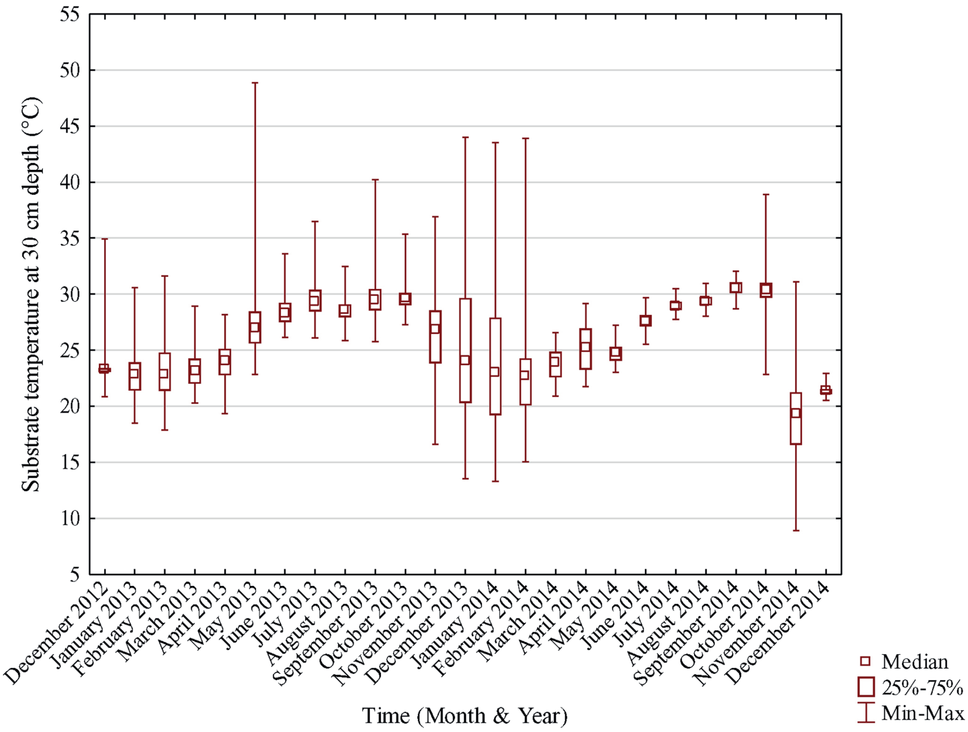

Figure 5. Substrate (sand) temperature fluctuation recorded by device AA at 30 cm of depth in Mouily area during the 2-year period (December 2012 – December 2014).

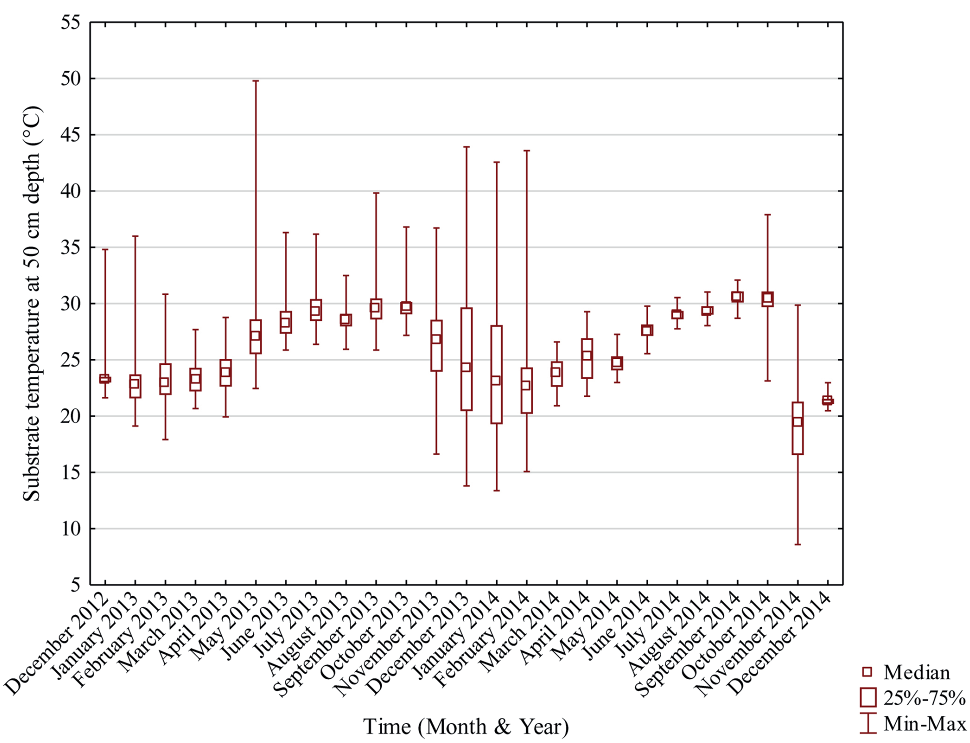

Figure 6. Substrate (sand) temperature fluctuation recorded by device AB at 50 cm of depth in Mouily area during the 2-year period (December 2012 – December 2014).

temperature at 30 cm could go as low as 27.7°C ± 0.03 SE and 27.6°C ± 0.03 SE (Mean ± Standard Error) in June 2014, and as high as 30.5°C ± 0.03 SE in September 2014 (AA and AC, Supplementary Tables S1 and S3). At the same time, mean substrate temperatures at 50 cm depth did not differ from the ones collected at 30 cm and also ranged from the lowest 27.7°C ± 0.03 SE in June 2014 to the highest 30.5°C ± 0.03 SE in September 2014 (AB, Supplementary Table S2).

Nest predation and poaching

Numerous traces of potential predators like African golden wolves (*Canis anthus* [Cuvier, 1820]; n=27), ghost crabs (*Ocypode cursor*; n=2), mole crickets (Gryllotalpidae; n=2) (Fig. 8), and humans (footprint) were recorded around nests or body pits. During our patrols, we recorded numerous sea turtle remains from different species (*C. mydas, C. caretta, D. coriacea,* and *L. olivacea*). These will be reported elsewhere. From five freshly butchered adult *C. mydas* individuals near Iwik locality, two were carrying eggs (L. Hama et al. unpubl. data).

Discussion

Several authors have reported *C. mydas* nests in the Central and Northern areas of the Mauritanian coast (Pasteur & Bons 1960, Maigret 1975, Maigret & Trotignon 1977, Gawler & Agardy 1994, Arvy & Dia 1995, Arvy et al. 1996) but without giving real evidence of direct nest observations in the Southern area. Except for a few nesting sites reported to us by fishermen, our team did not find evidence of sea turtle nests or nesting activities (bodypits) within the PNBA area or its surrounding villages. According to PNBA personnel at Iwik (M. Camara pers. comm.), nesting has not been confirmed in recent years. The lack of such evidence can also be the result of a limited time spent by us or PNBA personnel in suitable places in the PNBA area. *Chelonia mydas* is also known to breed regularly within the Langue de Barbarie National Park, close to the Mauritanian-Senegalese border. Nesting was confirmed in the 1970s and 1980s (Fretey 1990) and again annually (few nests) from 2009 onwards (A. Fall & M. Fall pers. comm.). Our observation of *C. mydas* breeding in the Southern area fills the gap between the aforementioned breeding distributions. This was not entirely unexpected, as Maigret (1983) already mentioned that according to fishermen all marine turtle species known from the region nested here. Interestingly, the beach between 28 and 65 km South of Nouakchott, which harboured the highest nest densities in 2014, also did so in 2015, albeit in lower numbers in the same period of the year. Infrequent nest recordings (only in 2010 and 2011) south of this area might equally be caused by our work largely being done outside the breeding season with a focus on stranded individuals. According to the native inhabitants, 2014 was an exceptional year during which they observed a high number of female turtles visiting the

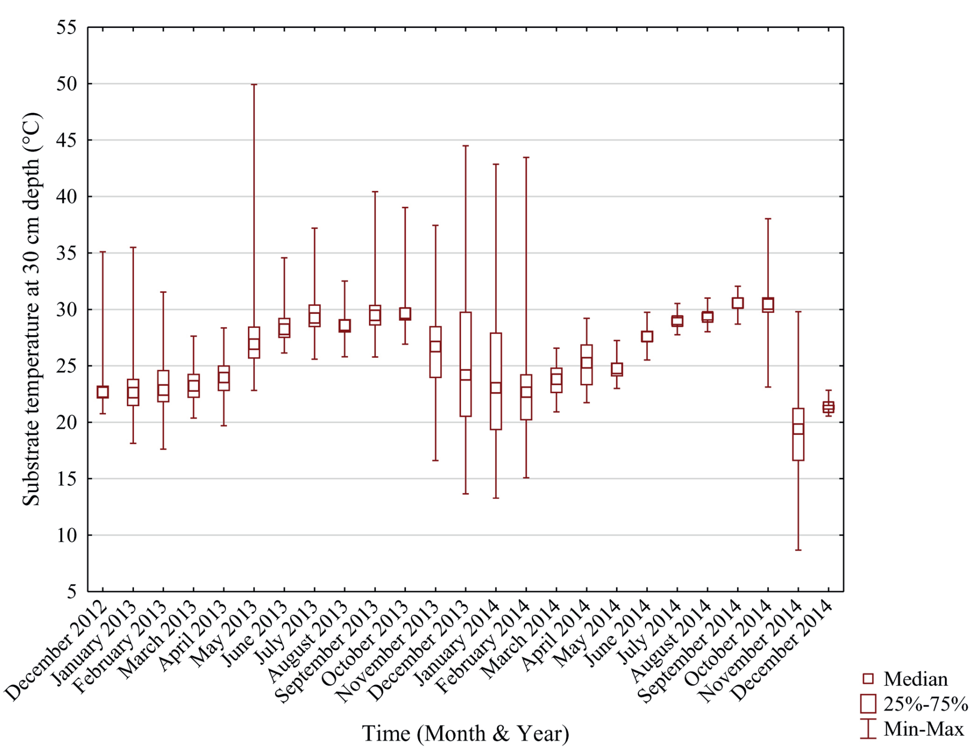

Figure 7. Substrate (sand) temperature fluctuation recorded by device AC at 30 cm of depth in Mouily area during the 2-year period (December 2012 – December 2014).

Figure 8. Example of a rotten egg membrane with a hole made by mole cricket jaws (left picture) and Green turtle nest "visited" by one or a group of African golden wolves and ghost crabs (right picture) (© J. Fretey).

Mauritanian coast. According to our data, the beach between 28 and 65 km South of Nouakchott represents the most important sea turtle nesting site north of the Bijagos Archipelago in Guinea Bissau. Even though there is evidence showing adult *C. mydas* females from Poilão (Bijagos Archipelago) (Godley et al. 2003, Auliya et al. 2012) heading directly to the seagrass areas located in the Banc d'Arguin National Park, we are still not sure of the extent to which adult *C. mydas* turtles, which nest on the Mauritanian coast, interact with *C. mydas* population(s) in the Bijagos Archipelago. Genetic studies are needed to elucidate if these individuals belong to two distinct populations or if there is a possible occasional "nesting site infidelity" of the Guinean female individuals during their time spent within the Mauritanian feeding areas. This is why we wonder if there can be a sympatry without interactions at sea between a migratory adult colony of both sexes belonging to the Guinean-Bissau breeding population and a resident Mauritanian adult colony. Where do thousands of immature *C. mydas* individuals present near the Mauritanian coast originate from? The number of annual nests in Mauritania cannot explain the presence of such a high number of juveniles.

The nesting season of *C. caretta* is between late August and late December. To our knowledge, the only previous report of *C. caretta* nesting activity in Mauritania (Tanit Bay area) dates from the 1990s (Arvy & Dia. 1995). Even though nests were previously observed on the Mauritanian coast (Arvy & Dia 1995, Arvy et al. 2000), we did not find evidence of its nesting activity during the first four years of our nesting survey (i.e. from 2010 to 2015). However, in August of 2015 we identified the first nest. The low number of nests (only one) and traces of nesting activity (only two) indicated that this species' nesting activity is possibly rare and sporadic in the studied area. As in the case of *C. mydas*, infrequent visits during the breeding season and strong winds which erase their tracks may have contributed to the low number of observations. Future monitoring which specifically covers the period between months June and October will allow us to obtain a better overview of *C. caretta* reproductive activities and the importance of the Mauritanian coast for the species' reproduction. The nearest population of *C. caretta* is found at the Cape Verde Archipelago. As for *C. mydas*, the question of interaction with the adult Loggerhead individuals from Cape Verde Archipelago hotspot remains open.

Our team previously recorded the finding of one stranded subadult *D. coriacea* individual 15 km north of Mouily area (Fretey & Mint Hama 2014). However, during our five years of research we did not find evidence of *D. coriacea* nesting activity along the Mauritanian coast suggesting that if they breed at all, it is extremely rare. Maigret (1983) indicated the area south of Cap Timiris as a possible nesting site, but this has never been substantiated. According to the information we gathered from natives inhabiting the Mauritanian coastal area, its nesting season should take place during the rainy season (late June to October).

Predation is a critical threat for many endangered or even locally rare species (Hecht & Nickerson 1999). Our observations along the Mauritanian coast indicate predation activity upon unhatched *C. mydas* eggs. Most of the observed *C. mydas* nests were evidently disturbed (visited) by African golden wolves. Similar predation activity in Tanit Bay area (Mauritanian coast) was previously reported for *C. caretta* (Fretey 2001) but not for *C. mydas* nests. Predation of this kind can have a severe negative impact on hatching success rates and sea turtle reproductive success

(Kadlec 1971, Schroeder 1981, Stancyk 1982, Erk'akan 1993, Mroziak et al. 2000, Engeman et al. 2003, Ellis et al. 2007, Engeman & Smith 2007). Even though our data (from 2014 and 2015) did not give us a precise estimation of destroyed sea turtle nests, it was clear that African golden wolf predation along the Mauritanian coast was frequently present. During our investigation, we located 26 sea turtle body pits with visible evidence of wolf predation (i.e. sand holes and tracks around and on the location of identified sea turtle nests). In most cases, between 10 to 50 dry eggs membranes were found scattered around predated nesting sites (including nests close to emergence). However, without a proper analysis, we can only hypothesize about the real impact of African golden wolf predation on sea turtle nests within the Mauritanian coastal area. Natural predators such as ants, ghost crabs, and foxes may use visual and olfactory clues to find the location of sea turtle nests (Stancyk et al. 1980). However, we do not know the precise way by which wolf detects sea turtle nests in the studied area, especially because sea turtle tracks are usually extremely hard to notice after a few days due to frequent and strong sand storms that occur here. Our observations confirm that ghost crabs and mole crickets also predate on *C. mydas* nests to some extent.

In addition to animal predation, according to our data gathered from the natives, we should also note the presence of human poaching activities on Mauritanian beaches, which is in accordance with our previous observations (Fretey & Mint Hama 2012, Mint Hama et al. 2013). Taking into account the fact that all of the interviewed natives had confessed to eating sea turtle eggs at least once in their life time, there is a clear indication that this kind of activity is common among natives and poses an additional threat to all sea turtle nests located on the Mauritanian coast.

Despite the fact that the accurate technique of nest displacement (or translocation) which includes reburial of eggs within two hours of their collection can decrease the number of turtle hatchlings by ~ 20% (Bustard 1976), it can still be used as an efficient sea turtle conservation method if turtle eggs are: 1) not traumatized, 2) displaced in time (within two hours of their displacement) in a clean way, and 3) translocated to a safe location (Wyneken et al. 1988, Girondot et al. 1990). However, according to Mortimer (1999), this technique should be used only as a last resort due to its potential negative effects, such as possible changes in sex ratio (Godfrey & Mrosovsky 1999) or the reduction of hatching success ratio (Limpus et al. 1979). Additionally, Mrosovsky (2006) has stated that, in the long term, the nest translocation procedure can also distort the genetic pool of the existing sea turtle population. Thus, we used this technique only once in the case of evident *C. mydas* nest endangerment with full respect to the translocation protocol. The translocated *C. mydas* nest was in clear danger of being drowned by tidal waves and/or destroyed by predators after waves exposed its content. The incubation success of this nest was at a satisfactory level (72%) with respect to the potential negative impact of the nest translocation procedure. Additionally, in the context of abovementioned animal predation and poaching, this conservation method has a potential to alleviate nest destruction observed on the Mauritanian coast.

The long Mauritanian beach is probably the only sea turtle nesting site in the world located in the hot Saharan zone. Thus, it is worth noting that during sea turtle embryonic development, environmental factors such as temperature can have a major impact not only on sex determination, but also on growth and overall development of the sea turtle individual (Ackerman 1994, Barrios-Garrido et al. 2006). If substrate (sand) temperatures during this developmental period exceed a certain threshold temperature, which ranges between 28–30°C (depending on the sea turtle species), the probability that all sea turtle eggs in a single nest will develop into female individuals increases. According to Bustard (1967) there is a threshold temperature that stimulates the emergence of *C. mydas* hatchlings from the sand (nest pit) and their subsequent scrambling towards the sea. Our two-year substrate (sand) temperature data gathered using temperature recording devices in the Mouily beach area, where *C. mydas* nests were first identified, were separately analysed. The analysis showed that during the period between August and October, in months that present thermosensitive periods for embryos, the substrate temperatures can range between 30°C and 49.8°C at depths of 30 and 50 cm (Figs 5–7, Supplementary Tables 1–3). Such temperatures can be lethal for the development of sea turtle eggs (Ackerman 1997, Miller 1997). Previous studies have shown that successful incubation of sea turtle eggs occurs within a tight temperature range from 26°C to 33°C (McGehee 1979, Yntema & Mrosovsky 1980, Miller 1985, Miller et al. 2003). However, some authors claim that *C. mydas* eggs can tolerate temperatures up to 35°C but with a lower incubation success ratio (Bustard 1971). Claude Pieau (pers. comm.) told us to that the embryo could still be viable at the temperature of 36°C. The crucial temperature for sex determination of *C. mydas* species in the Western Atlantic is reported to be between 29.2°C and 29.5°C. Our temperature data collected in different substrate (sand) depths (30 cm and 50 cm) during the potential sea turtle nesting period (June–October) show substrate temperatures often close to and occasionally (in the other half of the nesting period; September–October) above 30°C (Figs 5–7). This may suggest that *C. mydas* nests at the Mouily area could be prone to developing female individuals in the second half of the nesting period. However, more substrate (sand) temperature measurements at the nesting site locations are needed to fully elucidate this. Our observations together with the collected temperature data indicate that the nesting period of *C. mydas* and *C. caretta* species should occur between August (July as the earliest possibility) and November. In the overall context of global warming phenomena, it would be interesting to see if the *C. mydas* nesting activity calendar would change with respect to possible changes in the substrate (sand) temperature. At this moment Mauritania is an excellent location to study the future impact of the global warming on sea turtle nests and nesting sites.

Despite the relatively hot substrate temperatures, sometimes reaching ≥ 40°C, throughout the sea turtle nesting period (June–October), ten randomly excavated and analysed *C. mydas* nests showed good embryonic development with an incubation success ratio above 70% in 90% of cases (Table 1). Only one of the analysed nests showed low incubation success ratio (12%) with a relatively low number of eggs (25). However, we must note that our random preliminary *C. mydas* incubation success study is based on a rather small sample size and should be expanded to include a larger portion of identified nests.

Acknowledgments

The authors thank the Marine Turtle Conservation Fund (funded by the US Fish and Wildlife Service), in particular Earl Possardt, and the Federal Government Cooperation (Deutsche Gesellschaft für Internationale Zusammenarbeit; GIZ), a partner in the Biodiversity-Petroleum program in the Islamic Republic of Mauritania, for their financial and logistical support. We would like to thank Frédéric Marret and Florence Dovillez (GIZ employees). The authors thank the employees of the Mauritania Institute of Oceanographic Research and Fisheries (IMROP) and Banc d'Arguin National Park for permission to conduct research within the National Park. We would also like to acknowledge a Non-Government Organization Nafore as our partner from the beginning of this research endeavour for their invaluable logistical support during our field work. We thank the IUCN Office of Mauritania for providing the vehicle and a driver, and Bojan Karaica, Dean Karaica and Makso Herman for their technical support. Special thanks to Aya Ould Sidi Mohamed and his son for their assistance in fieldwork activities conducted within the Diawling National Park.

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Supplementary material

Supplementary Table S1. Substrate temperature data with device AA at 30 cm depth.

Supplementary Table S2. Substrate temperature data with device AB at 50 cm depth.

Supplementary Table S3. Substrate temperature data with device AC at 30 cm depth.