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BEACH FIDELITY AND INTERNESTING MOVEMENTS OF OLIVE RIDLEY TURTLES (*LEPIDOCHELYS OLIVACEA*) AT RUSHIKULYA, INDIA

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***Abstract.*—We studied the beach fidelity of Olive Ridley Turtles (*Lepidochelys olivacea*) for three seasons at the Rushikulya rookery on the coast of Orissa in India between December and May (2003-2005). We monitored sporadic nesting and arribadas for tagged turtles. Multiple nesting by individual turtles and recapture of tagged turtles confirmed beach fidelity in Olive Ridley Turtles. The inter-nesting intervals ranged from 20-25 d and remigration intervals varied between 1-8 yr. There was an inter-seasonal shift in movement of Olive Ridley Turtles from Rushikulya rookery. It is possible that beach exchange is part of a complex phenomenon that Olive Ridley Turtles use to colonize new areas or even move to another beach altogether.**

Key Words.* —India; internesting movement; Olive Ridley Turtle; Orissa; Rushikulya; site fidelity***

INTRODUCTION

Sea turtles migrate between their foraging areas and nesting sites with a high degree of accuracy (Limpus et al. 1984, 1992). Genetic studies show that breeding sea turtles return to their region of birth and tend to re-nest in relatively close proximity to natal beaches (Gyruis and Limpus 1988; Bowen et al. 1992). During subsequent nesting attempts within a season, a small percentage of female turtles utilizes more distant nesting sites within a few hundred kilometers from their earlier egg laying site (Bjorndal et al. 1985; Limpus et al. 1992). Results of tag recapture studies on Olive Ridley Turtles (*Lepidochelys olivacea*; Dash and Kar 1990; Pandav and Choudhury 2000) of Gahirmatha in India, Green Turtles (*Chelonia mydas*; Bosc and Le Gall 1986) of Tromelin Island in the Indian Ocean, and on Leatherback Turtles (*Dermochelys coriacea*; Chaves et al. 1996) of Playa Langosta, Costa Rica suggest that these turtles exhibit strong site fidelity to their nesting beaches.

Unlike most marine turtles that migrate among their breeding ground and foraging areas, Olive Ridley Turtles resemble nomadic migrants that swim hundreds of thousands of kilometers over vast oceanic stretches (Plotkin 1994; Plotkin et al. 1994, 1995). Knowledge of Olive Ridley Turtle migrations is fragmentary throughout most of the species' range. Along the northern Indian Ocean, Olive Ridley Turtles migrate to the Indian coast each winter (i.e., in October/November) to "breed" and nest on suitable beaches. However, the *en-masse* nesting occurs at three major rookeries on the Orissa coast in India. The Olive Ridley Turtle is well known for its mass nesting aggregation or arribadas (i.e., a Spanish word meaning mass arrival). The three rookeries at Gahirmatha, Devi, and Rushikulya in India support major portions of the world's Olive Ridley Turtle population (Pandav and Choudhury 2000). The recently discovered rookery at Rushikulya lies along the Orissa coast (Pandav et al. 1994). Arribadas have occurred here since 1994, although the estimated number of turtles fluctuates greatly and no accurate figures are currently available (Pandav 2000; Tripathy 2005).

Male and female Olive Ridley Turtles along the Orissa coast exhibit fidelity to breeding and nesting grounds (Dash and Kar 1990; Pandav et al. 2000). Females move between rookeries in Orissa, both within and between seasons (Pandav and Choudhury 2000). Sparse or anecdotal evidence suggests that females migrate and perform inter-rookery movements during the breeding and nesting season along Orissa coast (Pandav and Choudhury 2006). Hence, additional knowledge of the locations and temporal use of Orissa's nesting grounds by Olive Ridley Turtles will help us evaluate the extent of habitat loss and large-scale mortality of turtles in the offshore waters.

The traditional method of studying turtle migration is to tag the females on their flippers while they are nesting and record where these tagged turtles are subsequently recaptured (Chavez 1969). Multiple recaptures during nesting documents the migratory capability of sea turtles and nesting site fidelity. The present study adopts this method to examine the spatio-temporal spread of the nesting turtles along the Orissa coast (Fig. 1). We evaluated reproductive homing and inter-rookery movements of Olive Ridley Turtles at the Rushikulya rookery of Orissa, India for three nesting seasons; from 2002-03 to 2004-05.

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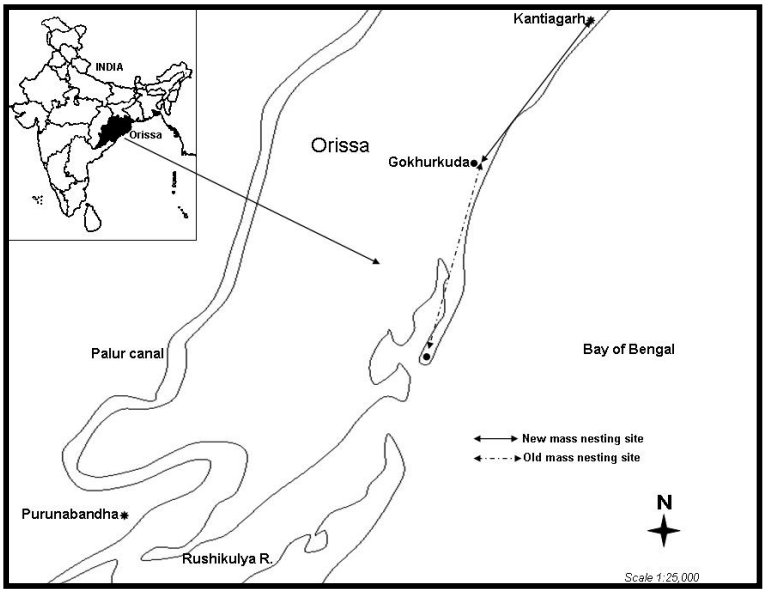

FIGURE 1. Map of the Rushikulya Olive Ridley Turtle (*Lepidochelys olivacea*) rookery along the Orissa coast of India.

MATERIALS AND METHODS

Study site.—We conducted fieldwork at the Rushikulya rookery on the Orissa coast of India. The beach is a 6 km sand spit along the northern side of the Rushikulya River mouth (Fig. 1) found 320 km south of the Gahirmatha rookery (19º 22' N 85º 02'E).

Beach monitoring for tag recapture.—We tagged females from 1995 to 2002 on both of the front flippers using monel tags (National Band and Tag Co., Newport, Kentucky, USA) marked "WG/WR & serial number" and a return address – "WII, PB 18, Dehradun 248001, India" on the reverse side (Pandav and Choudhury 2000). We conducted similar tagging programs contemporarily at Devi, Gahirmatha, and on three selected locations along the Orissa coast (Fig. 2). Volunteers from local villages collected the recapture data on tagged turtles from the nesting seasons (December to May) of 2002-03 to 2004-05. Each night, volunteers conducted hourly patrols. When they encountered a turtle they recorded data on tag number, date, location, and nature of nesting (arribada/solitary). We subsequently compared the tag information with the original tag data records compiled by the Wildlife Institute of India (WII).

RESULTS

During beach monitoring for three nesting seasons (2002-03 to 2004-05), we recaptured 1,070 tagged turtles during arribadas. We recaptured 609, 318, and 143 tagged turtles during the 2002-03, 2003-04 and 2004-05 seasons, respectively (Table 1). Of the 3,080 turtles tagged during arribadas and solitary nesting between 1996-1999, and 1,331 tagged in 2002, only 1,070 (24.3%) female turtles were recaptured during the study; 988 (92.3%) in arribadas and 82 (7.7%) as solitary nesters.

Of the 988 tags recaptured during arribadas, 88.7 % nested at least once on the beach during the same year. A total of 9.7% nested twice in the same season at the rookery and 1.47 % turtles nested three times within a season (Table 2). The inter-nesting period within a season ranged from 20 to 25 days (22.09 $\pm$ 0.58, n = 32). We observed only one turtle (tag number WR 25013L, 25014R; replaced with 33233 in 2002) that ascended onto the beach four times in the same season; it nested on two of these occasions. We tagged this turtle on 02 February 1997 and on two earlier occasions: Pandav (unpubl. data) recaptured it at this rookery on 13 March 1999 and then on 24 March 2002. Among year recaptures (2003-2005) occurred four times. A total of 90 turtles nested in at least two consecutive years. This led us to calculate remigration intervals of 11 months, 21 days to 8 years, 12 days.

During the study period, the beach profile was

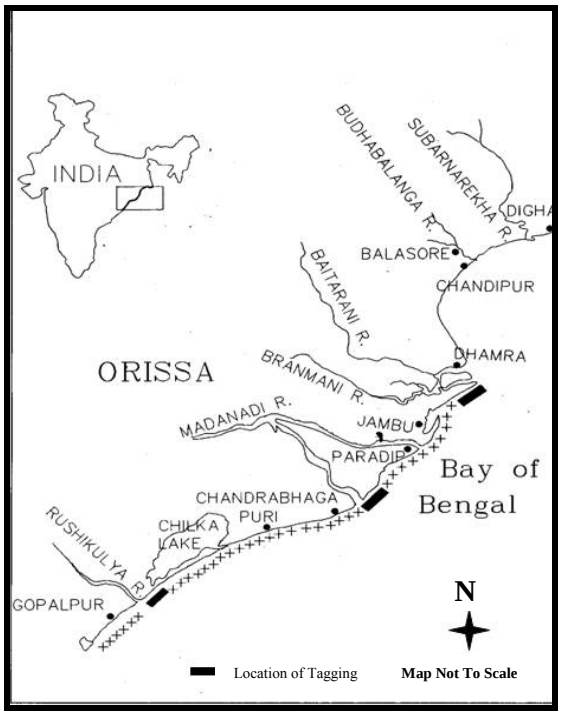

FIGURE 2. Map of the tagging locations of Olive Ridley Turtles (*Lepidochelys olivacea*) along the Orissa coast of India.

TABLE 1. Recapture of tagged Olive Ridley Turtles (*Lepidochelys olivacea*) at the Rushikulya rookery, India.

Year of Tagging	Turtles Tagged (n = 4,411)	Turtles Recaptured (n = 1,070)			
		2003	2004	2005	Recapture rate (%)
1997	518*	38	12	8	10.79
1998	2,063*	158	52	32	8.50
1999	499*	63	36	18	4.26
2002	1,331	350	218	73	20.7
Total	4,411	609	318	143	8.04

*****Data from Pandav and Choudhury (2000)

dynamic and underwent rapid changes. However, in 2004, the main beach became fragmented into many smaller submerged islands bordering a lagoon over the traditional mass-nesting beach. This change of beach profile shifted the mass nesting ground 2 km northward from the Gokhurkuda fish-landing center, formerly the extreme northern end of nesting of the rookery (Fig. 1). Beach profile changes during the study may be confounding variables for comparisons among beach segments. Therefore, we only considered tag recaptures for nest site fidelity analysis. Of the 4,411 turtles tagged at Rushikulya rookery (1997-2002), we identified 609 recaptures during the March 2003 arribada at the same mass nesting beach; whereas, during 2004, we captured 318 turtles, of which 128 turtles were tagged in 1997-1999 and 190 turtles in 2002.

We recaptured turtles at Devi and Rushikulya that we had tagged at Gahirmatha, and vice-versa (Table 3). Although inter-rookery movements of Olive Ridley Turtles in Orissa occurs (Pandav and Choudhury 2006), and turtles tagged in Orissa arose in Sri Lanka, this study revealed returns of turtles tagged further abroad. A nesting female Olive Ridley Turtle arrived during an arribada on 11 March 2004 with a metal carapace tag on its right marginal scute. We believe someone in the Philippines tagged the animal during the 1980s (Database of PAWIKAN Conservation Project, Government of Philippines), but we could not confirm the exact location. While monitoring mass nesting, we found 136 tagged turtles during the February 2004 arribada that nested during the subsequent arribada in March 2004.

DISCUSSION

The typical internesting period (IP) for other genera of chelonia is 10 to 15 days (Ehrhart 1982). IP is usually the time between successive arribadas (Cornelius and Robinson 1986), which can occur at two to four week intervals (Pritchard 1969; Márquez et al. 1976) but often exceeds two months. We found the IP for Olive Ridley Turtles at Rushikulya to be 22.09 days (SD = 0.58; range = 20 to 25 days). Internesting intervals range from at least nine days, observed in *Dermochelys coriacea* (Rostal et al. 2001), to 66 days in *Lepidochelys olivacea*, depending on environmental conditions (Plotkin et al. 1995, 1997). Olive Ridley Turtles sometimes perform solitary nesting between arribadas. These turtles nest for shorter intervals (14 days) than during arribadas (Rostal et al. 1997; Kalb 1999). In addition, solitary nesters have weak nesting site fidelity (Kalb 1999). One apparent difference between the *Lepidochelys olivacea* and the other species of chelonians is the ability to retain eggs for extended periods (Rostal et al. 1997). However, the mechanism of egg retention behavior in Olive Ridley Turtles is unknown.

Previous investigators reported movements by Olive Ridley Turtles between nesting beaches ranging from 85 km (Schulz 1971, n = 3) to 160 km (Meylan 1982, n = 1). Our observations at Orissa are the longest reported inter-beach movements by Olive Ridley Turtles (see Table 4). Eckert et al. (1989) recorded similar movements between nesting beaches for Leatherback Sea Turtles (range = 30-110 km). Bjorndal et al. (1983) reported the distance between intra-seasonal re-nesting attempts of 38 Loggerhead Turtles was ≤ 290 km. Other records of intra-seasonal nesting movements suggest that few Loggerhead Turtles travel long distances (Limpus 1985). Records of inter-beach migration by Olive Ridley Turtles exist for Nancite and Ostional in Costa Rica. Between 1980 and 1984, 29 Ostional Olive Ridley Turtles arrived at Nancite and 35 Nancite turtles appeared at Ostional (Cornelius and Robinson 1985). Therefore, it is possible that beach exchange is part of complex phenomena that Olive Ridley Turtles use to colonize new areas or to colonize new beaches. Thus, females may adopt reproductive strategies that increase the survival of their offspring (Morreale et al. 2007). Although shifts in nesting beach preference by Olive Ridley Turtles is poorly understood, coastal geomorphology in the river mouth (Prusty and Dash 2006), topography (Meijerink, 1983), or offshore approaches (Plotkin et al. 1991) may influence beach selection by arribada nesters. Continuous monitoring of these nesting beaches is essential to determine the degree to which movements between nesting beaches occur.

TABLE 2. Recapture of tagged Olive Ridley Turtles (*Lepidochelys olivacea*) at the Rushikulya rookery in Orissa, India from 2002-03 to 2004-05.

Parameter	2003	2004	2005	Total
No. of turtles encountered at least once on the beach	439	296	105	840
No. of turtles encountered twice on the beach	65	11	16	92
No. of turtle encountered thrice on the beach	12	0	2	14
No. of turtles encountered four times on the beach	1	0	0	1

Management implications.—The decade of data on Olive Ridley Turtle migration and movement from Orissa suggests that they use multiple habitats for breeding and mass

TABLE 3. Details of beach exchange by Olive Ridley Turtles (*Lepidochelys olivacea*) between sea turtle rookeries and sporadic nesting beaches in Orissa, India. We recorded 10 turtles straying between nesting beaches in Orissa, and displacement varied from 60 to 320 km.

Date of tagging	Place of tagging	Turtle tag ID	Date of recapture	Place of recapture	Distance between the sites (tagging and capture; km)
24-04-1999	Devi	WG 6910	09-03-2003	Rushikulya	220
17-03-1999	Devi	WG 6326	09-03-2003	Rushikulya	220
06-12-1998	Gahirmatha	WG 5176	10-03-2003	Rushikulya	320
30-03-1997	Chilka	WG 20020	09-03-2003	Rushikulya	60
22-12-1998	Gahirmatha	WG 13061	10-03-2004	Rushikulya	320
07-01-1998	Gahirmatha	WG 04901	11-03-2004	Rushikulya	320
22-01-1998	Gahirmatha	WG 13062	11-03-2004	Rushikulya	320
17-03-1997	Devi	WG 06142	17-02-2005	Rushikulya	220
30-03-1997	Chilka	WG 20020	17-02-2005	Rushikulya	50
17-03-1997	Devi	WG 6146	17-02-2005	Rushikulya	220

nesting. Thus, protection of isolated beaches is insufficient for population sustainability because Olive Ridley Turtles in Orissa use multiple beaches for nesting. A genetic study of Olive Ridley Turtles from Orissa supports that the populations that are nesting in Orissa could be a single population dispersed into the three rookeries along the coast, rather than three different populations (Shanker et al. 2004). Therefore, it may be necessary to pool data from the three rookeries when estimating the mass nesting population in Orissa. Also, many believe there is clearly unsustainable heavy mortality of turtles at the Gahirmatha and Devi rookeries. Therefore, an equal amount of protection should be applied to all three rookeries of Orissa. Development of suitable conservation and management plans for Olive Ridley Turtles from the Orissa Coast of India will require continued tagging efforts to identify more thoroughly their demographics.

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TABLE 4. Record of inter-nesting intervals (SI) of Olive Ridley Turtles (*Lepidochelys olivacea*) on the Indian Ocean coast

Number of intervals	Locality	Inter-nesting periods (days)	Reference
1	Surinam	17 – 30	Pritchard (1969)
2	Gahirmatha, Orissa	46 – 58	Dash and Kar (1990)
3	Gahirmatha, Orissa	29 - 58	Pandav and Choudhury (2000)
4	Rushikulya, Orissa	14 - 66	Pandav and Choudhury (2000)
5	Rushikulya, Orissa	19 - 52	Present study

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