Influence of environmental factors on the hatching success of olive ridley turtles: a preliminary study

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Introduction

Successful egg incubation is an essential component for the continued survival of sea turtles. Nevertheless, eggs are susceptible to a variety of natural and man-made pressures while they are incubating in the sand. One such pressure is disturbance of the eggs due to harvesting. For instance, as a way to balance the needs of the community with protection measures, some sea turtle projects accept a portion of harvested eggs for reburial in hatcheries (e.g. Hasbun and Melara 1994). The general idea is that at least some of the eggs will be protected and will eventually produce hatchlings.

Such a situation exists at Devbag in Karwar of the Uttara Kannada region of Karnataka on the west coast of India. There, the local community harvests sea turtle eggs for consumption. We purchased a proportion of olive ridley turtle eggs (664 eggs) from the community soon after the eggs had been collected, and buried them in open-air hatcheries to produce and release hatchlings. We were also interested in investigating the possible influence of various environmental variables on the hatching success of these relocated eggs, including temperature, nest depth, moisture, and sand type. Although there was no record as to how these eggs were handled prior to their procurement and thus no way of determining if they had been adversely affected by handling, we assumed all had been treated equally, thus any differences we found would be related to incubation treatment, rather than prior handling.

Methods

The study was conducted in Karwar, located in northern Karnataka, consisting of a coastal belt of 32kms (14°48'N, 78°07'E). It is well protected by a series of small to medium sized uninhabited barrier islands in the Arabian Sea. The study beaches - Majali, Devbag, Kodibag and Bhaitkol – are located to the north and south of the Kali River, which divides the main 15 km beach into two long sandy sections. Fishing communities can be found throughout the region.

A hatchery was constructed at Devbag, one of the four study areas. The beach vegetation was chiefly *Casuarina* and *Ipomea pes-caprae*. We purchased freshly collected eggs from the fishing villages and buried them in artificial egg chambers about 45cm deep, in November, December and January. Before and during incubation we measured sand temperature at different times of day at the surface and at nest depth (45 cm) with an alcohol thermometer. We also recorded nest depth, shape, sand texture and sand moisture. Nest shape was recorded by inspection.

Sand texture was recorded both by inspection and through sediment analysis, which included treatment with chemicals and sieving them through sieves of different mesh sizes, where sand, silt and clay get settled at different mesh sizes and finally are weighed to find their proportions. Sediments were analysed from 3 locations, from the hatchery site which had larger sand grains (ST1), from another site where nesting was recorded (ST2), and from close to the High Tide Line (ST3). ST1 was found to be more sandy with little proportions of silt and clay, while ST2 which was closer to the water line had almost equal proportions of sand and silt. Since silt and clay have the property to trap more water than sand, the proportions of silt and clay in any soil indicates the tightness and the strength of water absorbability of the soil. Sand moisture was recorded by comparative inspection of the two locations (ST1 & ST2). At ST1 wet sand could be obtained only after a depth of 30 cm, while at ST2, wet sand could be obtained after a depth of 15 cm. Upon emergence, the species was verified using

standard keys for sea turtle identification. Hatching success was determined by counting all live hatchlings produced by a cavity and dividing that by the total number of eggs originally placed in that cavity. Live hatchlings were kept in captivity for 1 – 3 months, after which they were released.

Results and Discussion

We purchased eggs from villagers in the months of November and December 2001, and January 2002 and their incubation was monitored in all the three months. Overall, hatching success was variable and ranged from 0% (in November) to 39%(in January).

Table 1: Details of eggs relocated in hatchery

Number of eggs	Hatching success (%)	Buried on	Emerged on
25	0	04-11-01	----------
40	15	26-11-01	10-01-02
42	14.5	26-11-01	11-01-02
50	36	12-12-01	27-01-02
19	4.2	23-12-01	11-02-02
109	0	24-12-01	----------
107	39	10-01-02	09-03-02
160	4.3	25-01-02	13-03-02
64	27	30-01-02	09-03-02

Table 2: Range of temperatures recorded in an open-air hatchery for olive ridley eggs in Devbag, Karwar, in 2001/2002.

Month	Surface Temperatures			Temperatures at 45 cm depth recorded at 6 AM, 1 PM, 6 PM
	6am	1pm	6pm	
November	31 – 38 °C	40 – 50 °C	32 – 33 °C	32 – 33 °C
December	31 – 36 °C	42 – 46 °C	35 – 36 °C	30 – 32 °C
January	33 – 35 °C	44 – 49 °C	39 – 41 °C	29 – 31 °C

Sand temperatures were more variable at the surface than at nest depth (45 cm), when measured in the morning, afternoon, and evening (Table 2). Temperatures at nest depth of 45cms were between 30 and 32°C. Previous studies on olive ridley turtles in Gahirmatha, India, indicate that incubation temperatures of > 30°C produce only females (Mohanty-Hejmadi and Dimond 1986).

Sand temperatures at depths less than 30 cm exhibited wide daily variations sometimes reaching 50°C (A. Kurian, unpubl. data) which is lethal for sea turtle hatchlings (Drake and Spotila, 2002). At 45 cm, these variations were far less, staying consistent between 30°C and 32°C (in December) and between 29°C and 31°C (in January). Later in the season (early February), we measured a natural olive ridley nest cavity that reached a maximum depth of 60 cm, which is consistent with some previously published studies (Silas *et al*. 1984). Other authors have reported that olive ridley nest depth can vary from 45-50 cm (Silas *et al*. 1984), or 55 cm (Firdous 1985). A few observations in February indicated that temperatures at this depth during different times of the day showed very little variation (29°C – 30°C) when compared to the temperature at 45 cm. Nest cavities in the hatchery were less urn-shaped than natural nests. The depth and shape of the nest cavity in the hatchery was likely to have been important in hatching success. This meant that eggs were not concentrated together in one large mass, but were more evenly spaced along a more or less straight column in the sand. This probably contributed to a reduced hatching success in the hatchery .

Sand texture in the hatchery was coarser and had bigger grain size than in natural nesting areas. Sand that is too coarse can result in reduced hatching success (Mortimer 1982). The relationship between sand type, water content, oxygen potential, and hatching success is complex (Ackerman *et al*. 1985). We discovered after the nesting season had begun that the hatchery was located in an area where an old road used to be. Thus, there was a large stony surface about 60 cm below the surface of the sand, which may have interfered with natural oxygen partial pressures and water tension of the sand. All

these factors may have contributed to the low hatching success in the hatchery. We suggest that future attempts at using hatcheries in the region should try to emulate natural nesting areas as much as possible.

Sand moisture may also have had an influence on hatching success. Preliminary results suggest that there was a difference in hatching success rates between eggs buried closer to the high tide line (15 m) and eggs buried further away from the high tide line (A. Kurian, unpubl. data). We recommend placing a hatchery as close as possible to the high tide line (without risking inundation), in order to benefit from the high moisture content of the sand. Interestingly, Kar and Dash (1984) reported that a plantation of *Casuarina* close to marine turtle nesting beaches contributed to the decline of the nesting populations over a period of time. This was because the plantations not only reduced the space available for the turtles to nest but also their root system and leaf litter negatively influenced the moisture and temperature of the sand. Therefore, we also recommend that hatcheries be placed away from concentrations of *Casuarina* trees.

After being reared in captivity for 1-3 months, hatchlings were released in the sea. Initially some hatchlings were allowed to crawl on the beach to the sea, but since they showed disorientation, they were carried to the water and released. Hatchlings released during night were drawn out of the sea due to the presence of torches or bonfires on the beach. Hatchlings released during daylight were never disoriented or drawn out of the sea. Thus, the time spent in captivity did not diminish the turtles' sensitivity to lights.

The current study focused on the possible environmental impacts on hatching success of olive ridley eggs in Karwar, as a means to minimize their negative effects. There are other pressures facing sea turtles in this region, and these threats also need to be addressed.

Threats

In this area, turtles are harvested for their eggs and meat during the nesting season between October and April. Turtles are also accidentally caught in gill nets during fishing. Although gear like purse seine and trawl nets are used in fishing, there is no evidence of turtles being caught in them.

Development activities along the coast may hinder sea turtles from nesting. These activities include sand mining, placing of rock revetments on the beachfront, construction and operation of beach resorts and fishing harbours in Karwar.

Increased pollution from nearby urban areas probably contributes to the reduced health of local sea turtles. In one instance, we noticed a large swelling on the head of an adult olive ridley. Continued vigilance concerning disease and sickness is required in the area.

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Status of marine turtles in Maharashtra, India

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Introduction

Studies on sea turtles in India have mainly focused on the east coast and very little information is available on their occurrence and nesting sites for the west coast. The occurrence of three species of marine turtles viz., hawksbill, green Turtle and Loggerhead has been reported in Maharashtra waters (Daniel 1976). Later Shaikh (1983), Bhaskar (1984) and Das (1985) recorded the presence of olive ridleys. According to Gole (1997), olive ridleys are known to nest all along the coast, while green turtles nest sporadically in Maharashtra. The poaching of the eggs by humans, incidental drowning in the fishing nets and developmental activities are the main threat to marine turtles along this coast.

Study Area

The coastline of Maharashtra extends from the border with Gujarat to the north to the border with Goa to the south and stretches about 720 km. A total of five coastal districts viz., Sindhudurg, Ratnagiri, Raigad, Thane and the urban area of Mumbai share the coast line of Maharashtra (Gole 1997). The main occupation of majority of the coastal population is fishing.

Methods

In the present survey, 60 localities were surveyed to assess the status of marine turtles along the coast of Maharashtra covering all the five districts. The field survey was carried out from March 2000 to April 2001. In addition to the field survey, secondary information was also collected from different sources, such as local coastal villagers, fishers, trawler owners and workers, fisheries and forest Departments and local non-governmental organizations. Landing sites were also visited and information on incidental catch was recorded from trawler owners and workers. Additionally, press releases on sea turtles were given in local newspapers. Schools and colleges located in the coastal villages or towns were also visited. Information was collected by distributing reply-paid postcards in some areas, either during the survey or as a follow-up of the surveys. The surveys were carried out in two phases. A preliminary survey was carried out along the coast of Maharashtra from 13 – 31 May, 2000 and 29 localities were visited during this survey. The second survey was site specific, and the selection of sites was based on the data collected during the first survey. This survey was carried out from 4-22 December 2000. During this survey 43 localities were visited (Table 1).