MASS NESTING BEACHES OF THE OLIVE RIDLEY *LEPIDO CHELYS OLIVACEA* (ESCHSCHOLTZ, 1829) IN ORISSA AND THE BEHAVIOUR DURING AN ARRIBADA

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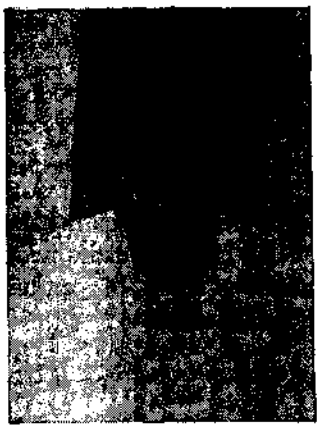
INTRODUCTION

Among sea turtles only the members of the genus *Lepidochelys* (i.e., the olive ridley *Lepidochelys olivacea* (Eschscholtz, 1829) and the Kemp's ridley *Lepidochelys kempi* (Garman, 1880) form reproductive aggregations, known variously as 'morrimas', 'arribazones', 'flotas', and 'arribadas'. Popularly the massed nesting is known as 'arribada' (a spanish term meaning 'arrival'). However, no one has yet described the term quantitatively. For convenience, in this paper we define the terms 'mini arribada' for a nesting aggregation involving 100 to 1000 nesters in a particular night on a stretch of less than 10 kilometers of beach and 'arribada' involving more than 1000 turtles.



Nesting aggregations were first discovered for the Kemp's ridley sea turtle by Hildebrand (1963). At Gahirmatha on the coast of Orissa, such aggregations of the olive ridley have been recorded by Daniel and Hussain (unpublished); Biswas (1982), Bustard (1974, 1976), Bustard and Kar (1981), FAO (1975), Kar

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(1980, 1982), Kar *et al.* (in prepn.), Kar and Bhaskar (1982), Silas *et al.* (1984) and Whitaker (1984).

Although the factors which synchronise such aggregation still remain unclear, most authors attribute a survival value to this trait as a means to swamp predation with a very temporary over abundance of food (Hildebrand, 1963 ; Carr, 1967 ; Zwinenberg, 1976 ; Pritchard, 1979 ; Marquez and van Dissel 1982). Pritchard and Marquez (1973) mentioned that 'survival value of the trait may be that local predator populations are bewildered by the sudden huge abundance of potential prey—the adult turtles, their eggs, or, two months later, the hatchlings—and although they may consume all they can, the manifestation is over so rapidly that many of the turtles will still survive, and excessively high predator population levels will be inhibited simply because they cannot be sustained by one or two big meals a year.'.

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Descriptions of the rookery near the Devi River mouth

Recently a rookery was discovered near the Devi River at the extreme southern part of Cuttack District, Orissa between Nadiakhia muhana and Akasia muhana (lat. 19°58' N 20° 01' N and long. 86°4'-86°45' E) (Kar, 1982). It lies between the main (southern) mouth of the River Devi which is at least 10 m deep and the secondary northern mouth which is never more than 1 m.

deep at low tide. The rookery extends for about 4 km in length and is about 100 km south of the Gahirmatha rookery (see below). The beach is wide, flat (small sand dunes of about 1-2 metre high are present on the northern side) and without any forests except recently planted casuarina. The mangroves, which were once abundant all along the coastal belt of Cuttack District, Orissa, have now totally disappeared from this region due to human encroachment and felling for firewood and other household purposes. The secondary branch of the river runs north parallel to the coast along its entire length before meeting the sea, thus forming a barrier island. The colour and texture of sand and beach topography resembles to some extent that of the Gahirmatha beach. About 100,000 female ridleys were estimated to have laid eggs during 1981 at the Devi rookery (Kar, 1982). It is not clear whether such large numbers are maintained each year or whether arribadas occur at the same time at both the rookeries. Tagging and monitoring are urgently required to confirm these and other facts.

GAHIRMATHA ROOKERY AND MASS NESTING BEHAVIOUR OF THE OLIVE RIDLEY

Gahirmatha beach is a 35 km long stretch in Cuttack District, Orissa forming the seaward boundary of the Bhitarkanika Wildlife Sanctuary (Kar, 1982). Mass nesting by the olive ridley takes place along 10 km of coastline from Habalikhati (the location of the main research centre) northwards upto Ekakulanasi. The beach runs in a north-east to south-west direction. It is remote from human habitation and is geographically separated from the mainland by mangrove creeks. At Habalikhati the beach is backed by sand dunes reaching heights of about 30 m. They extend about 2 km to the north-east upto ' Akhifuta Jora'. This section of the coastline has been planted with casuarina and is backed by dense mangrove forests. Creeks having blind ends but reaching nearly to the sea from the southern and northern limits of this stretch. Prior to 1981 the southern creek approached the sea in the form of a U-shaped loop near Habalikhati and then extended southwards to Satabhaya village, running almost parallel to the coast. In the cyclone of 10 December, 1981 the, beach was broken through

at Habalikhati connecting the creek with the sea. A few months later wind action redeposited the beach closing the seaward mouth and forming the blind end near Habalikhati which is presently approachable by boats only during high tides. North-east of 'Akhifuta Jora.' a section of about 2 km of coastline is almost devoid of high sand dunes and backed by dense mangrove forest. North-east of this another 3 km stretch has sand dunes approximately one to two metres high and a thin line of mangrove is present on the estuary side. The dunes are covered with beach vegetation viz., *Ipomea pescaprae*, *Spinifex* and other grasses. Between the mangroves and the nesting beach, plantations have recently been started by the Coastal Shelter Belt Afforestation Circle of Orissa Forest Department as an anti-cyclone measure. The remaining 3 km section with small scattered dunes (about 0.5 m high) occur progressively to the mouth of the Maipura River Nesting by olive ridley is exceptionally concentrated in this section which has no forest cover and is backed by open shallow waters without mangroves. The background of this section is the Maipura estuary extending from 'Kakranassi muhana' or 'Ekakulassasi muhana' right upto the Shortt's and Wheeler Islands (Palmyras Point).

At Gahirmatha rookery the nesting beach is very wide, flat and consists of sand which may contain some rare earths such as titanium. The colour varies from brownish white to blackish white or is completely black. The texture of sand varies from medium to fine hard packed particles. Often half of the beach near the high water mark looks brownish white and the remaining half removed from the high water mark looks black in colour. The nest site selection may be related to the texture and quality of the beach sand which in turn are related to digging a successful nest cavity, and thereafter conditions of temperature, moisture and aeration necessary throughout the incubation period for the developing embryos.

The average width of the main nesting beach remains almost constant during an arribada although it undergoes cyclical seasonal erosion throughout its entire length. In winter months the width of the rookery is maximum (50 to 60 metres) after the onset of the south-west monsoon in March-April erosion begins. During the

rainy season (June to September) the average width of the nesting beach is at its minimum. (5 to 10 metres). Hence, the arribada coincides with the period when the width of the rookery is at its maximum.

After the first mass nesting the subsequent arribadas may take place on the same or different parts of the beach. Perhaps this nesting site preference has adaptive significance as the numerous terrestrial beach predators will need to travel long distances to locate nests. Earlier workers have recorded nesting and have also remarked on the possibility of this sort of nest site preference by ridleys on other beaches (Pritchard and Marquez, 1973 and Loveridge, 1946).

The second mass nesting at Gahirmatha sometimes occur coinciding or prior to the hatching of eggs deposited during the first arribada. If the incubation period which is temperature dependant, varying from 45 to 70 days is more than the time interval between two consecutive arribadas, and if both the arribadas take place over the same stretch of coastline, clutches deposited during the previous arribada will be destroyed.

The shift of the arribada and the use of different parts of the beach in later mass nestings, therefore, appears to be a strategy of the olive ridley to avert the possibility of premature accidental excavation of developing embryos by subsequent nesters and thus to increase the overall hatching and emergence success of the hatchlings.

At Gahirmatha, the beach slope is gentle during the first arribada (late December to February). After conclusion of the first arribada erosion begins on the Ekakula-Ekakulanasi stretch preventing the later nesters to negotiate the beach in many places. Possibly the ridleys are capable of viewing the beach topography while swimming. Prior to commencement of an arribada masses of ridleys have always been observed swimming parallel to the coast just beyond the 3rd breaker line in the shallow coastal waters off Gahirmatha. They intermittently raise their heads out of water as if carefully scanning the beach. Nesting usually does not occur in eroded areas having vertical walls, whereas adjacent stretches having gentle slopes will host large numbers of nesters, thus support-

ing the above contention. The orientation capacity of ridleys appears to be greater (more accurate) in the water than on land.

Nesting of olive ridleys at Gahirmatha occur throughout the year with a variation on the number of solitary nesting ridleys from one, to one hundred or two hundred. Arribada usually occur two times in a nesting season during the period late December to April. The first arribada commences during late December to mid February while the 2nd arribada may commence between mid-February and April. The first arribada is usually very big when compared to the second arribada or subsequent mini arribadas during the months of April and May. The occurrence of arribada is known to be highly correlated with the phases of the moon (Marquez *et al.*, 1976) and usually takes place 2 or 3 days before or after the moon enters its last quarter (Marquez and Van Dissel, 1982). Observations made during the past seven years at Gahirmatha rookery strongly suggests that the arribadas usually take place coinciding with or one or two days after the neap tidal days along with increasing tide. Another interesting observation made at Gahirmatha is that immediately following an arribada the number of nesters abruptly decline and for about a week practically no turtles emerge to lay their eggs.

Big arribadas may continue after dawn into the morning hours upto 8.00 or 9.00 am, although the number of nesters emerging rapidly decreases. Diurnal emergences are more common when the sky is overcast and cloudy. During the 1982-83 nesting season after formation of the arribada, mass nesting continued for 3 days and nights, without any interruption although the number of nesting ridleys was comparatively less during the mid-day.

Large number of eggs are burried under the sand and after the peak hatching period a substantial proportion remains as unfertilised, unhatched or rotten eggs. It is possible that the presence of decaying remains of unhatched or rotten eggs and dead hatchlings which remain burried underneath the sand has an adverse effect on hatching success in the following nesting season. However, at Gahirmatha the erosion and subsequent deposition of sand helps in washing the beach and freeing it from various bacteria, fungi, organic detritus etc, and keeps the beach ready for the next seasons' arribada.

At Gahirmatha the arribada usually begins in the northern most section. In subsequent nights, as space or available nesting area become a limiting factor, the waves of nesting females spread south-west from 2 to 6 km of the beach (north-east—south-west). Within 2 to 3 days the arribada reaches its peak. Thereafter the concentrated nesting contracts slowly back to the northern end.

Some authors (*e.g.* Pritchard and Marquez, 1973) have reported that nesting emergences of ridley turtles, whether sporadic or aggregated, tend to correlate with a strong on shore wind. At Gahirmatha such a correlation could only be found with turtles nesting sporadically or when groups of a few hundred individuals nested on a particular night. No such correlation could be found during arribadas. However, it is interesting to note the mass nesting at the Gahirmatha coast usually takes place coinciding with, or immediately following, late seasonal rains associated with strong or moderate winds. In the subsequent nights, wind action appears to have no role after formation of any arribada. The above may have some bearing on the formation and triggering of an arribada.

How the ridleys maintain their aggregation during their migratory movements between their feeding and nesting grounds is a matter for speculation. They must have some means of finding each other. There are several possibilities. They may use visual means ; pheromonal secretions or they may be sensitive to mechanically produced vibrations resulting from surface swimming. The olive ridleys and the Kemp's ridleys are the only turtle species known to form arribadas and they are also the only turtle species that possess a complete and well developed series of secretory pores along the inframarginal scales of the plastron.

Remigration and Inter-Nesting Intervals

Tagging sea turtles commenced at Gahirmatha coast for the first time during 1978 (Kar 1982). So far a total of 15,000 turtles have been tagged at Gahirmatha using standard monel metal cow ear tags size : 49 from National Band & Tag Company, U.S.A., supplied by courtesy of FAO/UNDP. Tag return data strongly

suggests that a considerable proportion of Gahirmatha ridleys return to nest annually. Bustard and Kar (1981) have reported a 24% tag recovery during the 1979 nesting season. Tag recoveries also indicate that some turtles nest twice in a season at Gahirmatha. Tag return data will be discussed in detail in a later paper.

Formation of Arribada and Mass Migration

How the initial aggregation is formed in the olive ridley population coming for mass nesting is unknown. It is almost certain that olive ridleys migrate enmass and not solitarily from their feeding grounds to the mass nesting place. A number of small or large groups may migrate together upto the breeding ground until they congregate in very large numbers in the immediate vicinity of the mass nesting ground. Whitaker (1984) has reported that prior to the ridley mass nesting season in Orissa congregations of ridley turtles have been sighted by Sri Lankan fishermen, moving from north of Jaffna into the Bay of Bengal. Oliver (1946) and Deraniyagala (1952) have reported large concentrations of olive ridley in the coastal waters of Sri Lanka migrating northwards in the months of September and November respectively *i.e.*, prior to the peak nesting season on India's east coast. A large concentration of ridleys in December, 1978 in the above area apparently migrating northwards was reported by T.F.H. Hoffmann, Ex-President of the Nature and Wildlife Protection Society of Sri Lanka in his letter to R. Whitaker, with a request to protect the known nesting grounds of these turtles on India's mainland (Kar and Bhaskar, 1982). The first arribada took place at Gahirmatha rookery two months later.

Very recently, towards the end of November 1983 the Indian Coast Guard cabled the Chief Secretary of the Government of Orissa conveying the news about the mass migration of northward moving sea turtles in the coastal waters off Tamil Nadu 7 miles east of Pondicherry. Only a week later mating concentrations of sea turtles were sighted off Gahirmatha (Silas *et al.*, 1984). Mass nesting commenced on 25th January 1984. Zwinenberg (1976) reported the maximum speed of travel for a tagged ridley to be 83 km per day the turtle had been recovered within 23 days from a point off Geara (Brazil) 1900 km away from the place

originally tagged. Attributing a speed of travel of 83 km per day, the Gahirmatha turtles could have taken about 14 days to cover a straight line distance from Pondicherry to Gahirmatha coast (1165 km approximately) or about 16.3 days (1353 km. approximately) if they had hugged the coast line. Since the turtles were sighted only 7 miles east off Pondicherry it is probable that they had migrated along the coast rather than across the open sea.

The presence of about 600 carcasses of dead ridleys including both males and females on the Gahirmatha coast and about 500 carcasses at Hukitola island as a result of incidental catch during September 1983 to January 1984 confirms the presence of copulating pairs already during the above period. Therefore, it is possible that the Indian Coast Guard observed the tail end of a migratory concentration of ridleys off Pondicherry by which time the leading groups might have progressed further north. A proportion of them may even have reached the offshore waters off Gahirmatha by that time. It may be possible that the path chosen by the leading groups is subsequently followed by other groups. Physically handicapped and mutilated or deformed individuals may reach the nesting grounds later towards the end of an arribada (Silas *et al.*, 1984). Here, the pheromonal secretions may also be playing a role in the migration process. Silas *et al.*, (1984) have mentioned that between 20th and 22nd January, 1984 a tagged ridley was caught in a shoreseine net at Peddamylavamilanka (south), about 24 km south of Narasapur. The tag (number 14398)—had been applied in 1983 at Gahirmatha. The above evidence combined with earlier records of sightings of northward mass migration of ridleys off Sri Lanka waters indicates that the ridleys probably cover the entire length of the east coast of India to reach the mass nesting beaches along the Orissa coast with stray numbers nesting on the Tamil Nadu, Kerala and the Andhra Pradesh coasts during the long migration. Other populations possibly migrate from other areas such as Sunderbans, the Indonesian Archipelago and East Asia. However, such assumptions must remain for the present—at the level of speculation until more detailed research work is done by use of remote sensing techniques, radio telemetry, tagging ridley turtles and detailed observations are made in the open sea along the migratory routes (Silas, 1984).

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DISCUSSION

J. C. DANIEL : Plantations on or near beaches is a problem in other States also.

R. WHITAKER : Another cyclone may completely obliterate the Gahirmatha Beach. As such, plantations may be necessary as anticyclone work.

C. S. KAR : I have noticed nesting turtles shift to areas where plantations are not there.

J. FRAZIER : No proper study of this situation has been done so far. There are some cases in Mexico, but not in Costa Rica. We must think of a compromise solution—instead of plantations, recuperating mangrove may be taken up.

S. K. MISHRA : The Wildlife Authorities in Orissa are aware of the situation of beach plantation of casuarina affecting the nesting turtles. They have now recommended the stoppage of casuarina plantation along Gahirmatha Coast.

J. FRAZIER : Mixed planting programme of Casuarina plantation and mangrove development should be taken up.

K. SHANMUGANATHAN : Mangrove plantation may not help very much as an anticyclone measure since the cyclone winds are to be confronted at the highest level which is done by casuarina plantations.

E. G. SILAS : Grave danger to Gahirmatha Beach is from sea erosion. There are good indications of erosion along the southern stretch. Immediate interdisciplinary studies are necessary to find out the causative factors. Sand mining and Paradeep Port developments will also have to be looked into for understanding the problems of erosion and accretion along that coast. The area is also cyclone prone and direct hits may also cause heavy damage, but this is unpredictable.

SHIAM SUNDER : Nesting turtles along the Madras Coast are affected by the powerful lights from the beach resorts along the Madras—Mahabalipuram coastal stretch. A factory near Nelankarai is also letting out industrial waste directly into the sea which may also affect nesting. Some regulatory measures on switching off lights on nesting beaches and preventing pollution should be taken.

M. VIJAYAKUMARAN : The high sand-dunes on either side of the road from Madras to Mahabalipuram are being levelled or dug out for construction of farms and buildings. Will this not be dangerous in future?

S. KONDAS : Already the beach has been eroded due to these activities. There is a ban on construction of any building within 500 m of the high water mark. However, this is not strictly adhered to.

P. J. SANJEEVARAJ : What is the role of mangrove in the turtle food chain?

C. S. KAR : Decaying mangrove leaves may be eaten by turtle hatchlings.

M. VIJAYAKUMARAN : Olive ridley hatchlings do not consume any food upto 5 or 6 days after emergence. Their primary instinct is to reach the open sea habitat as soon as possible. As such mangroves may not have a direct role in the food chain of turtles.

T. SUBRAMONIAM : Do the salt gland in turtle produce any pheromones which help in mating migrations as in the case of sea snakes in polar regions?

C. S. KAR : I have no information.

J. C. DANIEL : How do you identify the tracks of different species?

S. BHASKAR : Tracks made by the nesting leatherback and the green turtles are distinctive for two reasons. These species as also the loggerhead which is apparently unknown from Indian waters drag themselves above the nesting beach using all four flippers in unison, an action which leaves a symmetrical set of tracks. Hawksbill and olive ridley move diagonal

limbs alone in unison thereby leaving staggered flipper per-imprints on either side of the midline of the track ; leatherbacks are among the broadest of any animal in the world and are therefore easily recognizable. Nesting green turtle tracks did not as a rule overlap in width with those of olive ridleys and hawksbills, the latter are usually smaller and never with those of leatherbacks which are larger. It appears to be difficult to distinguish ridley from hawksbill tracks for their widths overlap. It is possible that the hawksbill is a weaker swimmer than the ridley, this may result in the stride lengths of hawksbills on land being the smaller of the two, though this requires further investigation.

S. K. MISRA : Is there any correlation between the nesting beaches of marine turtles and mangrove area ?

S. BHASKAR : In Andamans even though vast stretches of sandy beach are available behind the mangrove vegetation I have not come across even a single nesting in that area. There is no correlation existing based on my surveys.

V. J. RAJAN : How about the existence of fishing villages along the stretch of our main coast line ?

S. BHASKAR : Always there will be fishing villages at least within a distance of 5 kms.

M. VIJAYAKUMARAN : Nesting of olive ridley is noticed off Okha in Gujarat in the month of June to November. In Tamil Nadu the nesting period is from December to March. Is there any relationship between the rainfall and the egg laying ?

S. BHASKAR : I have no definite idea about this problem.

K. SHANMUGANATHAN : Normally the egg laying starts after the monsoon period in Tamil Nadu. But unusually heavy rain occurred in the months of February along the Madras Coast. Whether the eggs collected and kept in the hatchery will be affected due to this has to be looked into.

M. VIJAYAKUMARAN : Most of the turtle eggs have the ability of absorbing water from the surrounding. The surrounding moisture condition may help in the normal development of the embryo.