HANDBOOK

MARINE TURTLES OF INDIA

K. VENKATARAMAN

M.C. JOHN MILTON

ZOOLOGICAL SURVEY OF INDIA

Handbook
On
MARINE TURTLES OF INDIA

(Resources, Exploitation and Conservation)

K. VENKATARAMAN
and
M.C. JOHN MILTON
Zoological Survey of India, Marine Biological Station, 130 Santhome High Road, Chennai-600 028

Edited by the Director, Zoological Survey of India, Kolkata.

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INTRODUCTION

Although man now dominates the earth, on the evolutionary time scale he is a newcomer, still in his infancy. If length of residence determined his right to rule, he would have to wait at the end of a very long line of less ambitious creatures. But man, the newcomer, can have a tremendous impact on the destiny of his older neighbors because of his ability to drastically alter the world in which he lives. They have a long past history, which dates back to about 120 million years to the Permian epoch of the Palaeozoic era. Sea turtles represent an ancient and distinctive part of the world's biological diversity (Ekanayake *et al.*, 2002). Although sea turtles are marine sometimes they are found in brackish water of the estuaries. Within the marine environment, different species of sea turtles occupy different ecological niches. Often the breeding areas are widely separated from the feeding areas (Fugazzatto and Behera, 1999). The present work focuses on just one of these "older neighbors" the endangered marine turtles of India

Turtle is the term used for a group of reptiles of the order Testudinata whose members are recognized by their short wide bodies encased in a protective armour, the 'shell' which is composed of the dorsal carapace and the ventral plastron. They are devoid of teeth but are provided with the horny sheaths. The body is covered with polygonal scutes or scales or a leathery skin. The word "turtle" is generally used to denote semi aquatic and marine species, "terrapin" to the hard-shelled freshwater species that are edible and "tortoise" to the strictly terrestrial species (Murthy, 1981; Murthy and Menon, 1976).

Sea turtles are air-breathing reptiles that are well adapted for their life in the sea. Their body is streamlined to move easily through the water with little resistance. Their front flippers are used for swimming, pulling them through the water with powerful strokes, the back flippers act like rudders for steering. Like other reptiles, the sea turtle's skin is protected by tough scales and fused bony plates form a protective shell (called the carapace on top, plastron on the bottom). There are seven species of sea turtles found in the world's warm oceans. They are *Chelonia mydas* (Linnaeus, 1758) (Green Turtle), *Chelonia depressa* Garman, 1880 (Flatback sea turtle), *Eretmochelys imbricata* (Linnaeus, 1757) (Hawksbill Turtle), *Caretta caretta* (Linnaeus, 1758) (Loggerhead Turtle), *Lepidochelys olivacea* Eschschlotz, 1829 (Olive Ridley), *Lepidochelys kempii* Garman, 1880 (Kemps ridley sea turtle) and *Dermochelys coriacea* (Vandelli, 1761) (Leatherback Turtle).

All the Indian turtle species are found to occur in the waters of Bangladesh and other neighbouring countries of India (Das, 1989; Hykle, 2000; Islam, 2001, 2002). The two species of ridleys are the smallest of all sea turtles. Some species are restricted to a particular locality. For example : the kemp's ridley in Florida, U.S.A. All other species of sea turtles are circumglobal in distribution. Although there are many common features in the lives of all species of sea turtles, yet each species has its own specialized strategy for survival and reproduction (Daniel, 1983).

Adult sea turtles are completely aquatic and spend most of their lifetime in water, but they start their lives on land, *i.e.*, on sandy shores, as hatchlings and then enter into the aquatic environment. After the hatchlings enter into the sea, the males never leave the sea during their lifetime (except the green sea turtle, which basks on the shore). The females, however, must report on to the beaches during the breeding seasons to lay their eggs. Periods, which they spend on land, although very brief, are critical and vital for the success of their reproduction and survival. The significance of the linkage between the sea turtles and the nesting beach is emphasized by the fidelity with which some sea turtles return, often after long periods of time and over great distances, to the same beach (Carr, 1964, 1967; Carr and Carr, 1972). The nesting process of the female and the incubation period of the clutch are models of unparalleled research potential for the zoologist (Owens, 1980).

Natural History of Sea Turtles

Sea turtles are ancient reptiles that have changed little over the 150 million year history on Earth. Turtles are the oldest living vertebrate animals. They may live to be 100 years old. They have been on Earth for 150 million years since even before the time of the dinosaurs. They are the largest reptiles in the world by weight. A giant leatherback that washed up along the coast of Wales weighed over 2,000 pounds and measured 9 1/2 feet from head to tail. They do not have teeth, but have powerful jaws with sharp edges, like birds. Turtles are adapted to living in the marine environment by having flippers instead of legs and a steam lined body shape, so they are fast and graceful in the water, but slow and clumsy on land. They breathe air like all reptiles and human, and can hold their breath for long periods of time and can dive very deep (Bustard, 1972, 1974; Fugazzatto and Behera, 1999).

Role in Marine ecosystem

The sea turtles are rivaled only by the sea snakes in adapting perfectly to the aquatic environment. With their forefeet modified as flippers, they have also developed an efficient swimming stroke. Sea turtles are also an important part of the marine ecosystem. Sea turtles are connected to the food web of the ocean by the prey that they eat and predators that eat them. Sea turtles eat jellyfishes, sponges, tunicates, algae, sea grasses, and crustaceans. The only natural predators of adult sea turtles at sea are sharks, killer whales and humans. Nesting females are sometimes attacked and eaten by jaguars, tigers and hyenas. The high protein eggs that are laid in great numbers on some nesting beaches provide food for a myriad of animals including raccoons, coatis, coyotes, jackals, dingos, mangooses, foxes, opossums, vultures, crows, varanid lizards, snakes, crabs, flies and ants. If the eggs survive to become hatchlings, they are predated by all kinds of fish including sharks, groupers, cod and more birds including herons, egrets, frigate birds and hawks (Bustard, 1972, 1974; Daniel, 1983; Fugazzatto and Behera, 1999).

General Morphological Features of Marine Turtles

Size : Adult males and females are equal in size. Green turtles reach about 78 to 112 cm and 68 to 186 kg. The largest green turtle collected so far was 1.5 m and 395 kg. Black sea turtles reach about 59 to 117 cm and 42 to 126 kg. The kemp's ridley and olive ridley are the smallest species, and reach about 55 to 65 cm and 30 to 50 kg. The leatherback turtle is the largest sea turtle species; the kemp's ridley is one of the smallest. Loggerheads reach about 82 to 105 cm and 66 to 101 kg. Hawksbills reach about 53 to 114 cm and 27 to 86 kg. Flatbacks reach about 81 to 97 cm and 60 to 84 kg. The leatherback is the largest of all living sea turtles. Mature leatherbacks reach about 1.2 to 1.9 m and 200 to 506 kg. The largest leatherback recorded was 916 kg. Each sea turtle has distinctive individual facial markings similar to fingerprints. Many sea turtles are recognizable by scientists on sight (Marquez, 1990; Sharma, 1998).

Body shape and Colouration : Sea turtles are characterized by a large, streamlined shell and nonretractile head and limbs. Depending on the species, sea turtles range in colour. They may be olive-green, yellow, greenish-brown, or black. The green sea turtle gets its name from the colour of its body fat.

Flippers : A sea turtle cannot retract its limbs under its shell as a land turtle can. Flippers are adapted for swimming sea turtles are awkward and vulnerable on land. Fore flippers are long and paddle like. Long digits are fused throughout the flipper. Only one or two claws are present on each fore flipper. A sea turtle swims with powerful wing like beats of its fore flippers. Hind flippers serve as rudders, stabilizing and directing the animal as it swims. The hind flippers of some species are quite dexterous and used for digging nests in the sand.

Head : A sea turtle cannot retract its head under its shell as a land turtle can. Sea turtles have large upper eyelids that provide protection for their eyes. Sea turtles do not have an external ear opening. Like other turtles, sea turtles lack teeth. Jaw shape varies among species. Each species has a jaw shape adapted to its diet.

Shell : The large, bony shell provides protection from predation and abrasion. In all species except the leatherback, the shell is covered with a layer of horny plates called scutes. Scutes are firm but flexible, not brittle. Scientists can identify sea turtle species by the number and pattern of scutes. The leatherback turtle has a thick and oil-suffused skin, which is an excellent insulator allowing this species to venture into colder waters. The dorsal (top) side of the shell is called the *'carapace'* Depending on species, the adult carapace ranges in shape from oval to heart-shaped. In all species except the leatherback, the bony shell is composed of broadened, fused ribs, and the backbone is attached to the carapace. In all species except the leatherback, the backbone is attached to the carapace. The leatherback's carapace is composed largely of cartilage raised into prominent logitudinal ridges. A layer of thousands of small dermal bones lies just below the leathery skin. The ventral (bottom) side of the shell is called the *'plastron'* (Marquez, 1990; Sharma, 1998).

Sexual dimorphism : There are no obvious external morphological differences between hatchlings of male and female. However the adult males are identified by their longer, thicker tail, which is strongly prehensile and has a hard, confined tip. Further the adult males have strongly developed, recurved claw on each fore flipper. These two claws along with the prehensile tail help the male to hold the female firmly during copulation. The plastron in case of males is slightly concave.

Habitat and distribution : Sea turtles are found in warm and temperate seas throughout the world. Adults of most species are found in shallow, coastal waters, bays, lagoons, coral reefs and estuaries. Some also venture into the open sea. Juveniles of some species may be found in bays and estuaries, as well as in sea (Marquez, 1990; Sharma, 1998).

Migration : Migration habits differ not only among species but also among different populations of the same species. Some sea turtle populations nest and feed in the same general areas; others migrate great distances. Green sea turtle populations migrate primarily along the coasts from nesting to feeding grounds. However, some populations travel 2,094 km across the Atlantic Ocean from the Ascension Island nesting grounds to the Brazilian coast feeding grounds. Black sea turtles migrate along the coast from breeding areas to feeding grounds between the northern and southern extremes of their distribution range.

Loggerheads leave foraging areas and travel on breeding migrations that range from a few to thousands of kilometers. Kemp's ridley turtles follow two major routes in the Gulf of Mexico : one northward to the Mississippi area, and the other southward to the Campeche Bank, near the Yucatan Peninsula. Populations of olive ridleys have been observed in large flotillas traveling between feeding and nesting grounds in the Eastern Pacific and Indian Oceans. Hawksbill migration studies have been limited. Evidence suggests that some hawksbill populations show cyclic nesting migrations. Other researchers have documented nonmigratory and short-distance migratory populations (Marquez, 1990; Sharma, 1998).

Flatbacks move from their nesting grounds on the northern coast of Australia and to feeding grounds in shallow waters of northeastern Australia. Distance covered ranges from 215 to 1,300 km. Leatherbacks have the longest migration of all sea turtles. They have been found more than 4,831 km away from their nesting beaches. Migration habits differ among sea turtle species. Migrations may range from a few to thousands of kilometers. The most common method used to track free-ranging sea turtles is flipper tagging. Although this method yields information on migration destinations, it does not reveal travel routes. Recently radio, sonic and satellite tracking have been successful in monitoring sea turtle movements. Hubbs-Sea World Research Institute has developed a radio transmitter harness for leatherback turtles. Its design allows secured attachment of a transmitter without affecting turtle mobility (Lutcavage *et al.*, 2002).

The migration of turtles for foraging and breeding has long been fascinated the scientists. Researches in these areas are flourishing. Dash and Kar (1990), based on evidence from tag returns and observations by the Indian Coast Guard, describe the breeding migration of olive

ridley turtles as a northerly course through the coastal waters off Tamil Nadu and Andhra Pradesh prior to their arrival in Orissa. Oliver (1946) and Deraniyagala (1953) have reported large concentrations of olive ridley turtles in the coastal waters of Sri Lanka migrating northwards during September and November. However, very little is known about the post-nesting movements of olive ridley turtles at Orissa and from other nesting sites in India.

Population : Total population figures of sea turtles are unknown because juvenile and male sea turtles do not come ashore and are difficult to count. Population data are usually based on the numbers of adult females that come ashore to nest. Even then, the numbers are ambiguous - some females nest every two to three years, some may nest more than once on the same beach in a season, and some females will visit more than one nesting beach in a season.

Researchers rely more upon the changing numbers of nesting females from year to year to determine population trends of increasing or decreasing numbers. Broad year-to-year fluctuations in numbers of nesting females make short-term data misleading, surveys of a decade or less may be insufficient to determine a population trend.

The Kemp's ridley is the most endangered sea turtle. In 1947, 92,000 nests were estimated. The numbers have been declining drastically since then. Surveys conducted between 1978 and 1988 indicated an average of about 800 nests per year. Since 1978, there has been a declining trend in the number of nests. The current nesting of Kemp's ridley is 14 per year. The total number of nesting females is as low as 350 on beaches where tens of thousands of Kemp's ridley used to nest.

Nesting populations of green and black sea turtles have not been surveyed long enough for determination of trends. However, qualitative observations during visits over several years suggest a steady decline.

The major loggerhead nesting grounds are located in the southeastern U.S. Population trends of logger heads show a decline in nesting areas of Georgia and South Carolina, but there may be possible increase in southern Florida Atlantic areas. More years of nesting data and population biology studies are needed to assess the Florida trends.

The olive ridley is the most abundant sea turtle in the world. In 1991, an estimated 610,000 turtles nested in a single week on a beach in India.

Very little data is available on hawksbill populations. Estimation of population sizes of nesting females is difficult by aerial assessment : tracks in the sand do not last long and are difficult to see, and nests are often obscured by beach vegetation.

Current population numbers of flat back turtles are not known; however, because of its restricted distribution, the flat back is the most vulnerable of all sea turtles to any habitat change or over-exploitation. There are less than 115,000 adult female leatherbacks worldwide. There are too few records to predict trends; however, the numbers do not appear to be declining (Marquez, 1990; Sharma, 1998).

LIFE CYCLE

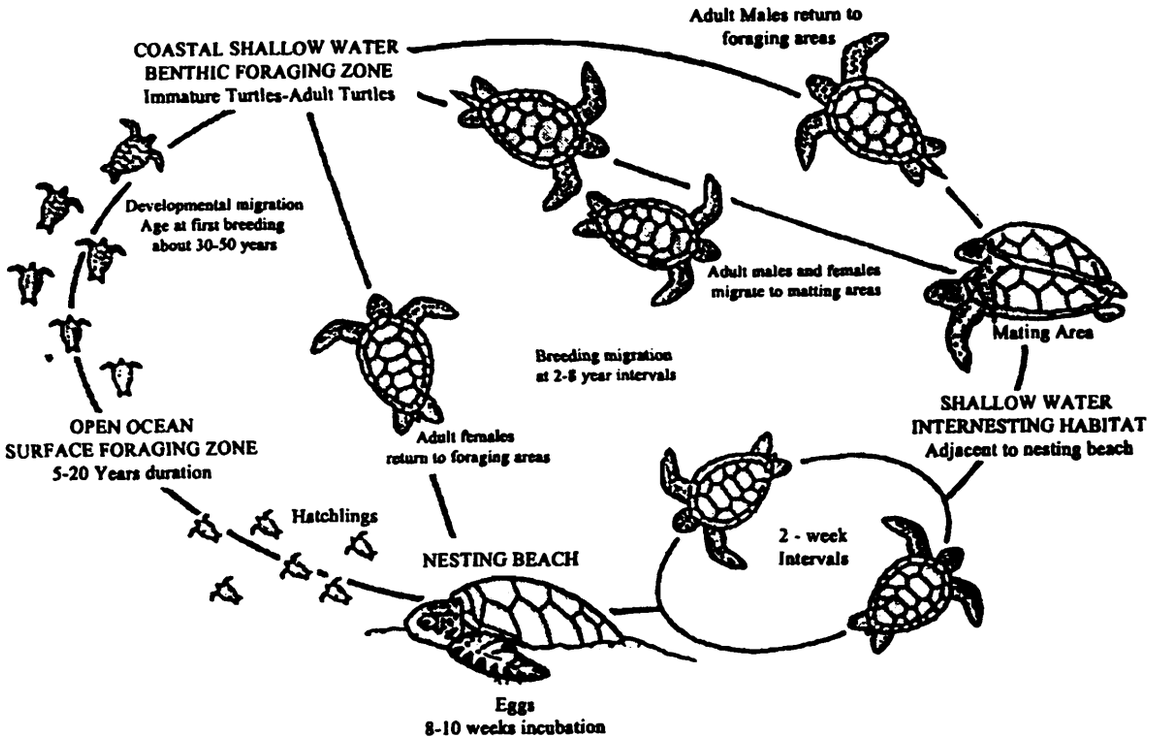

Fig. 1. Life cycle of sea turtles (Limpus *et al.*, 1994)

Though the reproductive cycle of males are completely unknown, the reproductive cycle of females of various species has been described. The adult males and females migrate in large numbers from the coastal shallow water and benthic foraging zone to breeding areas. This breeding migration of adult males and females takes place at 2-8 year intervals. Normally courtship takes place in the shallow water areas followed by mating. After mating the males return to the foraging zone. The females stay near the shallow water-internesting habitat adjacent to nesting beach for nearly two weeks. Nesting usually takes place at night. The females incubate the eggs for nearly 8-10 weeks and return to the benthic foraging zone. Soon after the emergence, the hatchlings move toward the sea and development lasts for 5-20 years. After attaining sexual maturity they undertake first breeding migration little over 30-50 years (Bustard, 1979; Anonymous, 2000) (Fig.1).

Nesting of sea turtles

A variety of qualitative terms have been used to describe occurrences of turtles beyond their breeding ranges, primary foraging areas and known migratory patterns (Wing and Hodge, 2002). Turtles migrate thousands of miles in the course of a year, moving between nesting and feeding grounds. An olive ridley tagged in Suriname, South America traveled 1,900 miles against the prevailing current in 23 days. Most species mate singly, but the ridley species have a unique mass nesting strategy called the "*arribada*", which is Spanish term

for arrival. Anywhere, from 500 to 150,000 female ridleys, will appear on the beach at the same time (all of them within a couple of days) to lay their eggs. This makes it impossible for a natural predator to take all the eggs that are laid, and increases the odds of hatching survival. Leatherback, green, olive ridley and loggerhead turtles are the most widely distributed species and have the habit of migrating long distances for feeding and breeding. Nesting takes place in a colonial fashion. Hawksbill turtle is not seen in large numbers, as it prefers an independent life. It nests individually in localities far apart. Temperature at the time of incubation determines the gender of the hatchlings. The hatching will be male if the eggs incubate at a cool temperature and female if the eggs incubate at a warm temperature (Bustard, 1979; Marquez, 1990).

Female sea turtles may take 20-50 years to reach sexual maturity, but then return to the very same beach where they were born, to lay their eggs. They spend virtually their entire lives at sea, but mate offshore, and return to land to lay their eggs. The females carefully dig a deep hole for a nest and lay up to 180 eggs at a time on sandy beaches. Turtle eggs are flexible shelled or rigid shelled. They take in water during incubation and categorized as non-cleidoic (Silas and Vijayakumaran, 1984). The eggs must be laid on land, so that the embryos can breathe air through the eggshell. They do not provide any maternal care to the eggs; eggs are laid, buried and the nest site is camouflaged to protect the eggs from predators (Silas, 1984 a and b; Marquez, 1990; Fugazzatto and Behera, 1999; Anonymous, 2000). Freshly laid eggs have a coat of albumin like mucus covering (cloacal fluid) and in between each dropping and at the end of egg laying process also such droppings are left on the eggs by the nesting animal before the nest is closed. The mucous string may help in the slow dropping of the egg, into the pit. Sand adhering to the mucus may play a vital role in preventing sand particles from infiltrating the space between the eggs and thereby create an effective air chamber which could maintain temperature and moisture conditions (Silas and Rajagopalan, 1984). Turtle egg yolk is the primary nutritional source of the developing embryos. Its chemical composition and nature interferes with the development and successful hatching of the hatchlings (Silas *et al.*, 1984 a and b). The hatchlings proceed towards sea soon after hatching. Studies on the captive reared hatchlings indicate that they can survive on starvation for upto or beyond 30 days. This is a built in mechanism of the hatchlings to facilitate their reaching the grow out and feeding grounds (Vijayakumaran *et al.*, 1984). Differentiation of sex in the hatchlings is extremely difficult. Visual sex determination in the olive ridley could not be made even in a 47 month old (Rajagopalan, 1984a).

Interaction with other animals

Pelagic (open ocean) sea birds spend the majority of their lives flying over the open ocean, and from time to time, they must rest. Some times they rest on top of the water, vulnerable to predators such as sharks, unless there is another object to rest on. These birds are often seen resting on the backs of sea turtles as the turtles cruise the open ocean. This is a form of mutualism, where two different species have an ongoing relationship. It is not well known whether this particular relationship is commensal (no effect on the turtles) or

whether it is mutualistic (both the sea turtles and the sea bird gain some benefit). The remora fish is known to attach on to turtles for a free ride. Barnacles and algae attach to the shells of sea turtles and travel across the ocean. Small fishes get protection from the shells of the turtles. Generally the microfauna on the beach depend on the turtles. For example the bacteria in the beach sand may feed on rotting unhatched turtle eggs.

A variety of marine organisms occur as symbionts of green (*Chelonia mydas*) and loggerhead (*Caretta caretta*) sea turtles (Dodd, 1988; Hirth, 1997). Among the commensal symbionts associated with *C. mydas* and *C. caretta*, stalked and encrusting barnacles occur with high frequency (Caine, 1986; Dodd, 1988; Hirth, 1997). More such studies are to be conducted in Indian waters.

Barnacles and Sea turtles

Four barnacle species (*Balanus improvisus, B. venustus, Conchoderma virgatum, and Lepas anatifera*) were observed as associates of sea turtles in Brazilian waters. Three species (*B. venustus, C. virgatum and L. anatifera*) attach only on *C. mydas*. One barnacle species (*Platylepas* sp.) grow only on *C. caretta*. *Chelonibia testudinaria* was the most common barnacle found on loggerheads in the United States (Caine, 1986; Bugoni, *et al.*, 2001), as well as the most common barnacle observed on green turtles in Australia (Limpus *et al.*, 1994). Two *Balanus* species (*B. improvisus* and *B. venustus*) associate on both green and loggerhead turtles in profuse incrustations. Despite the extensive records of *Balanus* spp. associated with live sea turtles (Caine, 1986; Frick *et al.*, 2000; Lutcavage and Musick, 1985), balanids are not obligate commensal barnacles (Foster, 1987). However, such studies are lacking in India.

Economic Importance

Most parts of sea turtle are of potential commercial value; the shell is used for jewellery and ornaments; the skin of the flippers and neck are tanned and used for leather articles; the meat is used as food. The meat of some species is considered a delicacy; flesh is used for soup; the eggs are universally consumed by man and also used as poultry feed; the oil from the fat is used as a cosmetic base. Due to its highly penetrating and unique moisturizing qualities, the oil is largely used in the preparation of conditioning creams, lotions, soap, bath oil, shampoo, etc. Live turtles, because of their beautiful colour pattern and gentle disposition are considered as ideal pets and are exported in great numbers to foreign countries (Murthy, 1981).

Turtle poisoning

Sea turtles mainly feed on the grass beds; their food include algae, jellyfishes and sponges. Sometimes the turtles eat poisonous sponges, although the poison doesn't affect the turtles

much, it is stored in the tissues and later, when these turtles' flesh is consumed by the local fishermen and dogs when they strand along the beach or entangled in the shrimp nets, it causes serious health hazards. The following marine turtles are known for such poisoning: *Caretta caretta, Chelonia mydas, Eretmochelys imbricata* and *Dermochelys coriacea.*

Reports have been published on the turtle poisoning in India and Sri Lanka. During certain period of time turtle flesh is not consumed to avoid poisoning. However, there is no definite way of telling when the turtle flesh would be poisonous. In the traditional practice of determining turtle flesh poisoning, the fishermen would chop off the liver of *Eretmochelys imbricata* and feed it to the crows if they discarded the liver the animal was considered to be poisonous (Deraniyagala, 1939). Feeding of turtle meat to dogs and cats for determining its quality is been reported from New Guinea (Bierdrager, 1936). However, the origin of chelonitoxin is still unknown. The clinical characteristics of marine turtle poisoning report the following as major symptoms which develop from within a few hours to even a week after the ingestion of poisoned turtle flesh such as nausea and vomiting, diarrhoea, facial tachycardia, pallor, severe epigastric pain, sweating, coldness of the extremities, vertigo, acute stomatitis-including dry burning sensation of the lips, throat and mouth, sensation of tightness in the chest and difficulty in swallowing, White coating on the tongue, and patient becomes lethargic and unresponsive that leads to coma.

Deaths due to the consumption of the flesh of *Eretmochelys imbricata* have been reported from Tamil Nadu and Kerala in 1961, 1977, 1979 and 1980. Consumption of *Chelonia mydas* flesh caused death in Tamil Nadu in 1977 and 1983.

The works of Bierdrager, 1936; Deraniyagala, 1939; Halstead, 1956, 1959 and 1970; Pillai *et al.*, 1962; Romeyn and Haneveld, 1956; Silas and Bastinfernando, 1984 report the symptoms, diagnosis, treatment and incidences of turtle poisoning in India.

Since the causing factor that turns the turtle flesh poisonous is not clearly known, the diagnosis and remedy for the turtle poisoning patients become complicated. In the recent past due to the strict enforcement of the conservation measures after the introduction of the Wildlife Protection Act, 1972, the consumption of turtle flesh has been brought under control. However, the illegal capture and consumption of turtle flesh continues in certain places and the turtle-poisoning incidences go unrecorded or often misinterpreted as other ailments.

TURTLE RESOURCES OF INDIA

India is a land rich in wildlife from tigers to elephants to sea turtles. Alexander Hamilton an English trader of the 18th century, in his travel accounts titled 'A New Account of the East Indies' refers to "prodigious number of sea tortoises" resorting to lay their eggs on the Orissa Coast (Hejmadi, 2000). Five species of marine turtles are reported from India, of these, the nesting ground of the loggerhead, in India is still not known, but it was reported to occur in Tamilnadu waters. According to Jones and Fernando, 1968, among the four to

five thousand turtles caught annually in the late 1960's in southern Tamil Nadu, three quarters were green turtles, olive ridley and loggerheads formed one-fifth of the total. The rest four species, which are known to nest commonly in the coasts of mainland India and Andaman and Nicobar Islands, are reported to occur in Orissa. However, only one species, the smallest olive ridley sea turtle, has been confirmed nesting in Orissa coast (Dash and Kar, 1990).

The coast of Orissa, in the eastern part of India on the Bay of Bengal, is the most important sea turtle nesting area in India and possibly the most important olive ridley nesting site in the world due to the incredible numbers of sea turtles coming ashore. It is estimated that upto one million sea turtles have nested in Orissa during a single year during the mid 1980's.

There are several major nesting beaches along the coast of Orissa, including Gahirmatha, Rushikulia in Ganjam, Konark – Balukhand and the Devi coast. Historically, Gahirmatha is the world's largest nesting site for olive ridley sea turtles. On this 35 kilometer long stretch of beach as many as 6,90,000 turtles nested in a single year. A 20 km radius of off shore habitat along the 35 km stretch has been declared a marine sanctuary where trawling is banned. At Ganjam, 200,000 turtles nested in a single year, making it the second largest nesting site in India (Pandav and Choudhury, 1999). The following are the sea turtles represented from India;

Class	REPTILIA
Sub-class	ANAPSIDA
Super-order	LEPIDOSAURIA
Order	TESTUDINA
Suborder	CRYPTODIRA

Family **CHELONIDAE** (Marine Turtles)

1. *Chelonia mydas* (Linnaeus, 1758) (Green Turtle)
2. *Eretmochelys imbricata* (Linnaeus, 1757) (Hawksbill Turtle)
3. *Caretta caretta* (Linnaeus, 1758) (Loggerhead Turtle)
4. *Lepidochelys olivacea* Eschschlotz, 1829 (Olive Ridley)

Family **DERMOCHELIDAE** (Marine Turtles)

5. *Dermochelys coriacea* (Linnaeus, 1766) (Leatherback Turtle)

TAXONOMIC KEYS TO FAMILIES AND GENERA

1a. Body without horny scutes, covered by leathery skin, small scales present only in hatchlings; carapace with 5 dorsal longitudinal ridges upper tomium with a pair of frontal cusps. Choanae open in two separate apertures on anterior half of palate. Patches of papillary projections arranged in rows on palate and floor of mouth and in throat. Flippers without visible claws ..... Family DERMOCHELYIDAE *(Dermochelys)* (Fig. 2)

1b. Scutes covering carapace and plastron; scales present on head and flippers. Choanae open in a single aperature on the rear half of palate. Papillary projections absent in mouth, but present in the throat. Flippers with one or two developed claws ..... Family CHELONIIDAE

2a. Carapace with 4 lateral scutes on each side, the first pair not in contact with the precentral scute.

2b. Carapace with 4 lateral scutes on each side, the first pair in contact with the precentral scute

3a. Carapace elliptical, covered by imbricate scutes, except in very old individuals. Head narrow, with two pairs of prefrontal scales; tomium hawklike, not serrated. Flippers usually with two evident claws ..... *Eretmochelys* (Fig. 3)

3b. Carapace nearly oval, with no imbricate scutes. Head blunt (short snout), the preorbital distance clearly smaller than orbital length; a single pair of prefrontal scales, usually 4 postorbital scales; tomium serrated. Flippers usually with only one evident claw ..... *Chelonia* (Fig. 4)

3c. Carapace nearly round and flattened, with slightly upward- folded margins, covered by rather thin, non-imbricate scutes, waxy to touch; preorbital distance nearly equal to orbital length; a single pair of prefrontal scales, usually 3 postorbital scales; tomium not serrated. Flippers with one evident claw ..... *Natator*

4a. Carapace cardiform, its length always greater than the width. Plastron usually with 3 pairs of inframarginal scutes, generally without pores. Carapace scutes thick and rough to touch. Head relatively large, with a heavy and strong tomium lacking an internal alveolar rim. Body colour usually reddish-brown or yellowish-brown ..... *Caretta* (Fig. 5)

4b. Carapace nearly round, its length similar to the width. Plastron usually with 4 pairs of pored inframarginal scutes. Carapace scutes smooth to touch. Head moderately small, with a cutting tomium provided with an internal alveolar rim. Body colour grey-olive or olive-yellowish ..... *Lepidochelys* (Fig. 6)

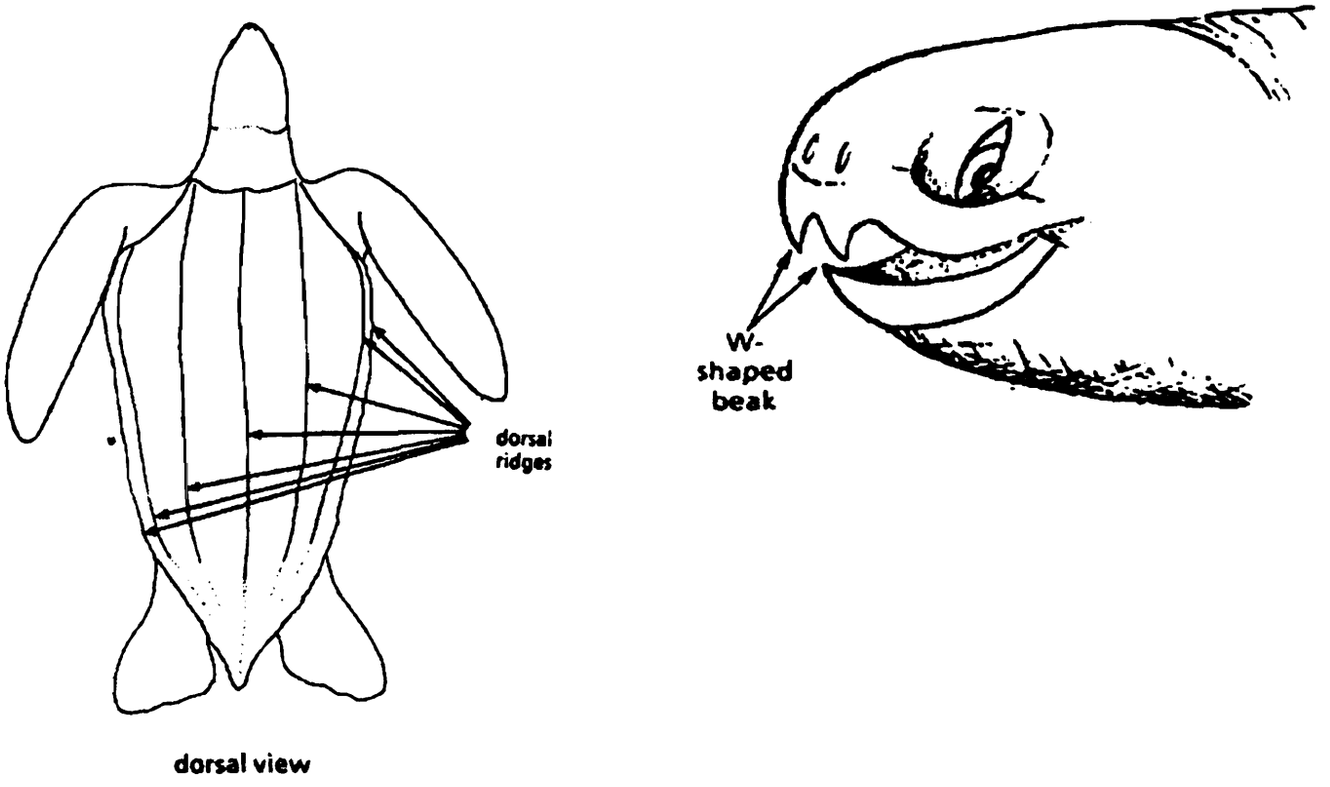

Fig. 2. Schematic view of *Dermochelys coriacea*

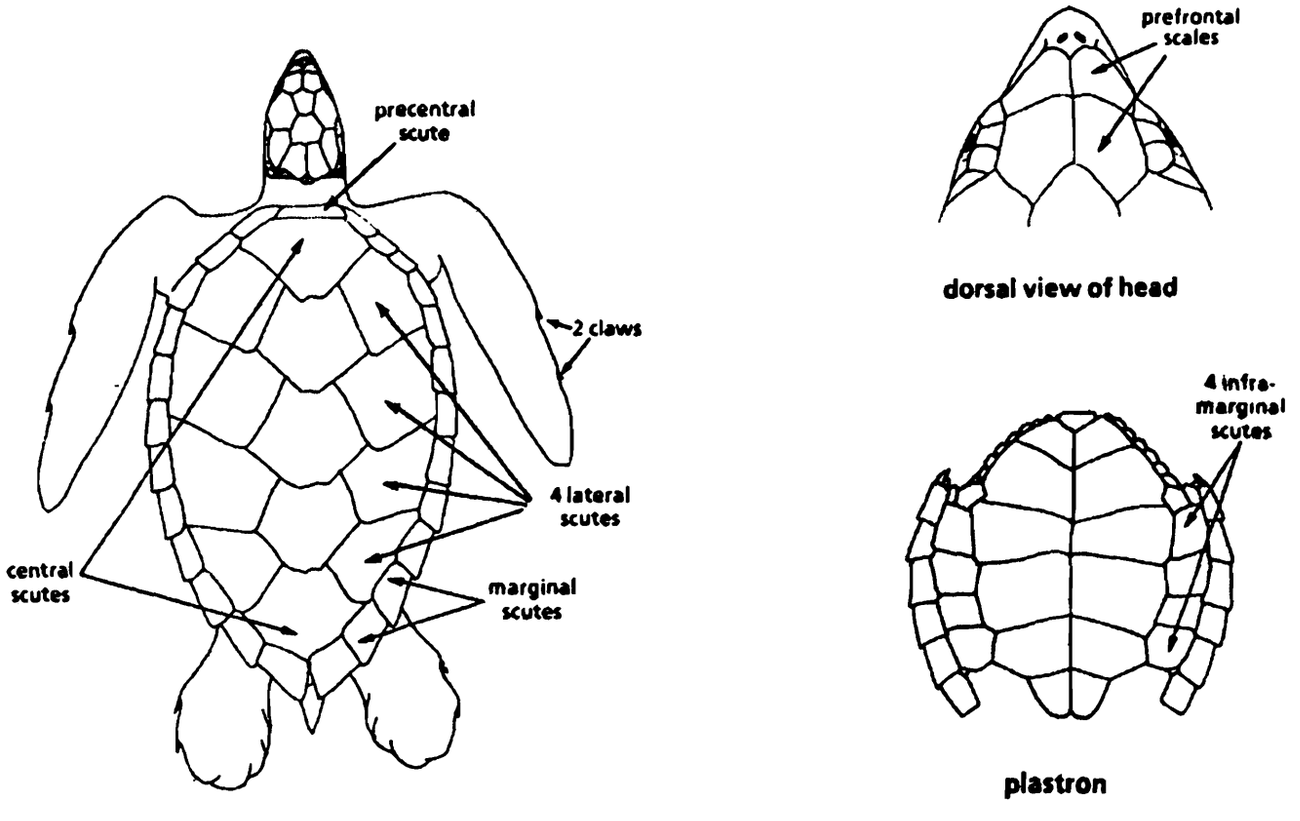

Fig. 3. Schematic view of *Eretmochelys imbricata*

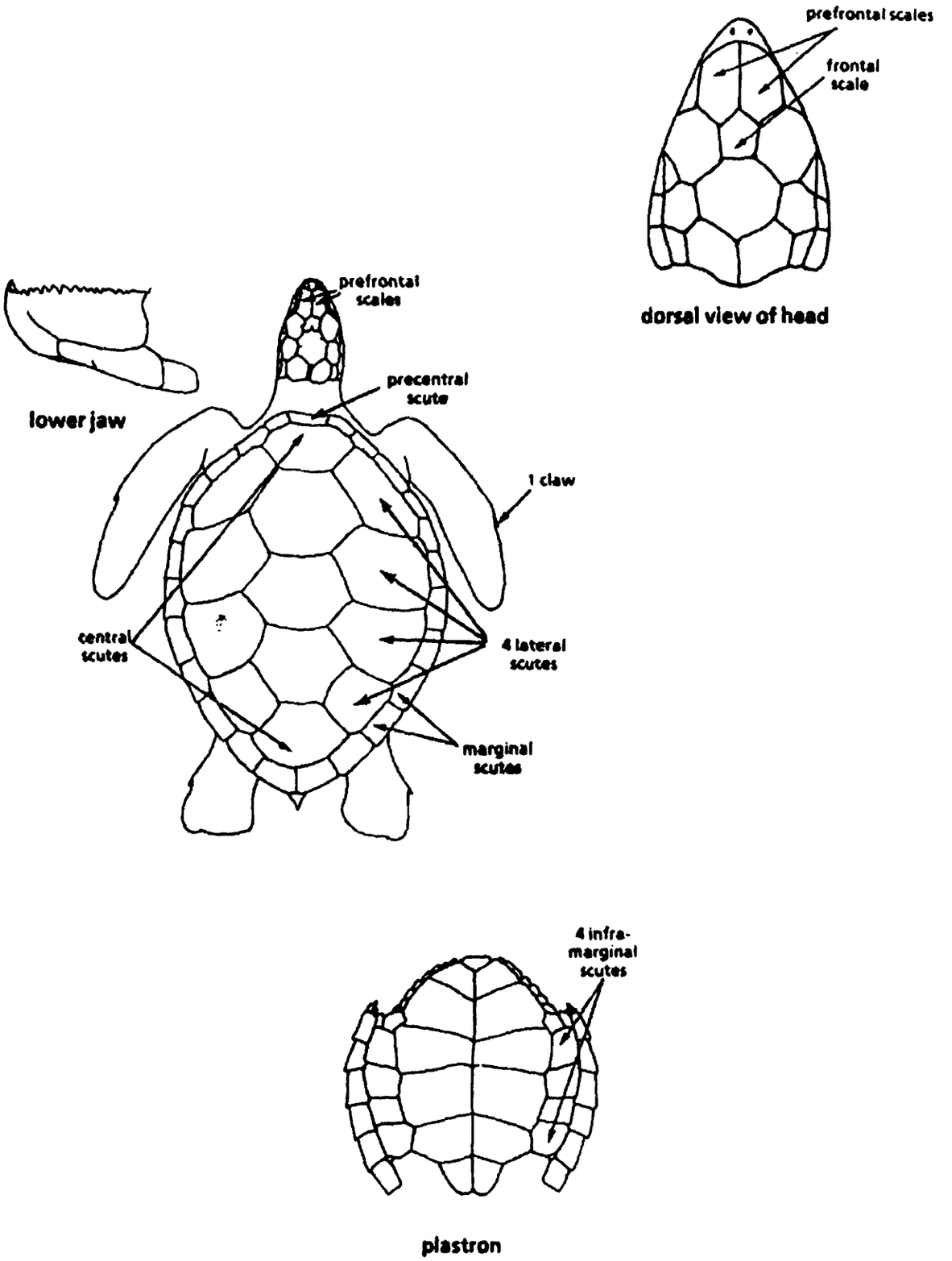

Fig. 4. Schematic view of *Chelonia mydas*

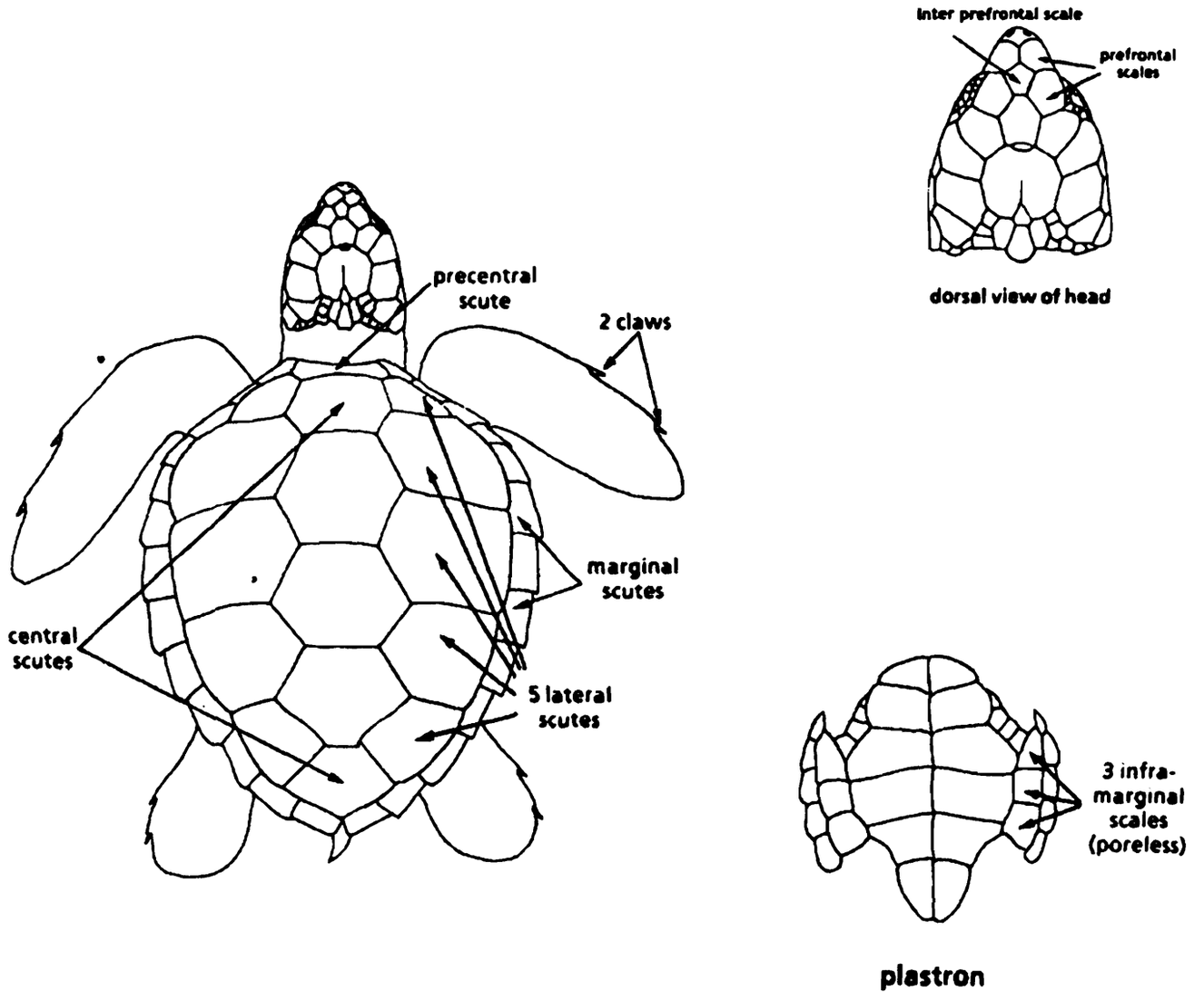

Fig. 5. Schematic view of *Caretta caretta*

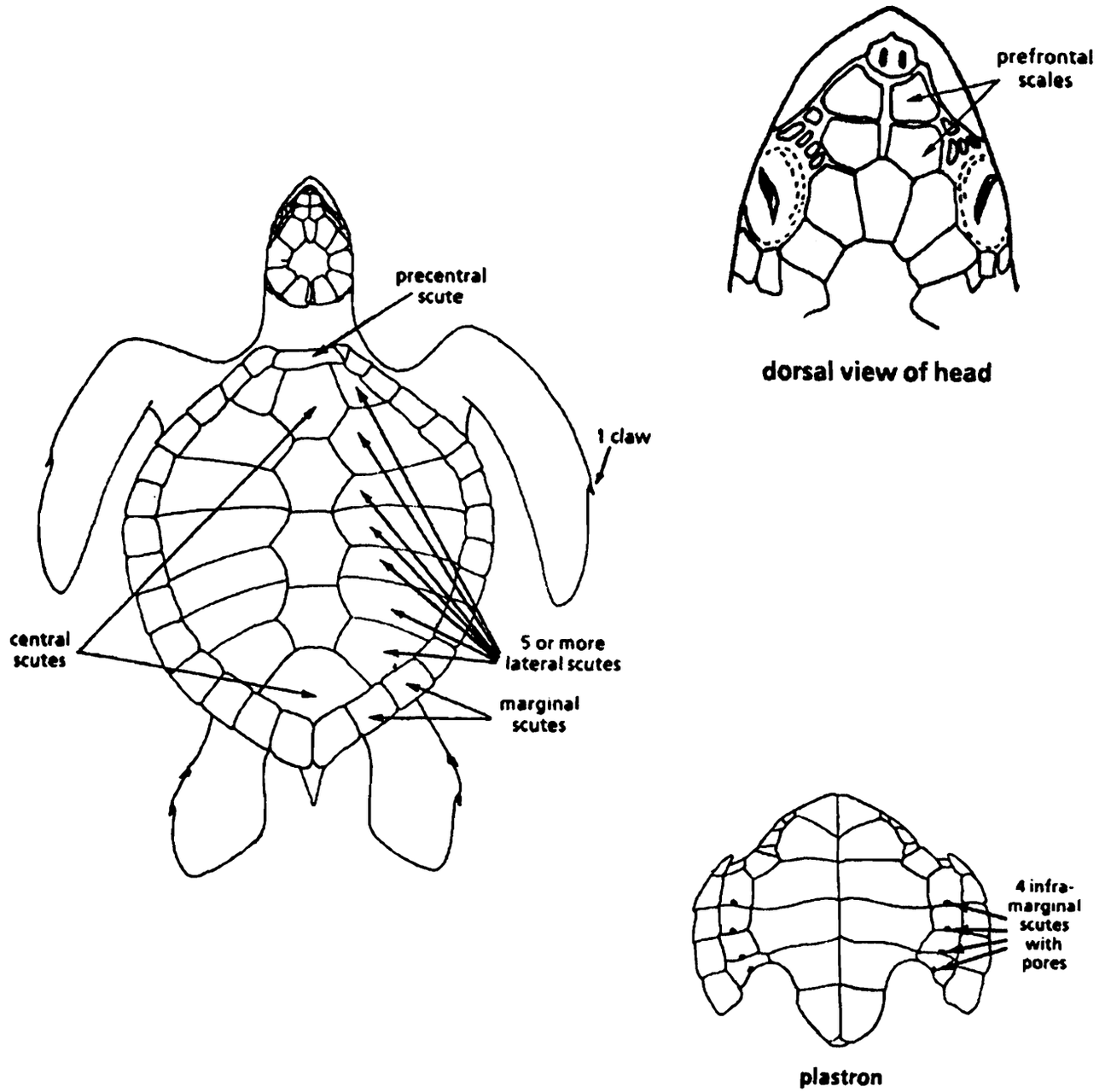

Fig. 6. Schematic view of *Lepidochelys olivacea*

1. *Chelonia mydas* (Linnaeus, 1758) (Fig. 7)

1758. *Testudo mydas* Linnaeus, *Systema Naturae*, Ed. 10, T. 1 : 197.

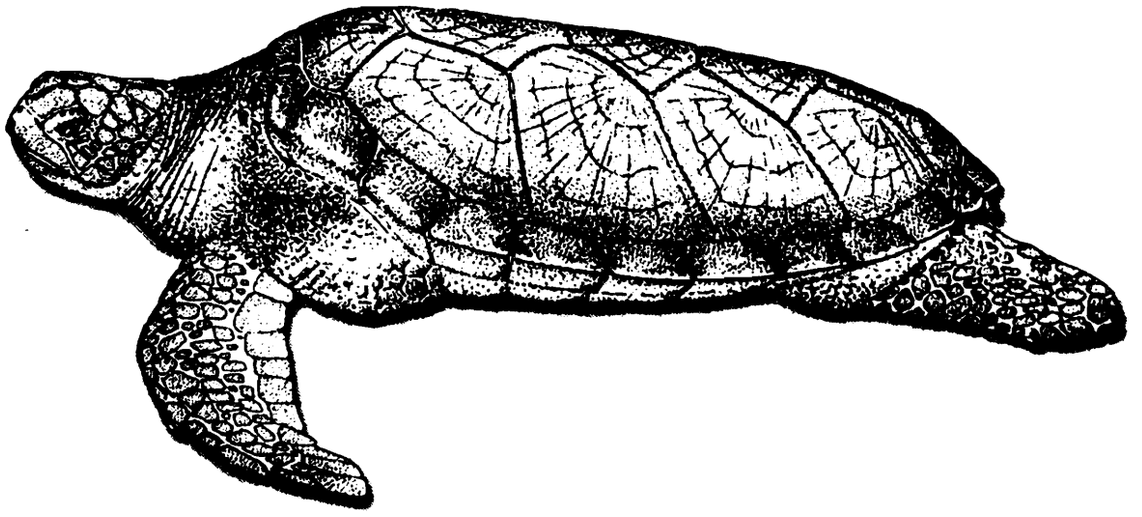

Fig. 7. Lateral view of *Chelonia mydas*

Morphological Features : Body depressed in adults, carapace oval in dorsal view, its width about 88% of its length. Head relatively small and blunt, about 20% of the carapace length; one pair of elongated prefrontal scales between the orbits; tomium of lower jaw with a sharply serrated, cutting rim that corresponds with strong ridges on the inner surface of the upper tomium, which loses its tip cusp with age. The carapacial scutes are thin, smooth and flexible when removed. Those of the dorsal side include 4 pairs of lateral scutes, the foremost not touching the precentral scute; 5 central scutes, low keeled in juveniles, but lacking a median keel in subadults and adults; and usually 12 pairs of marginal scutes. On the underside, the scutes are also smooth and rather thin and comprise 4 pairs of inframarginal, 12 pairs of central plastral, usually one intergular and sometimes one internal scute. Each flipper has a single visible claw.

Colour : On the dorsal side, the general appearance varies from pale to very dark and from plain colour to brilliant combinations of yellow, brown and greenish tones, forming radiated stripes, or abundantly splattered with dark blotches. The pacific populations are more melanistic than the Atlantic ones. In juveniles, the scales of the head and upper sides of the flippers are fringed by a narrow, clear, yellowish margin that is lost with age. Ventral side, the Atlantic forms are plain white, dirty white or yellowish white; the pacific forms are dark gray bluish green. The newborn hatchlings are dark brown or nearly black on the upper side, the carapace and the rear edges of the flippers with a white margin. Underneath they are white. The popular name of green turtle is due to the olive taint that suffuses the dorsal aspect of the adult.

Geographical Distribution : Widely distributed in tropical and subtropical waters, near continental coasts and around islands, rare in temperate waters. Together with the hawksbill the green turtle is the most tropical of the marine turtles. The green turtle ranges throughout the Atlantic, Pacific and Indian oceans primarily in the tropical regions. In India the green turtle usually inhabits shallow waters less than 25 m in depth and prefers areas sheltered by reefs where it feeds on algae. Generally distributed throughout the Indian and Pacific Oceans. In India it is found in abundance in and around the Krusadai and the Andaman and Nicobar group of Islands.

Habitat : It is a typical solitary nektonic animal that occasionally forms feeding aggregations in shallow water areas with abundant sea grasses or algae. This species migrates from rookeries to feeding grounds, which are sometimes several thousand kilometers away. Nearly all migrations are performed along the coasts. The major important nesting grounds are always found in places with seawater temperatures mainly over 25°C. Male green turtles are characterized by a long tail that is tipped with a heavy nail. Females have short tails, which barely reach beyond the rear of the carapace.

Natural History : The adult Green turtle's average weight is 136 kg with a carapace (top shell length of 1.07 m. There are two types of green turtles, the ones that live in the Atlantic Ocean and the others that live in the Pacific Ocean. While they are usually considered to be the same species, geographic separation has caused them to evolve slightly differently. For example, the green turtles that live in the Pacific have longer limbs than the turtles in the Atlantic. The Pacific population of green sea turtles is also known as the black sea turtles. Green turtles are able to swim very long distances, sometimes migrating up to 2,253 km between their feeding grounds and their nesting site.

Food : Adult green sea turtles are herbivorous, and their food includes sea grasses and algae. Young green sea turtles however are omnivorous. During daylight hours, green turtles browse in shallow water, which supports large amounts of submerged vegetation. Seaweed and grasses are the preferred foods but molluscs, jellyfish and sponges are also eaten. At night, the turtle sleeps on the shallow bottom as well as out of the water on rocky ledges.

Reproduction : There are many speculations about the age at first maturity. The size and age at which the sexual maturity is reached, show variations among individuals of the same population and the differences are more remarkable while comparing isolated populations. In captivity, green turtles reach 35 kg in weeight in about 3 years and start to reproduce in less than 10 years.

Reproduction involves courtship, copulation and nesting. Several males court a single female, near shore, copulation begins early in the breeding season and stops when nesting begins; usually the females avoid mating after they have laid the first clutch. It is hypothesized that fertilization of the eggs laid in any nesting season takes place several years before, and that the last encounter between males and females probably serves to fertilize eggs for the next season. New studies of the turtles in captivity show that fertilization occurs early in the season and that excess sperm is probably stored and used in the fertilization of later clutches,

and there may even be enough sperm for some clutches of the next season. Apparently there are no variations among hatch rates of successive clutches within the season, but rates of fertility vary, and a few are infertile.

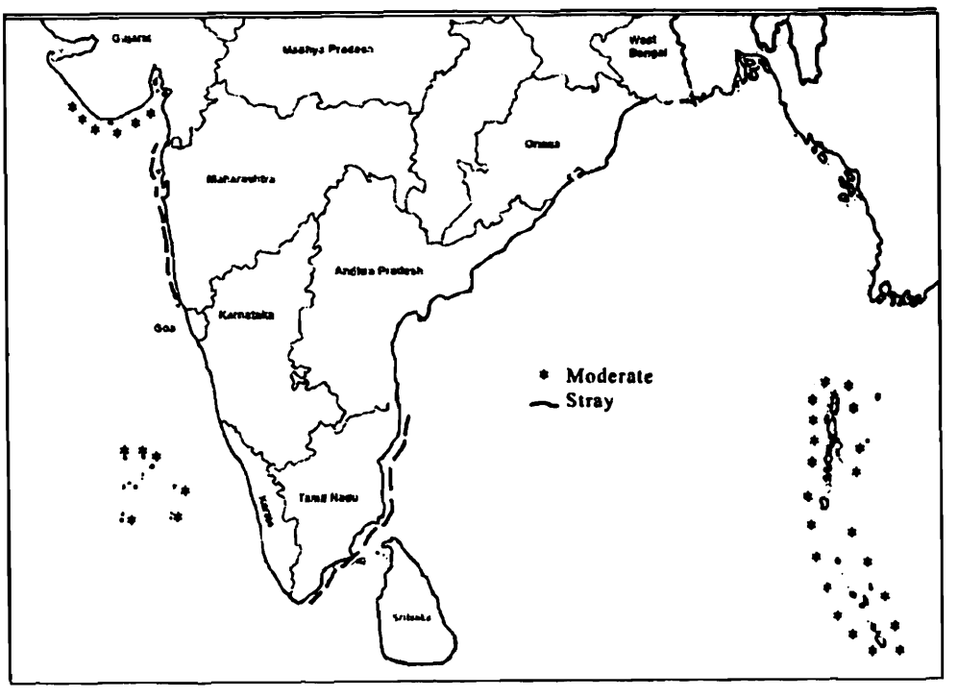

Fig. 8. Recorded nesting sites of *C. mydas* in India

Nesting : The females return to the very same beach where they first hatched, to lay their eggs. The interval between successive seasonal nesting migrations depends on population, feeding ground quality and remoteness. Usually there is two year breeding interval, but the turtles may breed in cycles of one, 3 or 4 years. or switch from one to another cycle, as a result of ageing or external influences (Food quality and quantity). The successive nesting within the same season are separated by intervals of about two weeks. Adults mate every 2 to 3 years during the nesting season just off the nesting beaches. Nesting occurs in the beaches. The females may nest several times during a season, laying as many as 150 soft, round white eggs per nest.

Incubation : Egg incubation on the sand beach normally extends from 48 to 70 days; the duration of the incubation is related to temperature and humidity, which change in the course of the season; hence it will be longer in cool weather conditions. Hatching and emergence occurs mostly at night and stop when the sand becomes hot. Hatching usually occurs 6 weeks to 2 months after laying. The newly hatched turtles emerge from the nest at night and make their way to the nearby sea. The colour of the hatchlings is black above and white below, probably an adaptation to nektonic life at the water surface and makes the turtle less conspicuous to fish and bird predators.

Natural Threats : There is high predation throughout the life cycle of green turtles, the eggs are consumed by mammals such as raccoons, shunks, opposums, mangooses, coatis, domestic pigs, dogs and also jaguars, and by other animals like the monitor lizards, ghost crabs, ants, fly maggots. When the hatchlings reach the water the main predators are sea

birds and carnivorous fishes. This predation continues until the turtles reaches a size big enough to avoid being swallowed. Sharks are the formidable enemy throughout the life cycle of green turtles.

Human impacts : The flesh and eggs of the green turtle have long been a source of food wherever available. People in lesser-developed countries still actively search for the turtle and its eggs. Exploitation of the nesting grounds either by human interference or pollution poses the greatest threat to the green turtle's future. Incidental catches by commercial fishing trawlers previously was a significant factor in mortality. Commercial fisheries now use techniques that reduce mortality due to fishing nets. For better management and developing a conservation program, all aspects of the biology and life history of the green turtle must be studied. There is little information concerning distribution and abundance, population parameters, habitat quality, human-induced mortality as well as other things that would greatly enhance man's understanding of this species.

The main commercial fishing gear used to catch green turtles are: entangling nets, drift nets, harpoons, grapnets, hooks and also turning nesting females onto their backs. Adults are often taken as bycatch in shrimp trawls, set nets, gill nets and beach seines and juveniles are sometimes captured with castnets. The other common methods are spear gunning by scuba divers and live fishhooks.

Economic Importance : The green turtle is considered as valuable living marine reptiles of the world because it's flesh has long been known as a delicacy. The flesh of this turtle is good to eat and is also the main source of the famous "turtle soup" on account of which the turtle itself is called by Germans as "Soppenchild krote" (soup turtle). In addition to its flesh, the eggs of a green turtle are a staple diet for natives in several parts of the world. Green turtle is also sought for their oil, which is used in the manufacture of cosmetics. The baby turtles are killed, cured, stuffed and sold as ornaments. Everything except the shell is edible. The blood of this turtle is also in demand in Tuticorin, Tamil Nadu where it is believed by the locals to be an elixir (Balazs, 1979; Harless and Morlock, 1979; Pritchard, 1979; Mittal, 1987; Marquez, 1990; Das, 1985; Tikader and Sharma, 1997; Sharma, 1998; Fugazzatto and Behera, 1999).

Factors responsible for extinction

- Large scale poaching of adult turtles for meat, shells and leather
- The drowning of sea turtles in shrimp nets
- Accidental catch and drowning of sea turtles in tuna and swordfish fisheries
- The development and destruction of nesting beaches
- General pollution of the oceans
- Commercial exploitation of sea turtle eggs.

2. *Eretmochelys imbricata* (Linnaeus, 1766) (Fig.9)

1766. *Testudo imbricata* Linnaeus, *Sys. Nat.*, Ed. 12. Vol. 1 : 350p.

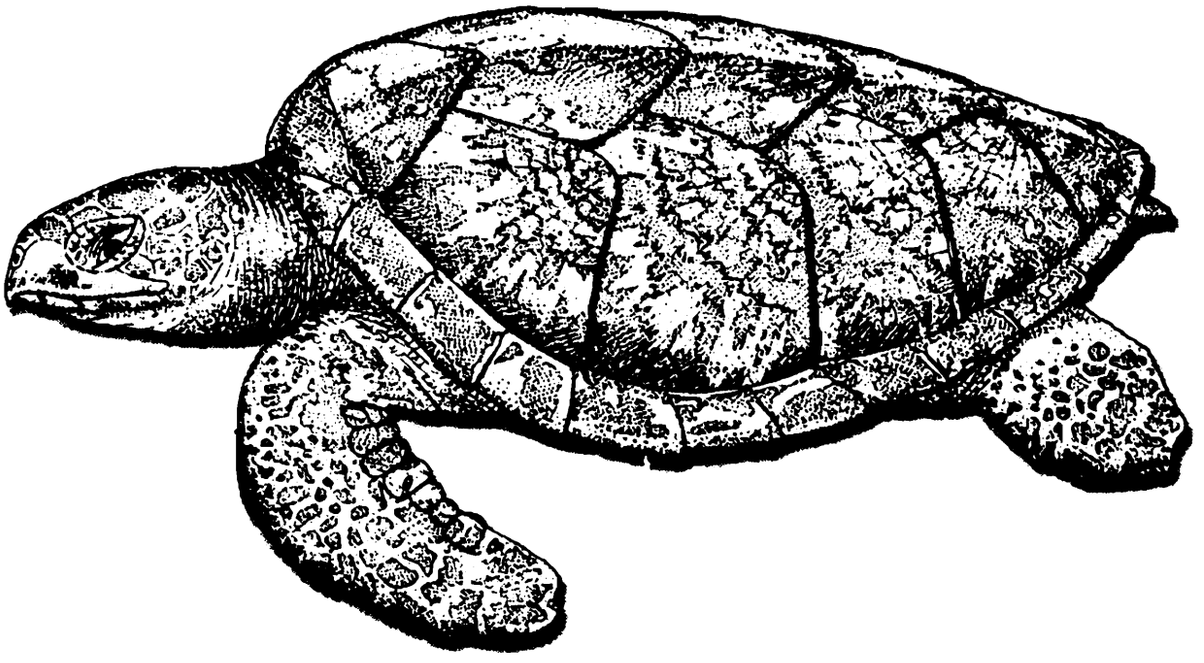

Fig. 9. Lateral view of *Eretmochelys imbricata*

Status : Schedule I of the Indian Wild Life Protection Act, 1972.

Morphological Features : It is a small to medium sized turtle with shell lengths up to 36 inches. Although similar to the green turtle, hawksbills have a shield-shaped carapace with keels on the vertebral scutes. The scutes may overlap or abut each other depending on the animal's age. Head is medium sized, narrow, with a pointed beak; 2 pairs of prefrontal and 3 or 4 postorbital scales; tomium not serrated on the cutting edge, but hooked at the tip. The narrow and elongated snout and the thick scutes of the carapace are adaptations to cope with waves and to obtain food from between corals and rocky substrates.

The scutes are most strongly imbricated at maturity, but in older animals the overlapping character is frequently lost. The snout is long and narrow, hence the common name hawksbill. Males are distinguished from females by their long tails, which extend beyond the rear margin of the carapace and a concave plastron. Hawksbills have a slender body and head, and a narrow beak that resembles that of the hawk. It is the only sea turtle whose scutes, sections on the outer carapace, overlap each. Hatchlings and juveniles have a wider carapace than adults.

Colour : This species is the most colourful among sea turtles. The pattern shows a large range of variation, from very bright colours to the heavy melanistic forms in the eastern Pacific. Carapacial colouration generally is dark greenish-brown and plastral colouration is yellow. The head scales are black to brown with the scale margins being somewhat lighter. The throat is yellow.

Geographical Distribution : The hawksbill is found principally in the warmer waters of the Atlantic, Pacific and Indian oceans from Japan to Australia and the British Isles to Southern Brazil. Hawksbills live around coral reefs, rocky shallows, shallow coasts and lagoons in tropical and sub tropical seas. It is distributed throughout the Central Atlantic and Indo-Pacific regions. The population is lower than the olive ridleys.

Habitat : Hawksbill turtles live in clear, littoral waters of mainland and island shelves; they perform migratory movements that cause variations of population density in certain areas and seasons. Frequently, individuals of several age groups are found together on the same feeding grounds.

Natural History : Much is still to be known about the hawksbill except that it is most active during the daytime. Hawksbills are aggressive when handled and bite readily with their strong, sharp jaws. Adult's average weight is 55 kg with a carapace (top shell) length of 8 m. Its shell, recognized as the most beautiful, is reddish or dark brown.

Food : It eats anything but has a preference for invertebrates such as sponges, jellyfish, sea urchins, molluscs and crustaceans. Hawksbills sometimes eat poisonous sponges. However, the poison does not harm them and they store it in their flesh. For this reason, hawksbill meat is often poisonous.

Reproduction : In this species, age at sexual maturity is uncertain; old reports quote ages from 3 to 4.5 years, but these figures were obtained from turtles reared in captivity, for wild stocks they may be much higher. There are few reports on courtship and mating observed in shallow waters. Mating occurs off the nesting beaches during the nesting period. During mating, the male holds the female by using its claws and tail, and this operation may last several hours. It has been observed that females are more receptive after nesting and that

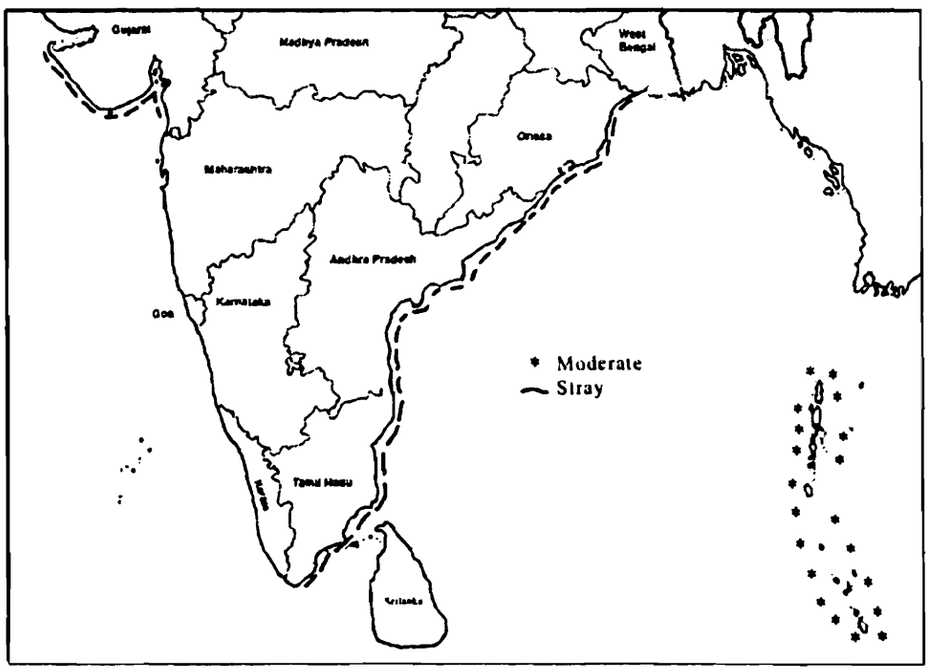

Fig. 10. Recorded nesting sites of *E. imbricata* in India

they commonly receive attention from several males and have no preference for any special partner. Hence, polygamy is the normal pattern.

Nesting : The hawksbill turtle has repeatedly been considered a solitary nester; although it does not form real arribazones there are few nesting beaches where females arrive in large groups. As in other turtles, the hawksbill shows nesting site fixity, which is more frequently observed among older individuals. However, subsequent nesting on beaches other than the original one also seems to be possible. Nesting occurs during the warm and rainy season, principally in summer, but it generally starts at the end of spring. This turtle has a nesting cycle of 2 or 3 years. In successive nesting periods, females may show irregularities during the same nesting season. Females may lay 2 to 3 clutches over a nesting period. 15,000 to 25,000 females nest each season in at least 60 different tropical and subtropical countries.

Incubation : The optimal incubation temperature ranges from 27.3° – 31.8° C. Hatchlings emerge mainly during the first hours of the night, when sand temperature is below 28° C, above this temperature their activity is inhibited. As in other species, the small turtles run rapidly to the surf zone; after reaching the sea they disappear for an unknown period and are again observed when approaching coastal shallow waters at sizes usually over 20 cm of carapace length.

Natural threats : As the other sea turtles, this species is subjected to predation throughout its life cycle. The eggs and embryos are consumed by several species of ghost crabs. Predation affects the hatchlings in and outside the nest. Mammals such as mangooses, coatis, domestic pigs, dogs and also jaguars, and other animals like the monitor lizards, birds like frigates, herons, vultures, kites and crows eat hatchlings when they emerge in daytime.

Human impacts : These turtles are exploited only for their meat and eggs. The hawksbill is the source of tortoise shell products, and harvest of the turtle for its shell poses the greatest immediate threat to its survival. Exploitation by man of its nesting beaches and pollution pose a long-term threat to its survival. Its eggs and flesh are hunted for food frequently. Hawksbill is usually captured by turning over (up side down) the females when they crawl onto the beach to nest. Spearguns, harpoons, hooks and ropes are also used to capture the hawksbills. Much more information on this little known species is needed to apply an effective conservation and management program.

Economic Importance : The economic importance of hawksbill turtle is well documented. The eggs are sold as delicious cuisine in many parts of the globe. The eggs are also considered to be aphrodisiac. Different parts of the body are used in industries viz. leather, oil, perfume and cosmetics (Maiti *et al.*, 2001). The Hawksbill turtle although not eaten, is famous for it's dermal plates, which are used as the famous turtle shell. This shell is known as Carey and is the famous product derived from turtles (Harless and Morlock, 1979; Pritchard, 1979; Mittal, 1987; Marquez, 1990; Das, 1985; Tikader and Sharma, 1997; Sharma, 1998; Fugazzatto and Behera, 1999).

Factors responsible for extinction

- Large scale poaching of adult turtles for their beautiful shells, oil and leather.
- Commercial exploitation of sea turtle eggs
- The drowning in shrimp nets
- The development and destruction of nesting beaches
- General pollution of the oceans.

3. *Caretta caretta* (Linnaeus, 1758) (Fig. 11)

1758. *Testudo caretta* Linnaeus, *Systema Naturae*, Ed. 10, T. **1** : 197.

Status : Schedule I of the Indian Wild Life Protection Act, 1972.

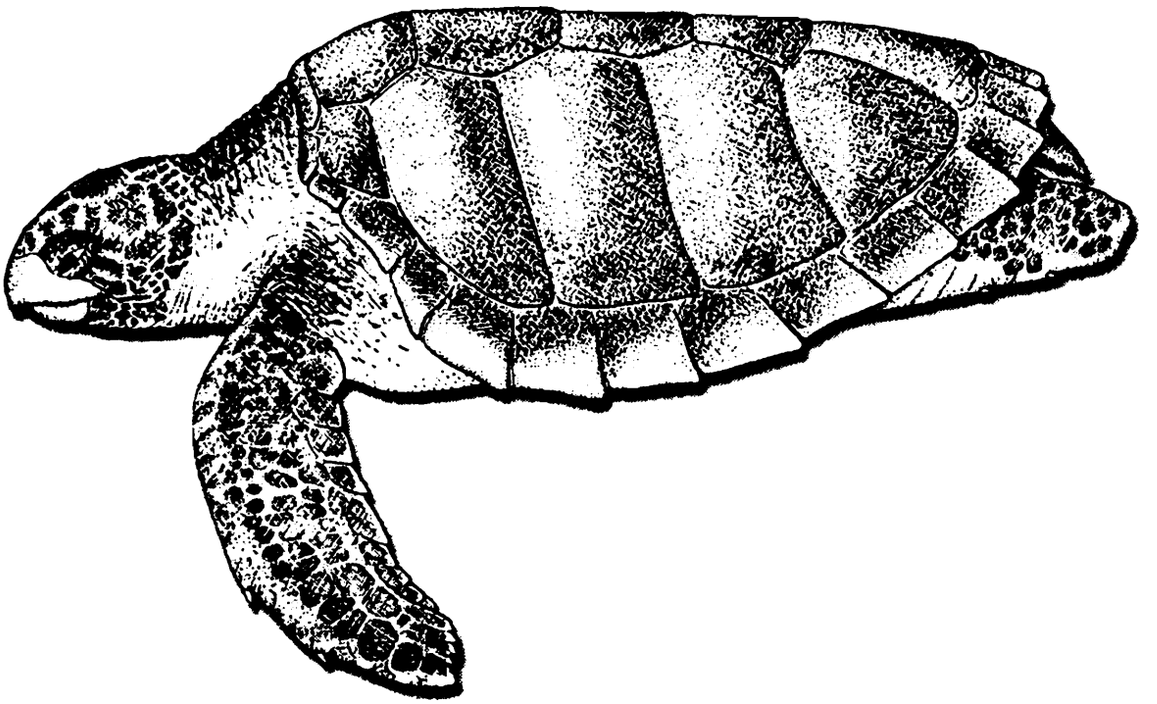

Fig. 11. Lateral view of *Caretta caretta.*

Morphological Features : It is said to be the largest member of the family Chelonidae. In adults, the carapace in dorsal view is heart shaped, its width about 76 to 86% of its length, with 2 pairs of prefrontal scales, and commonly one interprefrontal; horny beak very strong, comparatively thicker than in other sea turtles. Carapacial scutes are thin, but hard and very rough, commonly covered with barnacles. They include 5 pairs of laterals, the anterior

touching the precentral scute, 5 centrals and commonly 12 to 13 pairs of marginals, including the postcentral or pygal scute. Underneath the bridges of the plastron, there are 3 pairs of infra marginal scutes which rarely have pores. Fore flippers relativey short and thick, each with 2 visible claws on anterior margin; rear flippers with 2 or 3 visible claws. The carapace length is about 90 cm. There are five or more pairs of costal shields. Complete adults have ossification of carapace.

Colour : The adults have a constant dorsal pattern easily recognizable by the reddish brown colouration, sometimes with dark streaks. The hatchlings are dark brown dorsally, with the flippers pale brown marginally and underneath, and the plastron usually is much paler.

Geographical Distribution : *Caretta caretta* is widely distributed in coastal tropical and subtropical waters around the world. It is suspected that some loggerheads undertake long migrations using warm currents that bring them far from the nesting and feeding grounds. It is distributed throughout Pacific and Indian Ocean. It is particularly abundant in Andaman Islands and in the coasts of Sri Lanka. Loggerheads live in coastal bays, estuaries, lagoons and open oceans in warm and temperate waters.

Habitat : This turtle primarily is an inhabitant of continental shores of warm seas, common in shallow waters, but it also lives around some islands. The most important aggregations are temporarily formed just off the nesting beaches at the end of the spring, in summer and at the beginning of autumn. In some places, the nesting grounds are associated with underwater refuges such as crevices in rocky or reef points, near to the nesting beaches where the turtles remain throughout the reproductive period.

Natural History : Adults average weight is 113.5 kg with the carapce (topshell) length of 91 cm. The shell is brown to reddish brown in colour. The loggerhead is well adapted to its sea life. It has long flippers and special glands that help it to drink salt water. While the loggerhead is a relatively slow swimmer, it can show amazing bursts of speed when it feels threatened.

Food : The food of the adult loggerhead includes crabs, fish, clams, conches, molluscs, jellyfish, sea urchins, sponges, whelks and shrimps. Feeding behaviour may change somewhat with age, but this species is carnivorous throughout its life. Hatchlings obtain their food from the fauna living in sea grass mats, frequently distributed along the drift lines and eddies. Because of their carnivorous diet, loggerheads compete for food with olive ridleys. During their migration through the open sea they eat jellyfishes, pteropods, floating molluscs, floating egg clusters, flying fishes, squids and lobsters.

Reproduction : Age at first maturity has not been clearly determined yet. Data derived from research in captivity indicate ages from 6 to 20 years. Courtship and mating are usually not performed near or in front of the nesting beaches, but along the migration routes between feeding and breeding grounds. Underwater copulation has also been observed in this species.

It is also possible that through storage of the sperm of one or several males in the reproductive tract of the female, all clutches of the current season can be fertilized without repeated matings. Mating usually is performed several weeks before the nesting season.

Nesting : Major Indian Ocean nesting grounds occur in South Africa. Around the islands of the Indian Ocean, this species is nearly unknown. Nesting usually occurs in spring and summer, with variations according to the latitude and geographical characteristics of the coast.The females nest in warm temperate and subtropical areas. They lay from 105-120 eggs in each nest. The temperature of the sand determines the sex of the hatchling during incubation. Warmer temperatures result in female hatchlings and colder temperatures in male hatchlings.

Incubation : The incubation period varies among populations and with beach latitude. Optimal incubation occurs within a limited range of temperatures, usually between a minimum of 26°C and a maximum of 32°C; sex determination is male biased in cool temperatures and the survival rate decreases at the extreme temperatures of this range. As in all the other sea turtles, hatching occurs in the course of several days; it takes several hours for the hatchling to reach the surface of the sand and only a few minutes to emerge from the nests. Emergence occurs mostly at night. After the majority of hatchlings appear at the surface of the nest, they start a frenzied race to the surf and disappear in the waves.

Natural threats : Highest predation occurs in the incubation period and during the race of the hatchlings to the sea. Massive destruction of eggs and embryos is also caused by natural phenomena such as erosion or sea overwash. Eggs, embryos and hatchlings are devoured by a great variety of predators and are also affected by bacterial and fungal diseases. Mammals such as mangooses, coatis, domestic pigs, dogs and also jaguars, and other animals like the monitor lizards, birds like frigates, herons, vultures, kites and crows eat hatchlings. In the marine environment the natural threats to this species are sharks and orcas.

Human impacts : This species is captured for its meat, eggs, leather and skin. It is very common that in places where regulations are not strictly enforced, the eggs are consumed whenever found and also widely commercialized in unknown quantities, generally through illegal markets. The usual harvesting method of this turtle species is turtle turning and harpooning.

Economic importance : Though the flesh of this species is not edible, its eggs are much relished and sought after. The shells are put to good use in the preparation of ornaments (Harless and Morlock, 1979; Pritchard, 1979; Mittal, 1987; Marquez, 1990; Das, 1985; Tikader and Sharma, 1997; Sharma, 1998; Fugazzatto and Behera, 1999).

Stranding Records : A loggerhead was incidentally caught at Digha, West Bengal in 1997 and at Pondicherry (Swapankumar, 1997a and b).

Factors responsible for extinction

- Large scale poaching of adult turtles for shells, meat and leather.
- Commercial exploitation of sea turtle eggs
- The drowning in shrimp nets
- The development and destruction of nesting beaches
- General pollution of the oceans.

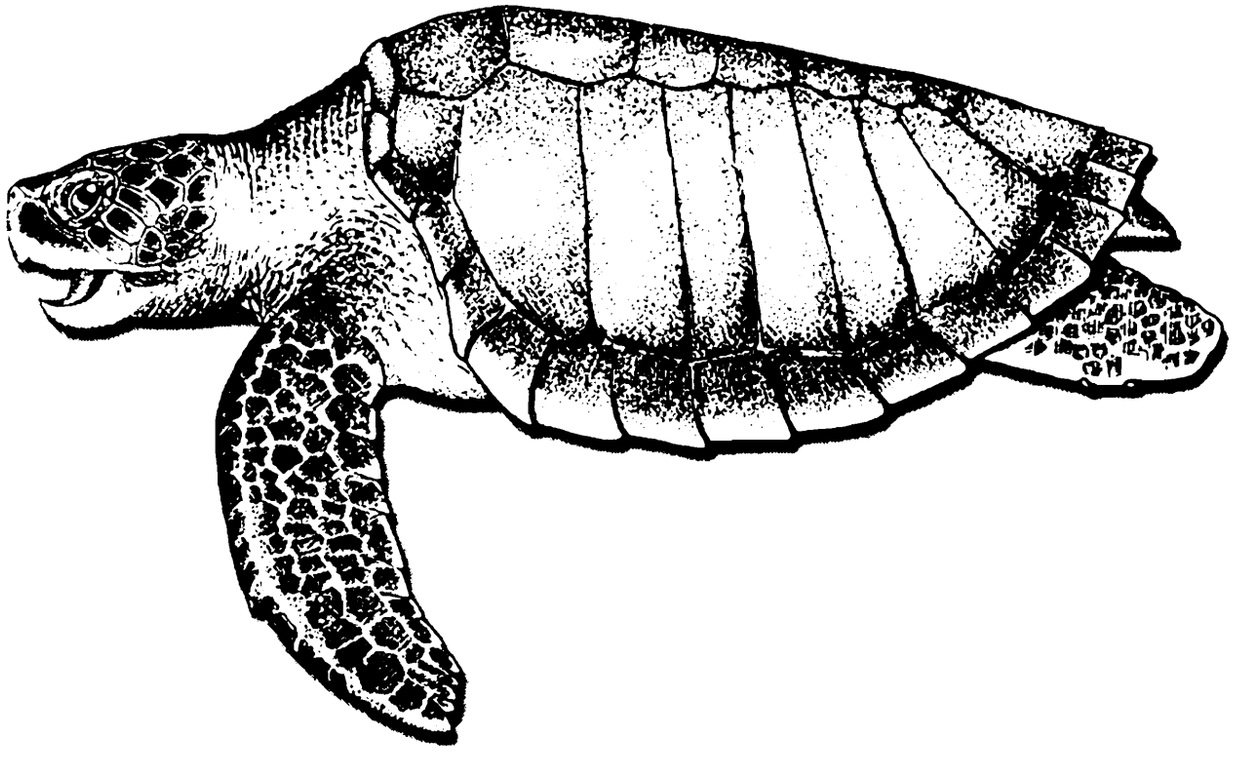

Fig. 12. Lateral view of *Lepidochelys olivacea*

4. *Lepidochelys olivacea* Eschschlotz, 1829 (Fig. 12)

1829. *Lepidochelys olivacea* Eschschlotz, *Zool. Atlas*, **1** : 3.

Status : Schedule I of the Indian Wild Life Protection Act, 1972.

Morphological Features : The olive ridley has a slightly deeper body. In adults, carapace is nearly round, upturned on the lateral margins and flat on top, its width 90% of its length. Head is subtriangular and moderate sized. Scales and scutes have the same configuration as in the Kemp's ridley, but the lateral scutes are often more than five pairs, the first pair is always in touch with the precentral scute. This species also has openings of the Rathke's glands on the plastral bridges, through a pore on the rear part of each inframarginal scute. Four flippers with one or two visible claws on the anterior border, and sometimes another

small claw in the distal part are present; rear flippers have two claws. As in other turtle species, males have larger and more strongly curved claws, as well as a longer tail. It is smallest of the marine turtles. The maximum shield length is about 790 mm. There are more than five pairs of costals. Plastron is with two tuberculate ridges and is smooth in adult. Carapace of the adult is uniformly grey.

Colour : Adults are plain olive gray above and creamy or whitish, with pale grey margins underneath. New born hatchlings, when wet, are almost completely black, sometimes with greenish sides, and general become dark gray after drying. With growth, they change to gray dorsally and white underneath.

Geographical Distribution : Distributed in the warmer parts of the Pacific and Indian oceans. Found abundantly along the coasts of India during the nesting season.

Habitat : The adults of this species are most frequently neritic, traveling or resting in surface waters, but also observations of turtles diving and feeding in 200 m deep have been reported. Basking behaviour on sand beaches is not common. During this kind of basking the upper part of the carapace dries and the turtle has difficulty to dive rapidly, a situation which is used during the capture and is advantageous for any predator. It is also common to observe birds resting on floating turtles.

Natural History : Adult's average size is 39 kg with a carapace (to shell) length of 0.76 m. Their carapace is plain olive gray above with a creamy or white colour beneath. Olive ridleys migrate thousands of miles in the course of a year, between nesting and feeding grounds. Adults travel and rest mostly in surface waters, but have been observed diving and feeding in waters 200 m deep. Olive ridleys spend their entire life in the ocean; only the females come ashore for nesting.

Food : The olive ridley is a facultative carnivore, which is capable of eating a single kind of food for longer periods, such as red lobsters. The food of the adult olive ridley includes lobsters, fish, crustaceans, molluscs, algae, fish eggs and jellyfish.

Reproduction : The age at maturity for the olive ridley is, as in the majority of other sea turtles, uncertain; since it is one of the smallest species, it may mature earlier, probably at average sizes of 62 cm. Courtship in this species is not often observed. Mating is performed near the nesting beaches or along the migratory routes, and occurs principally at the sea surface; the coupling pair may dive if disturbed, and soon afterwards the partners usually swim separately. As in other species, the male holds the carapace of the female with the claws of his four flippers, and mating may last for few minutes to several hours. It occurs before and during the nesting season. Multiple mating of the female, by several males, may occur but has not yet been reported.

Nesting : In general, the nesting season is summer and autumn, with variations from place to place. As in other species, the olive ridleys show nest site fidelity, and it is common to observe the same turtle nesting several times on the same spot of the beach and

also during subsequent nesting seasons; hence the reproductive activity of a turtle can be followed through several years. But there are also records of turtles nesting in different beaches, near or far away from the original one. When the nesting occurs on long beaches, it is common to observe turtles shifting their nesting sites from one section of the beach to another during the nesting season. The olive ridley is one of the two species having a phenomenal nesting behaviour known as *arribada* (Spanish for arrival). Breeding turtles congregate in the waters in front of the nesting beach and then, signaled by some, as yet unknown, cue (possibly the phases of the moon), they emerge from the sea en masse. They

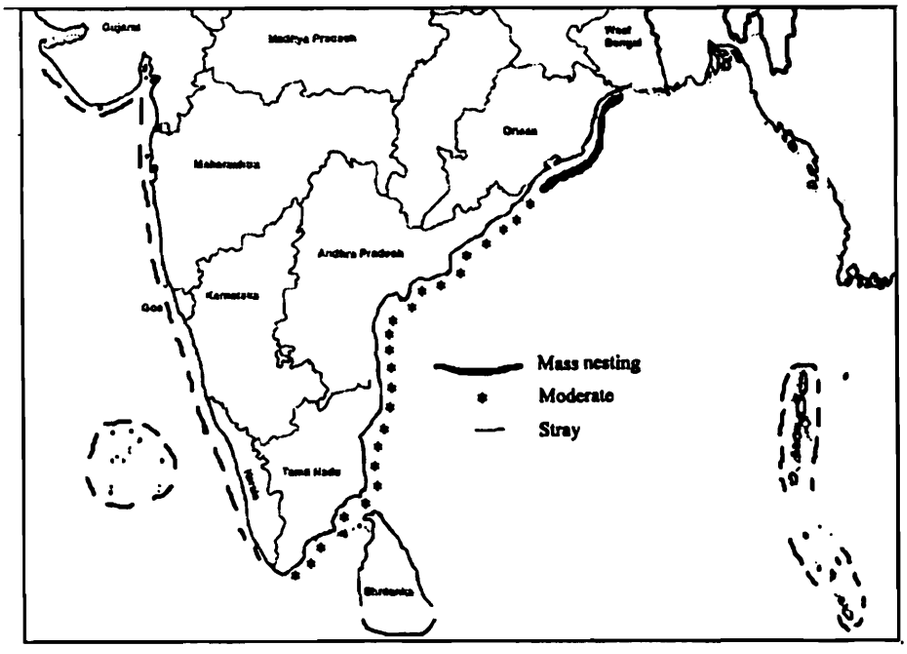

Fig. 13. Recorded nesting sites of *L. olivaceae* in India

return to lay their eggs on the very same beach from which they first hatched. As many as 610,000 females may nest in on *arribada*, which may continue for several days.

Olive ridleys lay about 100 eggs in each nest. Hatchlings incubation takes from 45-65 days, depending on the humidity of the sand and the clutch size (number of eggs laid). When born, hatchlings are about 1.5 inches long and almost completely black. In their race to the water, their dark colouring against the light coloured sand makes them easy prey. It is estimated that only 1 in 3000 eggs laid reach maturity to nest again.

Incubation : The incubation period of the egg clutch usually extends from 45 to 65 days, and is strongly correlated with temperature and humidity; in dry and cold weather, it lasts longer than under optimal temperature and humidity conditions, around 30° C and 14% respectively. Sand grain, organic matter content, clutch size and date of oviposition are the other factors, which influence the incubation period. A shorter incubation period reduces the possibilities for predation and the detrimental effects of bad weather. Depending on the weather conditions at the time of the arrival, the incubation period and hatchout will show different characteristics. If at these times the weather is dry and cold, the sex rate of hatchlings may be biased to males or to females and the success of the incubation substancially reduced.

Natural threats : The predators of olive ridleys include birds, jaguars, raccoons, hyenas, ghost crabs, monitor lizards, feral pigs and dogs. Once they reach the sea, they must contend with sea birds and carnivorous fishes. The major natural predators of adult olive ridleys are sharks and orcas. The time of day at which hatchlings emerge may affect their survival rate; usually they leave the nest between afternoon and early morning; outside this time span they are more easily prayed upon or dried by the hot sun before reaching the surf zone. Predation occurs in daytime and at night; during daytime many kinds of birds and mammals are visually attracted to the contrasting colours of the turtles. At night, predation diminishes, but is accomplished by nocturnal mammals like jaguars, opossums, jackals, hyaenas, feral dogs and pigs.

Human impacts : Hatchling success is affected by direct and indirect disturbance of the beach by man, storm, floods, erosion, dryness, bacterial and fungal invasion and predation. Olive ridleys are usually captured on the breeding or feeding grounds. Monofilament nylon nets similar to those used for sharks also been used to catch Olive ridleys.

Economic Importance : The eggs of this turtle are considered a great delicacy. This turtle yields 25% of its total body weight in meat, in addition to oil, and if industrialized, it provides a high quality protein and residual fertilizer (Harless and Morlock, 1979; Pritchard, 1979; Marquez and Dissel, 1982; Mittal, 1987; Marquez, 1990; Das, 1985; Tikader and Sharma, 1997; Sharma, 1998; Fugazzatto and Behera, 1999).

Current status : The olive ridley population in Orissa has been under severe threat with over 75000 turtles counted dead along the Orissa coast, with much of the mortality attributed to fishery related causes. While the turtles on this coast face several additional threats, one in particular has not so far been documented or assessed (Shanker *et al.*, 1999; Shanker, 2002a and b).

Stranding Records : A male *Lepidochelys olivacea* landed at the Basseein Kolliwada near Bombay in 1991 (Hotagi, 1992). An olive ridley turtle stranded at Janjira Murud Coast of Maharashtra in 1996 (Jadhav, 1996). Incidental stranding of this species is very common along the east coast of India particularly in the coasts of Orissa. Considerable number of olive ridleys landed at Pamban, Tamil Nadu and Ratnagiri Coast in 1988 (Kasinathan, 1988; Pillai and Kasinathan, 1989; Katkar, 1989 and 1996).

Factors responsible for extinction

- Large scale poaching of adult turtles for shells, meat and leather.
- Commercial exploitation of sea turtle eggs
- The drowning in shrimp nets
- The development and destruction of nesting beaches
- General pollution of the oceans.

5. *Dermochelys coriacea* (Vandelli, 1761) (Fig. 14)

1761. *Testudo coriacea* Vandelli, *Epistola de Holoturio et Testudine Coriacea ad Celeberrimum Carolum Linnaeum*, Padua : 2 (Maris Tyrrheni oram in agro Laurentiano).

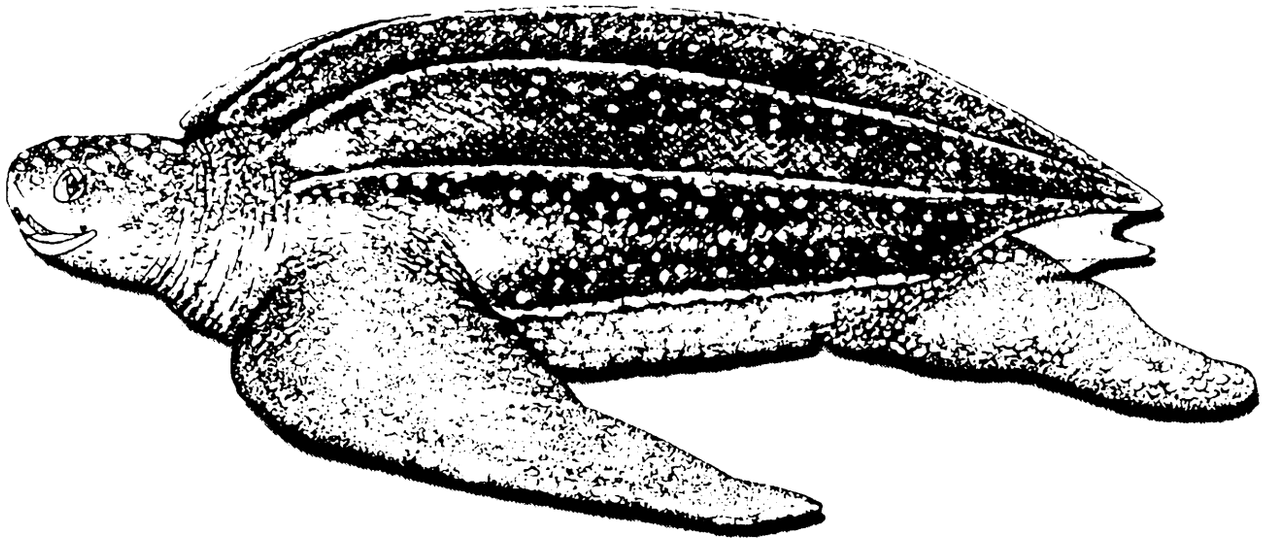

Fig. 14. Lateral view of *Dermochelys coriacea*.

Status : Schedule I of the Indian Wild Life Protection Act, 1972.

Morphological Features : The leatherback is the largest of all living reptiles reaching about 8 feet in carapace length. It is known as an open sea turtle that weighs 1,300 pounds. Occasionally, it enters shallow bays and estuaries. Unlike other marine turtles, the leatherback has a shell sleeps floating on the surface. The leatherback probably composed of a leather-like covering that is smooth, it eats anything but has a preference for jellyfish. Mating occur off the coast of the nesting beaches. The head of the adult leatherback is small, round and scaleless; beak is feeble, but sharp edged, lacking crushing surfaces, well adapted to grab sluggish pelagic food; upper jaw has two pointed cusps in front; lower jaw with a single pointed central hook that fits between the upper cusps, when the mouth is closed, giving the appearance of a 'w' in front view; part of mouth cavity and throat is covered with rows of posteriorly directed spine like horny papillae that prevent the prey from moving outward.

Colour : Adults show certain variability in colour pattern. Dorsal side essentially black, with scattered white blotches that are usually arranged along the keels. Pinkish blotches on neck, shoulders and groin becoming more intense when the turtle is out of water, probably due to blood congestion in the skin vessels.

Geographical Distribution : Leatherbacks live all around the world, in both tropical and subtropical seas. Since they are highly migratory, they have been spotted as far north as Nova Scotia and as far as south as Chile. They occur in the tropical seas of the Atlantic, Pacific and Indian oceans.

Habitat : The leatherback turtle is a highly pelagic species that approaches coastal waters only during the reproductive season. It seldom forms large aggregations. It frequently descents into deep waters and is physiologically well adapted to deep diving.

Natural History : The leatherback adult's average weight is 499 kg with a length of 1.8 m. The largest known sea turtle was a male leatherback, which was found on the coast of wales in 1988 and was about 3 m and weighed almost 908 kg. The leatherback is the only sea turtle without a shell. Its outer protection is a leathery, scaleless skin made of tough, oil-saturated tissues raised into seven prominent ridges. This is how the leatherback sea turtle gets its name. This sea turtle dives deeper and swims into colder waters than any other sea turtles because of its ability to regulate it's body temperature. Also, it has more body fat than other sea turtles. Adult leatherbacks have been known to dive upto 1,500 m.

Food : It is assumed that this species is carnivorous throughout its life cycle. The food of the adult leatherback consists primarily of jellyfish, especially lion's mane jellyfish.

Reproduction : Courtship is observed. Courtship lasts for few minutes and the male holds the female with its claws during copulation.

Nesting : Of all the sea turtles, the migratory routes and life history of the leatherback *Dermochelys coriacea* is shrouded in the most mystery (Lutcavage, *et al.*, 2002). The leatherbacks usually nest in autumn and winter when they arrive in large groups at the nesting sites and form "arribazones" The nest is usually constructed just across the high tide mark. Leatherbacks can lay from 50 to 180 eggs per nest.

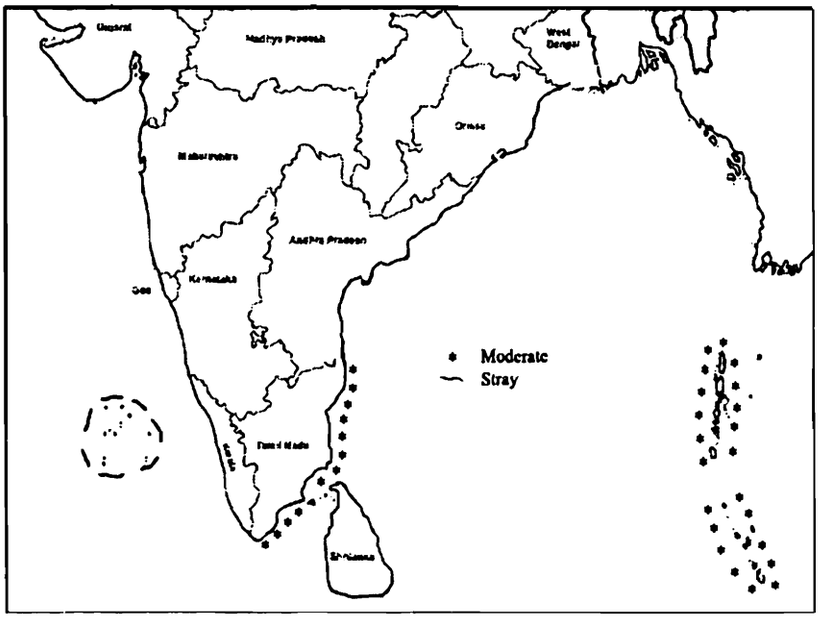

Fig. 15. Recorded nesting sites of *D. coriacea* in India

Incubation : Incubation time ranges from 50 to 70 days or more, in accordance with the weather. The optimal incubation temperature for eggs for this species is around 29°C. The sex determination is male biased in cool temperatures and vice versa. Hatchlings are tiny only 5 to 6 cm long and weigh 45.8 gm.

Natural threats : Eggs and embryos are mostly consumed by ghost crabs throughout the nesting range. Mammals such as mangooses, coatis, domestic pigs, dogs and also jaguars, and other animals like the monitor lizards, birds like frigates, herons, vultures, kites and crows eat hatchlings. Sharks attack juveniles and adults. Leatherback turtles nesting at Galathea, Great Nicobar Island is mostly killed by saltwater crocodiles (Aghue and Glen, 2002).

Human impacts : As is true in most marine turtle species, disturbance of nesting grounds is the most important threat to the Leatherback. This is due mainly to egg collecting by man. As the flesh is considered inedible, few leatherbacks are killed for food. In some countries, however, the turtles are eaten. Others may kill the turtles for sport or through incidental captures in trawlers. Plastic wastes are another cause of mortality, since the turtles confuse these materials with jellyfish and swallow them, thus clogging their throat, esophagus and intestines.

Economic Importance : The flesh is not edible but the eggs are considered a delicacy when fresh. Also, oil is extracted from the eggs. The skin is also of good value (Harless and Morlock, 1979; Pritchard, 1979; Mittal, 1987; Marquez, 1990; Das, 1985; Tikader and Sharma, 1997; Sharma, 1998; Fugazzatto and Behera, 1999).

Current status : The global decline in the number of leatherbacks in the Indian Ocean region has received significant attention in recent times, including predictions of extinction in the near future (Spotila *et al.*, 2000). Spotila *et al.*, (1996) dismiss the population of leatherbacks in the Indian Ocean as minor and also state that they may be under the gravest threat along crocodiles (Andrews *et al.*, 2002; Andrews and Shanker, 2002). Surveys conducted 10 years apart at Galathea, Great Nicobar do not indicate a decline in the population (Tiwari, 1991; Bhaskar, 1993, Andrews *et al.*, 2002). During 2000-01, a total of 1690 nests were counted in Great Nicobar Island (Bhaskar, 1993; Andrews *et al.*, 2002; Andrews and Shanker, 2002).

Stranding Records : A leatherback turtle was caught off Devbag near Malvan with the carapace length of 149.8 cm in 1985 (Karbhari, 1985). A leatherback turtle landed at Rameswaram and Kanyakumari in 1991(Pillai *et al.*, 1995; Ebenezer, 1992). A leatherback turtle washed ashore at Kovalam in 1993 (Rajagopalan, 1983).

Factors responsible for extinction

- Large scale poaching of adult turtles for shells, meat and leather.
- Commercial exploitation of sea turtle eggs
- The drowning in shrimp nets
- The development and destruction of nesting beaches
- General pollution of the oceans.

DISTRIBUTION OF MARINE TURTLES IN INDIA

Five species of sea turtles are occurring in the Indian waters: Olive ridley, green turtle, hawksbill, leatherback and loggerhead. The Leatherback is widely distributed in tropical seas and often visits temperate water zones also. The exact distribution of this species is still unclear. The maximum concentration of the leatherback in the Indian Ocean has been recorded at the Gulf of Mannar, Gulf of Kutch, Okha coast, Goa coast, Tangasseri reef near Calicut, the Palk Bay and in coastal areas of Sri Lanka (Fig. 12).

The Green turtle is circumtropical species, which is widely distributed in tropical and subtropical seas and comes ashore on particular beaches and nests in a colonial fashion. It's maximum concentration has been recorded at Gulf of Kutch, Okha coast, Salm districts in Maharashtra, entire Kerala coast extending south from Quilon, complete eastern coastline of Tamil Nadu and in all coral reef areas in the Gulf of Mannar and Palk Bay.

The hawksbill turtles inhabit tropical and subtropical seas and are not seen in groups, as they prefer an independent life, nesting individually in localities far apart, do not form breeding colonies and prefer to migrate short distances only. Their major concentration is at the coastal parts of southern Tamil Nadu, Kerala, Andaman and Nicobar Islands, Gulf of Kutch, all coral reef areas in the Gulf of Mannar, Palk Bay and Lakhshadweep Islands (Bastinfernando, 1983).

The loggerhead turtles are the most widely distributed species in all the temperate and subtropical waters of the world. They have the habit of migrating long distances and nesting takes place in a colonial fashion. The exact nesting location of this species in India is still unclear. The maximum concentration of this species has been reported from southern Tamil Nadu coast and coral reef areas in the Gulf of Mannar and Palk Bay.

The Olive Ridley turtle has a wider tropical range in Indian, East Pacific and Eastern Atlantic Oceans. The maximum concentration of this species has been reported from the coasts of Maharashtra, Goa, Kerala, south Tamil Nadu, Andhra Pradesh, Orissa, Andaman Islands, Gulf of Mannar, southern coasts of Sri Lanka, Lakhshadweep Islands.

Coastwise Distribution of Sea turtles in India (Fig. 16; Table.1)

WEST COAST

Gujarat : Four species of turtles are recorded from Gujarat and they are *Lepidochelys olivacea, Chelonia mydas, Dermochelys coriacea* and *Eretmochelys imbricata* (Sunderraj *et al.*, 2001). The best nesting locations on the west coast of India are in Gujarat, where the olive ridley nests everywhere on the available sandy beaches but the most favoured beach is a 2.5 km beach on Bhaidar island in the Gulf of Kutch. The green turtle is found to nest commonly in Kutch district and on the western and southern shores of the Saurashtra Peninsula. The hawksbill, loggerhead, and leatherback are encountered rarely by the fishermen.

The mangrove swamps of the northern shore of Saurashrtra Peninsula leave little nesting habitat suitable for olive ridley and practically none for green turtle which require nesting beaches where the sand above high tide level is deeper and covers more expanse. However, the sea grass beds and coral reefs in this area especially in Karumbar Islands provide food for a considerable population of green turtles. There is a possibility that some of the green turtles that feed in the Gulf of Kutch migrate to the nesting beaches at Sandspit and Hawkes Bay near Karachi, Pakistan. More number of olive ridley nesting and green turtle nesting have been reported on the Saurashtra Peninsula's western coast between Okha to Veraval, than on the southern coast between Veraval to Gogha. Uninhabited Bhaidar island and the little disturbed Piram island are also important olive ridley nesting areas. Bhaidar has a 2 km long sandy beach of which half-kilometer stretch on its northeastern end is favoured by nesting ridleys.

Maharashtra : Green and olive ridley turtles occur in Maharashtra waters. Report on other turtle species is scarce. According to World wide distribution of seaturtles nesting beaches by sea turtle Rescue Fund Centre for Environmental Education, the minor nesting places of green turtle in Maharashtra are Bombay (Chaupati) and Dhahanu and for olive ridley, Alibag and Ratnagiri. Major aggregation of olive ridley is observed at Bombay and Dahanu. Gorai, Khim. Manowrie and Versova have also recorded nesting of olive ridley (Shaikh, 1984).

Goa : Goa's 160 km coastline consisting sandy beach inherently suitable for sea turtles to nest on, the remaining coast being mostly rocky. In Goa, six major rivers including the Zuari and Mandovi flow into the Arabian Sea. Generally the leatherbacks favour beaches near river mouths, in order to nest on. It appears very likely that Goa's beaches once hosted large nesting populations of this species prior to man's intervention. Green turtle and olive ridley nestings are reported from the beaches of Goa. The declining trend in the annual nesting of turtles is attributed to the increasing commercial exploitation of the beaches.

Karnataka : Turtle nesting has been observed in few places in Karnataka (Chandarji, 1984).

Kerala : Four species of marine turtles such as Olive ridley, green, hawksbill and leatherback are known from Kerala waters. However, all except the olive ridley are now rare or uncommon (Pillai, 1997; Pillai, 2002) (Fig. 16). Fencing of beaches with granite blocks and embankments to protect from erosion. Predation on adult eggs and extraction of titanium at Chavara near Quilon keep the turtles away from nesting. Despite this, the nesting of olive ridley occurs commonly on the coasts of Kerala (Whitaker, 1984).

Lakshadweep : Olive ridley, green, hawksbill and leatherback turtles nest in the beaches of Lakshadweep. Suheli Valiyakara, Tinnakara, Bangaram, Suheli Cheriakara and Parali are the nesting islands for green turtles. A few hawksbill and olive ridleys also nest on the uninhabited islands of Androth, Kadmat and Agathi (Bhaskar, 1984; Silas, 1984a and b) (Fig. 16).

EAST COAST

Tamil Nadu : Nesting of all the five species of turtles Olive ridley, green, hawksbill, leatherback and loggerhead are reported from this state. The coral and sea grass areas in the Gulf of Mannar and Palk Bay provide rich feeding habitats for turtles. Nesting of olive ridleys are reported from all along the coast of Tamil Nadu (Shanmuganathan and Jogindranath, 1984; Pillai and Kasinathan, 1989; Abraham, 1990).

Andhra Pradesh : The entire coast of Andhra Pradesh has sporadic nesting of olive ridley turtles (Priyadarshini, 1997; Rajasekhar, 1998). The 270 km stretch between Kakinada and Uppada provide nesting grounds for the olive ridleys. Though the aggregations of olive ridleys do not form '*arribada*' as in Orissa, the nesting is in considerable number. The nesting of other species of turtles in Andhra Pradesh is discrete (Rao, 1985).

Orissa : The nesting of olive ridleys in and around the coasts of Orissa is enormous. The large mass nesting beaches in the Cuttack district, Roorkey, Ganjam, Rishikulia, Gahirmatha and another near Devi river estuary, together host one of the largest aggregations of olive ridleys in the world and certainly the largest in India. These areas receive about 5 lakh olive ridley nestings annually that lay more than 5 crores eggs. Each adult turtle in an average weighs 40 kg and thus about 40 thousand tons of turtle biomass visit the Orissa coast every year (Hemasundararao, 1998).

West Bengal : Nesting of olive ridleys is reported along the coasts of West Bengal. Nesting of other turtle species are remote (Swapankumar, 1996).

Andaman Islands : Olive ridley, green, hawksbill and leatherback turtles nest along the coasts of Andaman Islands.

Nicobar Islands : Olive ridley, green, hawksbill and leatherback turtles nest along the coasts of Nicobar Islands. Hawksbills nest at Pygmalion Point, the southernmost point of India. Great Nicobar Island is the most important nesting island. The two beaches at the mouth of the Dagmar and Alexandria River on the island's west coast are the main nesting grounds of leatherbacks. Islands of lesser but still appreciable importance as regards nesting are Katchal, Trinkat and Teressa Islands. It is reported that uninhabited Meroe Island is favoured by nesting green turtles.

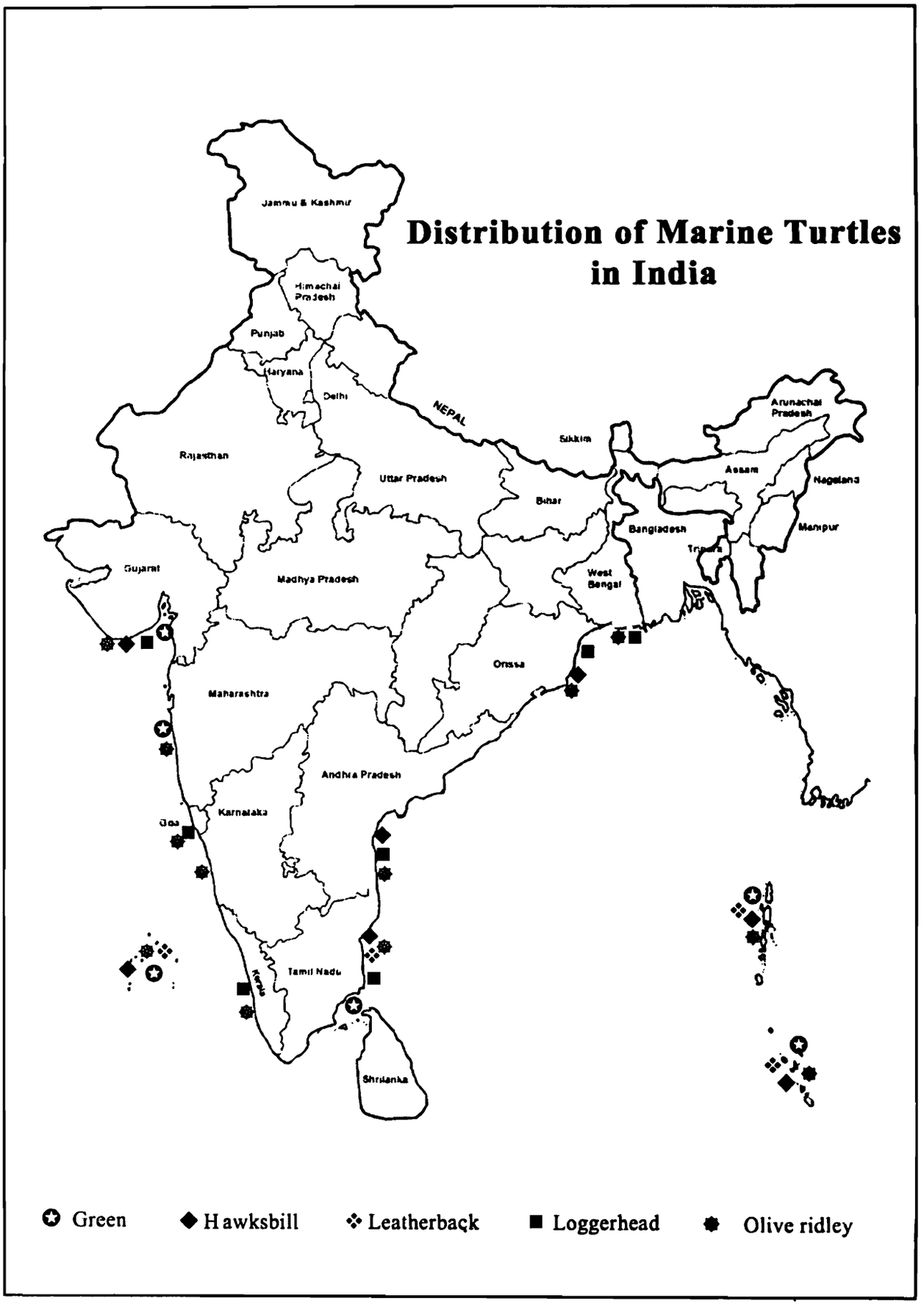

Fig. 16. Distribution of Marine Turtles in India

Species	Nesting Area	Nesting Season	Intensity
Green turtle	Kutch, Sourashtra	-	Moderate
	Maharashtra,	July-January	Sparse
	Tamil Nadu,	July-January	Sparse
	Andaman and Nicobar,	November-January	Moderate
	Lakshadweep	June-September	Moderate
Hawksbill	Tamil Nadu, Andhra,	-	Extremely low
	Orissa, Gujarat	-	Rare
	Andaman and Nicobar	April-January	Moderate
	Lakshadweep	-	Rare
Leatherback	Tamil Nadu	-	Very rare
	Andaman and Nicobar	December-April	Moderate
	Lakshadweep	-	Stray
Loggerhead	Tamil Nadu	-	-
Olive ridley	Gujarat	July-September	Moderate
	Maharashtra, Goa,	July-September	Stray
	Karnataka, Kerala	July-September	Stray
	Tamil Nadu,	December-February	Moderate
	Andhra,	December-February	Moderate
	Orissa,	December-February	Mass Nesting
	West Bengal,	December-February	Moderate
	Andaman and Nicobar	December-February	Stray
	Lakshadweep	June-September	Stray

A DECLINING TREND IN THE SEA TURTLE POPULATION AROUND THE WORLD

Sea turtle populations have seriously declined around the world due to destruction of nesting sites, expanding tourist industry and incidental capture (Nada, 2002). The world conference on sea turtle conservation held at Washington, D.C. in 1979 recognised that many sea turtle populations are extinct and six of the seven existing species are either endangered or vulnerable. All the seven species of sea turtles of the world have been listed as endangered, threatened and vulnerable by the US Endangered Species Act, the IUCN Red list and international treaties. These gentle creatures that have existed since before the time of dinosaurs are moving closer to extinction because of destructive human activities.

Groombridge (1982) and Ross (1982) have reviewed the reasons for decline of loggerhead and leatherback sea turtles. Groombridge (1982) and King (1982) have reviewed historical

decline of green sea turtle and hawksbill sea turtles. Depletion and even extinction have occurred wherever commercial exploitation has replaced a subsistence take, or where turtles have been exploited for an international market (IUCN, 1975 and Ross, 1978). Kemp's ridley is the most seriously endangered species of sea turtle. It has only one nesting ground (so far reported) at Rancho Nuevo in the State of Tarnaulipas on the Atlantic coast of Mexico. The number of females laying eggs at Rancho Nuevo has fallen from around 40,000 a year in 1947 to some 1,200 in 1974 (Carr 1977, 1979) and then to 550 or so in 1977 (Mrosovsky, 1978) and have hovered around that level since then (Marquez 1978, 1982; Mrosovsky 1979, 1983; Anonymous, 1981; Klima and McVey, 1982) until 1985 (Woody, 1985). This precipitous downward trend to the present low numbers and the restricted breeding range make Kemp's ridley critically endangered (Mrosovsky, 1983).

Although the olive ridley remains widespread and relatively numerous in tropical waters, most nesting sites support only small or moderate scale nesting (up to around 1,000 females per year) and most populations are known or thought to be depleted, often severely so, and some are virtually extinct (Groombridge, 1982). In the Pacific Coast of Middle America, olive ridleys are abundant only at Coasta Rica. In the Guanacaste Province of Coasta Rica, *arribadas* occur at two beaches, the estimated number involving between 350,000- 425,000 nesting females at Nancite and probably 200,000-250,000 at Ostional. Comparing the size of present *arribadas* with those of ten years ago, no appreciable change has been detected at Nancite, but a reduction of about 30 per cent has occurred at Ostional which is mainly attributed to egg poaching (Cornelius and Robinson, 1981-85). However, data are lacking on the former abundance of olive ridleys at the above two mass nesting grounds. Nesting occurs very rarely in French Guyana (Pritchard, 1982); in small numbers in the Pacific Coast of Honduras (Cornelius, 1982) and in moderate numbers on Shell Beach, Guyana (Pritchard, 1969). In the other two countries of this region, i.e., El Salvador and Guatemala, although no recent data on quantitative estimates of population sizes are available and no large scale nesting of olive ridleys is known, populations in general are reported to have declined in recent years (Cornelius, 1982).

In Indonesian waters olive ridleys appear to occur quite widely, but not in any large concentrations and sea turtle populations in general are reported to have declined markedly (Polunin, 1975). Nesting records are very sparse in the Lesser Sunda Islands; on West Sumatra and the Nusa Tengara islands (Nuitja and Uchida, 1982); and on the Sukamada beach within Meru Betiri Reserve of West Java (Blouch, 1981). A conservative estimate suggests that before 50s probably around 10,000 olive ridleys of both sexes occurred in the seas of Western Mexico and 3,185,000 in the mid-60s (Cliffton *et al.*, 1982) and then the population was reduced to only a few lakhs in the early 70s (Marquez *et al.*, 1982). The major *arribadas* were centered on three nesting beaches; El Playon de Mismaloya, Piedra del Tlacoyunque and La Escobila, Oaxacci (Cliffton *et al.*, 1982; Frazier 1979; and Sternberg, 1981) and it appears that *arribadas* at Tlacoyunque and Mismaloya had already collapsed by 1970 (Pritchard, 1982). Massive over exploitation has severely depleted olive ridley populations in Pacific Mexico; the total 1976 population involving both sexes was estimated at 485,000

(Cliffton *et al.*, 1982). *Arribadas* of around 75,000 females still occur at La Escobilla; Oaxaca (Marquez 1982; Marquez *et al.*, 1982) but this population is also reported to be currently collapsing (Anonymous, 1979; Cliffton *et al.*, 1982) and there is tremendous concern that this last economically viable olive ridley population in Mexico will be subject to continuing over exploitation.

In Nicaragua, the 20 km beach between Masachapa and Pachomil is known as a mass-nesting site for olive ridleys. The beach at Playa Chococente (Carrazo) may have up to 550 turtles per night. However, local inhabitants reported that the size and frequency of *arribadas* have decreased considerably (Cornelius, 1982). In Panama, atleast 30 beaches were formerly known to support large nesting aggregations, but today only 12 beaches are officially recognized as important nest sites; nesting populations are smaller and the season is shorter (Cornelius, 1982). Olive ridleys are the abundant sea turtles in Surinam waters with scattered nesting occurring at all sites around the island involving several thousand turtles per annum and spread through most of the year. However, continual population decline is reported (Frazier, 1982).

In Surinam, olive ridleys commonly nest on two beaches such as Eilanti and Bigisanti beach, west of the Marowijne estuary. This area is now the only nesting site of any importance on the Atlantic coast of America but the ridley population nesting in Surinam, estimated at 2,100-3,000 females in 1967-68, has dropped to an estimated 550-800 during 1978-79 (Schulz, 1982). The decline in number of nesting females is attributed to incidental catch by offshore shrimp trawlers (Schulz, 1982) and in part to marine erosion of the Eilanti beach in the 70s. The beach has started to reform in the 80s (Mrosovsky, 1982). The olive ridley is the most common sea turtle in Thai waters (Bain and Humphrey, 1980). However, sea turtle populations in general are reported to have declined markedly in Thailand (Polunin, 1975).

In India and particularly in Orissa, the olive ridleys are the commonest sea turtles. The major nesting grounds of *L. olivacea* have been known only very recently, after mid-70s. Data are completely lacking on the former abundance of the turtles at the above mass nesting grounds and elsewhere.

The Kemp's ridley sea turtle has declined to a mere 2000 nesting females worldwide. In the 1940's 40,000 sea turtles were documented nesting at a single Mexican nesting beach over a four-hour period. The pacific leatherback sea turtle population on one of Mexico's most important nesting beaches has dropped from 2000 to 10 in only about a decade.

THREATS TO SURVIVAL

The greatest threat to sea turtles is the increasing consumption of seafood and unsustainable industrial methods of fishing, which incidentally kill sea turtles. High seas drift nets are

responsible for the deaths of hundreds of thousands of sea turtles every year. Long line fleets, which set up to 10 billion hooks in the ocean every year in the quest for swordfish and tuna, kill countless numbers of sea turtles. But perhaps the worst and most preventable killing of sea turtles is through their drowning in the nets of mechanized shrimp trawlers.

In spite of adults being the master predators in the seas, the sea turtles are subjected to various types of biotic and abiotic threats during different stages of their life cycle.

Natural Threats

Predation : The biotic threats can be categorized as threats to the eggs, hatchlings, sub-adults and adults by predators. Non-human predators of eggs include invertebrates such as ants (*Dolyrus* sp.), flies (especially larvae of some species as secondary predators), Scarabidae *(Trox suberosus).* Reptiles such as *Boa* sp. (elapids); and varanid lizards; birds such as black vulture, turkey vulture, ibis, crows; small mammals such as rats (*Rattus* sp.), coatis, racoons, mongooses, genets, feral cats, white lipped peccary, pigs, hogs, jackals, dingoes, foxes, coyotes, hyenas and dogs (Hughes, 1972; Schulz, 1975; Diamond, 1976; Fowler, 1978; Richardson, 1978; Hopkins *et al.,* 1979; Talbert *et al.,* 1980; Stancyk, 1982; Limpus, *et al.,* 1994).

Predators of hatchlings include crabs such as ghost crab (*Ocypode* sp.), hermit crab (*Coenobite* sp.), coconut crab (*Birqus* sp.); sharks and other numerous varieties of fishes; snakes such as *Boiqa dendrophila* and *Python reticulates;* varanid lizards; birds such as sea gulls, crows, vultures, kites, night herons; mammals such as *Rattus* sp., mongooses, genet, feral cats, racoons, coatis, hogs, domestic and feral dogs etc. (Bustard, 1972; Witham, 1974; Diamond, 1976; Fowler, 1978; Richardson, 1978; Hopkins *et al.,*1979; Carr and Meylan, 1980).

The most commonly mentioned predators of hatchlings on land are diurnal birds (especially vultures, frigate birds, gulls and crows), but their role is probably overstated because most turtle hatchlings emerge at night (Stancyk, 1982). Avian predation on hatchlings accounted for very low percentage for some species of turtles particularly which nested solitarily. However, on mass nesting beaches of olive ridley *(Lepidochelys olivacea),* avian predation on hatchlings have been reported to be quite heavy on nests from which hatchlings do emerge in the day time, i.e., immediately before dawn and also in late afternoon hours (Fowler, 1978; Hughes, 1974). There are also reports of black vultures *(Coraqyps atratus)* attacking hatchlings on moonlit nights (Stancyk, 1982). At Gahirmatha coast, Orissa, black and brown-headed gulls often capture hatchlings even after they enter the sea due to the surface swimming habits of the hatchlings. Carr and Meylan (1980) reported the capture of a hatchling green turtle from Sargassum weed by a frigate bird. The familiar diving response of turtles to overhead shadows may be an adaptation to such aerial predation (Stancyk, 1982).

Of all, the greatest predation of hatchlings probably takes place after they have entered the water (Bustard, 1979). Hatchlings are eaten by numerous inshore predators such ascuttle fish and especially small sharks, barracuda, snook, jackfish and snappers (Stancyk, 1982). A large number of hatchling ridleys have also been reported in the stomachs of adult leatherback turtles (Pritchard, 1979) in the Pacific Mexico. Loss of newly emerged hatchlings in the nearshore environment is thought to be especially severe and there are many other examples of inshore predators captured with their digestive tracts filled with hatchlings (Hughes, 1974; Stancyk, 1982). Since a small percentage of the hatchlings, which enter the water, return to nest, mortality during maturation is assumed to be great (Bustard, 1979; Hirth, 1971; Richardson and Richardson, 1982). However, actual mortality rates in the nearshore environment are not exactly known. Mortality rates of hatchlings and juveniles between the times they reach open water and the time they mature are not known (Stancyk, 1982).

In the marine environment, predators of juveniles and adult turtles include different species of sharks and whales (Balazs, 1979). On land, mammals such as feral and domestic dogs, wild dogs, hyaenas, jaguars, leopards and tigers are the predators of sea turtles (Caldwell, 1969; Hendrickson, 1958; Hughes *et al.*, 1973 and Schulz, 1975). Sharks still remain a menace throughout their lives (Balazs, 1979). Although most species of sharks eat turtles, the tiger shark *(Galeocerdo cuvieri)* is the most commonly observed predator of juveniles and adults. Other large marine predators such as killer whales also take adult turtles (Caldwell, 1969). Turtles show antipredator refuging behaviour (Bustard 1972, 1979); and an account of an attack on *Dermochelys* by a white shark (Cropp, 1979) suggests that there may be stereotyped escape behaviour among turtles (Stancyk, 1982). Terrestrial predators, mainly the carnivorous mammals, may attack nesting adults, but their impact on turtle population is thought to be minimal.

Predation has been a natural mortality source affecting turtle populations throughout their evolution. Many aspects of the behaviour and life histories of sea turtles (such as elaborate nest covering, nocturnal hatchling emergence, protective sleeping positions, production of large number of offsprings etc.) can be viewed as adaptations to predation. From the conservation point of view the hatchlings are reared in captivity and released back in the sea to avoid natural predators. But, rearing of turtle hatchlings in captivity produce health problems related to the water quality, food quality and stocking density (Rajagopalan *et al.*, 1984). Unless some environmental changes had not given predators advantages over the adaptations of the turtles, predation alone could not have threatened turtle population with extinction. However, ecosystem modifications are often caused by humans, either by enhancing survival of predators or by placing additional mortality pressures on turtle populations (Dash and Kar, 1990).

Human impacts

1. Human interference

Some of the examples of ecosystem modifications by human interference adversely affecting sea turtle populations are: beach erosion (for example, Gahirmatha coast); construction of erosion preventive embankments; plantations along the beach as anticyclone measures; fencing of beaches or construction of palisades; sand mining for cement, titanium ore and Indian Rare Earths (I.R.E.); rapid colonisation of coastal areas and beaches for human settlements; temporary settlements by fishermen on nesting beaches; beach resorts and other constructions on shore such as jetties; physical barriers such as beached boats or vehicular traffic on beaches; defence set-up on beaches and experimental demonstration in coastal water in the vicinity of major mass nesting beaches; artificial lighting on beaches; oil drilling operations in river beds and river mouths adjacent to breeding ground of turtles; coral mining; various types of marine and land based pollution, etc. (Stancyk, 1982). Further, proliferation of non-mechanised and mechanised fishing boats increases the operational range and efficiency of turtle hunters and making beaches, breeding and feeding grounds once remote easily accessible. Activity of large number of fishing boats and use of nets often create artificial barriers temporarily in the coastal waters preventing turtles to emerge on the beaches for nesting. The classic example is the breeding ground of olive ridleys offshore of Gahirmatha coast in Orissa. The operation of gradually increasing number of mechanised vessels also contributes to marine pollution. Thus, even seemingly trivial modifications of the habitat could be severely detrimental and have disastrous consequences on the population of sea turtles.

Fig. 17. Turtle awaits human consumption in Andamans

Besides predation, other threats like habitat modifications and exploitation of the sea turtle resources by man for over centuries for; eggs, meat, tortoise shell, flipper, hide, oil, fat, blood and other by-products cause depletion of turtle populations (Fig. 13). Egg poachers remove virtually every clutch of eggs laid for consumption and sale.Markets are stocked with turtle eggs stolen from nests on beaches. In many places hunting adults for subsistence has been largely replaced by commercial exploitation. Non-judicious exploitation and indiscriminate hunting of adults at sea and on the beaches combined with incidental catch by trawlers and fishing nets have resulted in considerable depletion of sea turtle populations in many parts of India as well as in other countries.

Shrimp trawlers catch an estimated 150,000 turtles each year as by catch in the fishing nets. Drift nets are responsible for catching (and drowning) thousands of sea turtles and other endangered wild life. Local communities of human collect thousands of sea turtle eggs from the nesting beaches. Poachers kill adult female sea turtles as they come up on the beach to lay their eggs, and sell their skins and shells to be made into leather products and tortoise

Fig. 18. Turtle killing at vizak (Source: Vizakha – SPCA)

shell jewellary. Hotels, beach resorts, factories and other development destroy nesting beaches. The powerful lights used in the above said establishments prevent them from coming to the beach for nesting. These lights near nesting beaches disorient hatchlings; they don't crawl to the sea, and die in the heat (Dattatri, 1984). Plastic bags and other items thrown by the fishermen in the sea look like jelly fishes to turtles. These items get caught in their intestine (Marquez, 1990; Fugazzatto and Behera, 1999).

2. Human Consumption

Tortoises and sea turtles are both worshipped as God and consumed as food in India. It is worshipped as the *Kurma avatar* of Vishnu, the God of Creation. The poor, irrespective of

their caste and community consume the eggs and meat of tortoises and sea turtles all over the country. In West Bengal, the biggest market for turtles and turtle eggs, for example, turtle meat is eaten on *Pausha Sankranti*, a harvest festival dedicated to Laxmi, the Goddess of Harvest and Wealth in the Hindu religion. Consumption of turtle flesh is continuing even today in the remote fishermen villages on the east coast of India (Fig 18 and 19). From Orissa, since the 13th century, boatloads of olive ridley eggs were traded with the neighbouring state of West Bengal (Rajagopalan, 1984a and b; Sanjeev and Kar, 1999).

The poorer segments of the population mainly consume these eggs. Dried turtle eggs were also used as cattle-feed. The legal trade of olive ridley eggs went up to an astronomic

Fig. 19. Dissected Turtle at vizak (*Source:* Vizakha-SPCA)

one-and-a-half million eggs in the 1970s. The actual number of eggs traded was believed to be even higher. Assuming that one in every 1,000 eggs became an adult olive ridley, these eggs were the equivalent of 150,000 adult turtles. The Orissa Government, however, banned the legal trade in eggs in 1975. Adult olive ridleys were also traded during nesting season from Orissa to Calcutta, the capital of West Bengal, also on the East Coast of India. In the 1970s and 1980s, an estimated 50,000 to 80,000 olive ridleys, both male and female, were sold illegally (Sanjeev and Kar, 1999). In spite of the attempts of the Forest Department, the Indian Navy, and the Coast Guard, illegal trade in olive ridleys continued well into the 1980s. Apart from predation of eggs by stray dogs and shore birds large quantities of eggs were brought to the fishing markets for selling till the late eighties in Tamil Nadu especially in Mahabalipuram, Tuticorin, Rameshwaram and Kanyakumari (Silas and Rajagopalan, 1984). Egg predation by animals and local people for consumption are the common threats to sea turtles (Kar and Bhaskar, 1982; Silas *et al.*, 1983a and b; Bhaskar, 1984; Rajagopalan *et al.*, 1996; Pandav *et al.*, 1998; Andrews, 2000; Kutty, 2000; Anonymous, 2002).

3. Industrial Effluents

Apart from predation and natural calamities the chemical industries in and around the coastal areas destroy the nesting areas of the turtles. The Orissa coast is the largest breeding and nesting site for the olive ridley sea turtles in the world. However, this unique natural heritage is under serious threat. Apart from the killer trawlers the continuous discharge of effluents from chemical factories like the Oswal phosphate fertilizer factory located at Paradeep pose a serious threat to the nesting grounds of the olive ridleys. The following are the harmful substances released into the seawater from the chemical factories,

- Phosphogypsum containing the radioactive substance radium-226, which releases a harmful gas, called radon. Radon has been designated as a human carcinogen by The World Health Organisation (WHO) and US Environmental Protection Agency (EPA).
- Free Sulphuric acid, which is harmful to all living organisms.
- Sulphur dust which is also a poisonous chemical

These industrial discharges have serious effect on the marine ecosystem. The waters of the Atharabanki creek were grayish white in colour due to the continuous discharge of Phosphogypsum. A thick crust of gypsum was reported at the Mahanadi river mouth.

It is feared that the food chain of the coastal marine ecosystem of the entire east coast is affected by the continuous discharge of dangerous effluents into the sea. Strong ocean currents at the mouth of the river easily carry these pollutants both up and down the coast including the vital ecosensitive areas and sea turtle mass nesting sites like Gahirmatha Marine Sanctuary and Devi River mouth (Mohanty, 2002).

4. Sand mining

Sand mining is an important threat, which affect the nesting population in terms of habitat loss. Loss of nesting beach of leatherback and Hawksbill in Andaman and Nicobar is due to severe sand mining (Andrews, 2000). Sand mining and loss of nesting beach was also reported in Kerala and Andhra Pradesh (Bhaskar, 1984; Jayakumar, 2000). Tourism, pollution and sand mining are increasingly evident on the Madras coast in Tamil Nadu (Abraham, 1990).

5. Sewage pollution and marine debris

Presence of refineries, oil terminals and rapid increase in export and import of oils and petroleum products are major sources of oil and sewage pollution along the east coast of India especially in Gujarat (Anonymous, 2002). Accumulation of domestic sewages and marine debris were reported all along the Gujarat coast. There are many reports, which have documented the occurrence of marine debris in the digestive tracks of Loggerheads (Brongersma, 1968), Green turtles (Balazs, 1985), Leatherbacks (VanNierop and DenHartog, 1984 and Hughes, 1974), Kemp ridley and Hawksbill turtles (Balazs, 1985).

6. Commercial exploitstion of beaches

Luxury hotels and other commercial developments destroy nesting beaches. In our trash chocked oceans, sea turtles mistake plastic bags for jellyfish, a favourite food and choke to death. Adult sea turtles have been hunted for their meat and to fuel the high-tened apparel market to make eyeglass frames, combs and cigarette lighters. Economic imbalances cause coastal communities to steal eggs from nests to sell to city dwellers as aphrodiscacs.

7. The killer trawlers

In 1990, the US National Academy of Sciences concluded that more sea turtles die from shrimp trawling than from all other humans causes combined in US waters. Sea turtles breathe air like humans and in ideal circumstances can hold their breath for upto 8 hours. When sea turtles are caught up in the huge funnel shaped shrimp nets that scour the ocean floor, they panic, struggling for air. Eventually they drown unable to free themselves from the nets.

Turtle Mortality caused by shrimp trawlers in India.

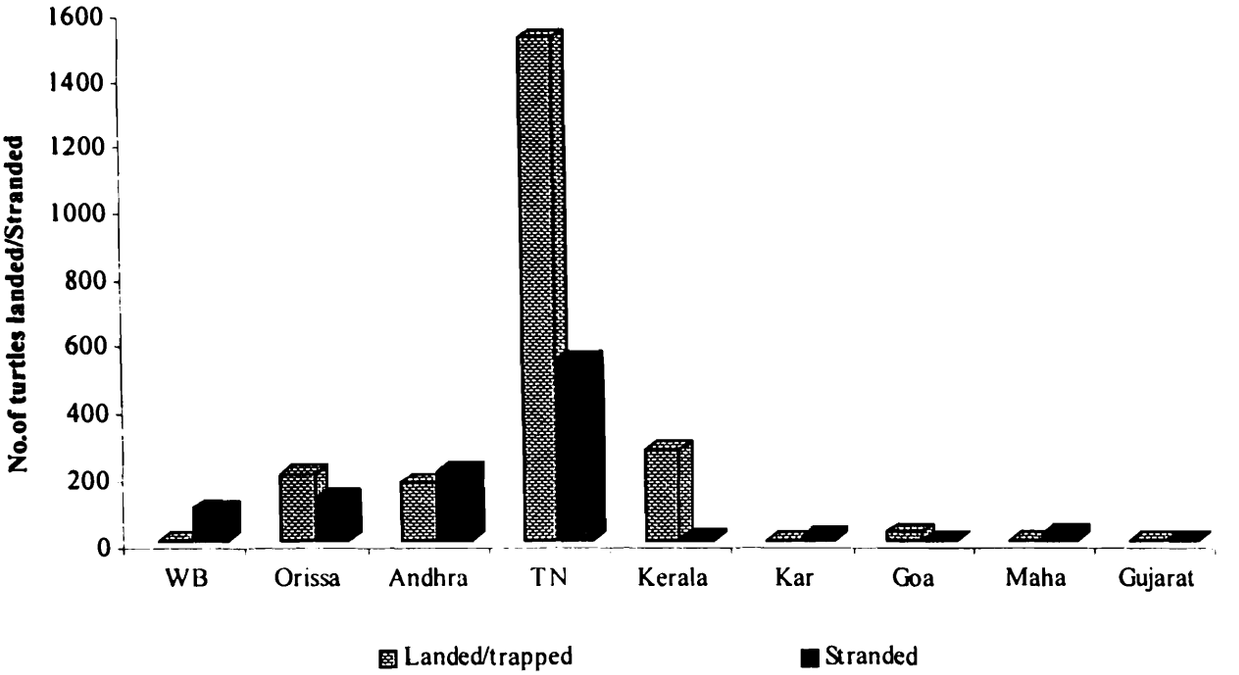

Fig. 20. Number of Turtles landed/stranded in different states in 1997
(Source: Wildlife Institute of India)

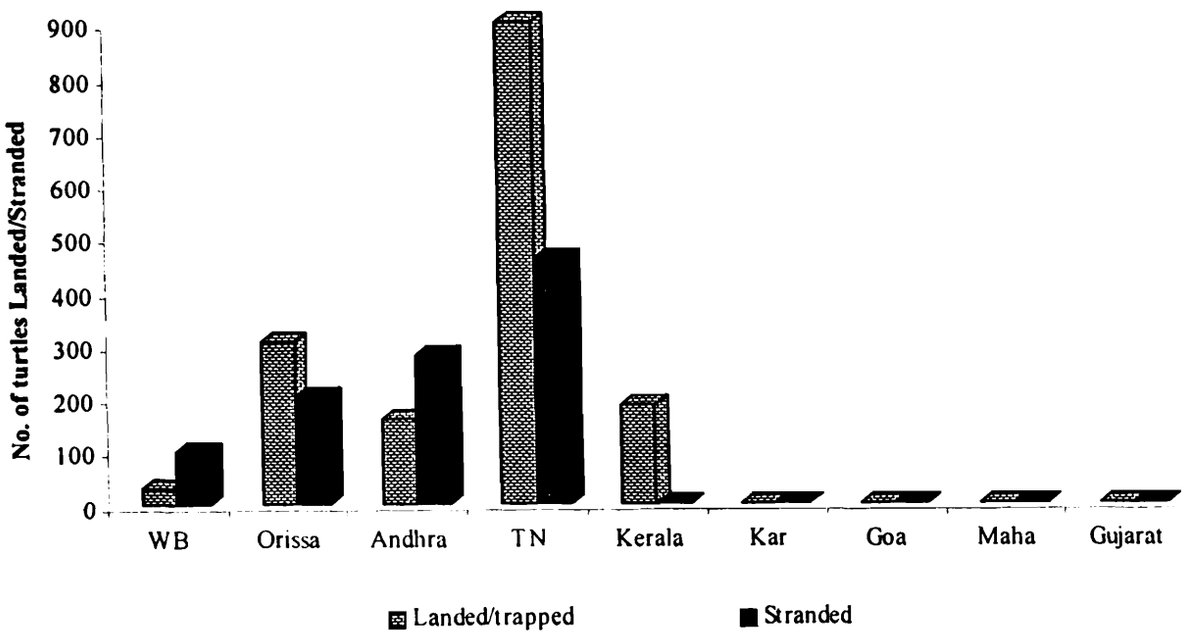

Fig. 21. Number of Turtles landed/stranded in different states in 1998
(Source: Wildlife Institute of India)

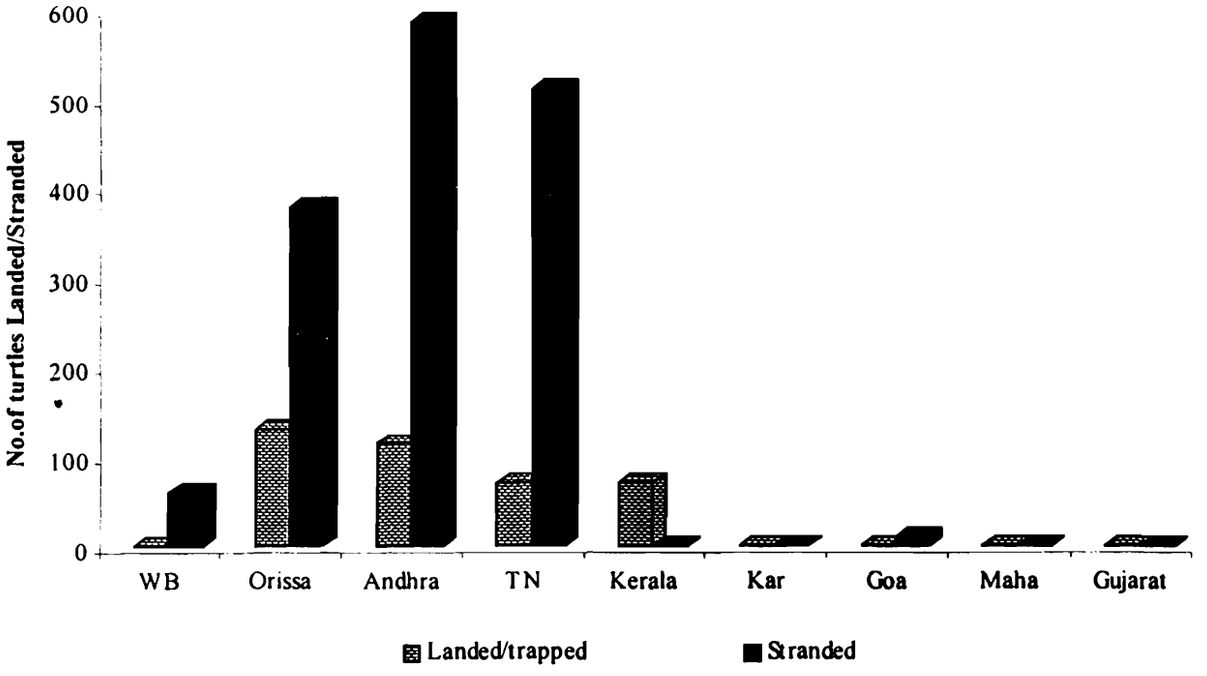

Fig. 22. Number of Turtles landed/stranded in different states in 1999
(Source: Wildlife Institute of India)

Fortunately, a simple inexpensive device attached to shrimp nets can help prevent this tragedy. A Turtle Excluder Device (TED) is metal grid that guides sea turtles out an escape flap while permitting shrimp to pass between the bars and into the back of the net. TEDs prevent the needless drowning of sea turtles by more than 97%. With an estimated 150,000 sea turtles getting caught in shrimp trawl nets every year. TEDs are an inexpensive, practical method of preventing the killing of turtles. TEDs also protect local fishery stocks and marine biodiversity by permitting by catch, nontargetted fish and other marine life, to escape as well.

While the US has been a notable laggard in many areas of environmental protection, especially when it comes to international cooperation, it took the lead in ensuring that shrimp trawl vessels world wide use TEDs. In addition to mandating that US shrimpers use TEDs under the Endangered species Act, the US also requires that nations who wish to export wild caught shrimps into the US develop policies requiring the use of TEDs. Due to the economic incentive of this law, 16 other nations have implemented comprehensive countrywide TED laws.

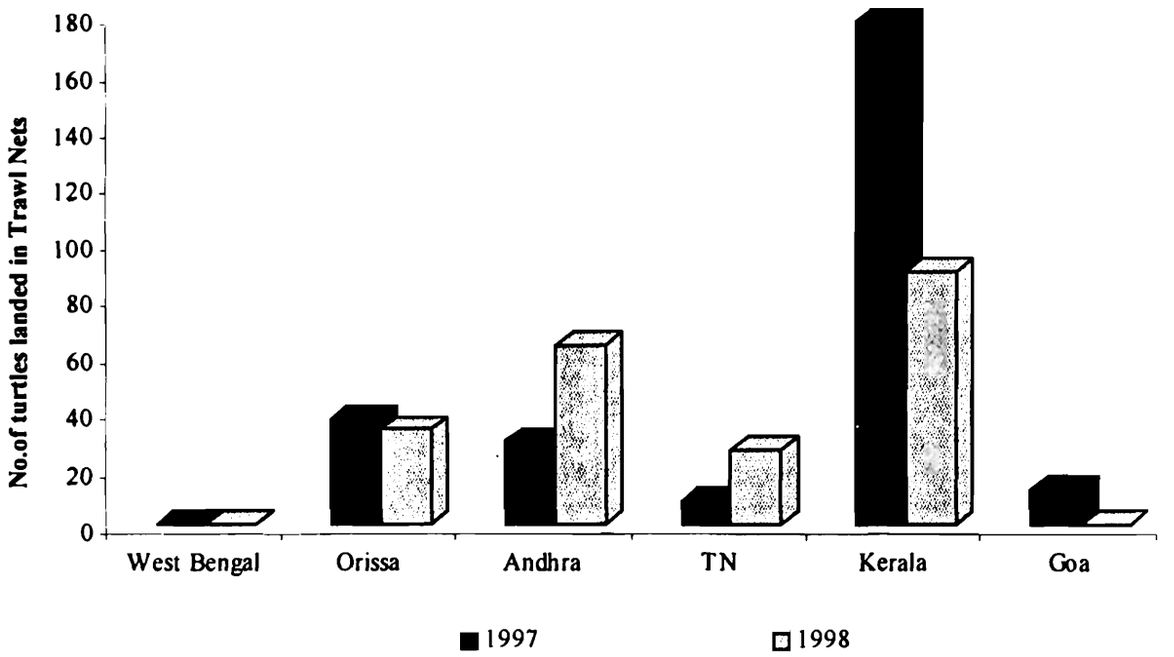

Fig. 23. Turtle landing in trawl nets (Source: Anonymous, 2000)

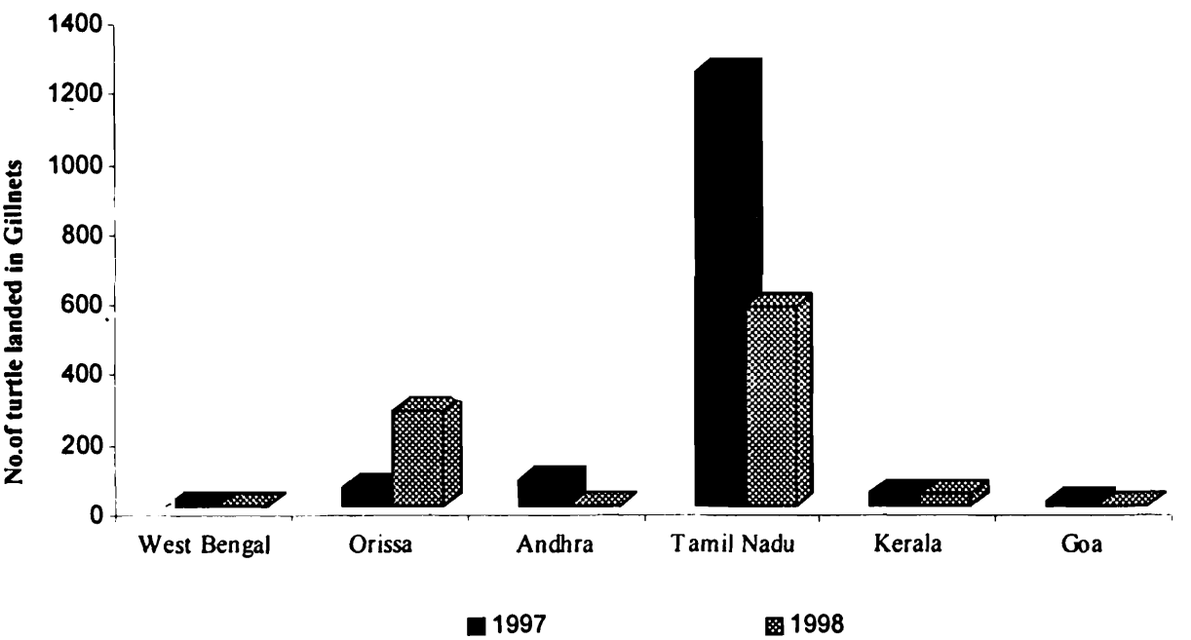

Fig.24. Turtle landing in Gillnets (Source: Anonymous, 2000)

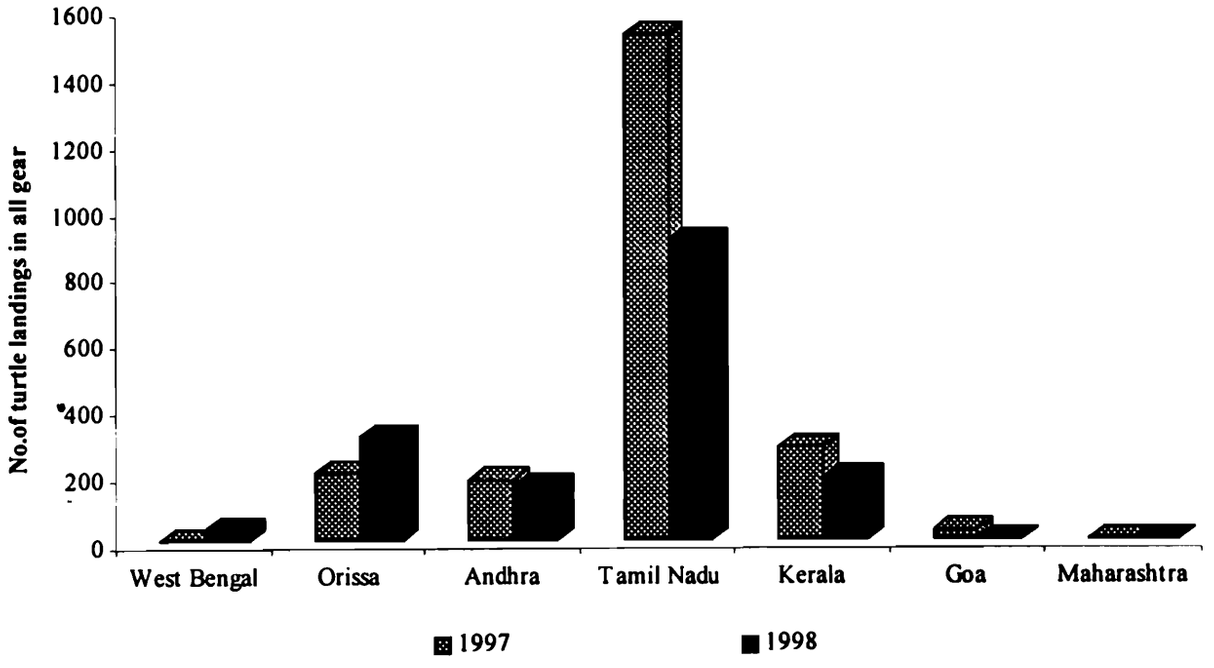

Fig. 25. Turtle landing in all gears (Source: Anonymous, 2000)

Unfortunately, India with its globally important olive ridley nesting beaches has refused to put a national TED law in place. Instead it has used the World Trade Organisation as an excuse to legitimatize its refusal to raise its fishing standards to the level of most other shrimp fishing nations. While the turtles are paying the price now, the future of local fisheries and coastal communities is also at stake (Hillestad *et al.*, 1981).

Generally trawlers in India do not use Turtle Excluder Devices. The 15000 – 3000 trawlers operating off the coast of Orissa in the Bay of Bengal catch and draw sea turtles. Shrimp trawl boats regularly ply the waters of a marine sanctuary, inspite of a ban. Conservationists documenting the activities of shrimp boats have found as many as 16 turtles in a single trawl net. The real impact of the trawlers is found on the beach, where alarming numbers of sea turtles are washing dead on the shores of Orissa. In 1999, some 13000 dead turtles have been counted, the majority having drowned in their struggle to escape the shrimp trawl nets (Rajagopalan *et al.*, 1996). Over the past five years, a single conservationist, from the wildlife Institute of India, has counted 40,000 dead olive ridley sea turtles. The figure does not take into account the number of dead turtles that have drowned in shrimp nets but that may have not washed ashore. Some studies have suggested that 80% of the turtles that drown in shrimp nets do not washed ashore. If this is the case in India, as many as 50,000 sea turtles could have been killed by shrimp trawlers this year, and as many as 200,000 over the past five years. In Tamil Nadu, Andhra and Orissa the number of turtles stranded/trapped was more in the years 1997, 1998 and 1999 (Fig. 20, 21 and 22).

Shrimp trawlers and gill-netters are the primary cause of mortality (Pandav *et al.*, 1998; Shanker *et al.*, 1999). These vessels have operated in near-shore coastal waters in violation

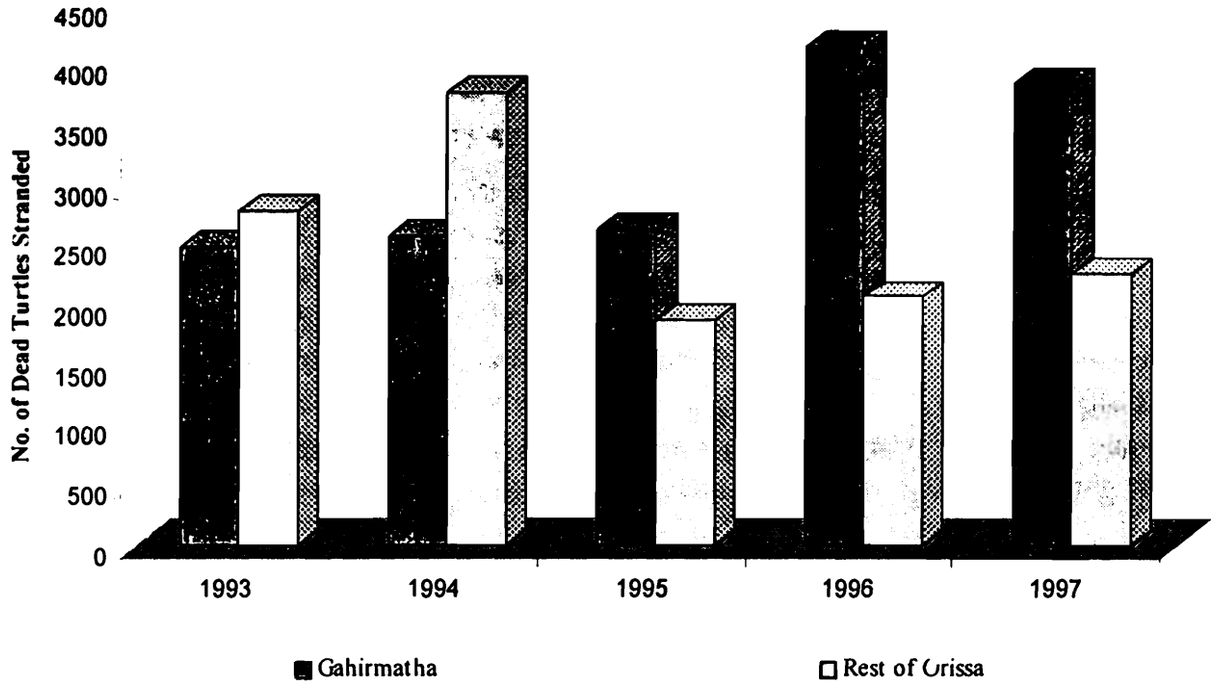

Fig. 26. Dead Turtles stranded at Orissa (Total 33,613) (Source: Pandav and Choudhury, 1999)

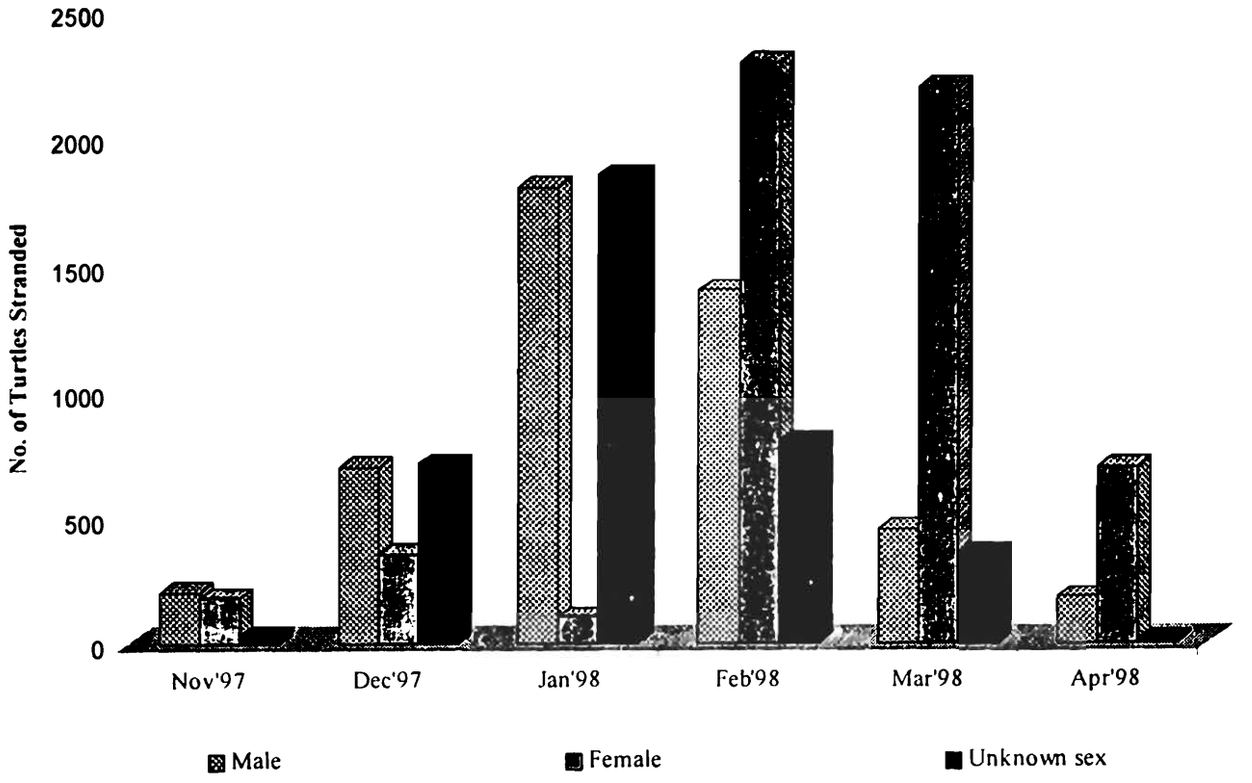

Fig. 27. Seasonal stranding at Orissa (Total 13,575) (Source: Pandav and Choudhury, 1999)

of the Orissa Marine Fisheries Regulation Act (1982) and Rules (1983), which bans all mechanised fishing within 5 km of the coast. Apart from the large-scale mortality of sea turtles, the small-scale traditional fisheries are also collapsing due to uncontrolled and illegal mechanised fishing within the prohibited zone.

According to World Trade Organisation (WTO), trawl nets cause more damage to the turtles than other nets. It is reported that an annual mortality of 5,000 from fish trawls and set nets from a nesting population of 600,000 with a recruitment of 85,000 appears relatively minor" (Anonymous, 1998). More than 180 turtles were got entangled in the trawl nets of Kerala in 1997 and 1998. Andhra and Orissa recorded considerable stranding incidences from trawl nets in 1997 and 1998 (Fig. 23). The number of turtles got entangled in the gill nets in 1997 and 1998 was much more than other states (Fig. 24). On comparision the number of turtles got entangled in different gears was more in Tamil Nadu (Fig.25).

Mortality of the olive ridley sea turtles in Orissa

Olive ridley turtles nest in low densities all along the eastern coast of India. The mass nesting or "*arribada*" sites of olive ridley in the world Gahirmatha, Robert Island and Rushikulya. Large scale of mortality of olive ridleys occur along these nesting areas due to illegally operated trawlers Fishing in the coastal waters off Gahirmatha was restricted from

Fig. 28. Mass stranding of Olive ridley in Orissa (*Source: Kachhapa, 2002*)

1993 and was completely banned in 1997, when Gahirmatha was given the status of a Marine Sanctuary (Pandav and Choudhury, 1998).

Mechanisation of fishing boats has caused large-scale mortality of adult sea turtles during the last two decades in Orissa (James *et al.*, 1989; Dash and Kar, 1990; Pandav *et al.*, 1994; 1997). Dash and Kar (1990) reported 4,682 adult olive ridley turtles stranded at Gahirmatha rookery between September 1978 and May 1985. James *et al.*, (1989) documented the stranding of more than 8,000 individuals between 1983 and 1987.

The stranding of turtles along the coast of Orissa is recorded since 1993, as a part of the ongoing sea turtle research programme of the Wildlife Institute of India. For this purpose the entire Orissa coast, stretching over 480 km has been divided into eight survey sectors (Pandav *et al.*, 1994) and each of these sectors is surveyed once every two weeks during the breeding season (November-April). Dead turtles washed ashore are measured, sexed and marked with white paint on their carapace to avoid repeat counts during subsequent surveys. In the 1993/94 seasons, 5,282 dead olive ridley turtles were recorded (Pandav *et al.*, 1994; Pandav *et al.*, 1997; Shanker *et al.*, 1999). Since then more than 30,000 olive ridley turtles have stranded in Orissa (Fig.26). Offshore fishing and shrimp trawling are thought to be the major cause of this high mortality (Hillstead, *et al.*, 1981; Henwood and Stunz, 1987; Ehrhart, 1987; Magnuson *et al.*, 1990; Robins, 1995). Mortality due to such illegal trawling has been increasing each year and reached a record high of 13,575 ridleys in the 1997/1998 season. Between 1993 and 1997 a total of 33, 613 turtles stranded in Orissa (Fig.28). Orissa witnessed stranding of 13, 575 turtles between Nov 97' and Apr 98' alone (Fig. 27).

The majority (89.6%) of the recorded strandings occurred on the coast near Gahirmatha, Paradeep, Kujang and Devi (Pandav *et al.*, 1994). The coastal waters of these four sectors are subject to the highest levels of shrimp trawling in Orissa. State fishery Authorities of Orissa speculates that disease, migration fatigue and marine pollution are the causes for the mass death of turtles in Orissa. Application of TEDs, carpet ban on fishing in the protected areas and strict enforcement of fishing regulations alone can bring down the mortality of turtles along the coasts of Orissa (Pandav and Choudhury, 1999). Declarations of Workshop on Olive Ridley Turtles in the Indian Ocean (4th March 1999) also emphasized these factors for effective Protection of the sea turtles in Orissa (Frazier and Tiwari, 1999). Between February – March, 2002, 10000 dead olive ridley sea turtles have been washed ashore in Orissa. A staggering 75,000 sea turtles have been slaughtered off the Orissa coast over the last six years (Wright and Mohanthy, 2002).

Impact of Unsustainable fishing Methods

In addition to harming sea turtles, unsustainable fishing methods, such as mechanized shrimp trawlers that do not use TEDs also severely impact global food supply and local economies by depleting local fish stocks through unselective fishing techniques. Unsustainable fishing has a much broader impact on social and economic issues than just environmental ones.

The UN Food and Agricultural Organization (FAO) estimates that 27 million metric tones of fish bycatch are discarded every year globally, equivalent to about 1/3rd of the total annual catch and that, in India, Malaysia and the United States, 90% of the fish caught is discarded and not consumed.

Shrimp trawling accounts for 35% of the total global bycatch or about 9.5 million metric tones of discarded marine life. Scientists have further identified trawling as the most important source of human caused physical disturbance on the ocean's floor, churning sediments on the seabed, crushing or burying marine life and reducing the structural complexity of the seabed. Shrimp, a high value fish product, has become an important part of India's exports to the North in the effort to service debt.

But an economy based on the demand of the voracious North has serious consequences not only for the environment, but also for people. While fish exports have grown over the years in India, there has been a decline in per capita fish consumption as the protein of the south is grabbed for the North and as nonselective industrial fishing techniques deplete fishery resources.

Throughout the world the catches of ocean is declining. Of the world's 17 most important fisheries, nine have suffered serious decreases and four are commercially fished out. The UN Food and Agricultural Organization estimate that 69% of the world's fisheries are either over fished, fully fished, depleted, or recovering from past overexploitation (Fugazzatto and Behera, 1999).

CONSERVATION

The olive ridley mass nesting ("arribada") sites in Orissa, particularly Gahirmatha, has been the focus of global attention in the 1990s because they are amongst the largest such sites in the world. The scientific community has known Gahirmatha since its discovery in 1974 (Bustard, 1974), while other sites were discovered later (Kar, 1982; Pandav *et al.*, 1994). Since 1993, more than 50,000 dead turtles have been counted along the Orissa coast over a distance of 400 km (Pandav *et al.*, 1994; Shanker *et al.*, 1999). It is not known what percentage of turtles that die are later counted on the beaches, but the total number dead is certain to be more than the number counted on the beaches. Furthermore, during most years, only key nesting areas have been monitored, therefore accounting for only 200-300 km of Orissa's 480 km coastline.

The basic practice of taking turtles out of the wild for short or long periods and then putting them back again, either in the original site or in a different site that may or may not have turtles there, has been widely discussed and debated as a conservation activity (Godfrey and Pedrono, 2002). In the 1982-83 season in Tamil Nadu hatcheries were established over the coastline of 150 km in Chennai, Kodiakkarai and Tiruchendur to protect eggs from predation (Shanmuganandan and Jogindranath, 1984). Elimination of human induced threats will reduce the mortality of sea turtles drastically (Rajagopalan, 1996; Aiken *et al.*, 2002).

Problems associated with turtle conservation in India

The main problems associated with conservation of sea turtles are the place and time of turtle nesting (Daniel, 1984). Though much has been stated about the nesting of olive ridley turtles the details about the nesting grounds and nesting season of other species are still unclear.

The only available legislation to protect turtles is the Indian Wildlife Protection act 1972. The species of marine turtle that occur along the Indian Coasts are included in Schedule I of the Act, which covers completely protected species whose destruction or capture draws severe penalty. Unfortunately the enforcing authority, which is the Forest Department in most cases has their main focus of interest miles away from where turtles occur so that enforcement suffers. In addition to that the people who are concerned with turtle exploitation, mainly the fisherfolk in the coastal villages are unaware of the existence of such legislation (Daniel, 1984; Frazier, 1984).

GAHIRMATHA : A TURTLE PARADISE

The Orissa Government's notification declaring Gahirmatha a marine sanctuary to provide the endangered olive ridley sea turtles a safe habitat will, probably, bring an end to the age-old struggle between man and nature that has been going on in this region for years. The 35 km long Gahirmatha coast is the world's largest rookery for the Olive Ridley turtles, which travel in lakhs from as far as the south of the Pacific Ocean every year to nest. Gahirmatha has been witnessing *arribadas* of olive ridley for a long time (Silas *et al.*, 1983a, b; Silas *et al.*, 1984a, b; Silas *et al.*, 1985).

This step is perceived as a big victory for the conservationists. However, thousands of fishermen who have traditionally been dependent on this region for their livelihood are affected. The notification, which came on September 27, 1997 following an international campaign to save the endangered turtles, encompasses an area of 1435 km^2 on the Bay of Bengal off the Orissa coast. The notification seeks to put an end to the economic exploitation of the area up to 10 km into the sea from south of the Dhamra fishing harbour in Balasore district to north of the Paradip port.

What was an environmental issue soon assumed the contours of a trade dispute. The Union Commerce Ministry was even forced to file a case, along with Thailand, with the World Trade Organisation (WTO) against the proposed U.S. embargo on shrimp imports from countries that do not require their fishermen to protect endangered sea turtles by using nets fitted with turtle exclusion devices (TEDs). Meanwhile, the World Wide Fund for Nature (WWF) also jumped into the fray, backing the U.S. threat of banning the import of turtle-threatening shrimps. In a recent report to the WTO, it accused countries like India, Thailand, Pakistan and others of using the trade body to evade their conservation responsibilities.

In 1993, the State Government of Orissa responded to the mounting pressure by banning fishing within a 20-km radius off the Gahirmatha coast for a specific period every year, pending the declaration of the marine sanctuary. It also empowered the forest department officials to enact the Orissa Marine Fishing Regulation Act (1981) and the officials of the Fisheries Department were declared honorary wildlife wardens to deal with offences under the Wildlife Protection Act (1972). But these moves did not prove effective. In fact, since 1985, the Forest Department has been repeatedly submitting that unless Gahirmatha is declared a marine sanctuary, it would be difficult to protect the turtles.

Though the turtles had been visiting this beach for centuries, the phenomenon came under the scrutiny of the scientific world only in 1974. The very next year the Orissa Government declared Bhitarkanika, the nesting habitat of these sea turtles, a wildlife sanctuary. But the measure proved inadequate in the face of large-scale fishing activities in the area with the advent of mechanised trawlers. Developmental activities around the breeding grounds only made matters worse. There was the added problem of rampant poaching, since turtle flesh is considered a great delicacy.

To add insult to injury, the lack of proper vigilance along the coastline led to wild pigs and dogs destroying the eggs. So high was the rate of destruction that researchers estimate that only four or five hatchlings out of some 1,000 eggs survive. These ecological disturbances, both on land and at sea, forced the turtles to change their nesting sites several times in the recent past. They have been moving to more isolated regions north of Gahirmatha to avoid predators. But with very little being done to check fishing activities and poaching, they were slowly being driven toward extinction. The high rate of mortality before nesting also contributed to the decline in the number of turtles arriving in Orissa every year.

The Government's move to ban fishing during specified time spans did not work for the simple reason that while the olive ridley turtles come twice a year to this area in January and March and this also happens to be the fishing season. An average of 5,000 to 6,000 adult turtles are found dead each year during the season and the Gahirmatha coast invariably accounts for most of the deaths. Though the declaration of Gahirmatha as sanctuary has brought significance to the conservation of turtles the true victory lies in its effective enforcement.

The worry of the conservation personnel is the sizeable presence of unregistered mechanised boats, operating from outside the state, which come and fish off the Gahirmatha coast. The number of registered mechanised boats operating in the area would not exceed 1,000, but it is difficult to keep track of those operating from other states. From the conservation point of view the declaration of Gahirmatha sanctuary has brought momentum to the protection to the world's largest nesting site of olive ridleys. But, enforcement often face problems from the trawlers not using TEDs. It even becomes impossible to monitor the trawlers not using TEDs, as the number of trawlers engaged in fishing is very large (Kar, 1982; Kar and Dash, 1984 a; Anonymous, 1997 a).

Present Status of Gahirmatha Beach in Bhitara Kanika Sanctuary, Orissa

Gahirmatha is located near Dhamra (21°N and 87°E) is the northern most of the mass nesting sites in Orissa, and is part of the Bhitarkanika Wildlife sanctuary, at the river mouth Maipura on the east coast of India in Kendrapara district of Orissa state. Bustard first reported mass nesting in 1974, and records suggest *arribada*s in the range of 100-500,000 nesting turtles. The current nesting beaches are islands, which was part of the mainland till 1989. In 1989, a cyclone storm cut off a 5 km spit from the main land and nesting has occurred on this spit thereafter. Since 1996, this island known as Nasi, has changed drastically from then year to year. In 1997, it became fragmented into two islands 1.1 km and 2.8 km long and a few hundred meters wide. During the supercyclone in October, 1999, the islands became narrower and further fragmented (Pandav, 2000). Since 1992, all *arribada*s and most of the nesting at Gahirmatha have occurred on these island fragments. One side of the fragment faces the sea while the other faces the river mouth. At times the hatchlings move towards the river mouth, one such movement was observed in 1999 (Das, 1998; Shanker, 2002 a and b).

Generally the mass nesting takes place twice a year (early January and early April). Geographically, the Gahirmatha has been well protected by a rich mangrove forest and provide excellent nesting ground for mass nesting (*arribada*s) of the olive ridleys. On an average 2-6 lakhs females nest in these beaches per year each laying more than 100-150 eggs. In 1997, the mass nesting (*arribada*) of the world's largest population of olive ridley turtles did not take place. This failure is attributed to the offshore fishing. Hundreds of trawlers and gill-netters operated in the area throughout the closed season during 1996-1997 nesting season blatantly violating the law. They were mostly from Orissa and neighboring West Bengal, though foreign trawlers also intruded into the area. Thousands of turtles were entangled in these nets and were killed. Some were swept to the shore by tidal action, more than 4000 washed ashore dead during what should have been the nesting season. Some dead dolphins were also found (Das, 1998).

In addition to the fishing harbours at Dhamra and at Paradeep to the north and south of Bhitara Kanika sanctuary, new landing facilities have been recently constructed on the fringe of the Bhitara Kanika sanctuary at Talchua, Kharanasi and Jambu. This will facilitate more movements of fishing trawler in the protected areas and endanger the turtles during nesting season (Das, 1998).

Orissa's mangroves, considered the second largest mangrove swamp ecosystem in the country, help counter the high salinity of coastal soils, resist strong wind velocity and tidal effects. The coasts of Orissa are severely damaged in the race for commercial exploitation of shrimps Singh (1996). More than 30 km^2 of the total 115.5 km^2 of Bhitarkanika mangrove forests have already been razed and the rest is threatened with ending up as one of the 6,500 or more prawn ponds already covering over 20,000 hectares of coastal Orissa. Prawn entrepreneurs have been able to illegally acquire over 2,000 acres of the forest inside the sanctuary area violating Coastal Regulation Zone (CRZ) and Wildlife Protection Acts.

From March 24 - April 1, 1999, over 200,000 turtles nested at the two islands (Nasi 1 and 2) that are the current sites for mass nesting at Gahirmatha. However, around 80% of the eggs were lost due to inundation and erosion. Mass nesting also occurred at a new site at the mouth of Barunei, 30 km south of Gahirmatha, with 8000 turtles nesting in the 2nd week of March and 20,000 turtles nesting on 21-22 April. Though the mass nesting in Gahirmatha and other new sites are encouraging for conservationists, over 10,000 turtles were found stranded on 360 km of coast between December and April despite the efforts of the Fisheries and Forest Department. Various factors contribute to this lack of success: lack of training and expertise in marine patrolling, lack of funds at implementation level, and inadequate coordination between the different departments.

The failure of the *arribada* in 1997 and 1998 was probably due to a combination of factors including beach suitability. The 1999 *arribada* does not reflect any decrease in turtle

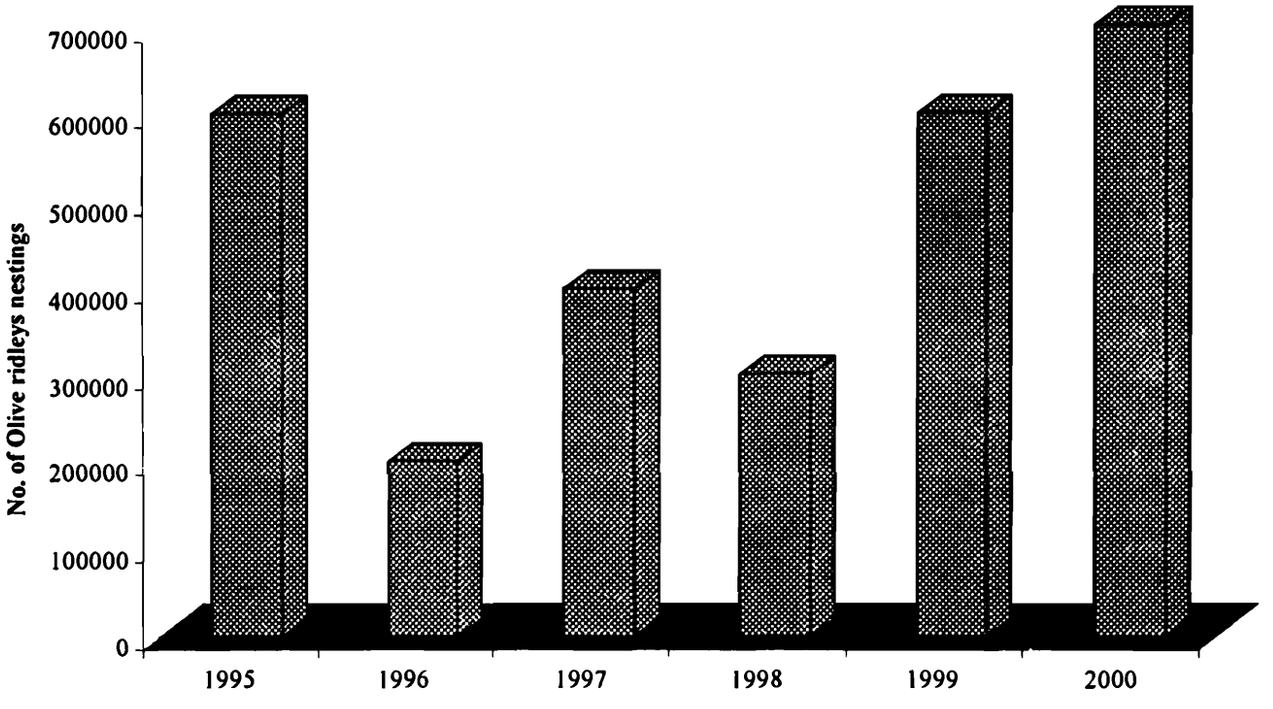

Fig. 29. Number of Olive ridley nesting at Gahirmatha, Orissa (Source: Anonymous, 2000)

mortality, or success in conservation efforts. The current nesting sites comprise two islands (fragments of an original island which became separated from the mainland in 1989) each of which is about 2 km long and less than 100 metres wide (Prusty *et al.*, 1999). The islands have become narrower over the past few years and inundation during spring tides may have been a primary cause for the failure of the *arribada* in 1997 and 1998. These need to be monitored closely over the next few years, while monitoring the coast for new nesting sites as well.

Due to the strict enforcement of fishing policies since 1999, the fishing activity has been severely hit according to the fishermen of Orissa. Turtle deaths are caused by factors other than drowning in trawl nets; most notable amongst these innovative hypotheses are pollution,

mating stress, egg laying stress and migration fatigue. Inevitably, there is a view that due to the large numbers of olive ridleys off the Orissa coast, the death of some thousands should not be a matter for alarm. Conservation of marine turtles in Orissa has entered into a new phase as various NGOs and Government bodies have joined hands for the conservation turtles along the coast of Orissa (Anonymous, 1997a).

It has been suggested by the conservationists and wildlife authorities that the effective management and protection of the Garirmatha sanctuary requires following measures,

- Fishing ban around the sanctuary has to be severely enforced.
- Turtle Excluder Devices (TEDs) should be made mandatory for the trawlers.
- The concerned authorities and the coast guard should effectively carry out vigilance.

The highest-ever mass nesting of Olive Ridleys nest at Gahirmatha in 2000

Over 700,000 endangered olive ridley sea turtles have come and nested at Nasi islands and Babubali Island in the Gahirmatha coast of Orissa in 2000. This was the highest-ever mass nesting of these turtles since recording of their arrival began nearly 15 years ago. In the mid-eighties, about six lakhs of these turtles had come and nested in the Orissa coast. Nearly three lakhs olive ridley turtles nested on Gahirmatha beach in 1999. No mass nesting was recorded in 1997 and 1998. These sensitive turtles did not come to the shore as their congregation in the sea was disturbed by the fishing trawlers.

The main location of mass nesting has been the Nasi-I Island, Babubali Island and a newly-formed island off Gahirmatha coast. The minimum nesting activity took place at Nasi-II Island, which recorded only 536 nesting. The olive ridleys prefer to nest in isolated patches where there are no human habitations or tree cover, which may harbour predators such as jackals, dogs, hyenas and wild pigs. The maximum nesting activity of over six lakhs has taken place at Nasi-I Island in 2000 (Anonymous, 2001a). The annual nesting statistics of olive ridley at Gahirmatha is illustrated in Fig. 29.

CONSERVATION PROGRAMMES

Olive ridley protection measures in Orissa

There are already provisions under the Marine Fishing Regulation Act of India to declare measures for conservation of fisheries resources, including declaration of closed area/season. The Orissa Marine Fishing Regulation Act, 1982 (Orissa Act 10 of 1982) and Rules, 1983 have declared a 3 nautical mile zone from the Orissa seaboard, closed to all mechanized fishing vessels presumably for this reason. With effect from 27 September, 1997, specific programmes were developed to improve sea turtle conservation. Gahirmatha was declared as a Marine (Wildlife) Sanctuary under the Wildlife Protection Act of India, 1972, and fishing

activities were banned in the sanctuary. The Fisheries Department expanded the scope of the Orissa Marine Fishing Regulation Act, 1982 also to protect reptiles, and issued a Notification in June 1997 prohibiting all fishing within the seaward radius of 20 km. from Gahirmatha area round the year to protect olive ridleys. With the same intent, another Notification was issued prohibiting all fishing to a seaward distance of 20 km. from the high tide line around Devi and Rushikulya river mouth, two other nesting sites in Orissa, during the period January to May in 2001 and 2002. Again, not only bottom trawls but all fishing activities, including artisanal fishing that involve only manual retrieval of nets, have been banned from the closed areas. No regulation for TEDs has been enacted as yet. However, at the valedictory meeting of the GOI/UNDP Workshop for the Development of a National Sea Turtle Conservation Action Plan at Bhubaneshwar, Orissa, from the 9 to 10 April, 2001, The Chief Minister of Orissa, announced that TEDs will be made mandatory for all bottom trawls (Shanker 2002a and b; Shanker *et al.*, 1999)

One of the main problems facing shrimp fisheries in Orissa is that the *arribadas* of olive ridleys occur at a time when shrimp resources are at its peak. December to April is also the best fishing season for shrimp in Orissa. The tow time was about one and a half to two hours in duration (If the catch of shrimp was good the tow time could be as low as one hour). According to Orissa Fish Producers Association, the closed areas around Gahirmatha, Devi and Rushikulya, about 1,200 sq km. would constitute 50 per cent of the territorial waters adjacent to Orissa coast of India. These closed areas are believed to deprive the fishing industry of 2,000 tonnes of shrimp, about 50 per cent of the total marine shrimp production of Orissa (excluding the tiny variety of shrimp). It is also believed to affect the catch potential of species like pomfret, ribbonfish, cuttlefish, sole and croaker, fish varieties with good consumer demand both in the export as well as the domestic market (Kar and Dash, 1984a and b; Pandav *et al.*, 1994; 1997; 1998; 1999).

Impact of closed areas/seasons on marine fisheries

The closed area in Gahirmatha alone is believed to affect the livelihood of 2,000 fishers in artisanal fisheries, about 7,000 fishers in mechanised gillnetting and about 2,000 people dependent on bottom trawling. In Devi, about 2,000 workers on board bottom trawlers are affected by the closed season and in Rushikulya, about 10,000 artisanal fishers are affected by the closed area/season to protect sea turtles. It is significant that while a 3-nautical mile zone is reserved for non-mechanized traditional fishing crafts under the Orissa Marine Fishing Regulation Act, 1982, no such provisions are made under the closed areas declared for sea turtle protection.

Orissa estimates a potential loss of Rs. 1,000 million (about $22 million at 2001 prices) to the fishing industry as a result of sea turtle conservation programmes. The impact, he said, has been particularly severe on the 400 bottom trawlers (all below 15 m in length) operating from Paradip, affecting the livelihood of 10,000 fishworkers in production, processing and marketing sub-sectors. On the whole, between 40,000 to 50,000 fishworkers and fishing

vessel operators have been affected in Orissa as a result of sea turtle conservation programmes. In a state with 48 per cent people below the poverty line (annual income of $300), and with marine fishers having an annual per capita income of less than 200, the potential loss of livelihood opportunity as a result of losing access to fishing ground seems quite significant. This aspect has so far been neglected and needs to be urgently looked into. A compensation package for fishing opportunities foregone should be worked out, including provisions for earning an alternative livelihood.

Operation Kachappa

It has become apparent over the past few years that the conservation of sea turtles and small-scale fisheries would require the formulation of a long-term strategy and a cooperative effort from various sectors of government and society to implement it.

It was with this goal that Operation Kachhapa was developed *(kachhapa = turtle;* in oriya language). Operation Kachhapa aims to protect sea turtles and their habitats by enabling strict enforcement of the 5 km non-mechanized fishing zone limit by the Forest and Fisheries Departments and the Coast Guard. It is believed that these measures would also help preserve small-scale fisheries in the region. Apart from Gahirmatha nesting beach, which is a classified as a sanctuary, none of the nesting beaches are legally protected. Operation Kachhapa aims to aid the Forest Department in protecting the nesting sites at Gahirmatha and to objectively monitor other turtle nesting sites and turtle mortality. An important focus is to increase awareness among the public and small scale fishing communities and integrate them into turtle conservation programmes. The project currently involves the following organisations: from the Orissa government, the Forest Department and the Fisheries Department; from the non-government sector, the Wildlife Society of Orissa, Project Swarajya and various other organisations and individuals. The Wildlife Institute of India (WII) in Dehradun, which has a sea turtle research programme on the Orissa coast has been assisting in monitoring nesting and mortality (Shanker and Mohanty, 1999).

Challenges before Kachhapa

The use of Turtle Excluder Devices is an issue that has been widely debated. While the government has allocated funds for TED implementation programmes and Project Swarajya has made efforts to introduce indigenously designed TEDs, it has to yet to gain acceptance amongst trawlers. Currently, none of the trawlers are using TEDs. Another issue that Operation Kachhapa will have to deal with is coastal development, particularly beach illumination. Some of the efforts to control lighting have been successful; the Defence Department and a privately owned factory near mass nesting beaches have been persuaded to control lighting during the nesting season (Shanker *et al.*, 1999). It is already evident that the mass awareness programmes launched under Operation Kachhapa to protect the livelihood of small-scale fishermen have started yielding results. On 10th May 1999, the fishermen of Orissa joined a strike by small-scale fishermen throughout the country demanding total stoppage of illegal

trawling within the coastal zone of 5 km reserved for them. These small successes encourage the notion that sea turtles can be preserved on the Orissa coast by integrating the local people and coastal residents into the conservation effort. It is hoped that the larger issue of protection of small scale fisheries and the livelihood of nearly 300,000 small scale fishermen would also ensure the survival of the olive ridley sea turtle in the future by compliance with the marine fisheries laws. Though monitoring and patrolling are likely to provide some relief from trawling mortality (which is, of course, essential), long-term solutions must involve the local people. It is in this area that one would expect Operation Kachhapa to create an impact over the next few years (Shanker and Mohanty, 1999).

MARINE TURTLE CONSERVATION ACTION (MTCA) IN INDIA

Marine Turtle Conservation Action (MTCA) is a voluntary initiative for developing conservation action for protecting marine turtle breeding areas along the western coast of India. MTCA, which was inaugurated on 5 June, 1996 at Trivandrum, is expected to grow to a large programme with individuals and organizations joining as signatories.

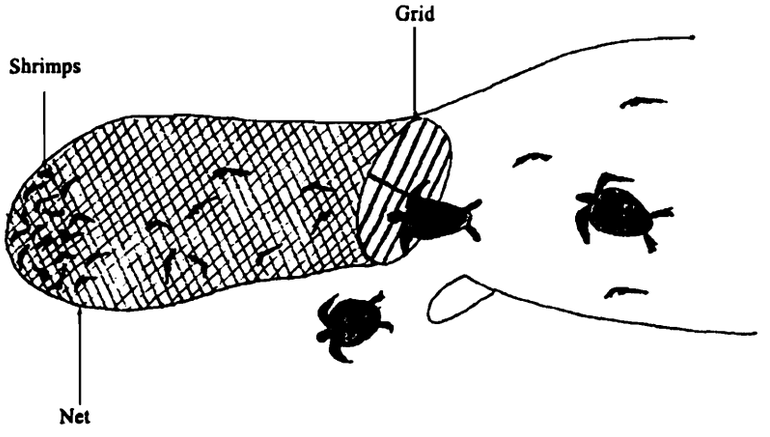

Fig. 30. Diagrammatic representation of TED operation

Priorities : MTCA undertake community based conservation action and carefully planned turtle walks. The objectives of MTCA are to (1) preserve and restore developmental, feeding and nesting habitats, (2) make nesting beaches acceptable to turtles by eliminating the impact of artificial lighting through technology, ordinances (law) and public education, (3) revise beach cleaning programs and control predators, (4) minimize solid waste and pollution of the marine environment, and (5) increase public awareness and participation in sea turtle conservation through public education (Anonymous, 1997b).

The Society for Prevention of Cruelty to Animals (SPCA) in Muthiyam beach, Kerala collect hatchlings from the nesting site and release them into sea to avoid predation (Damodar, 2002).

Vishakhapatnam Society for the Prevention of Cruelty of Animals (VSPCA) work for the protection of sea turtles in and around Vishakhapatnam (Shanker, 2002 a and b).

TURTLE EXCLUDER DEVICES

Marine turtles come to the surface to breath air. Those who are entangled in the shrimp trawl nets are not able to breathe and fail in the struggle to escape from the nets as the pore size of the shrimp nets are extremely small. The turtles entangled in the nets remain unconscious and die if they are not removed from the nets and brought to the surface. During the nesting seasons the number of turtles caught in the shrimp nets are more, and in order to avoid these turtles getting caught in the fishing nets researchers have developed special equipment called Turtle Excluder Devices (TED) that greatly reduce incidental death of sea turtles in shrimp nets. TEDs are devices that allow escapement of turtles without resulting in significant loss of shrimp or other catches. Sea turtles get caught in fishing nets, especially trawl nets, in large numbers during the mass-nesting season, resulting in mass mortality (Fig. 30). This problem is very acute along Orissa and West Bengal coast, from December to April.

What is TED?

A TED is a frame consisting of grid of bars installed before the codend of the trawl net at an angle leading upward or downward to an escape slit. Small animals such as shrimp, slip through the bars and are retained in the codend while large animals, such as turtles, large

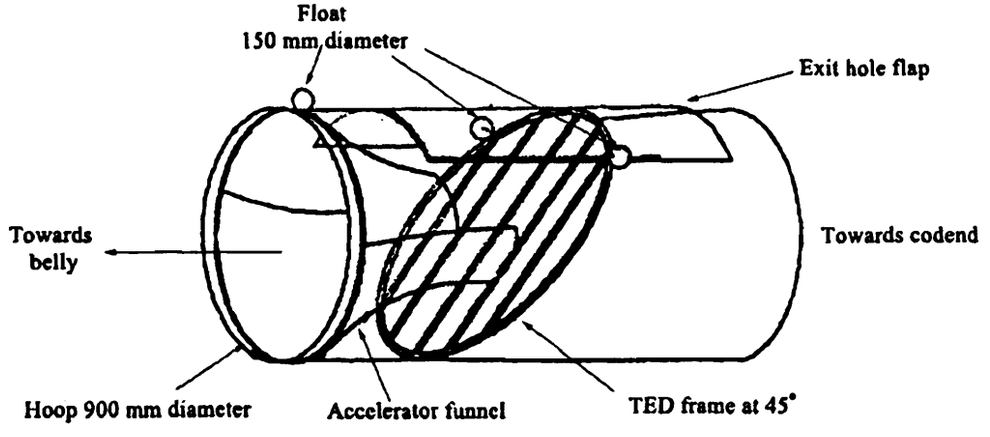

Fig. 31. Schematic representation of CIFT TED

fishes and large elasmobranchs are stopped by the grid bars and can escape through the opening. Experience has shown that the use of TEDs when combined with other elements of an integrated turtle conservation, can stop the decline in sea turtle population and will, over a period of time, lead to their recovery.

Turtle Excluder Device (TED) was first introduced to the US shrimp fishery in the late 1980s and extensive research and development to improve the performance of TED has continued. There are a variety of standard TED designs available today, which conform to grid size, bar spacing and material for TED construction etc. (Anonymous, 2001b).

The Turtle Excluder Devices were developed in the 1980s, modelled after the Cannonball Shooter, a device some American trawlers used to keep jellyfish from clogging their nets. This was the most cost-effective solution to minimize turtles drowning in bottom trawls. The U.S. government has made it compulsory for the shrimp trawlers to use TEDs in 1989. Section 609 of Public Law 101-162 (hereafter "Section 609"), of the Endangered Species Act of 1973 (ESA) of US emphasises the use of TEDs in all U.S. shrimp bottom trawlers.

US restrictions on shrimp trade

The Government of USA has banned the import of shrimps from countries that do not make Turtle Excluder Devices (TEDs) mandatory in the trawl nets, used by their fishing vessels. As the major shrimp importing countries have imposed ban on shrimp imports if TEDs are not attached to shrimp trawl nets, the use of TEDs in trawl nets has become a major issue (Deborah, 1999; Anonymous, 1998; Anonymous, 2000).

World Trade Organisation (WTO) and Turtle Conservation

In October, 1996, Thailand, Pakistan, Malaysia and India filed complaints with the World Trade Organisation (WTO) arguing that the USA ban is a restriction on trade and violates GATT principles. It was stated that Section 609 was in contravention of Article 20(b) and (g) of the WTO Agreement. In March, 1998, the WTO Panel held that the US regulations contradict the terms of GATT 1994. This was challenged by the US in July, 1998 before an Appellate Body which gave its ruling in October, 1998 overruling the earlier Panel. In summary, the ruling of the Appellate body did not require the US to repeal or even to amend Section 609. Instead the WTO decision called upon the US to implement Section 609 in a more transparent, flexible and even-handed manner so as to seek to negotiate relevant multi-lateral agreements with the affect nations and to provide technical assistance to those nations when asked. The sea turtle conservation law is consistent with WTO rules that bars the import of shrimp caught by vessels that do not use turtle excluder devices (Anonymous, 1998; Anonymous, 2000; Evans, 2002).

CIFT TED

The TED developed by Central Institute of Fisheries Technology (CIFT) was successfully field tested in Kochin, Vishakapatnam and Paradeep in 2001 (Fig. 31). During these testings CIFT-TED permitted 100% escapement of turtles while keeping escapement of catch at 1.2% and shrimp alone as low as 0.62%.

Components of CIFT-TED

Oval Frame : It measures 1000X800 mm and made up of 10 mm diameter stainless steel rod welded to the inside of frame. The space between deflector bars is 142 mm and the maximum spacing between the frame and the adjacent deflector bar is 86 mm.

TED Extension : It is constructed of single piece of polythene netting of 40 mm stretched mesh size and 1.5 mm diameter twine of size 150X60 meshes. The 60 mesh sides of the netting piece are sewn together to construct a cylinder.

Hoop : A single hoop having a diameter of 900 mm is constructed of 8mm stainless steel rod, for attachment to the leading edge of the TED extension.

CIFT-TED Operation

- It should be ensured that netting ahead of the TED is not twisted.
- Speed of the vessel should be increased so that the TED extension will ride high in water and twists if any.
- While hauling it is better to keep the vessel against the current or maintain a low speed, in order to prevent the catch from being washed forward, to the exit hole.
- After each haul, accumulated trash and debris have to be removed (Dawson and Boopendranath, 2001).

Resistance to turtle excluder devices (TEDs)

The use of TEDs in the trawlers are recommended under two schemes, one is an externally funded programme and the other is based on the recommendations of the Expert Scientific Panel (Frazier and Tiwari, 1999). These schemes are aimed at the free distribution of TEDs and training the fishermen. The schemes are approved and budgeted by the Marine Products Export Development Authority (MPEDA), under the Ministry of Commerce, Government of India. The reluctance of the fishermen to use TEDs is attributed to the potential impact of TEDs on their shrimp catch. There are three main reasons for the refusal of fishermen to use TEDs.

First, 30 per cent of their catch is feared to get lost if TEDs are to be fitted to their trawls. The fish would escape through the escape hole provided for turtles. It is further feared that turtles or ray fish, if caught in the grill of TEDs, might block the path of fish to the cod end. Second, use of TEDs would increase the drag on the net while trawling, and this would add to their fuel costs, which are already fluctuating in India.

Majority of the conservationists believe that TEDs are impractical in Orissa because of the massive number of olive ridleys that aggregate during the nesting season. TEDs would be practical only for a smaller population size.

The more practical conservation measure would be declaring a 3 nautical mile closed area round the year for mechanised fishing, and a closed season from 15 April to 31 May every year, for all fishing vessels. The closed season is also observed in the maritime states south of Orissa, *viz.*, Andhra Pradesh and Tamil Nadu from 2001. Majority of the fishermen are with an opinion that drowning in trawl nets is not the single most important cause of death of sea turtles.

Commercial Trade in the Past

Out of the seven species of living sea turtles, juveniles and adults of three species are heavily exploited of commercial trade. The green sea turtle is taken for its much-favoured meat; and its calipee'calipash (belly cartilage), neck and tail bones are used in manufacturing turtle soup. The hawksbill sea turtle has the most valuable shell. Due to thickness and colour patterns of the scutes, it is used for jewellery, ornaments, or as delicate inlays and veneer on furnitures. Most of the tortoise shell trade is believed to be from the hawksbill sea turtle. Between 1963 and 1974, India exported 102,022 kg of sea turtle products valued at roughly $ 100,800. The products included sea turtle meat, oil and shell (Murthy and Menon, 1976). Between 1976 and 1978, the major raw tortoise shell exporting countries were Indonesia, Thailand, the Philippines, India and Fiji. The volume of raw tortoise shell involved in international trade has increased dramatically since the early 70's. Between 1967 and 1970, Indonesia exported less than 10,000 kg of raw tortoise shell annually. In 1978 it exported 219,585 kg, which is more than double the exports of 1977. Thailand exported between 10,000 kg and 15,000 kg of raw tortoise shell annually between 1973 and 1975; but by 1978 exports had increased to 53, 618 kg.

Indian exports rose from under 3,000 kg annually prior to 1975 to 82,855 kg in 1977. during the 60's the Phillippines exported less than 5000 kg annually, but exports have risen steadily since 1975, reaching 38,145 kg in. The olive ridley sea turtle is captured mainly of its meat, skin, oil and eggs. The largest marine turtle fisheries in the world exist in Mexico and Ecuador, where more than 2 million ridley turtles have been slaughtered. Annual catches have been over 300,000 in mexico and as high as 150,000 in Ecuador. The crop consists of mature animals, mainly adult females; in Mexico the vast majority are gravid (Frazier, 1980). Details of the olive ridley trade statisitics in Mexico and Ecuador have been presented by Frazier (1980).

Roughly, an estimated number of 50,000 to 80,000 adult olive ridleys comprising both sexes, but mostly gravid females, were captured in every nesting season up to 1980-1981 offshore Gahirmathha rookery, Orissa, India. The live turtles were mostly exported to different market places of Calcutta. The resource protein potential is roughly valued at Rs. 50 lakhs per season involving 2-3 thousand tons of turtle biomass per season. From the time Kanika was a Zamindari area, people were paying "*Anda Kara*" (revenue for the eggs) and sere collecting boatload of eggs from the Gahirmathha rookery during the *arribadas*. The Forest department of Orissa was also issuing licenses for collection of eggs at the rate of Rs. 15 per boatload containing roughly between 35,000 to 100,000 eggs. The estimated legal egg

consumption in 1973 season was 15 lakh (FAO, 1974) but the actual illegal take was probably much more. Annually about 50,000 turtles were exported from Gahirmatha alone till 1982 (Kar and Dash, 1984a and b).

Turtle fishing was practiced for ages in Gulf of Mannar and Palk Bay. It was active till the late seventies. In the sixties it was estimated that on an average of about 3000 to 4000 turtles landed every year between Pamban and Cape Comorin. The main fishing cenres in Gulf of Mannar were Pamban, Kilakarai, Tuticorin, Ovari, Kuttankuli, Periathalai and cape Comorin while along the Palk Bay the centers were Rameshwaram, Tondi, Tirupallakudi, devipatnam and Pamban. Even though no organized fishery for turtles existed along Orissa and west Bengal the commercial exploitation of turtles were predominant till the late eighties (Rajagopalan, 1984b; Rajagopalan, 1996).

Eventhough no organized fishery for turtles existed along Orissa and West Bengal Coast, trade in turtle eggs and turtle flesh occurred every year during the *arribada* in Bhitarkanika area. From the time when Kanika was a Zamindari holding, people were paying Andakara (Revenue for the eggs) and were collecting boat loads of eggs from this area. The Forest Department of Orissa was issuing licences for collection of eggs. Eggs were sold in all the river side villages and large scale transport of eggs during the season to the Calcutta market also took place. Locally people used to preserve the turtle eggs in large quantities by drying them in the sun for future use. The estimated legal take in the 1973 season was 15 lakh eggs but the actual illegal take was probably much more (Rajagopalan, 1984b; Dan, 1982). India exported turtle meat, shell and live turtles to UK, Australia, France, Hong Kong, Italy, Japan, Netherlands, Singapore, Spain and Germany till late seventies. Between 1963 and 1974, 102,022 kg of sea turtle products were exported from India. Between 1971 and 1976, 120 kg of turtle shell were exported to France and UK. Turtle hoofs of 757 kg were exported to Japan, Singapore and UK between 1975 and 1980. Between 1974 and 1976, 106 kg of turtles were exported to Nepal and West Germany (Rajagopalaan, 1984b). In Andaman Islands all species except the leatherback was hunted for meat. The tribals of Andaman consume raw turtle meat minced with coconut. In Lakshadweep turtle meat is used as shark bait. Turtle fat was used to waterproof the boats in Lakshadweep islands (Rajagopalan, 1984b; Datta and Dan, 1985).

PRESENT STATUS

IUCN Red Data Book recognises seven categories such as Extinct (Ex); Endangered (E); Vulnerable (V); Rare (R); Indeterminate (I); Out of danger (O); and Insufficiently known (K) which can be assigned to any particular species of plants and animals for determining its status for conservation purposes. The recent edition of the IUCN Amphibia, Reptilia Red Data Book (1982) compiled by Groombridge has listed 6 of the 7 species of living sea turtles in its various categories, which are as follows :

Species Name	Status
FAMILY : CHELONIIDAE	
Caretta caretta	Vulnerable
Chelonia mydas	Endangered
Eretmochelys imbricata	Endangered
Lepidochelys kempii	Endangered
Lepidochelys olivacea	Endangered
FAMILY : DENNOCHELYIDAE	
Dermochelys coriacea	Endangered

Thus, five species of living sea turtles are at present endangered, one is vulnerable and another species, the flatback sea turtle, *Chelonia depressa* which was formerly listed as "Rare" in the IUCN Red Data Book (1975, 1979), has been excluded from the Red Data Book categories of the 1982 edition (Groombridge, 1982).

LEGAL MEASURES

In the international context there exists a very strong protective policy for sea turtles (Whitaker and Kar, 1984). At present, there are in force two global conventions of sea turtles.

- All species of the sea turtles including those found in India are included in the Appendix I or II of CITES, 1973, (Convention on International Trade in Endangered Species of Wild Fauna and Flora). Appendix I includes species that are threatened with extinction. Appendix II species are those which either may become threatened with extinction if international trade is not regulated, or species which must be subjected to regulation in order that trade in these first species may be controlled. Though not a comprehensive wildlife conservation convention, CITES, since it came into force in 1975, is mainly concerned with international control of trade in endangered and threatened species. India ratified CITES in 1975 and it came into force in India in October, 1976.
- The convention on the conservation of migratory species of wild animals was negotiated and signed by 22 nations (except USA) in Bonn, West Germany, in June, 1979. In June, 1981, India became a party to the Bonn convention on the conservation of Migratory Species of Wild Animals.
- This convention makes all migratory species and regions of the world eligible for consideration and is designed to stimulate as well as to provide direction and guidelines for negotiation of further conservation agreements for migratory animals. It also provides a mechanism for individual states to unilaterally conserve endangered migratory species.

Lepidochelys kempii and *Dermochelys coriacea* are included in Appendix I and all species of cheloniidae are included in Appendix II of the convention. Appendix I includes endangered species for which immediate and stringent conservation measure by the party states along the range of the listed species ("Range States") are required.

- Appendix II species are those recommended to be the subject of agreements by their range states. The convention is predicted upon the principle that all the states along the range of a migratory species must participate in its conservation and management. Besides, there are other international conventions such as draft law of the sea treaty and the convention concerning protection of world cultural and natural heritage. Several regional conventions which are directly relevant to the conservation of sea turtles include (i) Convention on Nature, Protection and Wildlife Preservation in the Western Hemisphere which came into force in 1940, (ii) African Convention on the Conservation of Nature and Natural Resources, 1968 came into force since 1969 in which all marine turtles have been listed as "Class A" protected species, and are totally protected throughout the entire territory of the parties with taking allowed under special circumstances, (iii) Convention on the Conservation of Nature in the South Pacific and (iv) international fisheries agreements.

- Existing international fisheries agreements do not address the problem of incidental take or the need to conserve sea turtles as a natural resource. However, the following organisations have the potential for supporting sea turtle recovery such as WECAFC, IOCARIBE, GCFI, UNESCO, MAB, etc.

- In India, all the five known species of sea turtles are now fully protected from hunting, killing and other forms of exploitation under the Indian Wildlife (Protection) Act, 1972 by an amendment of the schedules in September, 1977. In the above amendment, excluding the flatback sea turtle, rest six species were included in the list of Schedule I animals along with locally unreported kemp's ridley. Changes were made in the revised list of Schedules (Government of India Letter No. 1-28-78-FRY(WL), Dated 12th September, 1980, effective from 2nd October, 1980). *Lepidochelys kempii* was then removed from the list, as it is not known to occur in Indian waters (Kar and Dash, 1984).

MANAGEMENT MEASURES FOR CONSERVATION OF MARINE TURTLE SPECIES

The major threats, which the marine turtles, have been facing globally, in general are as follows; habitat destruction, incidental catch, predation of eggs and hatchlings, pollution and mortality caused by fishing trawlers.

To prevent the illegal and incidental catch of marine turtle species strict fishing policies and regulations are required, for which the following management measures, are recommended : habitat preservation, application of TED, strict enforcement of conservation laws and

regulations, awareness creation with regard to turtle conservation and further research on turtle biology for the better understanding of turtle conservation.

Habitat Preservation

As the number of population depending on the marine resources for the livelihood are increasing day by day, a wide range of activities are directly or indirectly influencing changes in the coastal habitat. Littoral drifts causing beach erosion, plantation of casuarinas trees in areas close to the high tide line, construction of fishing jetties, harbours and tourist complexes are the main sources of pollution and habitat degradation.

Casuarina plantations are grown in the seashore and they reduce the available space for the nesting sea turtles. They change the entire beach soil sub-structure by deposition of litter and by root growth. These plantations in the nesting grounds have to be uprooted and the beach should be restored to its original condition.

Construction of new fishing jetties and harbours has greatly influenced the *arribadas* of olive ridleys in Gahirmatha, Orissa. These facilities have to be carried out after thorough environment impact assessment.

Dumping of wastes, garbage and slaughterhouses along the coastal areas draw scavengers and they feed on the eggs and hatchlings. To avoid natural predators the coastal areas have to be maintained well and should be free from wastes and garbage.

Application of TEDs

Attachment of Turtle Excluder Devices to shrimp trawl nets has reduced the entanglement of turtles. Hence compulsory use of TEDs should be made by the states/union Territories to reduce the killing of turtles.

Strict enforcement of conservation laws and regulations

The Wildlife Protection Act, 1972 and Marine Fishing Regulation Act (MFRA), 1981 in Orissa have adequate provisions to safeguard the marine turtle populations. The enforcement of these regulations has to be taken up seriously. Fishing vessels should not be allowed to fish near the protected areas and during the nesting period. The fishermen folk have to be made aware of the existing conservation laws.

Awareness

Mass awareness campaigns have to be taken up to educate villagers and students about the need to conserve turtles. Those who depend on the marine resources for their livelihood have to be involved in the conservation programmes.

Further research on turtle biology is essential for the better understanding of turtle conservation.

Nesting cycle, Reproductive cycle and Migaration pathways of various turtle species are still unknown. Researches in these areas have to be strengthened in order to understand the biology of turtles for better conservation strategies.

Conservation strategies for sea turtles in India

- Intensified effort on basic research to understand biology, reproductive and nesting cycles and pathways of migration of sea turtles.
- Genetic analysis of turtle groups to determine their behaviour biology.
- Recovery programme should be encouraged to ascertain the pathway and global distribution of sea turtles.
- Incidental catch of turtles may be avoided by regularizing fishing practices.
- Mechanised fishing vessels should not be allowed in the protected areas during the nesting seasons of the turtles.
- Conventional TEDs causing minimal loss to the shrimps should be produced and distributed to the fishermen at affordable rates.
- Fishing jetties and harbours should be constructed far away from the protected areas.
- National policy on the conservation of sea turtles should be developed.
- National coordinated programme for studies on sea turtles.
- Conservation of nature and natural resources should be placed above economic gains.
- Awareness among youth and children should be developed with regard to the conservation of natural wealth of the country.
- Socioeconomic conditions of the people depending on the marine resources should be highlighted. Conservation measures should always take this into account.
- Longterm monitoring of breeding population
- Establishinng hatcheries
- Training on hatchery management
- Survey and monitoring potential nesting grounds
- Periodical status survey
- Establishing Turtle Protected Areas

SUMMARY

Five species of sea turtles are reported in the Indian waters : Olive ridley - (*Lepiodchelys olivacea*), green turtle - (*Chelonia mydas*), hawksbill - (*Eretmochelys imbricata*), leatherback- (*Dermochelys coriacea*) and logger head - (*Caretta caretta*).

Leatherback in the Indian Ocean has been recorded at the Gulf of Mannar, Gulf of Kutch, Okha coast, Goa coast, Tangasseri reef near Calicut, the Palk Bay and in coastal areas of Sri Lanka.

The Green turtle is circumtropical species, which has been recorded at Gulf of Kutch, Okha coast, Salm districts in Maharashtra, entire Kerala coast extending south from Quilon, complete eastern coastline of Tamil Nadu and in all coral reef areas in the Gulf of Mannar and Palk Bay.

The Hawksbill turtle inhabit tropical and subtropical seas and not seen in large numbers, as it prefers an independent life, it nests individually in localities far apart at the coastal parts of southern Tamil Nadu, Kerala, Andaman and Nicobar Islands, Gulf of Kutch, all coral reef areas in the Gulf of Mannar, Palk Bay and Lakhshadweep Islands.

The Loggerhead turtle is the most widely distributed species in all the temperate and subtropical waters of the world. They have been reported from southern Tamil Nadu coast and coral reef areas in the Gulf of Mannar and Palk Bay.

The olive ridley turtle concentration is maximum in the coasts of Maharashtra, Goa, Kerala, south Tamil Nadu, Andhra Pradesh, Orissa, Andaman Islands, Gulf of Mannar, southern coast of Srilanka, Lakhshadweep Islands.

The natural predators of sea turtles are reptiles such as *Boasp* (elapids); and varanid lizards; birds such as black vulture, turkey vulture, ibis, crows; small mammals such as rats (*Rattus* sp.), coatis, racoons, mongooses, genets, feral cats, white lipped peccary, pigs, hogs, jackals, dingoes, foxes, coyotes, hyenas and dogs. Sharks and other numerous varieties of fishes; snakes such as *Boiqa dendrophila* and *Python reticulates*; varanid lizards; birds such as sea gulls, crows, vultures, kites, night herons; mammals such as *Rattus* sp., mongooses, genet, feral cats, racoons, coatis, hogs, domestic and feral dogs etc. Apart from predation and natural calamities the chemical industries in and around the coastal areas destroy the nesting areas of the turtles. Construction of chemical factories, luxury hotels, and theme parks along the beaches distract the nesting grounds of the turtles and affect their aggregation on the beaches.

In 1990, the US National Academy of Sciences it is concluded that more sea turtles die from shrimp trawling than from all other humans causes. Shrimp trawlers and gill-netters are the primary cause of mortality. Apart from the large-scale mortality of sea turtles, the small-scale traditional fisheries are also collapsing due to uncontrolled and illegal mechanised fishing within the prohibited zone.

Out of the seven species of living sea turtles, juveniles and adults of three species are heavily exploited for commercial trade. Turtle fishing was practiced for ages in Gulf of Mannar and Palk Bay. It was active till the late seventies. In the sixties it was estimated that on an average of about 3000 to 4000 turtles were landed every year between Pamban and Cape Comorin.

All the seven species of sea turtles of the world have been listed as endangered, threatened and vulnerable by the US Endangered Species Act, the IUCN Red list and international treaties. In the international context there exists a very strong protective policy for sea turtles. All species of the sea turtles including those found in India are included in the Appendix I or II of CITES, 1973, (Convention on International Trade in Endangered Species of Wild Fauna and Flora). In India, all the five known species of sea turtles are now fully protected from hunting, killing and other forms of exploitation under the Indian Wildlife (Protection) Act, 1972 by an amendment of the schedules in September, 1977.

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