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OCCURRENCE OF OLIVE RIDLEY (*LEPIDOCHELYS OLIVACEA*) SOLITARY NESTS AND THEIR FUTURE CONSERVATION IMPLICATIONS IN GAHIRMATHA ROOKERY, ODISHA, INDIA

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ABSTRACT

The current study on olive ridley turtles was undertaken from 2007 to 2010 in Gahirmatha rookery of Odisha coast especially during their breeding season. Entire period of study the solitary nest and their predation and erosion level were studied in Islands as well as mainland beach. All successful nests were taken to nearest beat and translocated into temporary made hatchery. Total 3,046 solitary nests had been encountered in three years period of study. Out of 3,046 only 294 were translocated in hatchery and remaining nest were destroyed by predation, erosion and inundation in the field itself. The mean hatching success rate was 54.7% in three years of study. As soon as turtles start laying upon the nest; they become vulnerable to predation.

Key words : Olive ridley turtle, *Lepidochelys olivacea*, solitary nest, hatchery, hatching success, conservation, depredation.

Introduction

Sea turtles are known to occupy a series of different habitats in their life time, which are broadly categorized in to the terrestrial habitat of the nesting females, the pelagic and oceanic habitat of the immediate post hatchlings. The developmental habitat in which juveniles feed and grow, the adult foraging habitat and the off-shore nesting beach habitat occupied by adults during the breeding season (Musick and Limpus, 1997). The habitat that is of interest here is the terrestrial habitat of the nesting females. Being reptiles, sea turtles need to come on land to lay eggs and for which they must have access to beaches with deep, loose sand that are above the high tide (Hendrickson, 1982). Turtles arrive on the Odisha coast during early November and remain in the near shore waters for more than six months forming breeding congregations. The breeding season for olive ridley in Odisha spreads from November to April during which mating, egg-laying and hatching take place (Dash and Kar, 1990; Pandav and Choudhury, 2000; Behera *et al*., 2010). Conservation of sea turtles include management of nesting beaches, nest translocation to protected hatcheries, head starting, reduction or elimination of natural predators, and protection against poaching and fishing (Bjorndal, 1995; Ehrenfeld, 1995). The protection of nesting beaches and nests is considered part of a broader sea turtle conservation strategy, where mortality factors at other stages of the life cycle have to be addressed (Frazer, 1992; Spotila *et al*., 2000). The protection of nesting beaches and the nest translocation to enclosed hatcheries has been widely implemented (INP, 1990; Pritchard *et al*., 1993; Cornelius, 1995; Chan and Liew, 1995; Pritchard, 1995; Tow and Moll, 1995).

Several studies have been conducted on the nesting of olive ridleys along the Odisha coast basically in Gahirmatha (Bustard and Kar, 1981; Silas and Rajagopalan, 1984; Dash and Kar, 1990; Pandav and Choudhury, 2000, Shanker *et al*., 2004). The nesting of olive ridley turtles was monitored at Gahirmatha by Chandrasekhar Kar from 1976 to 1984 (Dash and Kar, 1990) and then Bivash Pandav from 1993 to 1999 (Pandav, 2000). All literature says mostly mass nesting estimation and population of olive ridleys in Gahirmatha. Literature in solitary nesting of olive ridley is scanty and anecdotal. In spite of its biological importance, solitary nesting has never been evaluated adequately in many important nesting rookeries (Castro, 1986). Although some information is available on solitary nesting of *L. olivacea* at Gahirmatha, Devi and Rushikulya Rookery (Pandav, 2000; Tripathy, 2008), since the discovery of Gahirmatha rookery the mass nesting has been recorded by Odisha Forest Department, However, it was not adequately evaluated. In this context we evaluated the solitary nesting all along the 35km coast and their future conservation implications of Gahirmatha rookery.

The intensive beach monitoring is a valuable conservation strategy of sea turtle nesting beaches, aimed to reduce both human and nature induced nests losses.

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Currently the olive ridley sea turtle has been listed is vulnerable by the IUCN Red List (Abreu-Grobois and Plotkin, 2008) and as per CITES it is prohibited for trade of any kind and also is included in the schedule I of Indian Wildlife (Protection) Act (1972) and is legally protected, however in recent decade the Department has unable to record solitary nest and predation rate precisely. The solitary nest has more capable success rate than compare to *arribada* nester (Eckrich and Owens, 1995).

Material and Method

Study area: Gahirmatha is an only marine wildlife sanctuary in Odisha which is situated in north-eastern site of Odisha coast (Fig. 1). The Gahirmatha Marine Wildlife Sanctuary encompasses an area of 1435 km², 1408 km² of which are coastal waters while rest constitute mangrove forests, mudflats and sand spits. However, 35 km of nesting rookery extends from the Dhamra river mouth to Barunei river mouth that also forms the eastern boundary of the Bhitarkanika National Park (N 20° 52 to 20° 72 N and E 80° 77 to 87° 05 E) (Fig. 1). The entire 35 Kilometre of Gahirmatha rookery was divided into five segments to monitor the systematic coverage of all sites for presence of solitary nest during 2007-2008, 2008-2009 and 2009-2010. In this connection solitary or sporadic nesting data was being collected in turtle breeding season which was started from November to May for three consecutive years. The study area encompasses three mainland beach and two Islets respectively, the mainland are Barunei to Chinchiri, Chinchiri to Satabhaya and Satabhaya to Ekakula Nasi and Nasi-I and South beach are Islets (South-Western part of Wheeler Island). The Barunei to Chinchiri is 7km, Chinchiri to Satabhaya is 11km, Satabhaya to Ekakula Nasi is 14 km, Nasi-I is 2 km and South beach is 1 km in length and nesting beach monitoring was carried out all along 35km length of Gahirmatha rookery. Daily four hour the entire segments was surveyed to collect the data on solitary or sporadic nesting. Additions the other potential factor along with nesting data, the inundation, erosion and predation on nest sites were recorded. The nest monitoring was executed during night time also. The successful nests remain left in the beach were collected and translocated near forest beat for *ex-situ* conservation in hatchery. Nests were located by following nesting crawls. Successful nest and false crawling data were recorded in the nesting beach during the survey period (Pandav and Choudhury, 2000). The status of nests were enumerated, whether it's good in condition or depredated by someone. At each predated nest, the species of predator was determined from footprints and faeces (Macdonald and Barrett, 1993). Observation was considered as direct sighting as well as evidences of foot prints near the degraded nests. Determination of clutch size, emergence success and hatching success provides information fundamental to the conservation and management of sea turtle (Miller, 1999). The hatching success rate of translocated nest was enumerated. Hatching success was calculated by method as suggested by Miller (1999).

Results

The study comprised of 21 months of fieldwork and 630 daily beach surveys on solitary nesting of

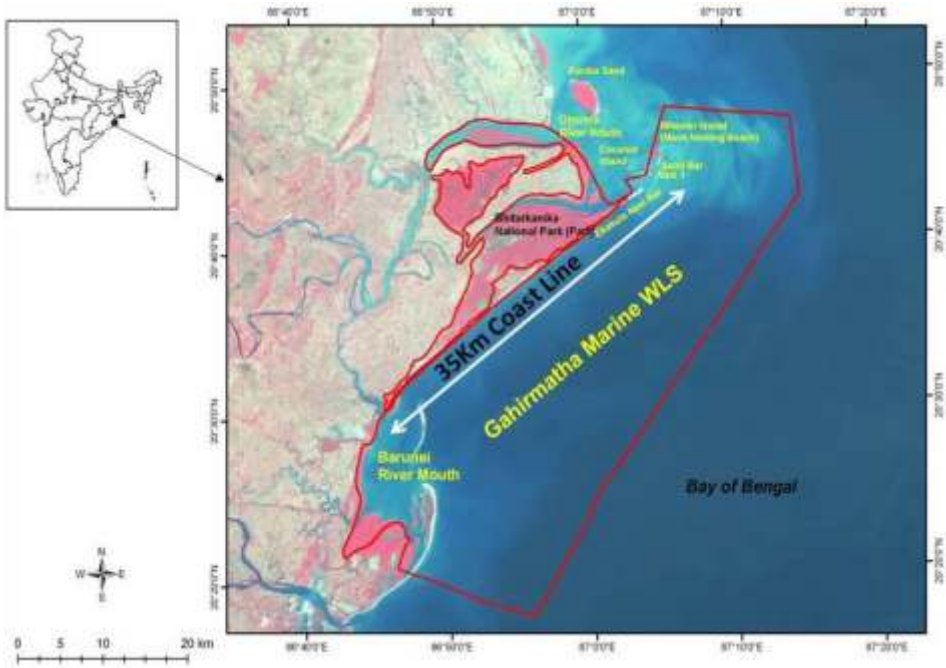

Fig. 1 : Gahirmatha Rookery extends 35 Km of Coast Line along the Odisha Coast.

Lepidochelys olivacea in Gahirmatha rookery. Altogether, 3046 nests were counted and 4981 non-nesting crawls recorded. Only 294 fresh successful nests were translocated near hatchery. The 32,340 successful hatchlings released in Gahirmatha from solitary nests in total three years period of study. The mean hatching success rate was 54.7 (S.D. = 23.8) calculated from successful 294 laid nests during breeding season of three years. The remaining 2752 nest got destroyed by inundation and predation (Table 1). However, highest tidal inundation was observed in Nasi-I (89.2%) and South beach (80%) whereas high predation was took place in Barunei-Chinchiri (79.5%) followed by other nesting segments. Inundation and predation was wide spread throughout the study area and peak level observed during 2007-2008 breeding season followed by other seasons. The frequency of laid nests during the breeding season (November-May) showed a peak of 70% nest laid in month of March (Fig. 2).

Mean number of nests estimated in 35 km study site for 21 months was 145/month (S.D. = 93.3), with the peak in March (mean = 555.3, S.D. = 298) and least in November (mean = 3.3, S.D. = 3), respectively. The comparison of nest/km in five nesting stretch are given in all along 35km coast Fig. 3. The lowest number of nest recorded Km^{-1} were in Satabhaya-Ekakula and Chinchiri-Satabhaya, however highest recorded nest in both islands followed by Chinchiri to Barunei mainland beach.

The nest located within 2m from High tide line was inundated by sea water, that nest counted as inundated nest and nest placed near vegetation line were depredated by predators like wild Pig (*Sus scrofa*), Hyenas (*Hyaena hyaena*), Jackal (*Canis aureus*), Water monitor lizard (*Varanus salvator*), stray dogs *(Canis familiaris)*. The partial predations of nest were re-predated by ghost crabs (*Ocypode* sps) and sea gulls observed. The major predators like wild pig, feral dog, jackal, hyena, monitor lizard were observed from direct and indirect evidences.

Intensive beach patrolling

Intense beach patrolling and nest translocation was an effective way to reduce nests losses in Gahirmatha. Altogether, the outcome of such efforts was the release of 32,340 hatchlings from 294 solitary nests. The number of protected nests showed an impressive recovery from 157 nests in 2007-2008, 90 nests in 2008-2009 and 47 nests in 2009-2010 breeding season (Fig. 4).

Effects of nest translocation

An important part of the success of programme was the translocation of nest to a forest beat to avoid nests losses by beach erosion and predation. The translocated eggs were kept in temporary made hatchery at near forest beat though there had no sophisticate hatchery facility. The results indicate that nest reburial technique may have few negative effects on hatching success rate (Eckert and Eckert, 1990; Marquez 1990; Cornelius *et al*., 1991; Pritchard *et al*., 1993; Bjorndal, 1995). Survival in removed nests was, however, much

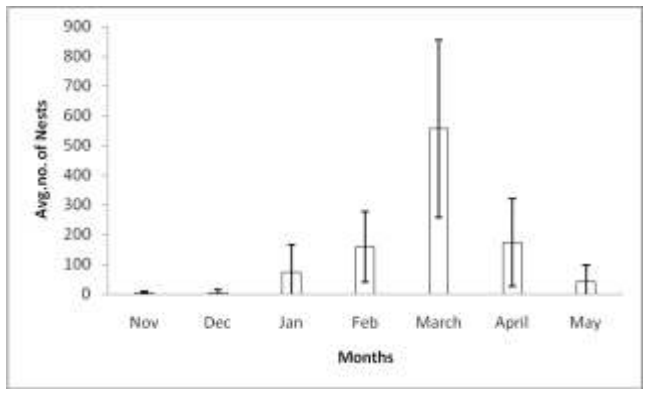

Fig. 2 : Annual nesting pattern of Olive ridleys (Lepidochelys olivacea) at Gahirmatha beach, from 2007-2008 to 2009-2010. A total of 3046 nests were counted, averaging 145 (S.D. 93.3) nests per month.

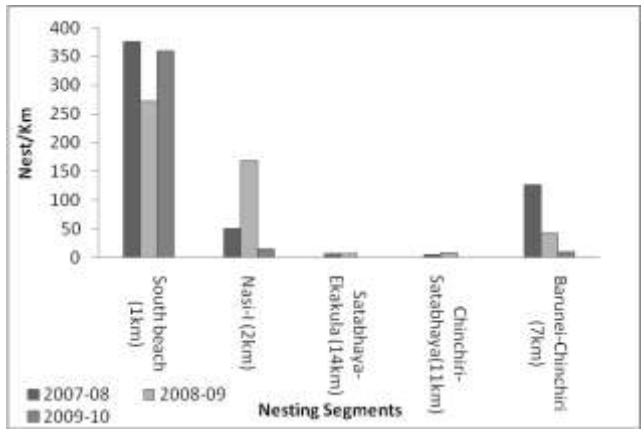

Fig. 3 : Relative importance (N/km) of the solitary nest laid by Olive ridleys (*Lepidochelys olivacea*) in Gahirmatha rookery from 2007-2008 to 2009-2010.

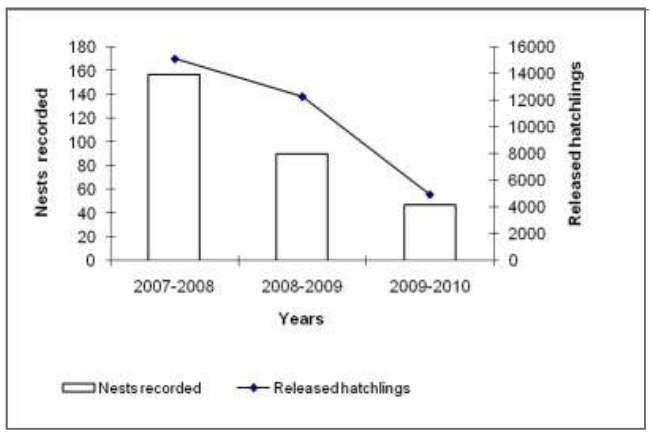

Fig. 4 : Recorded nests (bars) and released hatchlings (line) of Olive ridleys (*Lepidochelys olivacea*) at Gahirmatha rookery, from 2007-2008 to 2009-2010.

higher that *in-situ* nests, because of predation and beach erosion (Garcia *et al*., 2003). Here we have checked only the solitary translocated nest hatching success rate, so it needs to study the success rate in *in-situ*. All nests except one were carried through plastic gunny bag to near beat house. The hatching success rate in temporary made hatchery was 54.7 % (S.D. = 23.8) calculated in successful 294 translocated nests. However, our result showed significantly similar with that of Mexico (Garcia *et al*., 2003).

Discussion

Solitary nesting emergence of *L. olivacea* is known to occur almost every month along the Gahirmatha coast (Dash and Kar, 1990). However, it is greater numbers during January to May, indicating that this is the main nesting season for this species (Pandav and Choudhury, 2000). The result indicated the solitary nest number increases from January and peak in March and followed by decreases in April and May. However, the month of May was appeared to be less number of nesting has been recorded all along the coast across the three years period of survey. The satellite telemetry study revealed the turtle left Odisha coast by the last week of May or first week of June (Shanker *et al*., 2002; Unpublished DGH Final Report, WII, 2011), this may be additional reason behind the low intensity of nesting during month of May all along the Odisha Coast.

During 2007-2008 breeding season the mass nesting did not take place in Gahirmatha, the high sporadic nesting observed in subsequent period and subsequently extended over all nesting segments (Annual Report, WII, 2010). Initially, Cornelius (1982) considered all non-*arribada* nesters to be solitary nesters (Cornelius and Robinson, 1982). Yet just prior to and immediately after an *arribada*, the number of nesters gradually increases from and then returns to solitary or sporadic numbers. These solitary nesters reproductively highly effective and their nest need to be protected in conservation importance for future. Nesting of Olive ridley turtles appears to be evenly distributed throughout the nesting area and all segments in Gahirmatha rookery. However, the intensity of nesting had low in Chinchiri-Satabhaya and Satabhaya-Ekakula Nasi possibly because of heavy anthropogenic disturbances and high predator risk along these segments. The nesting olive ridley was observed directly attack by wild pig (*Sus scrofa*), when they are on approaching to beach for nesting during night time (Personal observation). The olive ridley in this study exhibited preference to lay their nests in locations with no vegetation cover which has previously been observed in Green turtles at Tortuguero, Costa Rica (Bjorndal and Bolten, 1992), therefore it may easy to be locate the nest by predators. Mrosovsky (1983) in his study also found, the ridley turtles nest closer to the sea were mostly inundated by sea water. Several Olive ridley clutches laid below the high-water mark were covered by subsequent high tides in northern Australia (Whiting *et al*., 2007). Chronic erosion, as opposed to acute storm-generated erosion may destroy some nests placed low on the beach, but these losses are frequently overestimated.

Rajasekhar and Subba Rao (1988) reported that most nests are dug up by humans (55%) and animals (45%) in Andhra Pradesh, While Tripathy *et al*. (2003) reported that almost all solitary nests were destroyed in Andhra Pradesh coast, mostly by animals. The Wild pigs and feral dogs destroyed most of the nest and humans

Table 1 : Solitary nesting record, inundation, predation and percentage of nest survival in stretch wise during three years of study at Gahirmatha Rookery.

Year	Site	Total nest	Erosion & Inundation (%)	Predation (%)	Nest survival (%)
2007-08	South beach (1km)	375	300 (80)	54 (14.4)	21 (5.6)
2008-09	South beach (1km)	272	192(70.5)	66(24.2)	14(5.1)
2009-10	South beach (1km)	360	287(79.7)	45(12.5)	28(7.8)
2007-08	Nasi-I (2km)	101	72(71.2)	20(19.8)	9(8.9)
2008-09	Nasi-I (2km)	336	300(89.2)	19(5.6)	17(5.1)
2009-10	Nasi-I (2km)	29	23(79.3)	6(20.6)	0(0.0)
2007-08	Satabhaya-Ekakula (14km)	86	10(11.6)	73(84.8)	3(3.5)
2008-09	Satabhaya-Ekakula (14km)	84	6(7.1)	77(91.6)	1(1.2)
2009-10	Satabhaya-Ekakula (14km)	9	0(0)	9(0)	0(0.0)
2007-08	Chinchiri-Satabhaya (11km)	62	5(8)	50(80.6)	7(11.3)
2008-09	Chinchiri-Satabhaya (11km)	95	6(6.3)	78(82.1)	11(11.6)
2009-10	Chinchiri-Satabhaya (11km)	2	0(0)	2(0)	0(0.0)
2007-08	Barunei-Chinchiri (7km)	880	63(7.1)	700(79.5)	117(13.3)
2008-09	Barunei-Chinchiri (7km)	290	45(15.5)	198(68.2)	47(16.2)
2009-10	Barunei-Chinchiri (7km)	65	7(10.7)	39(60)	19(29.2)

consumption of Olive ridley eggs in the Andaman Islands (Andrews *et al*., 2001). Most of the solitary nests were damaged by inundation and some were found to be destroyed by predators. Predation is also a major cause of sea turtle nests losses in many beaches of the World (Flower, 1979; Cornelius, 1986; Marquez, 1990; Cornelius *et al*., 1991; Stancyk, 1995). An important part of this study was the translocation of nest to an enclosed hatchery near forest beat to avoid nests losses by beach erosion and predation as frequent tidal influx after nesting season (Dash and Kar, 1990).

Nest translocation to an enclosed hatchery may be used in beaches where natural causes of nest losses are common (Parmenter, 1980; Ehrenfeld, 1995; Grand and Beissinger, 1997). Nest translocation is an important conservation tool on beaches where natural hatching is low or non-existent due to poaching, predation and erosion. Nests should only be translocated if they are low enough on the beach to be washed daily by tides or if they are situated in well documented high risk areas that routinely experience serious erosion and egg loss. The translocation of eggs should be considered only as a last resort and only when high egg mortality has been demonstrated and is certain (Witherington, 1999).

Sporadic nests contribute equally to the population recruitment as that of arribada nesters being hatching success is higher for the later (Castro, 1986; Tripathy *et al*., 2003). Due to heavy anthropogenic and predator pressure occurs in Madras coastline, local conservationists relocate eggs to a projected area or hatchery (Shanker, 2003). This study indicated the averagely 35% of nest has been damaged by erosion and inundation and 43% of nests destroyed through predators pressure. 30% of the nests in loss Playa Nancite and Ostional, Costa Rica was reported (Cornelius, 1986; Cornelius *et al*., 1991) and 60% of *Dermochelys coriacea* nests in the Virgin Islands (Eckert, 1987; Eckert and Eckert, 1990). Recent study looking at the incubation microenvironment of *arribada* nests moved to a hatchery and incubated in clean sand (ex-situ) exhibited a hatching rate significantly higher than nests incubated in situ (Clusella-Trullas and Paladino, 2007). The same nest translocation practice has been successfully accomplished in Mexico (Garcia *et al*., 2003). Therefore, along with protection of arribada nesters, it is necessary to monitor the beach and safeguard the sporadic nesters and their habitat at Gahirmatha rookery for future conservation as well.

Conservation Implications

The Gahirmatha sea turtle rookery needs constant monitoring during the breeding season to determine the intensity of sea turtle nesting based on which detailed management programmes can be laid out. This current study reinforces that beach protection is a priority strategy for sea turtle conservation (Alvarado and Figueroa, 1992; Ratnaswamy and Warren, 1998; Wang and Cheng, 1999; Garcia *et al*., 2003). The beach erosion, inundation and predation were natural causes of severe nest loss. Even direct sighting observed that the freshly egg-laying olive ridley has been attacked by wild pig in between Satabhaya and Ekakula nesting segments. Therefore weir mesh should be barricaded near the vegetation line to avoid intrude predator like wild pig, jackal and hyenas in to nesting beach. During 1976 the Government of Orissa had made Gahirmatha Marine Turtle Research Centre (GMTRC) at Habalikhati and started incubating the clutch in hatchery, now that centre is absolutely destroyed, so new hatchery needs to be constructed for future translocation of nest.

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गहिरमाथा रूकेरी, ओडिशा, भारत में ओलिव रिडले (*लीपिडोकीलीस ओलिवेसीया*) एकल घोंसलों की प्राप्ति और इनकी भावी संरक्षण जटिलताएं

सत्यरंजन बहेरा, के. शिवकुमार, बी.सी. चौधुरी, बी. त्रिपाठी एवं सी.एस. कार

सारांश

वर्तमान अध्ययन ओडिशा तट के गरिरमाथा रूकेरी में 2007 से 2010 तक ओलिव रिडले कछुओं पर विशेषकर इनके प्रजनन काल के दौरान किया गया। अध्ययन की सम्पूर्ण अवधि में द्वीप समूहों साथ ही साथ मुख्यभूमि समुद्रतट पर एकल घोसलों और इनके परभक्षण एवं अपरदन स्तर का अध्ययन किया गया। सभी सफल घोसलों को समीपवर्ती बीट में ले जाया गया और अस्थाई रूप से तैयार की गई अंडज उत्पत्तिशाला में स्थानान्तरित किया गया। अध्ययन की तीन साल की अवधि में कुल 3,046 एकल घोसलों को देखा गया। 3,046 घोसलों में से केवल 294 को अंडज उत्पत्तिशाला में स्थानान्तरित किया गया और शेष घोसले क्षेत्र में ही परभक्षण, अपरदन और बाढ़ से क्षतिग्रस्त हो गए। अध्ययन के तीन सालों में औसत हैचिंग सफलता दर 54.7% थी। जैसे ही कछुवे घोसले में अण्डे दे देते हैं ये परभक्षण के प्रति असुरक्षित हो जाते हैं।

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