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**SEA TURTLE RESEARCH  
AND CONSERVATION**

**CENTRAL MARINE FISHERIES RESEARCH INSTITUTE**  
(Indian Council of Agricultural Research)  
P.B. No. 1912, Cochin 682 018, India.

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Olive ridley *Lepidochelys olivacea* returning to sea at Gahirmatha Beach after nesting (Photo : E. G. SILAS)

## PREFACE

Five species of sea turtles are known from the Indian Seas and all are today protected and are placed in Schedule I of the Indian Wildlife (Protection) Act, 1972. The Convention of International Trade in Endangered Species of Wild Fauna and Flora (CITES) which prohibits trade in turtle products places these species in Appendix I of the Convention.

All five species have very wide distribution and there has been a traditional subsistence fishery for the green turtle *Chelonia mydas* along the Tuticorin Coast which has now been phased out. A new event in the recent past was the explosive development of an outlet for the olive ridley in the Calcutta-Howrah markets chiefly from the Orissa Coast, despite the Indian Wildlife (Protection) Act. This happens mainly during the mating and mass nesting of this species along the Gahirmatha Coast of Orissa and the capture is mainly in the gillnet fishing operations. This has been reported in detail in *Marine Fisheries Information Service, Technical and Extension Series*, No. 50 of this Institute. Incidental catch of turtles in fishing operations has been a matter of great concern and only an intensive extension programme can help to minimise the mortality from this source.

Unlike what was witnessed in 1983, during the mass nesting period of 1984 (January-February), I have seen very few carcasses of the olive ridley along the Gahirmatha Beach due to the almost complete cessation of operation of mechanised fishing boats along that coast resulting from the wider publicity given on temporarily regulating fishing. This is a positive and highly creditable achievement for which we should be thankful to the Honourable Chief Minister of Orissa, the Officials of the Forest Department and the fishermen sector. The Coast Guard has also played an important role to see that large trawlers were not involved with operations in the area.

The Government of Orissa needs our congratulations for setting up the Gahirmatha Marine Turtle Research Centre at Habalikhathi in the Bhitarkanika Sanctuary for studying turtles. Shri Chandrasekhar Kar who is in charge of the Research Centre has been observing and studying the mass nesting of turtles during successive years since 1977.

There has been a global awakening on sea turtle research and conservation which resulted in the World Conference on the 'Biology and Conservation of Sea Turtles' in November 1979 at Washington, D.C. This as well as the published Proceedings of the Conference have considerably enhanced the awareness on the imperative need for sea turtle conservation and resource management as well as the urgency of directed research on the biology of these animals.

At the Central Marine Fisheries Research Institute, a recovery programme for the olive ridley was taken up during the 1977-78 season at Kovalam, Madras and in this modest programme to date over 40,000 hatchlings have been released from the hatchery. This Bulletin besides embodying the results of some of these studies also discusses at length on turtle poisoning or Cheloniotoxication as well as the situation at the Gahirmatha rookery of the olive ridley during the 1984 mass nesting and research and conservation strategies for the future.

It is hoped that the studies and observations embodied in this Bulletin would stimulate further researches on the biology and conservation of Sea Turtles in this country.

I would like to specially thank the Government officials of the Department of Forest and Department of Fisheries of the Government of Orissa, particularly Shri S. K. Mahapatra, Chief Wildlife Warden, Shri S. K. Mishra, D.F.O., Chandabali and his staff and Shri Kindo, Director of Fisheries and his staff for making it possible for me and my colleagues to visit and work at Gahirmatha. Our thanks are also due to Shri Chandrasekhar Kar for the hospitality and courtesies shown to us during our visit. A special word of thanks is due to Shri G. N. Mitra, Fisheries Consultant and Adviser to the Government of Orissa for his encouragement.

Cochin-18  
16th February 1984

E. G. SILAS  
Director  
Central Marine Fisheries Research Institute

## SEA TURTLE RESEARCH AND CONSERVATION

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## SEA TURTLE RESEARCH AND CONSERVATION—SOME PROBLEM AREAS

E. G. SILAS

### ABSTRACT

In the light of recent researches on sea turtle biology, some of the problem areas which need urgent attention for developing research programmes in the country are discussed here. It is hoped that focus on these problems would help in developing more meaningful conservation and management programmes. The paper also outlines research and conservation strategies for the future.

### INTRODUCTION

There are five species of sea turtles in the Indian Seas and all are considered endangered and placed in Schedule I of the Indian Wildlife (Protection) Act of 1972. These species are also listed in Appendix I of the Convention of International Trade in Endangered Species of Wild Fauna and Flora (CITES) which prohibit trade in turtle products by party countries. None of the five species are endemic and may undertake long migration to feeding and breeding grounds often across international boundaries. There are recent suggestions on the existence of non-migratory populations or population segments. During their life-history, sea turtles pass through various ecosystems and this diversity from the nesting beaches to their sojourn to the feeding grounds and back to the nesting beaches is a complicated one. At all stages they are vulnerable to heavy natural predation and exploitation by man. In nature, recruitment to adults is extremely low, large-scale mortality occurring even before the hatchlings enter the sea and in the inshore waters.

With considerable importance given currently to the recovery programmes aimed at the conservation and management of sea turtle resources, there is a greater national awareness on the problem. More individuals and organisations are evincing an ever increasing involvement in researches on sea turtles. During the past year, I have been receiving requests from interested workers as to what type of studies could fruitfully be undertaken on the ecology, biology and behaviour of sea turtles with our limited resource facilities. The problem for many seems to be, where to start, what to look for, whether material will be available for long range studies and monitoring and how to go about it in the first instance as sea turtles are completely protected

animals. Benign research has no doubt a place in the Scheme of things. Today there is a school of thought advocating that hatching and release programme is a must and that investigations connected with these may only be meaningful. We may have to critically examine whether we are over reacting in this or whether the hatchery programmes have to be considered for selected areas. There is a clear case for such a programme along the Madras Coast where human and non-human egg predation is very high. On the other hand in a place such as the mass nesting beach at Gahirmatha, Orissa, perhaps transplantation of eggs to other parts of the beach may be a solution.

We may have to fix our priorities on conservation measures to be adopted and supported by research programmes. The fact remains that the sum total of our knowledge on the biology of sea turtles from India is so meagre that one should not feel defident to take up challenging researches which may aid conservation and management programmes. The subject is more complex as all five species of sea turtles show differences in their life habits and behaviour.

It is in this context I feel that the 'World Conference on the Biology and Conservation of Sea Turtles' held in Washington DC from 26th to 30th November, 1979 is a landmark. The published Proceedings of the Conference entitled 'Biology and Conservation of Sea Turtles' Edited by Karen A. Bjorndal, for the first time brings together expert opinion on various facets of turtle biology, life habits, reproductive physiology, population dynamics and other aspects to help in development of constructive programmes on conservation and management of the resources. I had occasion with two other Scientists from India to attend this very

important Conference and have felt that some of the problem areas identified in the presentations and in the course of the discussions also embodied in the published Proceedings have great relevance to us today. The lack of biological information to the conservationist is often frustrating and leads to the extreme view of total protection to be accorded but, why and how this is to be done still remains a problem. This is very true for sea turtles where basic knowledge of many of the life habits are wanting. There is a rapid accumulation of literature on nesting beaches and the nesting habits of sea turtles. What was considered good and positive at one time such as the hatchery programme for incubating the eggs and releasing the hatchlings or the head-starting programmes are today considered in some quarters as highly questionable. To give one example, recent researches have pointed to the effect of temperature on sex regulation and this in hatchery incubated hatchlings could create great imbalances if not properly managed. So also the once well thought of head-starting programme is today not considered favourably in view of the disorientation that may happen in the young turtles which may find it difficult to reach the natural feeding grounds. This feeling has surfaced since activities in these directions have not resulted in visible signs of building up of the resources. In the light of the perspectives in turtle research and the need for developing a coordinated programme of research on sea turtles in India, I would like to discuss here some of the problem areas which need our special attention.

There is very little sociality among sea turtles, except during courtship and mating and when large reproductive aggregations known as arribadas occur. Group activity is also seen at the time of emergence of the hatchlings from the nest where they trash about and emerge in quick succession and thenceon have to fend for themselves.

The mechanism that enables the hatchlings to take an accurate seaward heading is not still fully understood, although a good amount of literature has accumulated on this subject (Ehrenfeld, 1968; Schone, 1975, Mrosovsky, 1978; Van Rhijin, 1979, Carr, 1981).

Carr (1963, 1981) has focused on the spectacular response of the hatchling to the surf within minutes of its emergence. The ability of the hatchling to circumvent the forces of the breaking waves and get beyond the surf with ease needs study under different surf conditions.

The 'lost year' has been a puzzle for a long time since hardly anything is known about the hatchlings once they reach beyond the surf. Frick (1976) and Carr (1981) talk about the seaward drive of the hatchlings which head towards the open sea. Little is known about the pelagic existence of the hatchlings. Silas *et al* (1984) have discussed the utilization of the reserve yolk in the hatchlings in captivity for several days after their emergence. Their movements in relation to surface currents and other oceanographic parameter needs study.

The migration of the turtles to the feeding grounds and thence for reproduction to the nesting beaches needs study through tagging or marking experiments as well as work on their sensory physiology to understand the mechanisms helping in such guidance system. Better methods of tracking the migrating turtles including the use of internal tags and satellite telemetry should be explored. The turtles which are tagged on the nesting beaches will be females and as such more information will be needed on non-breeding stages of both sexes. Little is known about the male segment of the population except from incidental catches in fishing gear. We have no information from our waters of sea turtles basking on the beaches close to feeding grounds nor of their hibernating at the sea bottom.

#### REPRODUCTION

The ethology of mating is today better known for the green turtle *Chelonia mydas* (Bustard, 1972; Booth and Peters, 1972, Hendrickson, 1958). Information is very scanty on courtship and mating in other species.

According to Ehrhart (1982) the temporal relationship of copulation, fertilization and egg laying has puzzled marine turtle biologists for over 25 years. The need of repeated matings or the long term storage of sperms from one mating yet awaits elucidation. Carr and Hirth (1962) and Carr (1965) opine that pre or post nesting mating may fertilize eggs to be laid 2 or 3 years later, and not eggs laid during the season. This concept of delayed fertilization has been questioned by Frazier (1971) on the following grounds:

- a. There is no evidence that nesting females without claw mark on the carapace have not mated and the eggs laid by such females are fertile.
- b. It appears non-adaptive for virgin females to migrate long distance to mate, but not nest for the next two or three years.



- c. The need for the males to migrate to the breeding grounds to mate in order to deposit spermatozoa about 3 years in advance instead of mating at the feeding grounds a few months before nesting.
- d. The mechanism by which females could maintain viable sperms in the reproductive tract which has been doubted has now shown to be possible by Solomon and Bain (1979) in the case of *C. mydas*.

In short, delayed fertilization or otherwise, needs verification in the different species. The frequency of mating prior to or during the nesting season, and whether this happens once or more during a season needs further elucidation.

As regards nesting, Carr and Ogren (1960), Hirth (1971) and others have identified and categorised eleven stages of activity. Ehrhart (1982) has discussed selected traits among different species such as gait, oviposition, character of body pit, and time of day when nesting takes place. More quantified information on these and other habits are wanting. Reproductive potential has been discussed for the different species by many authors based on clutch size. Here we find a good amount of variability between clutch size of the same species in the same nesting ground, clutch in relation to body size and so on. Egg size also differs in the same clutch. At the same time, it is not known whether the same animal returns to nest a second or a third time during the nesting season and whether the variability in clutch size has anything to do with such behaviour.

#### REPRODUCTIVE PHYSIOLOGY

Owen (1982) has delineated three areas where reproductive Physiologists could fruitfully interact with turtle conservationists. These are the identifications of critical reproductive processes; improving conservation and research techniques for instance through determination of sex in hatchlings and immature sea turtles; and continuing basic research in sea turtles adopting also technique such as radioimmunoassay of hormones, x-ray photography, laparotomy, hormone manipulation and electroejaculation, without harming the animals. A dependable sex determination method has been the estimation of circulating levels of androgens which is higher in male turtles.

#### TEMPERATURE DEPENDENCE OF SEXUAL DIFFERENTIATION

The pivotal temperatures at which more females or more males could result during incubation is an important new area of research in sea turtle biology

having far reaching consequences. Mrosovsky and Yntema (1982) have critically reviewed this in the light of implications in conservation practices. In principle it has been found that females predominate when incubation temperatures are high and more males are obtained at lower temperature and females at still lower temperatures in the freshwater snapping turtle *Chelydra serpentina*. As mentioned earlier, one of the major lacunae is information on male population of sea turtles which is not accessible as the females in the nesting grounds. Thus the fact that embryonic sex differentiation depends on temperature, makes this an important tool to help manipulate sex ratio. The need here is to develop a rapid technique for sex identification which will not involve sacrificing the animal. In *C. mydas* it may take 4 to 6 years before any visible external signs are available for differentiating male turtles. Armed with this knowledge, we may now try to find out :

- The implication of temperature variabilities in hatcheries where eggs are incubated or in alternate nesting sites where clutches are transplanted.
- Whether in a single clutch sex differentiation happens on temperatures as follows: the eggs dropped in the latter half of oviposition and closer to the surface and subjected to marginally higher temperature turning out to be females and those dropped first lying at the bottom of the nest males? It is imperative that data be obtained on sex ratio in eggs developing in natural nests as compared to those incubated artificially.
- The reason for protracted incubation period — specifically whether this can be correlated with temperature. According to Mrosovsky and Yntema (1982) a 1°C lowering of temperature will be reflected in a 5-day increase in incubation time. Hence, what would be the effect of a decrease of 2 or 3°C on masculinization or the increase of 2°C on producing predominantly females and the relative increase or decrease in the number of days of incubation?
- There are suggestions that eggs from a clutch may be kept apart in 2 or three lots to ensure better hatching success. Since metabolic heat is produced by eggs, would smaller clutches be cooler and produce all males? In short, would the size of the clutch affect sex ratio?
- The crucial question is at what stage of embryonic development does the pivotal temperature play its role in sex differentiation.

I feel that temperature dependence of sex differentiation is basically one of the most important aspect in sea turtle research which calls for immediate indepth research. The well intentioned hatchery programmes without utmost consideration to this may for all lead to negative results.

#### REPRODUCTIVE ENDOCRINOLOGY

Licht (1977) was the first to show that two distinct gonadotropins viz., Follicle Stimulating Hormone (FSH) and Leutinising Hormone (LH) were present in the pituitary of *C. mydas*. In captive rearing populations it has been found that the FSH peaks during the nesting and LH and the steroid progesterone about a day later when ovulation of the clutch occurs. Verification of this in the wild population and in other species has still to be carried out. Further, in captive fresh water turtles the use of oxytocic hormones has been found to induce the turtle to deposit a clutch of eggs (Ewert and Legler, 1978). Such work should be attempted in sea turtles.

#### BEHAVIOURAL ECOLOGY

A whole range of problems can be posed in behavioural ecology of sea turtles of which we are totally ignorant of. To mention a few :

- We have very little knowledge of the internesting intervals and travels of sea turtles.
- Experiments elsewhere have shown the ability of migrating adult turtles to hold courses independent of the prevailing ocean current (Meylan, 1982). Turtles (*Lepidochelys kempi*) after nesting and returning to sea are known to initially travel against the current and later return with it.
- The distances to which turtles travel during the internesting period is still a question mark.
- Day time and night time activity of the post-nesting turtles is still blank. Diurnal activity could differ from species to species and intraspecifically.
- On what cues do turtles orient themselves at night? What is the mechanism involved?
- What are the swimming speeds of turtles? Here tag recoveries may give clues. For *Chelonia mydas* Carr, Ross and Carr (1974) have recorded as much as 7.2 km/hr.

#### BEACH SELECTION BY NESTING TURTLES

Heaviest nesting have been observed along unlit beaches with no obstacles in the offshore approaches. Mortimer (1982) found a decreasing density of nesting with different types of beaches from those with no

offshore obstacles to rocky approaches to lighted beaches in the Ascension Island. Bustard (1972) has reported the green turtle nesting when a good amount of beach front vegetation including large bushes and trees are present. Hawksbill is known to nest beyond the sandy beaches amongst vegetation (Frazier 1975; Mortimer 1982)

Studies on beach sands have been carried out, some positive and some inconclusive. However, Mortimer (1981) has found an optimum range of grain size for hatching success. He opines that nests could fail if sand is too fine or too coarse. Biotic factors such as beaches between estuaries and sand banks off open beaches may also have a role to play in nest site selection by the turtle.

Human interference such as lighted beaches, physical structures on beaches and antierosion works, beach mining and so on are known to have adverse effects on the nesting habits of sea turtles as well as also affect emerging hatchlings. Henrickson (1982) has rightly pointed out that besides interspecific and intraspecific differences in details of nesting behaviour among sea turtles, little is known about the effect of perturbations on nesting successes, particularly those of human origin. Effects of high amplitude low frequency sound vibrations which could mask surf sounds which could be a beach 'signature' for homing sea turtles is not known.

#### NESTING CYCLES OF SEA TURTLES

It is well recognised that nesting cycles do exist but according to Hughes (1982) what needs to be known is whether the nesting cycle embraces the majority of the population or only a small segment of each population.

With the exception of the olive ridley in Surinam the tagged turtles returning as remigrants are fewer. However, information is available that the green turtle nests twice or even upto five times in consecutive years or at intervals of two, three or four years. We know that the remigration rates have been extremely low in the olive ridley tagged in Gahirmatha rookery in Orissa during the last four to five years.

Tagging has not led to any better understanding of feeding migrations. However, it has given information on average distances covered by turtles per day, approximate distances travelled, migration against prevailing currents and so on. Little is known of group migration of turtles. Use of long-term internal tags for hatchlings has been suggested (Schwartz, 1981). While this may be a useful tool, I am a little defident when I think about the detection part of tag returns where an x-ray machine will have to be used. The

problem looks at present formidable as a working proposition in inaccessible beaches. To be meaningful, tagging (Monal tags) has to be taken as a long term project and on an intensive scale to yield any useful results. Still its greatest focus will be on the breeding migrations, and regular and irregular nesting behaviour.

#### FEEDING ECOLOGY

Feeding ecology is an emerging area of interest for sea turtle biologists in view of the fragmentary information available. A wide variety of items have been reported as the food of sea turtles and the findings are mostly qualitative in nature. Since they are protected species and cannot be sacrificed, the method of pumping stomachs of freshly captured sea turtles in the field as developed by Balazs (1979) should be of interest. The foraging patterns of turtle in feeding grounds especially where algal and sea grass beds exist warrants study. The Gulf of Mannar along the Tuticorin Coast is known to be the foraging ground of the green turtle through earlier capture of sub-adults in the fishing operations; but no detailed work on the feeding ecology has been carried out. It is pertinent to mention here that the flesh of *C. mydas* and *E. imbricata* are known to be poisonous during certain periods and the consumption of poisonous algae/seaweeds are said to be one of the reasons for tainting the meat, the others being the animals feeding on the Portuguese man-of-war or jelly fishes. This needs a special study since during the last two decades there have been a number of fatalities as a result of consuming turtle flesh along the South Tamil Nadu — South Kerala Coast (Silas and Fernando 1984).

Food could affect growth rate, sexual maturity and the reproductive potential as has been reported for the Caribbean green turtle by Bjornal (1982).

#### GROWTH AND MATURITY

Growth rates in the wild population will not agree with what is seen in captive rearing. Tagging gives some clues as to growth since annuli in bones have not given good results.

Maturation age of turtles may differ. According to Balazs (1982) in green turtles it is known to range from 4 to 13 years based on growth rates in captivity. They are also said to mature at different sizes, some maturing at a small size while others attain a larger size before maturing. Information on other species is wanting. There are no answers to questions such as the influence of sea surface temperature on growth in sea turtles.

#### ESTIMATION OF POPULATION SIZE

Except in the nesting beach, it is difficult, time consuming and expensive to conduct census of sea turtles. In short it is impracticable. Estimating total population is not possible at present on account of large gaps in our knowledge of the biology of the species; even natural sex ratio; leave alone the age structure. In the light of these, it will be evident that it will not be possible to estimate total population size only on nesting estimates. Hence a considerable amount of basic research has to go in before we could ensure that population estimates could be done without bias. Meylan (1982) enumerates three steps towards population estimation as follows:

'(1) Determining the total number of female turtles nesting in a season; (2) relating the yearly number of nesting females to the total number of reproductive females in the population; and (3) relating the total number of reproductive females in the population to the number of turtles of both sexes and all age classes.'

The importance of aerial surveys for crawl track counts combined with 'ground truth' data for estimating nesting population during the season needs no emphasis. Again tagging helps in estimating the female reproductive population.

Long range tagging programmes may help in developing population models for hatchlings and nesting female sea turtles. According to Richardson and Richardson (1982) 'Marine turtles may prove to be unique among wildlife species, in that a management decision by one man may not become apparent in the turtle population until an entire human generation has passed..... Predictive simulation models are one way to suggest management and research approaches to population with unusually long time lags.' They further opine that quantitative studies of juvenile sea turtle population should receive the highest priority if realistic population models are to be developed.

#### NON-HUMAN PREDATORS

Turtle rookeries have a wide variety of non-human predators which have been very exhaustively classified by Stancyk (1982). These are predators on eggs, hatchlings, juveniles and adults. 'Predator control on natural nesting grounds is a major problem and cannot be done by chemical poisons (they affect also secondary consumers) and by trapping or shooting. Aquatic predation by a wide variety of bony fishes and sharks is a formidable hazard which cannot be controlled.

Transplanting of eggs to safer sites and releasing the hatchlings further out at sea may be a partial solution, but these are also fraught with dangers of induced imbalances in sex ratio of hatchlings or the wanting of natural imprinting of beach conditions in hatchlings.

There is need for studying the non-human predators in the nesting grounds and make quantitative estimates of the damage they do to the eggs, developing embryos and emerging hatchlings. In the inshore waters the gut contents of fishes may be examined to identify the species preying on hatchlings and even juveniles.

#### HYBRIDIZATION

Carr (1952, 1967) suggested the possibility of hybridization among sea turtle species. However, the first report of hybridization among the species, is in the case *C. mydas* and *E. imbricata* reported by Wood *et al.*, (1983). Recently Carr and Dodd (1983) have discussed the problems of hybridization in sea turtle at intraspecific levels among discrete sub-populations as well as among species. The former could happen by stocking turtles from different breeding populations in farms for breeding and the transplantation of eggs or hatchlings to other beaches as conservation measure. Hence, before translocation of eggs in different distant beaches, basic genetic studies on turtle species may have to be carried out to delineate the spatial distribution of discrete sub-populations and avoid any imbalances. Intraspecific hybridization could become a potential problem in mariculture operations.

#### CONSERVATION OPTIONS

Ehrenfield (1982) indicates the following as deserving highest priority considerations in any sea turtle conservation programmes :

- ' Protection of nesting grounds and aquatic habitats, including minimization of environmental disruption at these sites.
- Use of hatcheries and short-range transplantation of nests to protect eggs at the nesting beaches ;
- Conservation education ;
- Control of international trade;
- National and international coordination of conservation strategies ; and
- Dissemination of improved fishing trawls.'

He has indicated lower priorities for

- ' long range transplantation of nests ;
- headstarting ;
- fisheries-type management of turtle catch ;
- manipulation of sex ratios ;
- cottage industry turtle ranching ; and
- non-commercial captive breeding to maintain gene pools.'

#### RESEARCH AND CONSERVATION STRATEGIES FOR THE FUTURE

I have highlighted here some of the important problems that need urgent consideration in developing research inputs to help conservation and management. However, this does not mean that there are no other equally important subject areas which will be needing our attention. In the light of our meagre experience on sea turtles biology and their life habits, I would like to suggest the following strategy for consideration :

1. An intensified effort be expended on basic research to understand the biology of sea turtles, their reproductive and nesting cycles, nesting grounds and seasons, pathways of migration to feeding and breeding grounds and the ecological relationships.
2. It will be necessary to identify genetically the populations and discrete sub-populations so that their behaviour biology and above mentioned aspects could be studied for the segments of the population, if genetic differences are established.
3. In view of the global decline in the population sizes of all sea turtles, except probably the leatherback, recovery programmes should be encouraged but with caution exercised on hatcheries and transplantation of clutches, bearing in mind, the possibility of incubation temperature having pronounced effects on sex ratio as well as on chance intra-specific hybridization. Nevertheless, under situations where there is heavy non-human predation on eggs and emerging hatchlings on the beaches and where man also resorts to collection of eggs for utilization, and where regulations are difficult to implement or take time, well planned hatchery programmes become imperative.
4. The hatchlings entering sea are subject to heavy predation by a wide variety of bony fishes, sharks as well as sea birds and data on inshore

predation as well as predation on beaches will be necessary for quantifying recruitment estimates at this point of their life. Differential growth and the wide range in the number of years taken to attain maturity, and uncertainty of remigrations may be impediments in developing a forecasting system on recruitment to adult population.

5. Incidental catch of hatchlings, juveniles and adults in fishing gear, their monitoring and ways and means by which this could be avoided or minimised need our serious consideration. Regulatory measures on fishing during the seasons of courtship, mating and mass nesting of sea turtles in inshore waters as well as at the time of emergence of hatchlings from nesting beaches may be a way to circumvent the problem. However, the social implications and obligations to the artisanal fisheries sector will have to be studied before promulgating any restrictive regulations or introducing modified fishing gears.
6. Education, training and extension assume great importance. Building up a greater awareness to develop public policy should also be the goal of the scientist and conservationist.
7. There are diametrically opposing views on the question of mariculture of turtles, one school strongly advocating the impracticability and undesirability of such schemes and the other being optimistic. I have made an indepth study of the problem based on available data and am of the opinion that we shall not be in a position to consider mariculture an economically viable proposition whether on large scale or in the artisanal sector due to the complicated life habits of the sea turtles and our utter ignorance of vital aspects of their biology. Husbandry may be a possibility of the distant future, when we are in a position to manipulate and control the environment, the nutritional requirements, growth, reproduction and nesting cycles.
8. Under the circumstances, I feel that the option open to us is for stepping up recovery programmes to sea-ranching programmes once methodologies and experiences are gained in the proper incubation and release of the hatchlings. Conservation measures of protecting the nesting beaches from human interference and non-human predators, and managing the inshore ecosystem aimed at higher survival and better recruitment to juveniles and adults should greatly enhance such programmes. Thus in

the near future, I would say that sea-ranching has a greater potential than mariculture of sea turtles.

9. This brings us to the question of candidate species for major sea ranching programmes. Amongst the five species undoubtedly the olive ridley stands out as far as numbers are concerned, although commercial products from it may not be of the quality that could be obtained from the green turtle *Chelonia mydas* or hawksbill turtle *Eretmochelys imbricata*. When we consider that about 3 lakhs olive ridley annually nest at Gahirmatha beach, some rough calculations could be made as to the total impact this would have on recruitment to the population. Theoretical estimates of the magnitude could be as follows :

Assuming that on an average each clutch consists of 100 eggs nearly 30 million eggs are annually laid on this stretch of beach. Allowing for predation by non-human predators, destruction of earlier nests by subsequent nesting turtles, unfertilised eggs, arrested development due to imbalances, and hatchling predation on beaches, this may allow for only 25 per cent survival to the point of the hatchlings entry into the sea. This itself would amount to about 7.5 million hatchlings. Could we assume a 10 per cent survival of this number to adult size at first maturity? This would amount to about 75,000 turtles. If the annual estimates of recruitment is of this order with females around 70 per cent, with good annual remigrations it is likely that saturations point would be reached at Gahirmatha if it is not already so.

10. Hence the need is also towards developing a future strategy of the rational utilisation of the resource by finding out whether culling of adults would be necessary in order to remove any imbalance of saturation nesting and heavy destruction to eggs in limited areas or whether this could be countered by transplantation of eggs on a continuing basis. We may objectively consider the options open. At present we have no information whether culling operations will be beneficial to the population, but the conservationist may have to address himself to answer such a question in the future. Thus, as I see it, there is need for a concerted co-ordinated effort for accelerating research on various facets of sea turtle biology, behaviour and ecology to help develop the rational management of this resource.

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**RECOVERY PROGRAMME FOR OLIVE RIDLEY  
LEPIDOCHELYS OLIVACEA (ESCHSCHOLTZ, 1829)  
ALONG MADRAS COAST**

E. G. SILAS AND M. RAJAGOPALAN\*

ABSTRACT

A recovery programme for olive ridley *Lepidochelys olivacea* was started along the Madras Coast by the Central Marine Fisheries Research Institute in 1977 and in the course of 1977-78 to 1982-83 seasons, useful data have been collected through the setting up of a turtle hatchery. This paper embodies information on nesting behaviour of olive ridley, clutch size, incubation period, emergence and release of hatchlings. The constraints and problems encountered in the hatchery programme are also discussed.

INTRODUCTION

A perusal of the literature shows that from the early seventies a greater awareness on sea turtles has been evinced in India by workers from within and outside the country. Many of the earlier reports recorded the occurrence of sea turtles, their capture and trade or described observations on nesting. While reviewing the exploitation of marine turtles in the Indian Ocean Frazier (1980) has summarized the earlier information available on sea turtles in Indian Ocean based on published literature. Hence we do not propose reviewing the literature except to draw attention to the following important references which are more pertinent to the present study on the biology and conservation of sea turtles (Jones and Fernando, 1968; Valliappan and Pushparaj, 1973; Bustard, 1976; Biswas, 1981; Bhaskar, 1978 a-e, 1979 a-c, 1981; Whitaker, 1977, 1979; Kar, 1980, 1982a, b, 1983; Dan, 1982; Bhaskar and Whitaker, 1983; Fernando, 1983; Kar and Bhaskar, 1982; Rajagopalan, 1983; Silas *et al.*, 1983 a-c). More organised programmes on sea turtles have come up from the mid-seventies with the advent of greater focus on the annual arribada of the olive ridley along the Orissa Coast.

A subsistence fishery for the green turtle *Chelonia mydas* has been in existence for several decades along the Tuticorin Coast. There has been a traditional trade of the green turtle from Tuticorin to Sri Lanka, the turtles being stocked in pens in the sea and

transported alive over land to Rameswaram, restocked in pens (Fig. 1), and thence to Sri Lanka when sufficient numbers were gathered. Locally at Tuticorin there has been a preference for turtle meat as well as blood of turtles as an efficacious remedy for certain ailments. Even in the recent past, it was not unusual to see well-to-do people of Tuticorin queuing up at the slaughter shed to get a glass of turtle blood which was consumed fresh when it is butchered or fried and eaten.

The seventies has seen a global interest to protect and conserve the turtle resources since in many areas directed fishery for species such as *C. mydas* has resulted in near depletion of the populations. Besides, the common phraseology has been that 'hardly anything is known about the biology of . . . . species'. The statement is more apt for India and the other littoral states of the Indian Ocean. It is in this context that while promulgating in September 1977, Amendments to the Schedules to the Indian Wildlife (Protection) Act (1972), all the five species of sea turtles viz., the leather back *Dermochelys coriacea*, hawksbill *Eretmochelys imbricata*, green turtle *Chelonia mydas*, olive ridley *Lepidochelys olivacea* and loggerhead *Caretta caretta* have been placed in Schedule I of the Act, thereby according them complete protection.

In the early seventies under a project on 'Investigations on sea turtles' the staff of Central Marine Fisheries Research Institute carried out some studies in the Gulf of Mannar, particularly on the landings and utilization of turtles (CMFRI, Annual Reports 1975, 1976). During 1975 on an average 50 to 60 *Chelonia mydas* were caught at Tuticorin each month, in the size range of 65-70 cm across the plastron. *L. olivacea*,

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and *E. imbricata* were rare. In 1976 about 301 turtles were caught at Mandapam and adjacent places and about 421 around Tuticorin. More than 90% were *C. mydas*, the rest being *L. olivacea* and *E. imbricata*. *Caretta caretta* was observed very rarely at Pamban. Specimens of *L. olivacea* caught at Tuticorin during October-January were found to have well developed eggs. It is of interest that a specimen of *E. imbricata* butchered on 28th November 1976 had 356 developing and 50 fully developed eggs. At the same time 87 specimens of *C. mydas* examined were not found to bear any egg. Examination of the gut of *C. mydas* showed that it fed mainly on the sea grass *Halophylla ovalis*, thereby suggesting that the Gulf of Mannar adjacent to Tuticorin is a foraging area for the green turtle. At the same time, some of the beaches along the mainland coast and the islands in the Gulf of Mannar are nesting grounds for sea turtles at different periods of the year.

We are grateful to the Chief Wildlife Warden, Forest Department, Government of Tamil Nadu for granting permission to the Institute to collect turtle eggs for studies relating to the olive ridley recovery programme. The Technical Assistants attached to the Field Laboratory of CMFRI, Kovalam S/Shri P. Poovannan, K. Srinivasagam, A. Ramakrishnan and K. Shahul

Hameed have also been helpful in the recovery programme.

#### RECOVERY PROGRAMME FOR OLIVE RIDLEY

Around the mid-seventies Romulus Whitaker (1974, 1977, 1979) and his staff at the Madras Snake Park Trust, Guindy took the initiative of incubating turtle eggs taken soon after nesting, maintaining them in hatchery and releasing the young ones. During 1977-78 season the Central Marine Fisheries Research Institute at its Field Laboratory at Kovalam, Madras took up an active sea turtle recovery programme. On account of the heavy predation on the eggs from the nests by dogs and jackals and the large scale collection of eggs by people for sale and consumption, the turtle hatchery and release programme was found to be a prerequisite. The species was the olive ridley *Lepidochelys olivacea* (Eschscholtz, 1829) which, during the months November to March, nested in moderate numbers along the Madras Coast (Ennore to Mamallapuram) (Fig. 2). In view of the heavy predation on eggs, it was felt necessary to enhance and continue the programme started by the Madras Snake Park Trust so that eggs could be incubated and properly maintained in hatcheries and young ones released at the same beach on hatching.



Fig. 1. Turtle pen at Rameswaram in the late sixties.



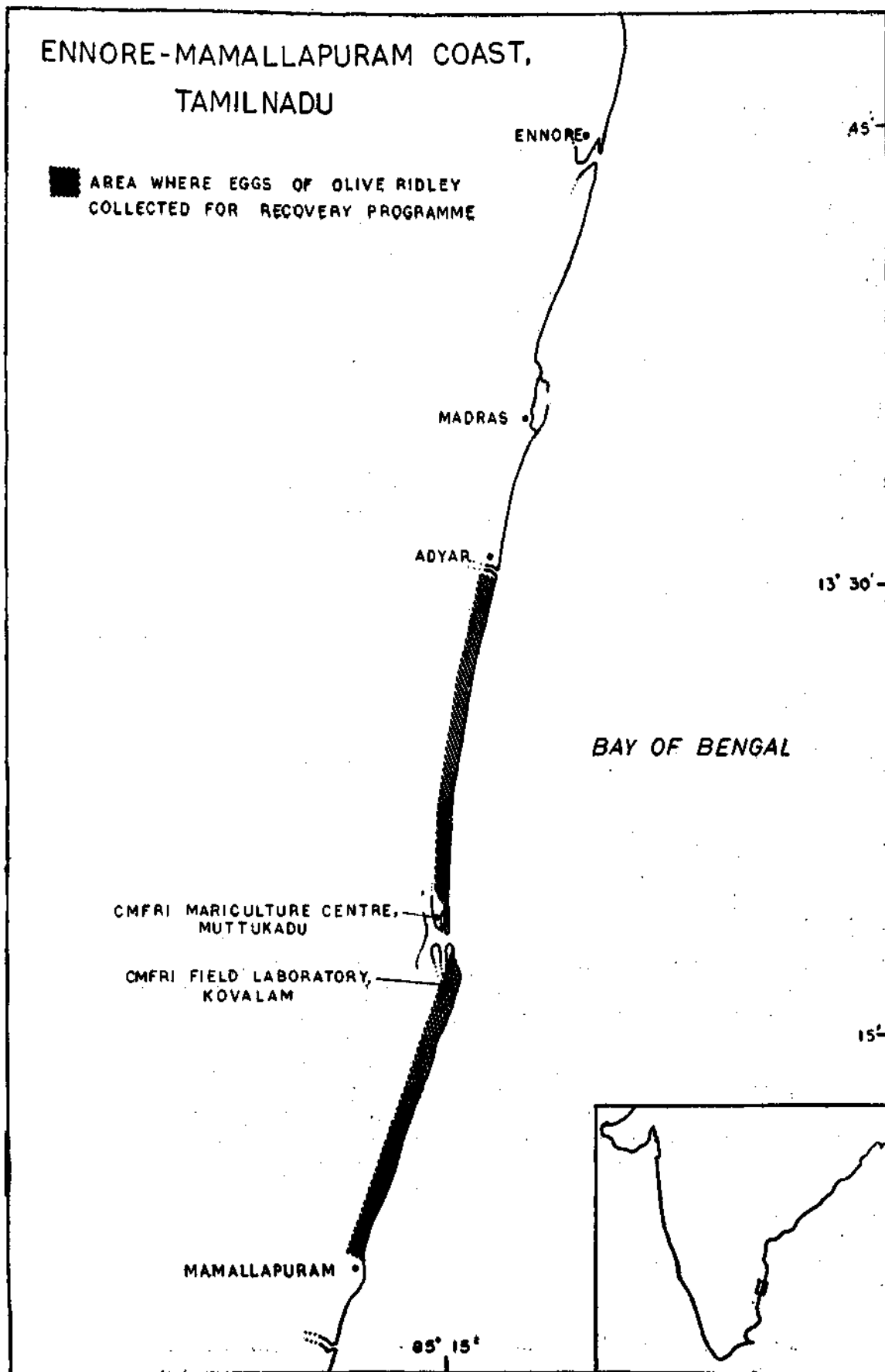


Fig. 2. Map showing the Ennore-Mamallapuram (nesting beaches under study) stretch of coast, showing location of Kovalam Field Laboratory of CMFRI.

### *Nesting habits of olive ridley*

Much has been written about the arribada of olive ridley along the Gahirmatha Beach, Orissa Coast where they come ashore in several thousands on a few successive nights during the nesting season, the dates and intensity varying from year to year. In the beaches along the Madras Coast, few turtles come ashore each night, but the numbers increase about two to three days around new moon and full moon. Often scouting or 'turtle walks' undertaken over a 10 km stretch during the night, neither resulted in sighting a single nesting turtle nor crawl tracks made on that day. But during January-February invariably four to five or even more turtles or fresh crawl tracks were noted in stretches of 5 km along the beach. It is likely that during certain years the nesting population increases, while in some years it is minimal. Quantified data on this aspect is wanting and with proper monitoring we may be able to obtain more fruitful information.

As shown in Plate I A-F, the topography of nesting beaches are not always the same. Beaches with gentle gradient as well as those with a steep embankment of sand due to wave action occur along the coast and the olive ridley was seen to crawl over the latter type of beaches with ease and move several metres beyond the crest for nesting. Nesting has been observed even in sandy beaches with rocky out crops in the intertidal region. Generally nests are located about 20 metres from high-water mark but we have measured nests from 8 to 41 metres away from high-water mark along the Kovalam-Mamallapuram stretch. On one occasion a nest was located at the high-water mark itself and in another case a damaged nest was located about 150 metres away from the high-water mark. Nesting was also observed between beached catamarans at Chemmenjeri village.

The olive ridley characteristically after emergence from the sea crawls, stopping at one or two places to disturb the surface sand with its flippers and then proceeds to the site where it starts the nesting activity, scooping the sand with the hind flippers. The sequence of nesting of olive ridley observed at the Kovalam Beach is shown in Plate II A-F and Plate III A-H. On the nest site the female rests and adjusts lifting the head with puffed gular prominence and exhaling hissing once or twice and makes a few backward movements with its front flipper alternatively to make the body pit. The sand thus thrown backward also partly cover the marginal and lateral scutes and may remain on the carapace in most cases till the animal re-enters the sea (one way to verify whether the animal has attempted nesting or not). Once settled in the body pit it rotates

the hind left flipper inside out and starts scooping the sand alternating with similar movements with the hind right flipper. Sand is deposited on the mouth of the pit. Normally about 25 to 30 such scooping action with the hind flippers are made before the animal is 'satisfied'. In between, it may rest occasionally for a few seconds. This whole action of nest building may take about 20 to 25 minutes. Once the egg pit is neatly shaped the animal rests. Just before oviposition the animal slightly lifts the posterior part of the body and simultaneously one or the other posterior flipper may twitch upward and the cloacal tube descends a couple of inches. As the animal settles down the eggs are dropped single or two, three or even four in a clutch followed by copious dropping of the cloacal fluid. The cloacal tube then contracts but a string of cloacal fluid may continue to drip. The action is repeated after a rest period of 15 to 30 seconds. We estimate that on the whole from a quarter to even half a litre of cloacal fluid may be dropped on the egg during the process of oviposition. On completion of egg laying the animal makes one or two lateral movements with the posterior part of the body and then slumps down tired. This is followed by action commencing with the scooping of the sand from the mouth of the pit by flexing the hind flipper inward and the action invariably starts with the hind left flipper. The activity is repeated alternatively and normally the pit is covered with about 25 to 30 such scoops.

At this point the animal resorts to the most peculiar behaviour of lifting its body and hammering down on the sand with each side producing a 'dhum-dhum' sound quite audible for several metres. This peculiar activity is performed in several spells each with three to eleven such 'dhum-dhums'. As many as 27 to 30 such spells have been noticed. Then the posterior flippers are both used to smoothen and press down the top of the nest presenting a unique feature as though the activity is carried out by the animal facing backward and 'the palm' of the posterior flipper working alternatively. After this the right anterior flipper and left posterior flipper work in unison to shove sand back and forth followed by the left anterior flipper and the right posterior flipper alternatively. This action is repeated a few times to smother the surrounding area with sand sprayed in all directions. This is followed by the animal pressing down with the right anterior flipper and cart-wheeling half a circle with the left anterior flipper throwing sand backward and repeating the same in the opposite direction with the movement of the opposite flipper. This half-cartwheeling was noticed to be repeated five or more times with the animal occasionally resting and lifting its head and contracting the expanded

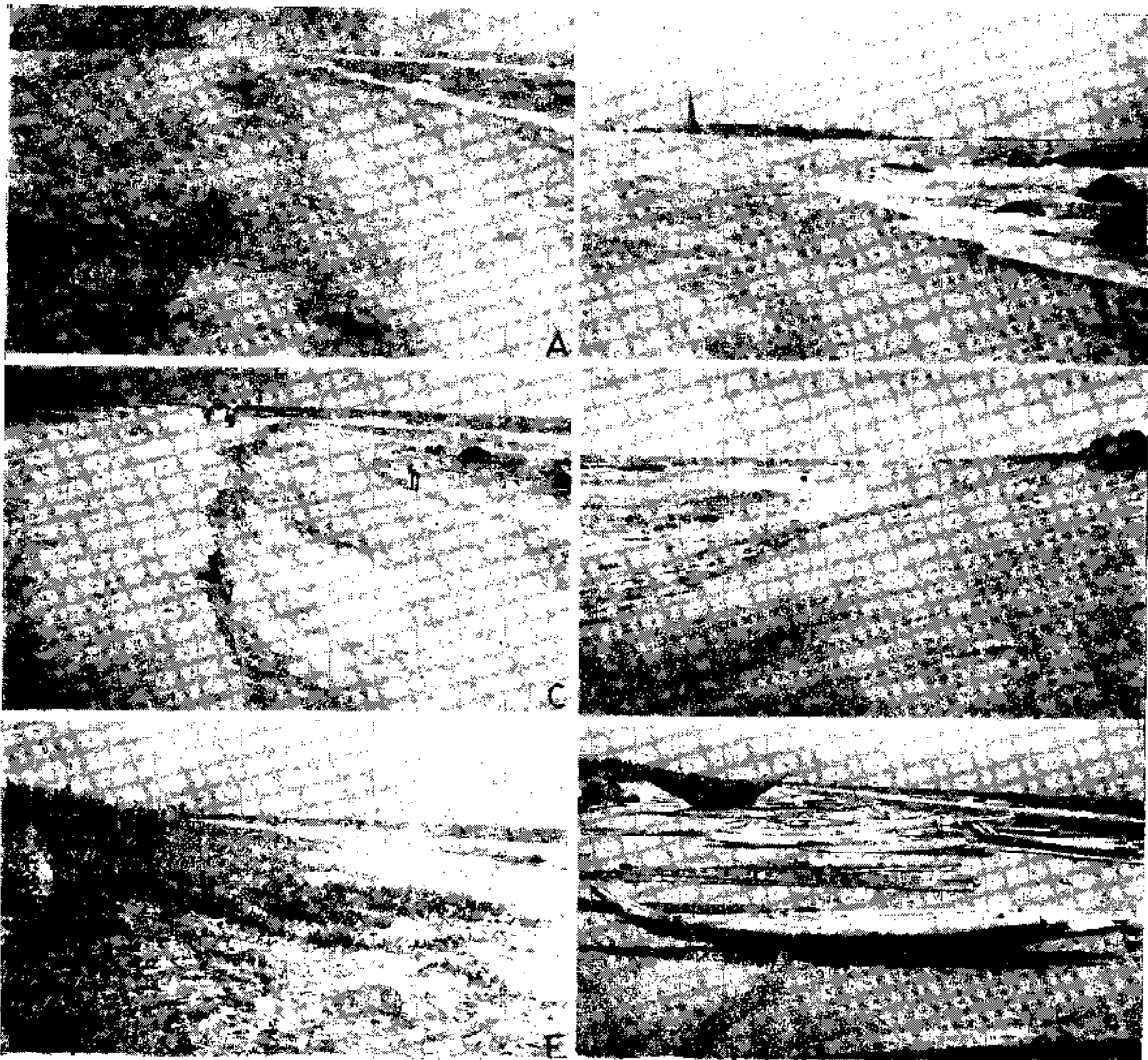


PLATE I. A-E. Beach configuration along the Kovalam-Mamallapuram stretch where olive ridley nests ; F. Nesting of olive ridley was also noticed between beached catamarans at Chemmenieri village.

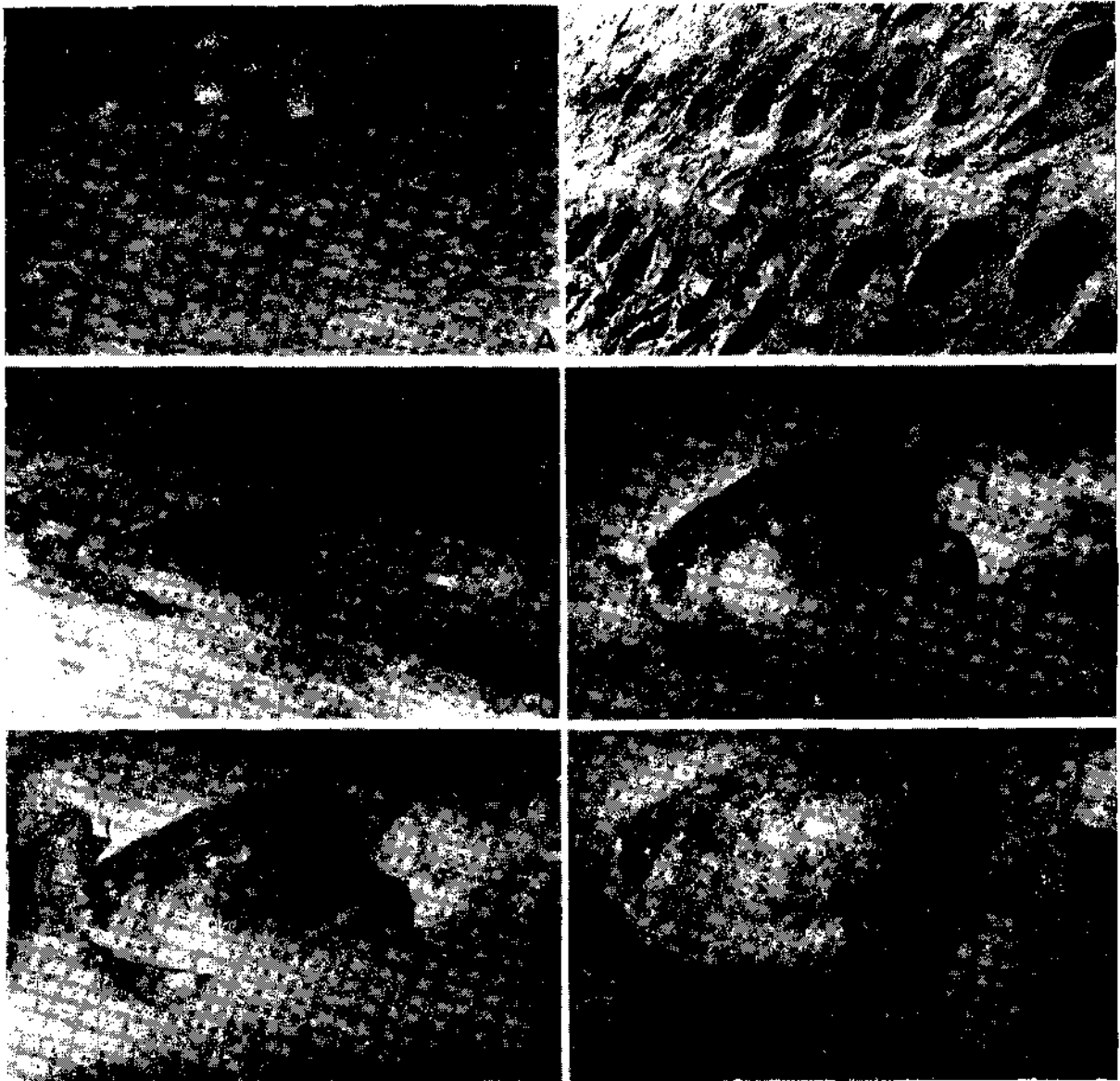


PLATE II. A-F. Nesting of olive ridley: A. Crawl mark on the sandy beach; B. A close up view of the crawl mark; C. Pit digging D-E. Scooping of the sand from the pit and F. Nest ready for laying.

gular prominence to hiss out air noisily. Invariably, at the end of nesting a tear drop impregnated with sand may be seen hanging from the eye. After these actions the animal heads towards the sea resting enroute for a few minutes at a time. Often in the crawl back to the sea the 'beak' pushes forward along the sand probably as the animal is exhausted. On more than one occasion, it was noticed that the turtle did not directly head to the sea but took an inverted 'L' shaped route (Plate II-A). The crawl impression on the sand is quite characteristic (Plate II-B). This spent turtle approaches the incoming waves more rapidly and enters the surf with vigorous movement of swimming. During our observations along Adyar-Mamallapuram stretch of Coast, we noticed nesting even near beached catamarans (Pl. IF) and thorny bushes (Pl. IE) but the maximum numbers were in plain sandy areas.

Valliappan and Whitaker (1974) gave an account of size range of 10 nesting females observed along the Madras Coast as carapace length 63-74 cm (71.0), carapace width 59-62 cm (60.3) and plastron length 52-60 cm (55.7).

The measurements of captured olive ridley at Digha and the carcasses at Digha, Digha Muhana, Bhankshalghat and along Gahirmatha beach are given below (Silas *et al.*, 1983b, c):

Area	Carapace length (cm)	Carapace width (cm)	Plastron length (cm)
Digha (females N - 13)	65-69	54-64	49-59
(males N - 5)	67-72	56-68	50-54
Digha (carcasses N - 14)	57-67(63.0)	48-61(57.1)	48-58(54.1)
Digha Muhana (carcasses N - 12)	63-71(66.7)	53-65(58.6)	55-61(58.3)
Bhankshalghat (carcasses N - 15)	59-70(64.2)	49-64(57.7)	49-59(57.1)
Gahirmatha, Orissa (carcasses N - 57)	51-72(62.2)	48-63(57.8)	44-57(51.8)

In the case of carcasses we had not been able to separate them sex wise due to the complete deterioration and the soft parts already been damaged or eaten by dogs and wild animals. However, Kar and Bhaskar (1983) who examined 172 stranded olive ridley carcasses in the Gahirmatha Beach found that 106 (61.6%) were females.

The comparison of olive ridley observed by us (present study), Valliappan and Whitaker (1974) and Biswas (1981) is shown in Fig. 3. From this it would appear

that the olive ridley nesting along the Madras Coast are slightly larger in size than those along the Orissa—West Bengal Coast. This is a point of interest which needs to be investigated to see whether they belong to different year classes of the same unit stock or to different unit stocks.

#### Nests

The nests were located at night without any difficulty by the crawl marks leading to them. The measurements of fresh nests of the olive ridley were made while collecting the eggs for transfer to the hatchery. The width of the pit varied from 30-37 cm (28) at the widest part of the egg chamber and 20-30 cm (23) at the neck of the egg chamber and the depth of the pit varied from 35-85 cm (48). The uppermost eggs in the clutch were 15-50 cm (28) below surface.

#### Nesting season

Nesting season along the Madras Coast is from late October to April with the peak from mid-January to mid-February. Emergence from the sea was observed both during high and low tide phases. Nesting of olive ridley was observed only during nights between 2000 hrs and 0500 hrs and none were seen to emerge for nesting during day time. No basking turtle was found on the beaches during day time. Sightings of olive ridley in

the coastal fishing ground off Kovalam-Mamallapuram, probably migrating or coming in for nesting are not infrequent. Incidental catches in gill nets during other parts of the year do occur. However, evidence is lacking as to whether they are coming for nesting or are caught on their passage to feeding or other nesting grounds.

#### Clutch

The clutch size in 23 nests collected and transferred by us to the hatchery varied from 79 to 160 (126). The

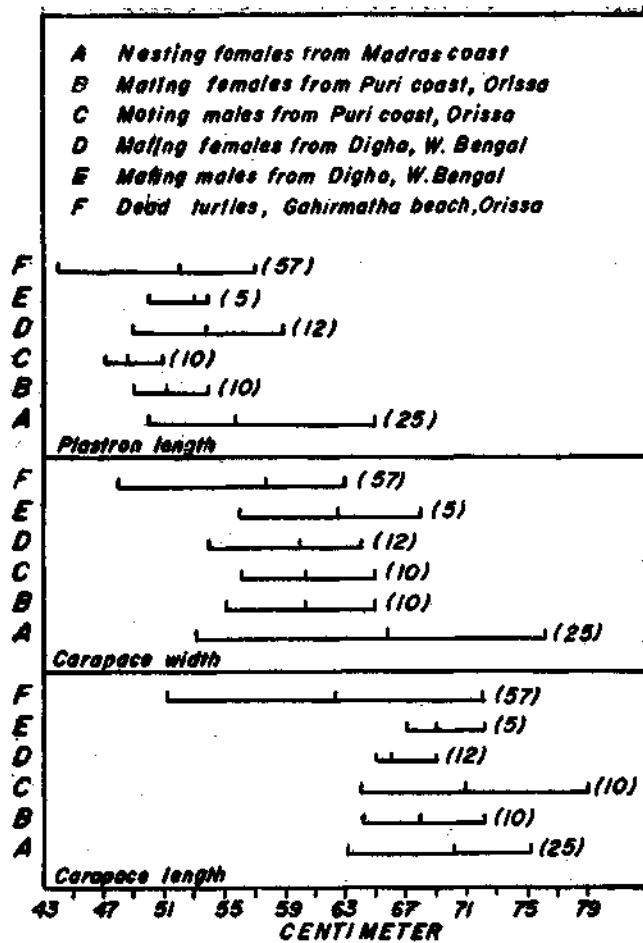


Fig. 3. Comparison of carapace length, carapace width and plastron length of olive ridley observed by the present authors, Valliappan and Whitaker 1974 in Madras coast and Biswas 1981 in Orissa and Silas et al., 1983 in Gahirmatha. (The horizontal line represents the total range; the short vertical line the mean. The number of specimens is indicated in parenthesis).

information on the relationship between nesting female and clutch size is given in Fig. 4. The observations

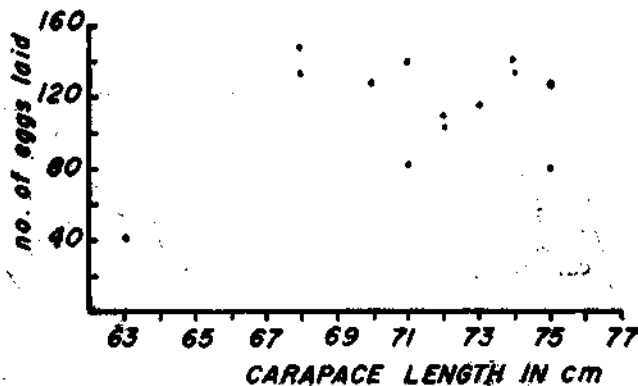


Fig. 4. Relationship between carapace length of nesting females of olive ridley and clutch size.

are not sufficient to arrive at any conclusion as to whether or not the number of eggs laid has a relationship to the size of the animal. The diameter of the freshly laid egg in a single clutch showed differences varying from 35.1 to 39.6 mm (38.0). The weight of the egg in different clutches varied from 22.9 to 36.5 gm (29.0). The frequency of occurrence of eggs of different weights in two clutches of freshly laid eggs taken on 24.2.1981 and 5.3.1981 is shown in Fig. 5. The eggs were wiped of adhering mucous and sand particles before weighing in an analytical balance of 1 mg accuracy. The fact that there is wide variability

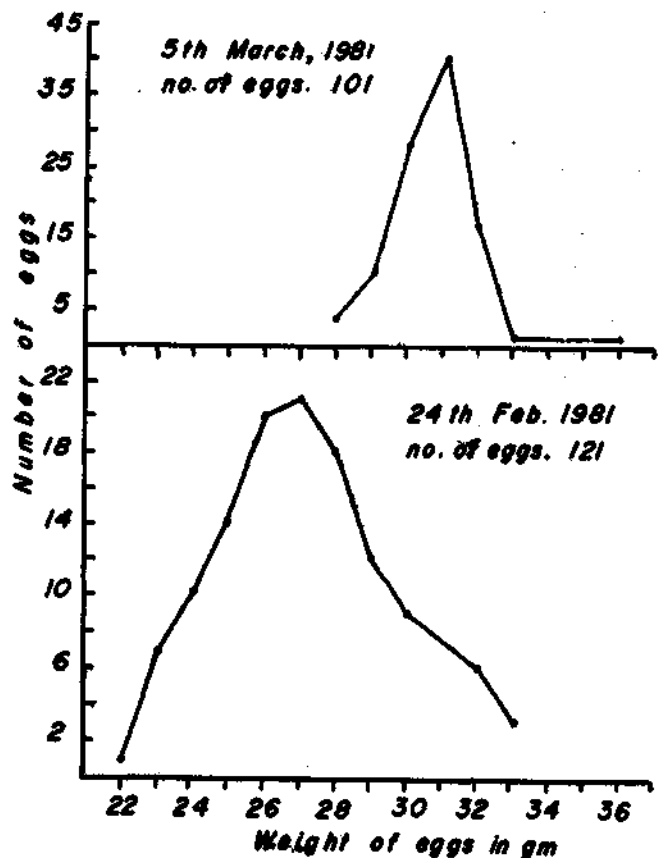


Fig. 5. The frequency of eggs of different weights in two clutches of freshly laid eggs by olive ridley.

in the egg weight in a clutch as well as between clutches is of interest. However, eggs taken from different layers in the clutch to see whether there was difference in the weight of the eggs first dropped or at mid point of laying or those dropped last, indicated very little variability in a single clutch examined (Fig. 6). Details of eggs examined showed that the 28 first dropped eggs varied from 29.3-32.9 gm (31.05); the 39 eggs collected at mid level varied from 28.3-33.5 gm (30.87) and the 34 last dropped eggs varied from 28.4-36.4 gm (31.47)

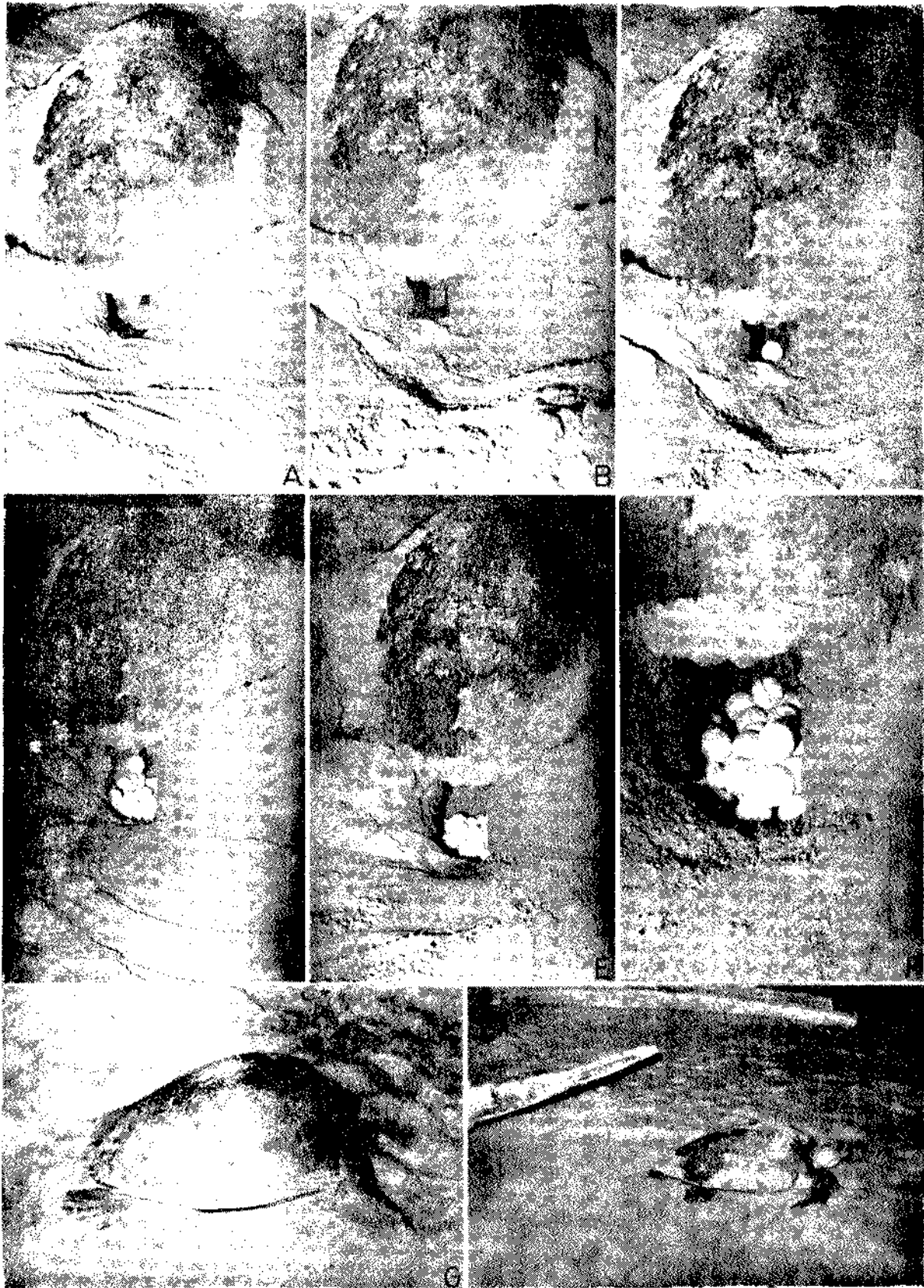


PLATE III. A-F. Process of egg laying; G. Closing of the plastron after egg laying by an olive ridley; (Note the mucus 'string' on the dropping egg in D) and H. Same turtle heading back to the sea.

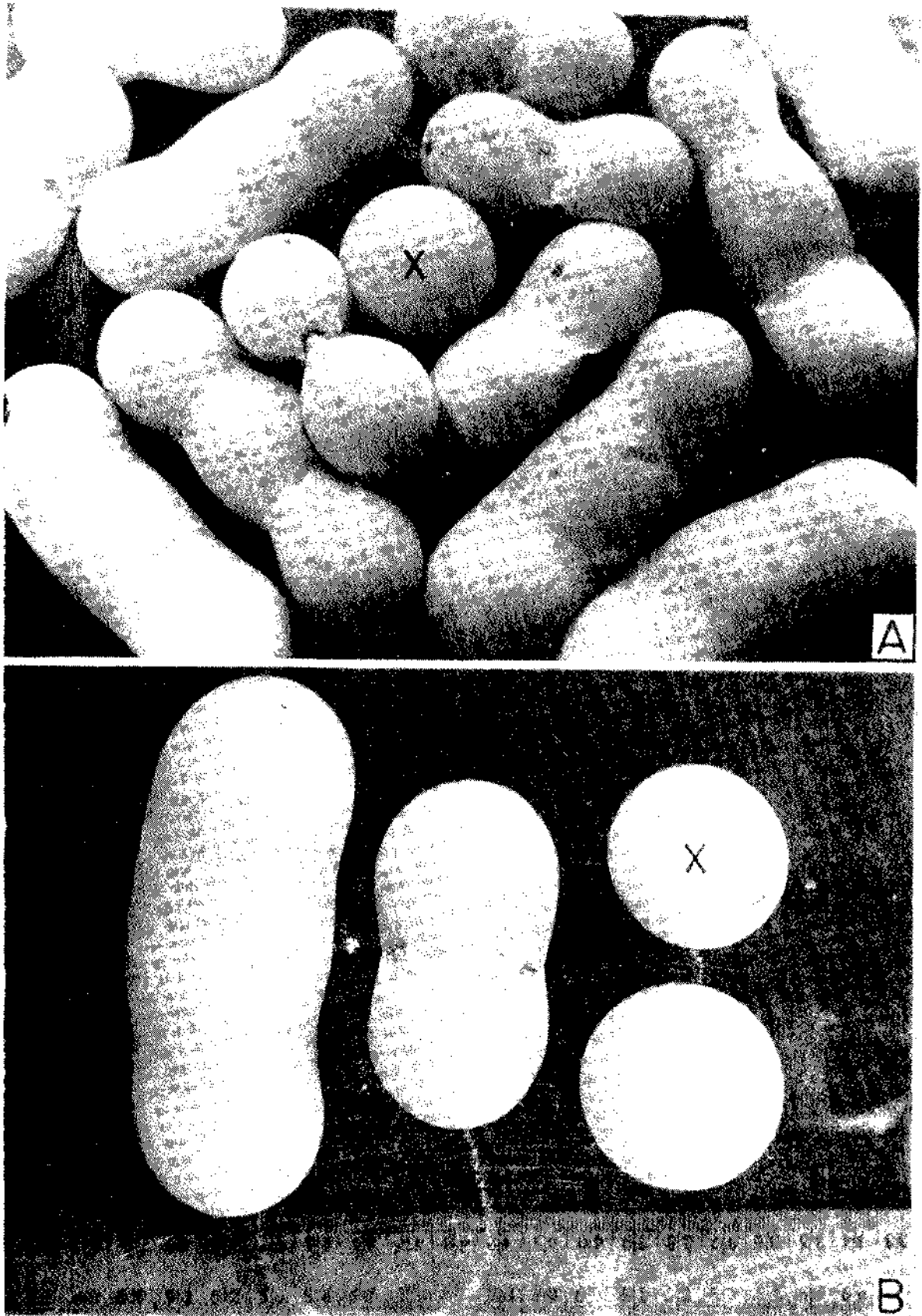


PLATE IV Eggs of olive ridley A. Normal (X) and several abnormal eggs from a single clutch and B. Close up view.



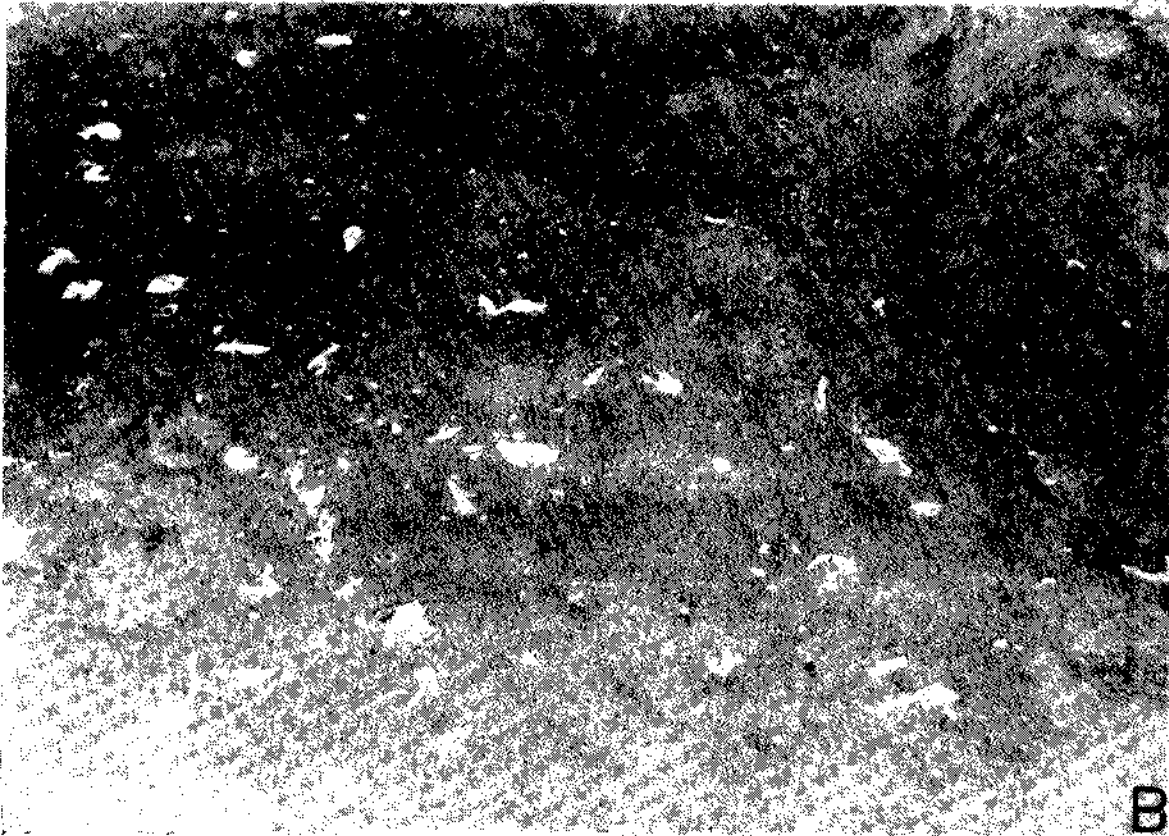
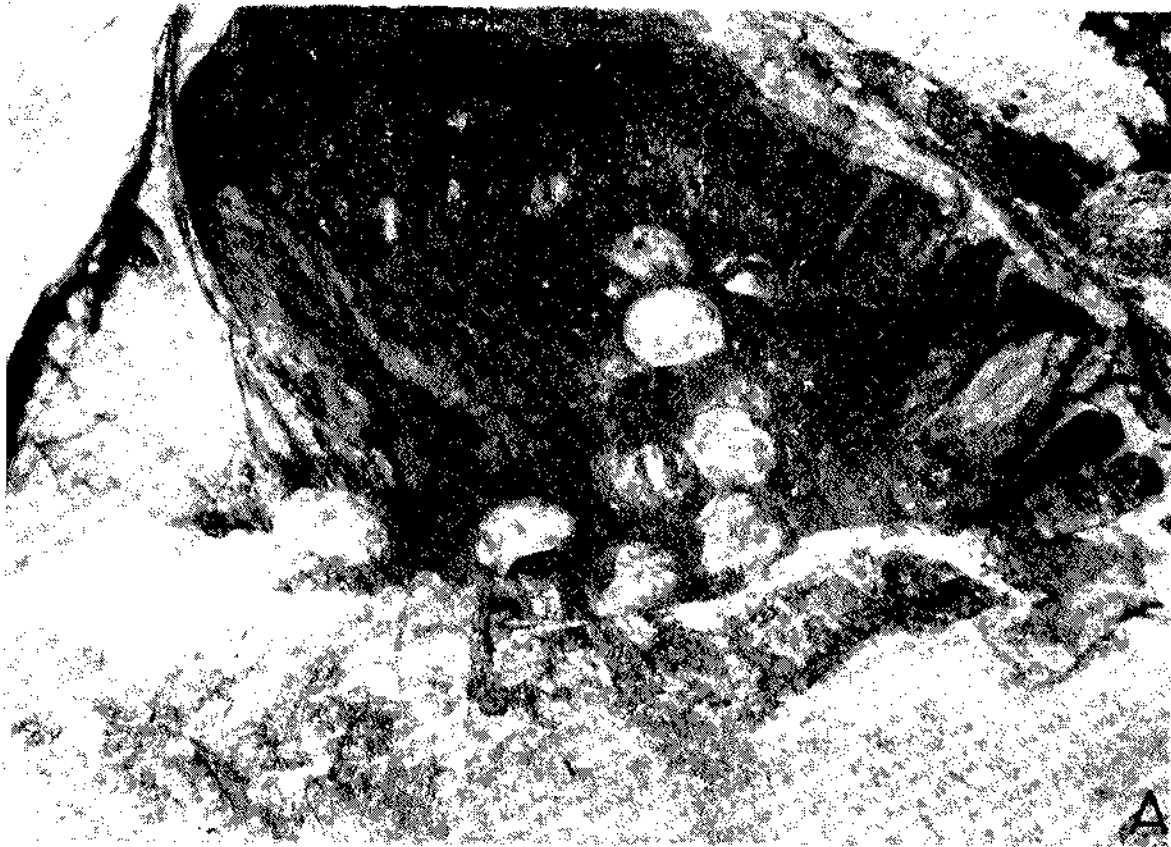


PLATE V. Carcass of olive ridley from incidental gillnet catch washed ashore at Kovalam—cut open to show unlaidd eggs and B. Nest and eggs destroyed by jackals.



PLATE VI. Brisk trade of olive ridley eggs at Saidapet market, Madras in February 1981. A, Part of eggs from the sack displayed in the market; B, A busy sale of turtle eggs.

More information on the size of the eggs and variability in the weight of the eggs may be pertinent to understand problems related to development and hatching success.

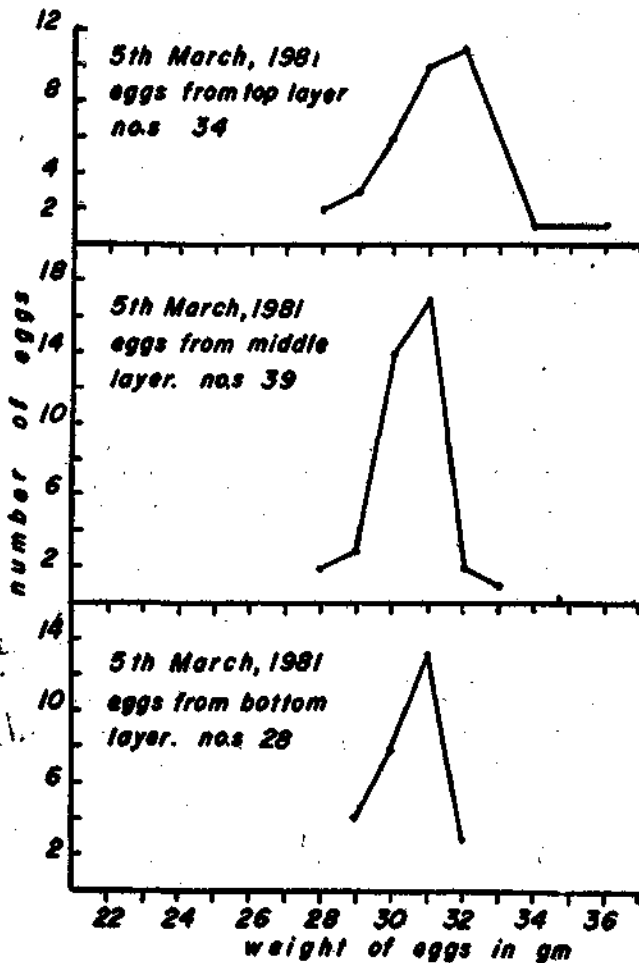


Fig. 6. Egg weight (gm) variability from three different layers of a single clutch of olive ridley.

On a few occasions abnormal eggs were noticed (Plate IV A, B). The abnormality was mainly in the form of two or three eggs which were fused. In a freshly laid clutch of 112 eggs, six numbers of fusion of three eggs and eight numbers of fusion of two eggs and one abnormally large egg were seen showing the following details :

Nature of egg	Length (mm)	Weight (gm)
Fusion of 3 eggs (6 numbers)	109.1-121 (114.8)	94.4-104.9 (102.2)
Fusion of 2 eggs (8 numbers)	71.3-78.4 (75.3)	60.02-67.20 (65.4)
Abnormally large egg (1 number)	.. Diameter : 42.6	46.6

All these abnormal eggs were transferred carefully to the hatchery and kept for hatching, but none hatched out or showed any development indicating that they were all infertile.

Freshly laid eggs have a coat of albumen-like mucous 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 mucus 'string' may help in the slow dropping of the egg, into the pit (Plate III D). Sand adhering to the mucus may play a function in preventing sand from infiltrating the space between the eggs and thereby create an effective 'air chamber' which could maintain temperature and moisture conditions. However, we feel that this aspect should be examined critically in future investigations to enable developing more natural conditions when hatcheries are to be established.

The clutch size is variable and we also noticed from published literature that the number of eggs in a clutch markedly differ in the olive ridley nesting in different geographical areas (Table 1). Again, to what extent this may also depend on the year class of the nesting turtle or on successive nesting during the same season or year is not known.

TABLE 1. Clutch size of olive ridley *Lepidochelys olivacea* in different geographical areas

Location	Range	Mean	Source
Sri Lanka	.. 90-135	—	Deraniyagala, 1939
Pacific	.. 73-132	—	Carr, 1952
Surinam	.. 30-168	116	Schulz, 1975
India (Orissa)	.. 105-119	—	Biswas, 1981
India (Madras)	.. 79-160	126	Silas and Rajagopalan, 1984

#### Incidence of mortality during nesting season

Incidental catch of nesting turtles in fishing operations along the Madras Coast is not uncommon. Some of the turtles entangled in gill nets get drowned and are thrown overboard to be washed ashore. Most are nesting females which were caught on their passage to the beaches as evidenced from the unlaidd eggs seen in the carcasses (Plate V A). Along a 10 km stretch of beach from Kovalam southwards about 20 turtles were seen washed ashore during the 1982 season from November to April. The measurements of these in cm are as follows :

Carapace length	63-75 (68.7)	Carapace width	55-70 (63.0)
Plastron length	50-65 (58.5)		

Since the nesting along the Madras Beach can be categorised as only 'thin' or moderate, mortality due to incidental catch in fishing operations of nesting females could have an adverse effect on the breeding population visiting the coast and consequently on recruitment. A careful study of this is needed in order to advice any preventive and precautionary regulatory measures to be adopted in specific type of fishing operations during the nesting season. Wide publicity in the area for releasing the live turtles noticed in fishing gears, especially gill nets, and for reducing the soaking time of the nets by itself may help to minimise the mortality. Scouting the gill net units by those operating the nests for the timely release of any turtle caught in the same could also help. While the turtles have the capacity to remain underwater for long durations, it is their struggle and extreme stress when entangled in the net that results in their drowning. The fishermen also may injure the animals when retrieving their nets causing mortality as was observed by us earlier along the Orissa and West Bengal Coasts where mutilated dead turtles were seen washed ashore with remains of webbings on them (Silas *et al.*, 1983b, c).

#### *Predation of egg*

During 'turtle walks' at nights, we have observed jackals in casuarina plantations and dogs along the beach. In some cases we have also seen dug up nests with the shells of destroyed eggs strewn around (Pl. V B). On many occasions we have seen batches of egg collectors going for collecting eggs from nesting beaches. They successfully use crawl marks and easily detect the nest

by prodding the soil with a stick. We found this method very useful in locating the nest from 'false pits'.

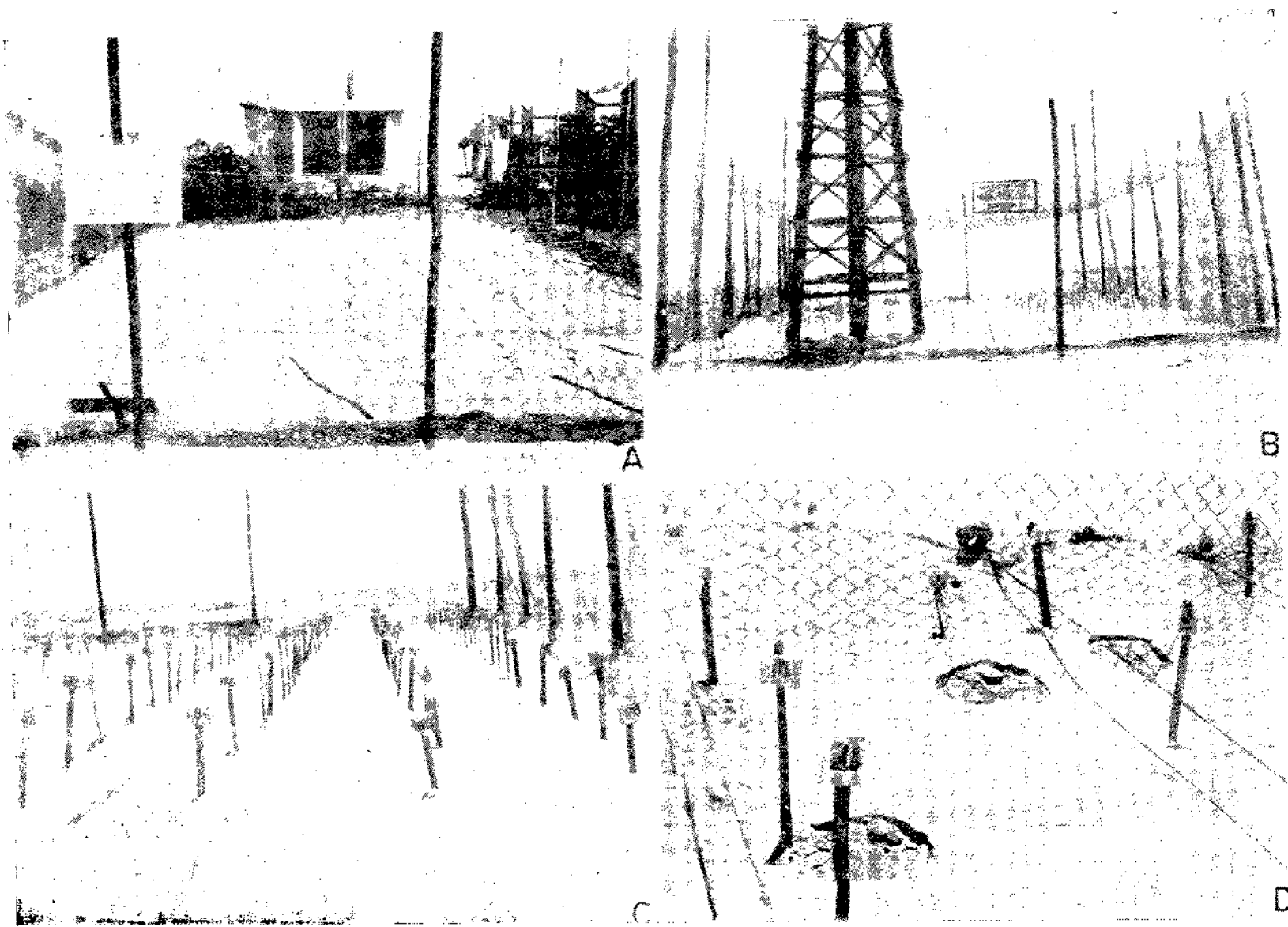
The eggs collected by the professional collectors were sold openly in fish markets in Ennore, Thiruvotriyur, Zam Bazaar, Purusawalkam, Saidapet and Alandur at the rate of 10 to 12 paise per egg. On an average 1000 to 1500 eggs were kept for sale at Saidapet market as late as the 1981 season (Plate VIA, B). After the implementation of the Wildlife (Protection) Act, the sale of turtle eggs openly in market has been reduced to a great extent by the steps taken by the Chief Wildlife Warden, Tamil Nadu Forest Department. With more public awareness and co-operation through an intensified extension programme on the need of conservation of sea turtles, the sale of eggs for consumption in the Madras markets can be completely stopped.

#### *Hatchery*

At Kovalam, Madras with the permission of the Wildlife Department, eggs were collected and brought to the hatchery (Pl. VII A-D). Cloth bags were supplied to the professional egg collectors with instructions on the care to be taken in keeping the eggs of each clutch in a separate bag to transport to the Field Centre on the same night. Depending on the season they were paid 7 to 10 paise per egg. Besides this method of collection, we have also personally undertaken several 'turtle walks' at night to collect eggs from freshly laid nests for incubating in the hatchery. The total effort put over 1978 to 1983 is summarised in Table 2. During this period 40,091 emerging hatchlings

TABLE 2. *Details of recovery programme of olive ridley during 1978-1983 seasons*

Period of collection	Number of eggs collected	Number of nests observed	Period of release of emerged hatchlings	Number of hatchlings released	Number of days taken for incubation
18.2.78-18.3.78	11,423	106	8.4.78-1.5.78	5,386	45-50
27.1.79-1.3.79	38,817	309	16.3.79-18.4.79	5,007	48-55
21.1.80-11.2.80	20,438	165	9.3.80-26.3.80	5,849	47-58
12.2.81-10.3.81	13,403	128	3.4.81-23.4.81	748	45-53
23.1.82-17.2.82	30,013	234	12.3.82-12.4.82	18,090	45-52
16.2.83-19.3.83	8,133	72	3.4.83-23.4.-83	5,011	45-50
Total	122,227	1,014		40,091	



LATE VII. A-D. Olive ridley hatchery at Kovalam Field Laboratory of Central Marine Fisheries Research Institute, Madras. A. Hatchery located 250 metres away from the sea which yielded very poor results ; B. Hatchery 10 metres away from high water mark. C. Close up view of numbered netsts and D. 'Cave in' an indication before the emergence of hatchlings from the nests.



PLATE VIII. Hatchlings of olive ridley A. Hatchlings soon after emergence at the turtle hatchery, Kovalam and B. Release of hatchlings at Kovalam.

were obtained and retaining a few dozens for follow up studies, all were released back to the sea on the same beach. The hatching success of eggs collected by us varied considerably (Table 3).

TABLE 3. Details of live emerged hatchlings, dead hatchlings in the pit and spoilt and unfertilized eggs observed (percentage in parenthesis) during 1981-1983 based on the collection made by the authors

Year	Clutch size	Live hatchlings emerged	Dead hatchlings in the pit	Spoilt and unfertilized eggs
1981	135	91(67.34)	11(8.14)	33(24.42)
	125	105(84.00)	5(4.00)	15(12.00)
	150	92(60.72)	26(17.16)	32(21.12)
	110	89(80.10)	4(3.60)	17(15.30)
1982	149	105(70.46)	3(2.00)	41(27.50)
	104	65(62.50)	1(0.90)	38(36.50)
	160	96(60.00)	1(0.60)	63(39.30)
	138	87(63.00)	5(3.60)	46(33.30)
	79	62(78.12)	4(5.04)	13(16.38)
	103	82(79.54)	3(2.91)	18(17.46)
	86	61(70.76)	3(3.48)	22(25.52)
1983	135	92(68.08)	1(0.74)	42(31.08)
	145	74(50.32)	2(1.36)	71(48.28)
	111	57(51.30)	3(2.70)	51(45.90)
	150	89(58.74)	5(3.30)	56(36.96)
	135	74(54.76)	6(4.44)	55(40.70)
	90	52(57.68)	7(7.63)	31(34.69)
	130	65(49.40)	4(3.04)	61(46.36)
	109	72(65.52)	2(1.80)	35(31.85)
	80	35(43.75)	7(8.75)	38(47.50)
	132	76(57.00)	2(1.50)	54(41.50)
	131	71(53.96)	3(2.28)	57(43.32)
	127	99(77.22)	4(3.12)	24(18.72)

Besides viable eggs, it was also noticed that unfertilized eggs were also present in each clutch. Arrested development both in early or later stage was noticed in some eggs in each clutch. In such eggs, the flexible shell of the egg was not pure white and the colour was light yellow to dark yellow. Such eggs were also crinkled in some places with dark spots. In some cases reddish patches varying from 2 to 3 cm were also noticed due to the yolk adhering to it. Spoilt eggs were invariably found to have the yolk and albumen mixed in a thin liquid consistency. In a few cases, it was like a solid yellow mass without any sign of developing embryo at the end of the incubation period.

During the 1982, 1983 seasons we had reasonably good success with the hatchery where the emergence of hatchlings was as high as 60 and 91% respectively.

The earlier trials, particularly during the year 1961 was very unsuccessful since the hatchery had to be located 250 metres away from the high-water mark close to the Field Laboratory due to some local problems in the area. On the experience gained through our earlier studies it has now been possible to improve the hatchery programme.

#### Incubation period

The incubation period upto the point of emergence from egg transferred to pits in the hatchery varies from 45 to 58 days. The largest number of emergence was noticed between 48-52 days. In a few cases after the emergence of most of the hatchlings, the remaining eggs were examined and it was found that some had developing embryos which had almost reached the pipping stage. Eggs suspected to be of this type were placed back in the nest and allowed to develop, but did not respond. It is our feeling that the handling of eggs should be avoided and the 'nests' in the hatchery be maintained for a few days more to allow the delayed emergence of hatchlings. We are not sure whether such hatchlings would be healthy and viable to undertake the strenuous process of emergence, crawl to the sea and subsequent life in the sea when released. We have also not come across information whether in the olive ridley, in natural nests, incubation period is extended or emergence is at one time. The importance of temperature, moisture, depth of pit and other parameters in relation to incubation period and hatching success needs careful study and evaluation.

In the turtle hatchery at Kovalam the successful emergence of hatchlings from the clutches transferred by us to the hatchery (eggs collected on payment excluded) varied from 43.7 to 84.4% (63.7%). The percentage of embryos which were fully developed but found dead (prior to pipping stage) varied from 0.6% to 17.16% (4.0%). The unfertilized or spoilt eggs varied from 12.0 to 48.28% (30.5%). The details of observations made by us during 1981-83 season on 23 individual clutches are shown in Fig. 7.

The first indication of emergence activity was noticed in the sinking of sand of the surface of the pit (Plate VII D) and invariably this was seen in the early hours of the day. When such caving in took place, the new hatchlings emerged within a few hours or even after a day or two and the hatchlings were collected and kept in plastic basins under shade. When most of the

hatchlings had emerged they were taken to the beach in the early hours itself or at dusk and released so that they crawl several metres before entering the sea (Pl. VII A, B). An interesting thing noted was that none of the hatchling which was carried away by the receding waves were washed ashore on the same beach or adjacent areas. In fact, the hatchlings were seen actively paddling and moving beneath the breaking surf and passing beyond. None has been encountered in the gill nets being operated off the coast. Natural adaptation is that the yolk sac containing the residual yolk is withdrawn into the body cavity through the umbilicus, between pipping and emergence so that the hatchling is not burdened with a protruding yolk sac. If under exceptional circumstances this does not happen, it may become an impediment for hatchling to dive once entering the surf. At the time of emergence and release into the sea, each hatchling

has a part of the yolk still retained as reserve energy for the following days (Silas *et al.*, 1984). In captivity the hatchlings were observed to take food *ie.*, chopped clam meat, about 6 days after emergence. Their food preferences have been dealt with elsewhere (Vijayakumaran *et al.*, 1984).

The variation in the size in mm and weight in gm of emerging hatchlings observed by us in the hatchery in the 1981, 1982, 1983 seasons are as follows :

Carapace length 33.7-41.3 (37.8); Carapace width 24.1-32.8(28.2);  
Plastron length 23.8-36.1 (31.8); Body weight 10.4-20.1 gm (16.3);

The percentage frequency of carapace length, carapace width, plastron length and weight for 466 hatchlings observed by us is given in Fig. 8. A higher percentage of hatchlings were in the size range of carapace length 37.0-37.9 mm, carapace width 27.0-28.9 mm plastron length 30.0-31.9 mm and body weight 16 to 17 gm.

The relationship between the carapace length and weight for 466 hatchlings was worked out. The logarithmic relationship between carapace length and weight of hatchlings of olive ridley is shown in Fig. 9.

Some variability in the number of lateral scutes was noted. In 309 hatchlings it varied from 6 to 8 with more number of animals with 6, the percentage frequency of 6, 7, 8 lateral scutes being 55.0, 37.5 and 7.5 respectively (Fig. 10). A few of the hatchlings were retained at Kovalam Field Laboratory for detailed studies on bio-energetics and information on growth with different diets (Silas *et al.*, 1984 ; Vijayakumaran *et al.*, 1984).

Some of the hatchlings retained in captivity showed health problems and the observations made are given elsewhere (Rajagopalan *et al.*, 1984). Abnormalities in emerging hatchlings in the hatchery were extremely rare. In a few specimens, lateral compressions of the carapace to give a hump back appearance was seen but the hatchlings were quite active and had no difficulty in crawling to the surf. 'Albinism' was noticed in three hatchlings. No abnormality was noticed in the flippers or other parts of the body.

About 20 of the olive ridley hatchlings of the 1981 season were grown for one year in individual plastic containers (Pl. IX A, B) and later transferred into pens constructed at the Mariculture Farm of the Central Marine Fisheries Research Institute at Muttukadu, Madras (Pl. IX C). The observations on growth in captivity is presented elsewhere in this bulletin (Rajagopalan, 1984).

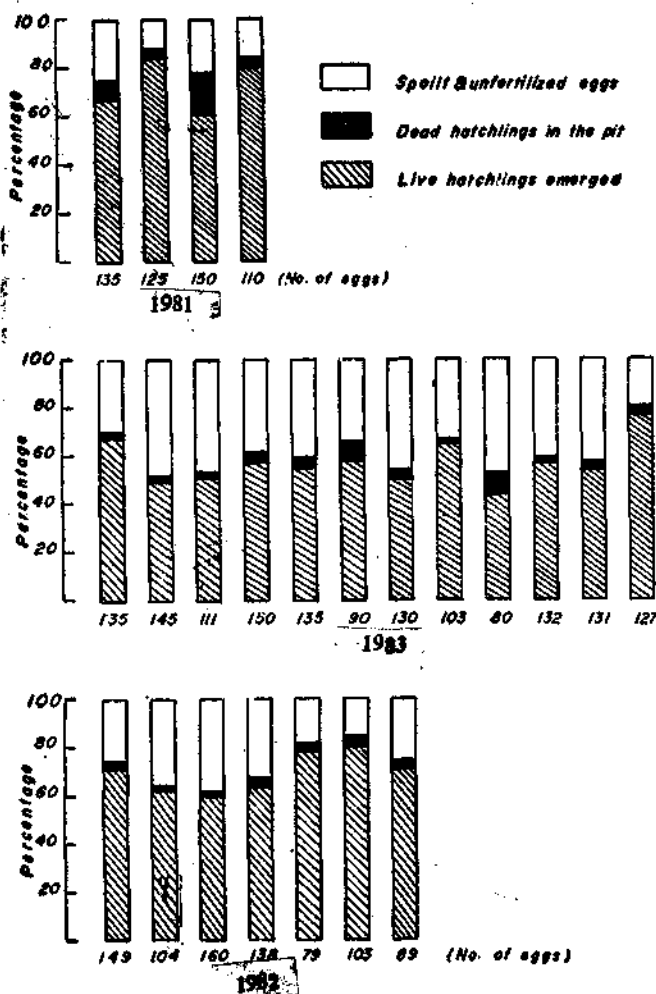


Fig. 7. Percentage of live hatchlings, dead ones and spoilt and unfertilized eggs observed during 1981-1983 season.





PLATE IX. Rearing of olive ridley in captivity. A-B. Individual and group rearing at Kovalam Field Laboratory and C. Rearing of subadults in pens at CMFRI, Mariculture Farm, Mutlukadu.

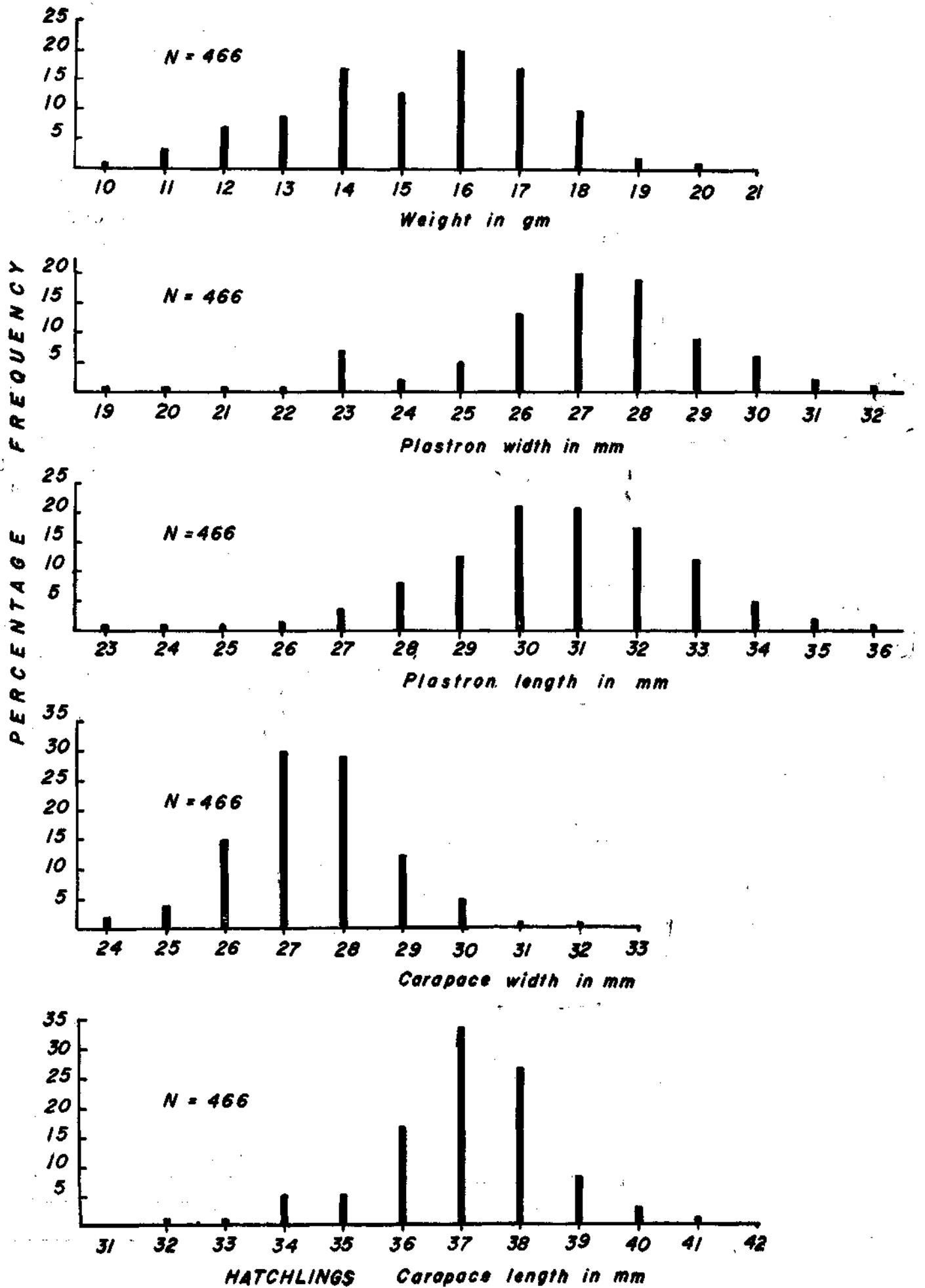


Fig. 8. Percentage frequency of carapace length, carapace width, plastron length (mm) and weight (gm) for 466 olive ridley hatchlings observed at Kovalam.

### Problems encountered in the hatchery

Site selection for the hatchery is important. It has to be on the beach preferably few metres away from the high-water mark where the turtle normally nests. In case, it is located further away from the beach the texture of the sand, the sub-soil moisture conditions and temperature prevailing at different depths may be equally important. During our programme between 1978-1983 the hatchery was set up at four different places which gave in varied results. The best results were obtained when the hatchery was located at Kovalam Beach about 10 metres away from the high-water mark during the 1982 and 1983 seasons. In all cases the pits were made as per average dimensions seen in the case of natural nests.

Due to some social problems prevalent in Kovalam village, the hatchery could not be located during the 1979-1981 seasons on the beach proper and had to be about 150 metres away from high-water mark close to the temple at Kovalam (in 1979, 1980) and near to CMFRI Field Laboratory about 250 metres away from highwater mark in 1981. Although sprinkling of water was resorted to, the high temperature that was prevalent during the day time would have had an adverse effect on the arrested growth of the embryos at a late stage resulting in extremely poor hatching.

In one year we had the unfortunate experience of having mongooses enter into the hatchery, destroying several nests and eggs. The placement of welded mesh netting helped to prevent further depredation. Hatchery may be covered with some nylon netting to prevent crows preying on emerging hatchlings.

### CONCLUSION

The turtle hatchery programme at Kovalam has clearly shown the greater possibilities of utilizing the additional knowledge gained for improved hatchery techniques.

1. When heavy predation of egg from the nest by man and animals is present and where implementation of regulatory measures may not be effective or may take time, the option of developing a hatchery programme seems to be the only alternative.
2. Temperature as the most important parameter affecting the sex in developing embryos has been stressed in some of the recent publications. We have noted that high temperature (38.4C)° results in arrested development of the embryos.

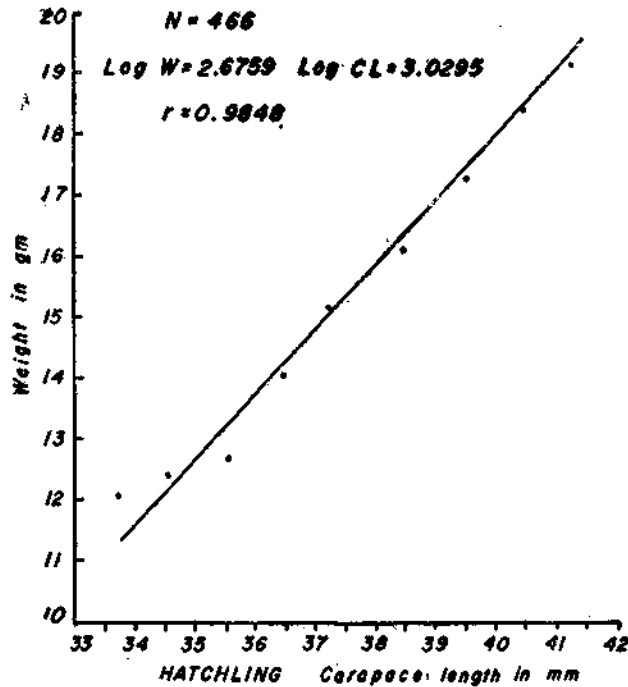


Fig. 9. Logarithmic relationship between carapace length and weight of olive ridley hatchlings.

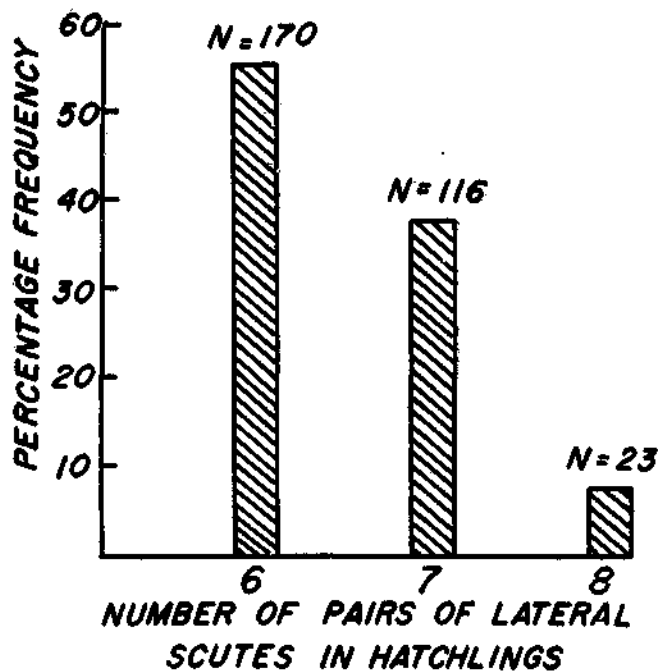


Fig. 10. Percentage frequency of number of pairs of lateral scutes in olive ridley hatchlings.

This would call for very intensive study of the nest through the incubation period to determine the variabilities in temperature, moisture content and so on for developing better hatchery practices.

3. No information is available about the emerging hatchlings which enters the sea. This is a major lacuna calling for more intensified observations.

4. The sea turtle recovery programme should also be supported by a major effort of research on aspects of behaviour, reproductive biology, ecology, nutritional requirements of turtles, their feeding grounds, migratory pathways, growth and longevity. To achieve this the co-ordinated effort of different individuals and organisations will be necessary.

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## YOLK UTILIZATION IN THE EGG OF THE OLIVE RIDLEY *LEPIDOCHELYS OLIVACEA*

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### ABSTRACT

Yolk utilization has been studied in the eggs of olive ridley *Lepidochelys olivacea* from laying to pipping (hatching), pipping to emergence and in hatchlings. Chemical and calorimetric changes in the whole egg, in yolk, in the embryo and in the post emergence hatchling have been discussed. Cumulative conversion efficiencies of the whole egg and of yolk and net utilization efficiency of yolk have been determined using chemical and caloric values. Cumulative conversion efficiency of whole egg and of yolk at pipping in terms of energy are 71.97% and 30.42% respectively. At the time of emergence these values further reduced to 66.97% and 26.17% respectively. Based on the utilization of yolk energy, embryonic development in *L. olivacea* has been divided into three phases.

### INTRODUCTION

Yolk is the primary nutritional source of the developing embryos of oviparous and ovoviviparous animals. Much attention has been given recently to study the utilization of yolk by the embryo. Chemical and energy conversion of yolk to hatchling have been studied in terrestrial and aquatic eggs and based on this and the capacity of the egg to absorb water from the environment the eggs are classified as cleidoic and non-cleidoic (Needham, 1931).

There has been some vagueness about the categorisation of the eggs of turtles, laid in nests not far from the high water mark, either as cleidoic or non-cleidoic. Silas and Vijayakumaran (1984) have discussed this aspect based on earlier available literature on the subject as well as from observations on the development of the egg of olive ridley. They conclude that turtles lay non-cleidoic eggs since the egg is not a 'closed box' (as defined for cleidoic egg by Needham 1931) and based on the utilization of protein and lipid during development and the excretion of nitrogenous wastes.

There is no study on yolk utilization, chemical or calorimetric, in marine turtle eggs except on the metabolism of developing eggs of *Thalassochelys corticata* from Japan. The only report on yolk utilization in

marine turtles by Kraemer and Bennet (1981) is on post-hatching yolk utilization in the loggerhead turtle *Caretta caretta*. The present study reports the chemical and calorimetric changes in the egg of olive ridley *Lepidochelys olivacea* from laying to pipping (hatching), pipping to emergence and from emergence to the 16th day of post-hatching yolk.

We are thankful to Dr. E. Vivekanandan, Madras Research Centre of Central Marine Fisheries Research Institute, Madras for useful suggestions and discussions during the course of this work. We wish to express our sincere thanks to the Chief Wild Life Warden, Forest Department, Government of Tamil Nadu, for permission given to the Institute to collect olive ridley eggs for studies relating to recovery programme of the species.

### MATERIAL AND METHODS

The eggs of *L. olivacea* used in the present study were collected immediately after oviposition on 5-3-81 at 0200 hours from Kovalam beach, Madras, along the South East Coast of India, a natural nesting site. A total of 104 eggs were present in the clutch. The eggs were brought to the laboratory where they were numbered with marking pen from 1-102 (two eggs were damaged while removing), and weighed to 1 mg accuracy in an analytical balance. The eggs were then transferred to the hatchery in the same beach and buried in two pits. Eight eggs were removed for initial analysis; of these 4 were dried intact while the rest were

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dissected and yolk, albumen (egg white) and shell were separated for analysis. Four eggs, two from each pit, were removed at 5 day intervals up to the 40th day and then four hatchlings on 42nd, 44th and 45th days and treated similarly. Pipping (breaking of the shell) is considered as hatching in marine turtles and the emergence is the time when the young turtle comes out of the nest (Ewert, 1979). The same definitions are used in the present study also. Pipping (hatching) in this study took place on the 42nd day. Of the 4 hatchlings removed from 42nd to 45th day, two were kept intact and the other two were dissected and the yolk and the hatchling minus yolk were taken separately for analysis.

On 45th day the rest of the hatchlings numbering 16, emerged. These were weighed and reared individually in 10 litre aquaria and were starved for post emergence studies. One or two hatchlings were sacrificed on 2, 3, 4, 6, 8, 10, 12, 14 and 16th day for analysis.

In addition to this, eggs and hatchlings from different clutches were collected at random at 5 day intervals upto 40th day and then on 42nd, 44th and 45th days, from the turtle hatchery of the Kovalam Field Laboratory of the Central Marine Fisheries Research Institute, where about 30,000 eggs were incubated. These samples were also treated similarly for analysis. Initial sample and initial weight of the eggs, however, could not be obtained from the general hatchery. Pipping took place on 42nd or 43rd day and emergence on 45th or 46th day in the hatchery.

Whole egg/hatchling and the tissues were weighed and dried to constant weight at 60°C in an electric oven to determine the water content. The dried tissues were then minced, homogenised, made into a fine powder

and stored in airtight bottles in desiccators. Chemical analysis were performed on such homogenised samples. Protein was estimated by modified biuret method (Sumitra Vijayaraghavan and Vijayakumaran, 1976), lipid by chloroform, methanol (2:1) method (Raymont *et al.*, 1964) and caloric content by Gallencamp ballistic bomb calorimeter (Model No. CB 370). The temperature in the nest varied from 24.8 to 34.2°C during the whole period.

Since values for eggs from a single clutch and those obtained from the general hatchery were similar in yolk utilization, both the values were pooled for calculations. Values given are mean of 3 or more samples upto emergence and of two or single samples after emergence.

## RESULTS

The proportionate weights of shell, albumen (egg white) and yolk in the freshly laid egg of olive ridley is given in Table 1. The clutch size varied from 79 to 160 (Av. 126) and the average weight of the egg in a clutch was 29.0 g (Range 22.9-36.5 g) (Silas and Ragagopalan, 1984).

TABLE 1. Proportion of yolk, albumen (egg white) and shell in the freshly laid egg of the olive ridley *Lepidochelys olivacea*

Material	Wet weight (g)	% in wet weight	Dry weight (g)	% in dry weight
Shell	1.50	3.24	0.73	10.38
Albumen (egg white)	12.18	39.42	0.20	2.84
Yolk	17.22	57.34	6.10	86.78
	30.90	100.00	7.03	100.00

TABLE 2. Changes in the weight of a single egg of the olive ridley *L. olivacea* from the day of laying to emergence

Days after laying	Wet weight of the egg/hatchling (g)	% increase/decrease in wet weight (from initial)	Dry weight of the egg/hatchling (g)	% dry matter in egg/hatchling	% of water in egg/hatchling
0	30.90	—	7.03	22.74	71.26
6	30.22	— 2.20	7.04	23.30	76.70
10	30.63	— 0.87	6.95	22.69	77.31
15	31.21	1.00	7.01	22.47	77.53
20	31.07	0.55	6.91	22.24	77.76
25	30.97	0.21	7.04	22.75	77.25
30	31.33	1.36	7.04	22.48	77.52
35	31.32	1.35	6.54	20.88	79.12
40	29.27	— 5.28	6.45	22.05	77.95
42	16.74	— 45.83	5.02*	29.96	70.04
(Pipping embryo)					
44	16.82	— 45.56	4.99*	29.66	70.34
45	15.96	— 48.35	4.63	29.00	71.00
(Newly emerged hatchling)					

\* Shell weight excluded

### Changes in the whole Egg

The change in wet weight, dry weight and percentage dry matter and water in the egg over 45 days of development are presented in Table 2. The egg lost weight initially (upto a maximum of 2.2% of the initial) and from about the 10th day started gaining in weight upto 35th day (maximum gain 1.36%). From 35th day onwards the weight reduced rapidly. The percentage of water in the egg did not change considerably until the 35th day. On the 35th day the percentage of water increased from 77.52% recorded on the 30th day to 79.12% and thence onward decreased to 77.95% on the 40th day. On the 42nd day the egg hatched (pipping) and the water content dropped to 70.04%.

Chemical changes in the egg from laying to emergence of hatchlings are given in Table 3. The initial water

content of the egg was 77.26%, lipid and protein contents were 30.0% and 52.94% respectively in dry weight.

TABLE 3. Changes in chemical composition of the egg of olive ridley *L. olivacea* from laying to emergence

Days after laying	% water	% lipid in dry weight	% protein in dry weight	K. cal/g dry weight
0	77.26	30.00	52.94	6.03
10	77.31	29.00	51.70	5.91
20	77.76	29.50	53.15	5.86
30	77.52	30.00	50.90	5.95
40	77.95	27.40	50.38	5.63
42*	70.04	26.82	52.21	6.09
44	70.34	26.02	49.67	5.84
45@	71.00	25.80	49.38	5.93

\* (Pipping embryo).

@ Newly emerged hatchling.

TABLE 4. Changes in chemical composition of post emergence *L. olivacea* hatchling observed under starvation

Days after emergence	Live weight (initial) (g)	Live wt. on sampling day (g)	% water	% lipid (in dry weight)	% protein (in dryweight)	K. Cal/g dry weight
1	15.96	—	71.00 (74.77)]	25.80 (21.64)	49.38 (47.22)	5.93 (5.69)
2	16.98	16.16	67.85 (73.41)	23.76 (21.16)	65.08 (61.49)	5.88 (5.69)
3	17.64	16.42	68.74	— ]	—	—
4	16.69	16.13	71.95 (74.74)]	23.71 (20.31)	58.90 (59.80)	5.68 (5.61)
6	16.61	16.62	71.15 (76.50)	23.50	58.09	5.78
8	16.98	18.89	71.75	—	—	—
10	16.66	18.71	76.77	—	—	5.72
12	16.07	18.84	75.96 (77.20)]	— (17.62)]	— (64.27)	5.27 (5.09)
14	17.02	19.55	76.10 (77.41)	20.27 (18.23)	56.39 (57.48)	5.79 (5.66)
16	18.27	20.19	—	— (16.28)]	— (60.09)	—

From 3th day onwards values of chemical composition given for whole hatchling are calculated from separate estimations of yolk and hatchling without yolk.

Values in parentheses are for hatchling minus yolk.

The caloric content was 6.03 K. cal/g dry weight. During development there was no appreciable change in the lipid content upto the 30th day, but by the 40th day the percentage of lipid dropped from 30.0 to 27.4 and further reduced to 26.82 in the pipping embryo on the 42nd day. By the 45th day when the hatchling emerged out of the nest, the lipid further reduced to 25.8. The protein content of the whole egg was seen to decrease gradually upto the 40th day from 52.94% to 50.38% (except on the 20th day with a value of 53.15%). The percent protein then increased to 52.21 in the pipping embryo but again reduced to 49.38% in the newly emerged hatchling. The caloric content of the whole egg reduced from 6.03 K. cal/g dry weight at the time of laying to 5.63 K. cal/g dry weight on the 40th day; the caloric value of the newly emerged hatchling was 5.93 K. cal/g dry weight.

#### Post Emergence changes in the Hatchlings

Post emergence changes in the hatchlings kept under starvation are presented in Table 4. The percentage of water reduced from 71.00 on the first day to 68.74 on the 3rd day and thence increased to 71.95 in the 4th day, which is also reflected in the live weight of the hatchlings, which decreased by 3.38% on the 2nd day and by 7.36% on the 3rd day. The reduction was only 3.18% on the 4th day and by the 5th day the live weight increased by 6.18% of the initial, the increase continued and reached 10.0% on the 14th day. The initial decrease was due to loss of water and the subsequent increase was due to absorption of water. Lipid in the dry matter decreased from 25.80% on the 1st day to 23.50% on the 6th day and further reduced to 20.27% on the 14th day. The percentage of protein increased from 49.38 to 65.08 on the 2nd day and thereafter declined to 56.59 on 14th day. Caloric value reduced from 5.93 K. cal/g dry weight on the 1st day to 5.79 K. cal/g dry weight on the 14th day.

#### Changes in Yolk

Yolk constitutes 55.73%, 86.77% and 96.70% of wet weight, dry weight and caloric content of the fresh egg of *L. olivacea* (Fig. 1). The combined values for yolk and albumen were 95.16%, 89.61% and 97.92% respectively for wet weight, dry weight and calories. This indicates that even though albumen constitute about 40% of the wet weight of the egg, its contribution in dry weight and calories (2.84% and 1.22% respectively) are negligible. In other amniotes such as chick, however, albumen is reported to provide substantial amount of energy to the embryo (Needham, 1931; Romanoff, 1967). The dry weight of yolk to fresh weight of whole egg ratio for *L. olivacea* is  $0.192 \pm 0.07$ .

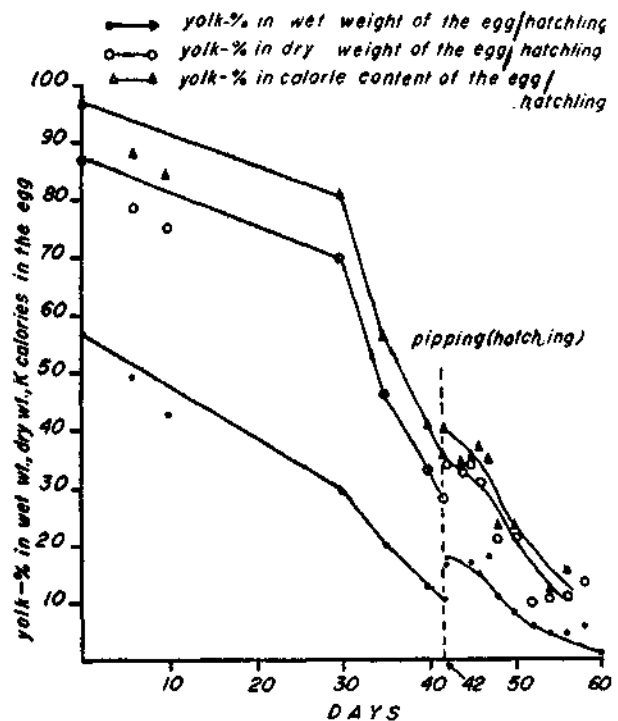


Fig. 1. Changes in the proportion of weight and caloric content of yolk in the whole egg upto pipping (hatching) and in the hatchlings upto the 16th day after emergence in the olive ridley *L. olivacea*.

This compares favourably with 12 species of turtles 0.139 to 0.230 (mean 0.180) and is close to the ratio of 0.165 for the chick (Ewert, 1979). Changes in per cent weight of yolk and yolk + albumen in the developing egg and subsequently upto 16th day after emergence (yolk alone) are represented in figures 1 and 2 respectively. The data on yolk + albumen is presented since yolk could not be separated from the 10th to the 30th day in the egg.

The percentage of yolk in wet weight of egg reduced from 55.73% on the day of laying to 42.59% on the 10th day. Further data are available only on the 30th day, by which time the contribution of yolk in wet weight reduced to 29.50%. By 40th day the wet weight steeply reduced to 12.79% of the initial. The percentage of yolk in wet weight of pipping embryo (42nd day) and at the time of emergence (45th day) were 17.20 and 17.23% respectively.

The corresponding values for percentage dry weight of yolk in egg were 86.77 on the first day, 75.40 on the 10th day, 69.74 on the 30th day and 33.02 on the 40th day. Here also the sharp decline is noticed between the 30th and 40th days. On 42nd day, 34.26 of the dry weight of the pipping embryo was contributed by yolk. On emergence, this value was further reduced to 33.91%.



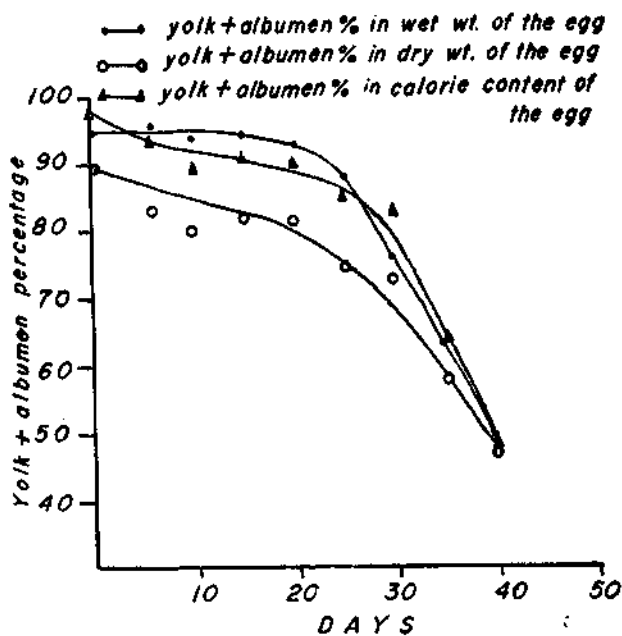


Fig. 2. Changes in the proportion of weight and caloric content of yolk + albumen in the whole egg upto pipping (hatching) in the olive ridley *L. olivacea*.

Total energy of the yolk (Percentage in total calories of the egg) declined from 96.70 on the first day to 84.33 on the 10th day and 80.98 on the 30th day. As in the case of wet weight and dry weight the reduction in energy content of yolk from 30th to 40th day was steep, from 80.98% to 56.48% of the total energy of the egg. It further declined to 35.75% on the 42nd day and in the pipping embryo on the 42nd day yolk provided 40.03%

of the total energy of the animal. On emergence this percentage dropped to 34.82. The mean caloric value of the yolk was 6.74 K.cal/g dry weight in the freshly laid egg and a maximum value of 7.26 K.cal/g dry weight was recorded in the yolk of the pipping embryo.

Similar trend was recorded in the yolk + albumen expended (on dry weight and energy basis). Except for the period from 5th to 30th day, the values for yolk + albumen were calculated from separate values obtained for yolk and albumen. Albumen or egg white represented here includes amniotic and allantoic liquids also.

Table 5 gives the data of expenditure of yolk and yolk + albumen in a single egg. Yolk wet weight dropped from 17.22 to 13.04 g on the 10th day. It further declined to 9.24 g on the 30th day. The reduction after 30th day was faster and the value dropped down to 3.67 g by the 40th day. 2.88 g of yolk was retained by the embryo at the time of pipping and this amount further declined to 2.75 g at the time of emergence. Corresponding values for dry matter were 6.10 g to 5.24 g on the 10th day, 4.91 g on the 30th day and 2.13 g on the 40th day. At the time of pipping, the hatchlings retained 1.72 g dry matter of yolk which again declined to 1.57 g on emergence.

Same trend was recorded for yolk + albumen also. An interesting observation was the reduction in percentage of water in yolk as the development progressed. The per cent dry matter of yolk increased gradually from 35.42 in the fresh egg to 57.3 in the newly emerged hatchling.

TABLE 5. Changes in wet and dry weights of yolk and yolk + albumen in a single egg from the day of laying to emergence in the olive ridley *L. olivacea*

Days after laying	Egg weight (wet) (g)	Yolk weight (wet) (g)	Yolk weight (dry) (g)	Yolk + albumen weight (wet) (g)	Yolk + albumen weight (dry) (g)
0	30.90	17.22	6.10	20.94	6.30
6	30.22	14.75	5.53	28.96	5.85
10	30.63	13.04	5.24	28.88	5.56
15	31.21	—	—	29.54	5.76
20	31.07	—	—	28.74	5.66
25	30.97	—	—	27.56	5.28
30	31.33	9.24	4.91	23.74	5.13
35	31.32	5.86	3.01	18.51	3.81
40	29.27	3.67	2.13	14.34	2.75
42	16.74	2.88	1.72	—	—
(pipping embryo)	(Pipping embryo)				
44	16.82	2.82	1.63	—	—
45	15.96	2.75	1.57	—	—
(Newly emerged hatchling)	(Newly emerged hatchling)				

Changes in chemical composition of the yolk during the developmental period are recorded in Table 6. Since the contribution of albumen in chemical composition or in caloric value are negligible, the values for yolk + albumen are considered as good as those of yolk. Lipid formed 35.94% of dry matter in the yolk

TABLE 6. Changes in chemical composition of yolk during development in the egg of olive ridley *L. olivacea*

Days after laying	% water	% lipid in dry weight	% protein in dry weight	K. cal/g dry weight
0	64.58	35.94	58.02	6.72
10	59.82	37.37	55.98	6.61
20	—	35.82*	58.50*	6.85*
30	46.81	35.60	55.23	6.91
40	42.03	36.00	53.67	6.74
42	40.18	34.71	55.01	7.26
(Pipping embryo)				
44	42.23	35.75	52.17	6.79
45	42.70	34.50	53.88	6.81
(newly emerged hatchling)				

\* Values are for yolk + albumen.

of fresh egg, the same value for the hatchling was 34.50%. No significant change in lipid content was apparent during development. Percentage of protein in yolk dropped from 58.02 to 55.01% in the pipping embryo and declined further to 53.88% at the time of emergence. The caloric value of yolk recorded in this study (6.61 to 7.26 K.cal/g dry weight) is much lower

than the average (7.88 K.cal/g dry weight) recorded for yolk of hatchlings of *Caretta caretta* by Kraemer and Bennet (1981), but is quite comparable to the values obtained for *Chelydra serpentina* (6.6 K.cal) and *Pseudemys scripta* (6.7 K.cal) by Slobodkin (1962) and the calculated value of 6.8 K.cal/g dry weight for *C. caretta* (from the data of Tomita, 1929).

#### Post Emergence changes in Yolk of Hatchlings

Reduction in weight and changes in weight and chemical composition of post emergence yolk are recorded in Table 7. Weight of yolk dropped from 2.75 g (wet) and 1.57 g (dry) to 0.22 g (wet) and 0.12 g (dry) by the 16th day respectively. The reduction in weight of post emergence yolk was 92.2% and 92.5% (wet and dry) respectively by the 16th day. The reduction in quantity of yolk until 6th day was gradual but thenceon the decline was sharp. Percentage dry matter varied from 57.3-51.40. Percentage of lipid reduced from 34.50% in the first day to 32.81%, on the 16th day. Percentage of protein increased initially but declined to 51.49%, from the initial 53.88%, on the 13th day. Caloric value of the yolk varied from 6.18 to 6.89 K.cal/g dry weight. Post emergence study was possible only upto the 16th day on account of limitation of number of hatchlings for the experiment. By the 16th day 92.5% of the yolk had been utilized. Elsewhere, Vijayakumaran *et al.* (1984) have shown that on starvation *L. olivacea* hatchlings could survive upto 36 days. The utilization of the balance 7.5% of the yolk could thus take place during part of this period

TABLE 7. Changes in weight and chemical composition of yolk in hatchlings (post emergence) of olive ridley *L. olivacea*

Days after emergence	Wet weight of animal (g)	Yolk wet weight (g)	Yolk dry weight (g)	% dry matter in yolk	% lipid in dry wt. (yolk)	% protein in dry wt. (yolk)	K. cal/g dry wt. (yolk)
1	15.96	2.75	1.57	57.30	34.50	53.88	6.89
2	15.14	2.27	—	—	35.40	55.75	6.79
3	15.93	2.88	1.52	52.60	30.35	54.65	6.95
4	16.61	1.83	1.00	54.79	33.00	53.65	6.34
6	19.21	1.62	—	—	—	—	6.18
8	18.89	1.05	0.57	54.24	—	—	—
10	18.71	0.90	0.46	51.40	—	—	6.72
12	18.84	0.88	0.45	56.25	—	—	—
14	19.55	1.22*	0.68	55.56	32.81	51.49	6.70
16	20.19	0.22	0.12	55.00	—	—	—

\* The single hatchling analysed contained high yolk material

### Changes in the Embryo

Development of embryo is represented as proportion of embryo in the egg on wet weight, dry weight and calories in Fig. 3. The embryo can be separated on the 15th day onwards and on that day it constituted 0.96%

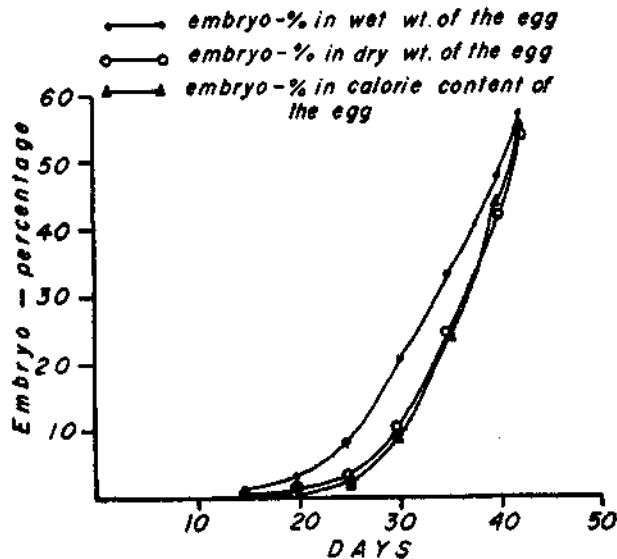


Fig. 3. Changes in the proportion of weight and caloric content of the embryo in the whole egg upto pipping (hatching) in the olive ridley *L. olivacea*.

and 0.44% of the wet and dry weights of the egg respectively. Increase in weight of the embryo was slow upto 30th day. Percentage of weight of embryo in egg weight increased sharply from 20.75% (wet) and 9.82% (dry) on the 30th day to 47.38% (wet) and 41.2% (dry) on the 40th day. At the time of pipping (42nd day) these values went upto 55.75% (wet) and 52.46% (dry). The sharp increase in the growth of embryo from the 30th day onwards was correlated with the sharp decline in weight and energy of the yolk in the egg.

Growth of embryo in a single egg is given in Table 8. From 0.31 g (wet) and 0.025 g (dry) weight on the 15th day, the embryo grew to 6.50 g (wet) and 0.68 g (dry) on the 30th day. From 30th to 40th day it increased its weight upto 13.86 g (wet) and 2.70 g (dry). The increase in growth rate was continued upto the 42nd day (pipping day) when the embryo reached 16.74 g (wet) and 5.02 g (dry). At the time of emergence, on the 45th day, weight of the hatchling declined to 15.96 g (wet) and 4.63 g (dry).

In the initial stages of development water content of the embryo was very high. It declined from 91.96% on the 15th day to 89.47% on the 30th day; and then

sharply to 80.55% on the 40th day. Water content of the pipping embryo (42nd day) was 70.04% and there was no appreciable change thereafter upto the emergence.

The percentage of lipid increased from 15.78% in the 20th day embryo to 25.80% at the time of emergence. Protein content of the embryo decreased from 64.66% on the 20th day to 51.52% on the 40th day and again increased to 52.21% at the time of pipping. From pipping to emergence, protein content further declined to 49.38%. Caloric value of the embryo increased from 4.55 K.cal/g dry weight on the 20th day to 6.09 K.cal/g dry weight on the 42nd day (pipping embryo). The value at the time of emergence was 5.93 K.cal/g dry weight.

### Cumulative Conversion Efficiency in the Egg

Cumulative efficiency in a single egg in terms of wet weight, dry weight, protein, lipid and calories are presented in Table 9. Upto the time of pipping on the 42nd day, *L. olivacea* spent 11.88 K.cal. of energy which amounted to retention of 71.97% of energy in the egg. Cumulative efficiencies for lipid and protein at pipping were 63.51% and 70.43% respectively. It has been reported that turtle hatchlings spend considerable energy in their struggle for emergence from the nest (Evert, 1979; Kraemer and Bennet, 1981) which usually happens 3 to 4 days after pipping. In the present study, *L. olivacea* spent energy equivalent to 2.12 K. cal (0.16 g protein and 0.05 g lipid) for emergence from the nest. Cumulative efficiency for the whole egg at the time of emergence was 66.97%, 61.14% and 66.13% for calories, lipid and protein respectively.

### Cumulative Conversion Efficiency of Yolk

Cumulative conversion efficiencies for yolk alone were 30.42%, 27.40% and 26.55% in terms of calories, lipid and protein respectively at the time of pipping (Table 9). At the time of emergence these values reduced to 26.17%, 24.66% and 24.01% for calories lipid and protein respectively.

Total combustion of lipid through ignition in a calorimeter provides 9400 calories/g dry weight where as protein gives 5600 cal/g dry weight (West *et al.*, 1966). Computing this value in the present study, out of the total 40.99 K.cal of yolk 20.61 K.cal was contributed by lipid and 19.82 K. cal by protein. Based on these values cumulative energy conversion of yolk lipid and yolk protein have been calculated (Table 9). Cumulative efficiencies at pipping are 32.02% for yolk lipid and 26.69% for yolk protein energy. At the time of emergence these values reduced to 24.79% and

TABLE 8. Changes in weight and chemical composition of the developing embryo of the olive ridley *L. olivacea*

Days after laying	Wet weight of the egg (g)	Wet weight of the embryo (g)	Dry weight of the embryo (g)	% water in the embryo	% lipid in dry weight of the embryo	% protein in dry weight of the embryo	K. cal/g dry weight
0	30.90	—	—	—	—	—	—
15	31.21	0.31	0.025	91.96	—	—	—
20	31.07	0.96	0.075	92.17	15.78	64.66	4.55
25	30.97	2.52	0.206	91.90	—	—	4.63
30	31.33	6.50	0.68	89.47	21.50	63.11	5.32
35	31.32	10.26	1.60	84.37	—	—	5.76
40	29.27	13.86	2.70	80.55	23.43	51.52	5.84
42 (Pipping embryo)	16.74 (Pipping embryo)	16.74	5.02	70.04	26.82	52.21	6.09
44	16.82	16.82	4.99	70.34	26.02	49.67	5.84
45 (Newly emerged hatchling)	15.96 (Newly emerged hatchling)	15.96	4.63	71.00	25.80	49.38	5.93

TABLE 9. Cumulative conversion efficiency in a single egg of the olive ridley *L. olivacea*

Parameter	Initial	42nd day (pipping)	Cumulative efficiency at pipping (%)	45th day (emergence)	Cumulative efficiency at emergence (%)
<i>Whole Egg</i>					
Wet weight of egg (g)	30.09	16.74	55.63	15.96	51.65
Dry weight of egg (g)	7.03	5.02	71.40	4.63	65.86
Energy (K. cal)	42.39	30.51	71.97	28.39	66.97
Lipid (g)	2.11	1.34	63.51	1.29	61.14
Protein (g)	3.72	2.62	70.43	2.46	66.13
<i>Yolk</i>					
Wet weight (g)	17.22	2.88	16.61	2.75	15.96
Dry weight (g)	6.10	1.72	28.20	1.58	25.90
Energy (K. cal)	40.99	12.47	30.42	10.73	26.17
Lipid (g)	2.19	0.60	27.40	0.54	24.66
Protein (g)	3.54	0.94	26.55	0.85	24.01
Lipid energy (K. cal)*	20.61	6.60	32.02	5.11	24.79
Protein energy (K. cal)*	19.82	5.29	26.69	4.75	23.97

\* Calculated by using complete combustion values of 9400 cal/g for lipid and 5600 cal/g for protein (West *et al.*, 1966).

23.97% respectively for lipid and protein energy in the yolk.

#### Net Utilization Efficiency of Yolk

Yolk utilization efficiency at different stages of the embryo are given in Table 10. Upto 30th day 18.64% calories, 20.09% lipid and 23.45% protein have been utilized. The development was faster from the 30th day and the values went upwards to 69.58% for calories, 72.61% for lipid and 73.16% for protein at the time of

TABLE 10. Net yolk utilization efficiency on different days of incubation in the egg of the olive ridley *Lepidochelys olivacea*

(Values in parantheses are percentage reduction from initial value)

Days after laying	Dry weight of yolk (g)	Total lipid in yolk (g)	Total protein in yolk (g)	Total energy in yolk (K. cal)
0	6.10	2.19	3.54	40.99
10	5.24 (14.08)	1.96 (10.50)	2.93 (17.23)	34.01 (17.03)
30	4.91 (19.49)	1.75 (20.09)	2.71 (23.45)	33.35 (18.64)
40	2.13 (65.08)	0.74 (66.21)	1.19 (66.38)	14.36 (64.97)
42 (Pipping)	1.72 (71.80)	0.60 (72.61)	0.95 (73.16)	12.47 (69.58)
45 (emergence)	1.57 (74.26)	0.54 (75.34)	0.85 (75.99)	10.73 (73.82)

pipping. At the time of emergence 73.82% calories, 75.34% lipid and 75.99% of protein were utilized by the embryo. Of the total energy expended until emergence 25.25% was utilized during the first 30 days, 69.03% between 30th day and pipping and 5.72% for emergence. The embryo conserved 26.18% of total yolk energy for post emergence requirements.

#### DISCUSSION

While the terrestrial cleidoic eggs are closed to the environment, the non-cleidoic aquatic eggs depend mainly on the environment for water and minerals. Water uptake by parchment shelled or flexible shelled reptilian eggs (eggs that indent easily when laid and tend to expand through uptake of water during incubation) are well documented (Cunningham and Hurwitz 1936; Cunningham and Huene, 1938). The present study on *L. olivacea*, with parchment shelled egg, sup-

ports this observation as modest uptake of water is observed in this egg. Initially, upto 10 days, the egg shrinks losing water and dry matter, but from thence on it absorbs water, becomes turgid, chalkywhite and attains a perfect round shape.

There is no appreciable difference in water content of the egg until the 30th day, it increases from 77.52% on the 30th day to 79.12% on the 35th day and then reduces to 77.95% on the 40th day. This increase in water content after the 30th day corresponds to the intensive growth of the embryo. The uptake of water at this stage may facilitate the combustion of protein. The percentage of water reduces to 70.04% in the pipping embryo, the reason for the immediate drop in water content being the loss of albumen and other fluids which surround the embryo inside the egg and the inclusion of 'spare' yolk in the embryo.

Reviewing water content and growth rate in embryos in general, Needham (1931; p. 884) remarks that 'several authors have concluded that a decrease in water content, is a universal accompaniment of growth, and the more rapidly the latter takes place, the more rapidly does the drying up of the tissues go on'. This is true of the development of *L. olivacea* where we find maximum growth between the 30th day to pipping (hatching) on the 42nd day and the water content of the embryo shows a decreasing relationship.

The most important change in the chemical composition of the whole egg is reduction in percentage of lipid from 30.0% in freshly laid eggs to 26.82% at the time of pipping and to 25.8% at emergence. The reduction is mainly from the 30th day onwards, which is the period of maximum growth of the embryo. The percentage of protein reduces by 2% just before pipping, but the embryo retains the percentage of protein of the fresh egg. From pipping to emergence, however, the protein content reduces again by 3%. Reduction in lipid and increase in protein from eggs to newly hatched larvae have been reported in many marine and fresh water invertebrates (Pandian, 1970 b, 1972; Pandian and Schuman, 1967; Shakuntala, 1977). In *L. olivacea*, however, lipid reduces but protein content does not increase. No appreciable difference in the energy content (K. cal/g dry weight) has been noticed in the egg and the newly emerged hatchling, because of the yolk carried over to the hatchling which contributes about 33.91% in the dry weight at this stage.

Due to significant reduction in the percentage of water in the yolk, the latter gets concentrated as development progresses. Lipid content of the yolk does not reduce, but the protein of the yolk reduces to 55.01%

and 53.88% at the time of pipping and emergence respectively from the initial value of 58.02%. Since there was no appreciable change in chemical composition, the caloric value of the yolk also did not vary much during the course of development.

Romenoff (1967) referred to the early developmental period as that of differentiation and late development as that of growth. In *L. olivacea* only from the 15th day the embryo was observed to have the characteristic shape and profile and the development was slow until that 30th day.

On the basis of energy utilization it is possible to broadly define the embryonic development of olive ridley, in which the emergence was on the 45th day, into 3 phases as follows :

**Phase—I : Period of slow growth**

Duration : Upto 30th day of development.

Features : (a) Percentage of water in the embryo is very high (>89.5%) and

(b) Of the total energy utilized until emergence, 25.25% is used during this period.

**Phase-II : Period of fast growth**

Duration : From 30th day to pipping (42nd day)

Features : (a) Percentage of water reduces considerably (from 89.5% on the 30th day to 70.04% in the pipping embryo) and

(b) 69.03% of the total energy expended until emergence is utilized during this period.

**Phase-III : Pipping to emergence—period of intense activity for emerging out of the nest.**

Duration : 3 days, from 42nd to 45th.

Features : 5.72% of the total energy utilized is spent for the emergence.

It is interesting that a similar trend of growth in terms of utilization of organic materials (lipid and protein) and growth of embryo has been observed earlier by the Japanese workers (Tomita, Karashima and Nakamura, 1929) in the marine turtle *T. corticata*, although they had not tried to categorise growth phases during embryonic development (Tables 11 a, b and c).

TABLE 11a. Movement of nitrogen within the egg during development in *Thalassochelys corticata* (Nakamura 1929)

Day	Milligram Nitrogen				
	Whole egg	Egg white	Egg yolk	Amniotic & Allantoic liquids	Embryo
0	592	41.2	548	3	—
16	586	17.8	544	24	—
30	549	12.2	501	25	10
45	506	—	119	64	323

Total N<sub>2</sub> lost by 45th day is 25.34% of the initial (Initial-592 mg; 45th day-119 (yolk) + 329 (embryo) = 442 mg).

TABLE 11b. Weights of egg white, egg yolk, amniotic and allantoic liquids and embryo, at different stages of incubation in *T. corticata* (Nakamura, 1929)

Day	Grams weight of the fractions			
	Egg white	Egg yolk	Amniotic & Allantoic liquids	Embryo
0	18.7	11.4	3.3	—
16	10.5	10.8	12.5	—
30	5.8	10.4	15.1	1.1
45	—	2.6	12.7	17.5

TABLE 11c. Movement of fatty acids in the egg of *T. corticata* during incubation (Karashima 1929b)

Days of development	Grams fatty acid per egg
0	1.64
15	1.68
30	1.63
45	1.36
Hatched	1.12

The amount of energy contributed by the lipid and protein in the fresh yolk of *L. olivacea* was almost equal (50.3% was contributed by lipid and 48.4% by protein). The cumulative efficiency of lipid energy at pipping and emergence are 32.02% and 24.79% respectively and that of protein energy are 26.69% and 23.97% respectively. This indicates that both lipid and protein of the yolk are equally utilized for development. But the cumulative efficiency of the total lipids and proteins in the whole egg are 63.51% and 70.43% and 61.14% and 66.13% respectively for pipping and emergence. It is possible that part of the protein energy has been utilized for structural build up of the hatchling.

Only 77% of the potential energy contained in protein, as determined by combustion in a calorimeter, is utilizable by the embryos whereas more than 95% of the potential energy of lipid is (Ewert, 1979). If this correction in energy calculation is applied to the present study it will become evident that the contribution of lipid to metabolizable energy is about 20% more than that of protein.

A comparison of the cumulative conversion efficiency of energy, lipid and protein of *L. olivacea* and *T. corticata* and other cleidoic, non-cleidoic and non-cleidoic eggs with certain cleidoic properties (Table 12) reveals that the eggs of *L. olivacea* and *T. corticata*

Until emergence 73.82% of the total energy of yolk is utilized by *L. olivacea* embryo and the rest 26.18%, which corresponds to the cumulative conversion efficiency of yolk, is available to the hatchling for the entry into its new habitat, which is a strenuous process involving crawling to the sea, new experience of swimming, feeding and escapement from predators.

*L. olivacea* spends 19% of yolk energy available at the time of pipping for emergence from the nest. This value is considerably lower than the energy spent (50% of post hatching yolk) by the loggerhead turtle *C. caretta* (Kraemer and Bennet, 1981). This point needs further consideration since in our studies with removal

TABLE 12. Cumulative energy conversion efficiency in developing eggs

Habitat/species	Property of the egg	Cumulative conversion efficiency (%)		
		Protein	Lipid	Energy
Terrestrial eggs (1)	Cleidoic	97.00	45.30	64.40 (2)
Marine demersal eggs (1)	Non-cleidoic with certain cleidoic properties	85.30	46.10	60.60 (2)
Fresh water eggs (1)	Non-cleidoic	68.90	66.20	67.20 (2)
Marine turtle eggs :				
<i>Thalassochelys corticata</i>	Non-cleidoic	83.50 (3)	66.00 (3)	72.50 (4)
		74.66 (5)	66.00	69.23 (5)
<i>Lepidochelys olivacea</i> (6)	Non-cleidoic	70.43	63.51	71.97
		upto pipping (hatching)		
		66.13 (upto emergence)	61.14	66.97

(1) from Pandian (1970).

(2) Recalculated values from Pandian (1970).

(3) From Needham (1931).

(4) Calculated from the values given by Needham (1931).

(5) Calculated from the nitrogen values upto 45th day of incubation given by Nakamura (1929).

(6) Present study.

belong to the non-cleidoic group. Protein metabolism is not 'suppressed' in *L. olivacea* egg and the lipid metabolism is high, if not 'geared up'. But unlike the other non-cleidoic eggs uptake of water is very much restricted in *L. olivacea* egg (Silas and Vijayakumaran, 1984).

Irrespective of the property of the egg, whether protein metabolism is suppressed or not or lipid metabolism is 'geared up' it is imperative that 28 to 40% of the available energy has to be used for development (Table 12). The cumulative conversion efficiency of the egg does not vary much (between 60.6% and 72.5%).

of eggs for analysis there was a decrease in clutch size to a minimal number at the time of pipping and emergence. Hence the intense metabolic activity involved in the action of emergence, as experienced in a normal clutch may be reduced. Our observations also indicate that utilization of yolk in post hatching period may be extended over several days. The utilization of 'spare' yolk from the time of emergence to the 16th day shows that 92.5% is utilized upto that period.

In conclusion we would like to emphasize that there is a paucity of information on energy utilization during development in turtles. Priority attention is needed

in the following areas of basic research for a better understanding of the problem.

1. An indepth study of the metabolism of protein, lipid and inorganic matter during development of sea turtle eggs.
2. Energy expended from pipping (hatching) to emergence in relation to clutch size, depth of the nest and soil conditions.
3. The incubation period could extend or decrease due to changes in temperature. The pattern

of energy utilization under such conditions needs study.

4. The complete utilization of 'spare' yolk in the post emergence phase has not been investigated. In the olive ridley, it is seen that feeding is resorted to only from the 6th day onwards. The onset of feeding after hatching needs study in the different species under different conditions.

We hope that this paper would stimulate more work in this less trodden ground.

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## ARE TURTLE EGGS CLEIDOIC OR NON-CLEIDOIC?

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### ABSTRACT

Experimental data to determine the true status of the turtle eggs as to whether they are cleidoic or non-cleidoic has been very meagre. Needham (1931) deduced that turtle eggs are non-cleidoic or 'imperfectly cleidoic'. Further reviewing the problem, Needham (1942) termed turtle egg as 'intermediate'. Recently Pritchard (1979) has indicated that turtles lay cleidoic eggs. In the case of the spiny softshell turtle *Trionix spiniferus* which lays rigid shelled eggs, Packard and Packard (1983) opined that the egg is cleidoic. Our observation on the flexible shelled egg of the olive ridley *Lepidochelys olivacea* has shown that the egg of this sea turtle is non-cleidoic. Based on the available data on capacity for water absorption, protein and lipid utilization and nitrogen excretion during incubation in turtle eggs we feel that the sea and freshwater turtles lay non-cleidoic eggs.

### INTRODUCTION

In a recent review on the taxonomy, evolution and zoo-geography of turtles published in 'Turtles, Perspectives and Research' Pritchard (1979) mentions that 'Turtles, being poikilothermous, laying cleidoic eggs, and having a typically scaled integument, are unquestionably reptiles.' During 1981-82 and 1982-83 nesting seasons of the olive ridley *Lepidochelys olivacea*, along the Madras coast, we have made a study of the yolk utilization during development and in the post hatching stages (Silas *et al.* 1984). Our findings indicate that the olive ridley egg evinces considerable differences from the typical cleidoic egg. A perusal of the literature indicates that a major effort to study chelonian egg was made in the late twenties (1929) by a team of Japanese workers (Tomita; Karashima; Nakamura and Sendju) who had studied the egg of the Japanese sea turtle, *Thalassochelys corticata*. Apparently, their findings led Needham (1931) to indicate in his review at two different places that the turtle eggs are 'non-cleidoic' (p. 899) and are 'imperfectly cleidoic' (p. 1142). Reviewing the evolution of cleidoic egg again, Needham (1942) opined that the eggs of modern chelonians may be 'intermediate'. It is obvious that with available data Needham could not clearly define the status of turtle egg, which is evident

from the following statement '... but for proper interpretation of the situation in the chelonia, we need to know a good deal more about the nitrogen metabolism of their embryos. As we have seen (p. 35), their eggs are non-cleidoic as regards water but they may be and, probably are, cleidoic as regards the exit of nitrogenous waste products'. Recently Packard and Packard (1983) reported that the rigid shelled egg of the spiny softshell turtle, *Trionix spiniferus*, is 'fully cleidoic'.

At this stage it may be better to define what cleidoic and non-cleidoic eggs are. Needham (1931) used the term cleidoic to mean a 'closed box' which can be penetrated by matter only in a gaseous state. He has described the evolution of the cleidoic egg, the characteristics of which briefly stated would be as follows: (1) The cleidoic egg is not dependent on the environment for water or ash, and hence is a 'closed box'; (2) Oxidation of protein is suppressed to a considerable extent and the end products of protein metabolism are accumulated in the form of non-soluble uric acid to save water for the developing embryo and to reduce the exchange of matter through the egg shell; and (3) consequently, oxidation of lipids is enhanced to meet the energy requirements of the developing embryo. By these characteristics, the hen's egg, the eggs of certain terrestrial reptiles and insects are all cleidoic. Eggs that absorb water and minerals from the environment, and utilize both protein and lipid as energy source for development, as seen in aquatic eggs, are non-cleidoic. The chelonia occupies a unique position

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in that it has terrestrial as well as aquatic forms. Needham (1931, 1942), has used the expression 'imperfectly cleidoic' and 'intermediate' to denote the eggs of the turtles. The term 'imperfectly cleidoic' by itself does not definitely define the true characteristics but at that point of time and state of knowledge, perhaps, was of an indicative nature. Needham has heavily drawn on the results of the investigation of the team of Japanese scientists on the egg characteristics of *T. corticata* to come to such a conclusion. It is surprising that the ensuing years has not seen much work on this subject matter except for the related aspect dealt with by Cunningham and Hurtwitz (1936), Cunningham and Huene (1938), Cunningham *et al.* (1939), Plummer (1976) and Packard *et al.* (1981).

In the course of our work on the embryonic development of the olive ridley *L. olivacea*, we have found certain very interesting characteristics which clearly indicate that the egg of olive ridley is non-cleidoic. Perhaps if a critical reappraisal of the work of the Japanese workers (Tomita, Karashima, Nakamura and Sendju) is made in the light of the accepted definition of cleidoic egg, it will again turn out that the egg of *T. corticata* is also non-cleidoic. In order to clarify this position we shall discuss below the aspects connected with water absorption, protein and lipid metabolism and nitrogen excretion in turtle eggs during development.

The investigations on *T. corticata* by the Japanese workers indicate that the egg of *T. corticata* absorbs 42% of the initial store of water during development. Needham (1931) refers to the work of Cunningham (1923) on the turtle *Chrysemys cinerea* where the turtle moistens the dry ground by water (urine) from a supernumerary bladder before laying the eggs. The eggs in turn, swells during development. According to Needham 'This is a notable link in the evolutionary chain, for here the turtle goes out of its way to provide a store of water for its terrestrial eggs, yet outside not inside them. This must be the furthest point to which a non-cleidoic egg could go in a terrestrial environment.' (Needham 1931, p. 899). Hildebrand and Hatsel (1927) and Deraniyagala (1930) have indicated that the eggs of the loggerhead turtle, *Caretta caretta*, absorb water during incubation. Cunningham *et al.* (1939) reported that the eggs of *Caretta caretta* increases its weight by 50% during incubation by uptake of water. Our observation on the eggs of olive ridley *L. olivacea*, clearly indicates that from the initial, there is a weight decrease in the egg upto the 5th day of incubation, from whence weight increment is seen and by the 15th day the egg swells up and the flexible shell becomes turgid; in other words, it does not indent on slight pressure. Expressed in terms of initial loss of water and later gain, the values for water absorption

TABLE I. Evidence of absorption of water by flexible or rigid shelled egg of chelonians

Species	Aquatic or terrestrial egg*	Water absorption	Reference
<i>Thalassochelys corticata</i>	A ?	42% of the initial quantity of water absorbed by the egg.	Karashima, 1929.
<i>Chrysemys cinerea</i>	A ?	Flexible shelled eggs swell by absorbing water.	Cunningham, 1923.
<i>Caretta caretta</i>	A ?	Eggs take up good quantity of water during incubation,  50% increase in weight of egg by uptake of water during incubation.	Hildebrand and Hatsel, 1927; Deraniyagala, 1930;  Cunningham & Hurwitz 1936; Cunningham & Huene, 1938, Cunningham <i>et al.</i> , 1939.
<i>Dermochelys coriacea</i>	A ?	Eggs swell by absorbing water.	Deraniyagala, 1930.
<i>Lepidochelys olivacea</i>	A ?	Flexible shelled eggs swell by absorbing water—6.31% of the initial quantity of water absorbed.	Silas <i>et al.</i> , 1984.
<i>Malachemys concentrata</i>	A ?	Egg gains 28% weight by uptake of water during incubation.	Cunningham <i>et al.</i> 1939.
<i>Trionix muticus</i>	A ?	Some of the naturally incubated calcareous shelled eggs crack, probably due to absorption of water.	Plummer, 1976.
<i>Trionix splniferus</i>	A ?	Calcareous shelled eggs that are in contact with the substratum of the nest are capable of absorbing water from the surroundings to compensate for the transpiration of water through the exposed region of the egg.	Packard <i>et al.</i> , 1981.

\* Eggs are laid in nests above high water mark where the moisture content will be very high or in damp ground after heavy rain. Hence these cases represent a transitional phase from truly aquatic to terrestrial eggs.

in *L. olivacea* were  $-2.50\% + 3.81\%$  (Total  $6.31\%$  absorption) of the initial store of water. All the examples cited above are on the flexible shelled eggs. Packard *et al.* (1981) discussed water exchanges in artificially incubated eggs of the spiny softshell turtle, *Trionix spiniferus*. They have demonstrated that the rigid shelled eggs of this species, which are in contact with the simulated substratum of the nest, do absorb some amount of water to compensate for the water lost through transpiration of water vapour from the exposed part of the egg. Plummer (1976) attributed the cracking of some of the naturally incubating rigid shelled eggs of the softshell turtle, *Trionix muticus*, to the absorption of water. However, Packard *et al.* (1981) consider such occurrence as very unusual since 'uptake of sufficient liquid to cause cracking of the calcareous shell is not of frequent occurrence in nature.'

The above observations clearly indicate that there is absorption in both the flexible shelled and rigid shelled eggs of chelonians (Table 1) studied so far. Hence we would consider that these eggs are not the 'closed box' type as envisaged by Needham, Needham (1942) himself has opined that as regards water absorption Chelonian eggs are non-cleidoic. This property of the

egg is quite distinct from the eggs of the chick or even the water fowl (Grebe) (eggs of which are laid in water) which do not absorb water and are truly 'cleidoic' (Table 2).

#### UTILIZATION OF PROTEIN

The few references on utilization of protein in turtle eggs we could find in literature is that of Tomita (1929); Karashima (1929); Nakamura (1929) and Sendju (1929), referred to also by Needham (1931) in the case of *T. corticata*. Here,  $16.5\%$  of the total protein are combusted for energy by the developing egg of this species (refer Needham, 1931, p. 1134). The total depletion of protein in yolk, calculated from nitrogen values given by Nakamura (1929), until the 45th day of incubation in the *T. corticata* egg (Total incubation period = 47 days) is  $78.3\%$ . By the 45th day  $25.34\%$  of the total nitrogen available in the egg has been utilized (Initial nitrogen in the egg = 592 mg; amount of nitrogen in yolk + embryo on the 45h day =  $119 + 323 = 442$  mg) in the *T. corticata* egg (calculated from Nakamura, 1929). This clearly indicates that a considerable amount of protein is metabolised for energy in *T. corticata* egg (Table 3).

TABLE 2. Categorisation of absorption of water by developing eggs

Type of egg	Aquatic or terrestrial egg	Water absorption	Reference
<b>CLEIDOIC EGGS</b>			
Chick ( <i>Gallus domesticus</i> )	T } A }	No absorption of water from the environment	Needham, 1931.
Water Fowl			
<b>NON-CLEIDOIC EGGS</b>			
(a) Marine demersal eggs which release planktonic larvae	A	Average percentage of water rises from 60.8 in egg to 84.0 in larva	
(b) Marine planktonic eggs which release planktonic larvae	A	Average percentage of water rises from 90.9 in the egg to 91.8 in the larva	Needham, 1931 and Pandian, 1970.

TABLE 3. Utilization of protein and lipid as energy source in the developing eggs of turtles

Species	Incubation time (days)	Aquatic or terrestrial egg	Depletion of protein in % of the respective initial value	Depletion of lipid in % of the respective initial value	Reference
<i>Thalassochelys corticata</i>	47	A ?	16.5	34.0	Karashima, 1929 ; Tomita, 1929 ; Nakamura, 1929.
			Upto 45th day calculated on the basis of total nitrogen content. 25.34		Calculated from the data of Nakamura, 1929.
<i>Lepidochelys olivacea</i>	45	A ?	Upto pipping (hatching) 42nd day. 29.57	26.49	Silas <i>et al.</i> , 1984.
			Upto emergence 45th day. 33.87	28.86	

Our work on the yolk utilization in *L. olivacea* (Silas *et al.* 1984) also indicates the utilization of a considerable amount of protein by the developing egg of *L. olivacea*. 29.57% and 33.87% of the initial store of protein in the egg is utilized at the time of pipping (hatching) and emergence respectively in the egg of *L. olivacea*. The reduction in the protein content of yolk at pipping and emergence are 73.31% and 76.03% respectively. The total incubation time of *L. olivacea* (45 days for emergence; pipping or hatching on the 42nd day) is not much different from that of *T. corticata* (47 days).

The utilization of protein seen in these two cases are typical of the non-cleidoic type of eggs (Table 4). This is quite distinct from the minimal utilization of protein—about 4-5%—in the truly cleidoic eggs of chick and silkworm moth (Table 4).

#### UTILIZATION OF LIPID

Since protein metabolism is greatly suppressed in the cleidoic egg, the energy for the developing embryo has to come mainly from the lipid store of the yolk. As indicated by Needham (1931) the total protein

content in the cleidoic egg is almost equal to the total lipid content of the egg, with the exception of silkworm moth (*Bombyx mori*). In the non-cleidoic eggs, the percentage of total lipid is considerably low in comparison to the total protein content in the egg; the ratio of protein/fat varying between 1.5 and even 12.5 in fishes and marine invertebrates (Needham, 1931, Table 31). In tortoise he has given the protein/fat ratio as 2.271. In the olive ridley we find the ratio to be 1.75; in other words 52.94% protein and 30.0% lipid. This condition approximates closely to the non-cleidoic type. Thus, it is seen that even in the availability of organic material required for development, the tendency is to minimize utilization of protein during development in the cleidoic eggs.

In Table 4, the values of total lipid utilized during development by cleidoic and non-cleidoic eggs in percentage of total lipid present are given. The data of lipid utilization in the turtles *T. corticata* (Karashima, 1929) and *L. olivacea* (Silas *et al.*, 1984) are recorded in Table 3. It is evident from the data presented that in the marine turtles the utilization of lipid is distinctly lesser than in the true cleidoic egg *e.g.*, chick, lackey moth, etc. Here again the evidence points to the more non-cleidoic condition of the egg of sea turtles.

TABLE 4 Utilization of protein and lipid as energy source in developing eggs

Type of egg and species	Aquatic or terrestrial egg	Depletion of protein in % of the respective initial value	Depletion of fat in % of the respective initial value	Reference
<b>CLEIDOIC EGGS</b>				
Chick ( <i>Gallus domesticus</i> )	.. T	4.5	60.0	Needham, 1942 and Pandjan, 1970.
Silkworm moth ( <i>Bombyx mori</i> )	.. T	3.9	48.0	
Sheep blowfly ( <i>Lucilia sericata</i> )	.. T	0.5	44.5	
Grasshopper ( <i>Melanoplus sp.</i> )	.. T	—	54.0	
Lackey moth ( <i>Malacosoma sp.</i> )	.. T	—	85.0	
Potato beetle ( <i>Leptinotarsa sp.</i> )	.. T	—	36.5	
Average	..	3.0	54.7	
<b>NON-CLEIDOIC EGGS</b>				
Frog ( <i>Rana temporaria</i> )	.. A	29.6	28.0	
Salamander ( <i>Cryptobranchus sp.</i> )	.. A	27.8	30.8	
Salamander ( <i>Hynobius sp.</i> )	.. A	—	25.5	
Carp ( <i>Cyprinus carpio</i> )	.. A	41.0	—	
Trout ( <i>Salvelinus fontinalis</i> )	.. A	19.5	—	
Trout ( <i>Salmo iredius</i> )	.. A	32.5	51.0	
Salmon ( <i>Salmo farlo</i> )	.. A	36.3	—	
Average	..	31.1	33.8	

## NITROGEN EXCRETION

In the cleidoic eggs any substantial combustion of protein would result in the accumulation of undesirable residues of ammonia, urea or uric acid which are toxic and will be detrimental to development. Hence total cessation of combustion of protein should be the ideal situation. However, in nature this does not happen as we find that even in the truly cleidoic eggs of chick or the silkworm moth a minimal combustion of 4 to 5% protein takes place (Table 4). The inability of the cleidoic egg to absorb water necessitates the disposal of the waste products of protein metabolism in the form of uric acid crystals which are deposited in the walls of the embryonic membranes thereby saving the water reserve for use of the developing embryo. Needham (1942) had suggested that disposal of nitrogenous waste products by chelonian eggs probably are uricotelic as seen in cleidoic eggs. But the data on nitrogen excretion in the developing eggs of turtles presented by Needham (1931) himself and the recent study by Packard and Packard in *T. spiniferus* egg (Table 5) clearly indicates that nitrogen excretion in turtle egg is predominantly ureotelic. This points to the non-cleidoic nature of the turtle egg. However, Packard and Packard (1983) have indicated that the egg of the spiny softshell turtle *T. spiniferus* is 'fully cleidoic'. Since the nitrogen excretion in this egg is predominantly ureotelic, they have opined that 'our results raise the possibility that uricotelic is not a necessary outcome of natural selection for mechanism to conserve water during embryonic development and indicate a need to reassess the adaptive significance of ureotelic among embryos of other terrestrial vertebrates.'

The type of nitrogen excretion in the egg of turtles (ureotelic) is the same as obtains in the adult. Similarly, the adults laying cleidoic eggs exhibit the uricotelic metabolism. Form of nitrogen excreted by an animal depended primarily on the conditions under which its embryo had to live (Needham 1942). Hence study of nitrogen excretion in the adults will give an indication of what happens to the nitrogenous wastes in the developing embryos.

According to Moyle (1949) the turtles which are almost wholly aquatic, semi aquatic or live in damp places frequently entering water are predominantly ureotelic, while the tortoises living in very dry, almost desert conditions are uricotelic (Table 6). This is reflected in the mechanism of excretion in turtle eggs also.

In the light of these facts we feel that the condition obtaining in the spiny softshell turtle *T. spiniferus*, discussed by Packard and Packard (1983) should be viewed taking into consideration the following points :

1. The *T. spiniferus* egg is not 'fully cleidoic' and allows absorption of water linked with transpiration of water vapour from the egg. The eggs do not swell due to the hard shell.
2. The nesting takes place soon after rains (Plummer, 1976) indicating a behavioural pre-adaptation or 'aquatic affinity'. Does the timing of the nesting soon after rain indicate a behavioural instinct for ensuring availability of water for absorption for the developing eggs?

TABLE 5. Pattern of nitrogen excretion in turtle eggs

Species	Aquatic or terrestrial egg	N <sub>2</sub> partition in % total N <sub>2</sub> excreted					Reference
		Ammonia	Urea	Uric acid	Amino acids, creatine & creatinine	Purines other than uric acid	
<i>Turtle</i>							
<i>Chrysemes pinta</i>	.. A?	15.3	39.0	18.8	11.5 and 18.6 (undetermined)		Needham, 1931 (Table 163)
<i>Chelonia mydas</i>	.. A?	16.1	45.1	19.1	—	—	
<i>Trionix spiniferus</i>	.. A?	24.0	70.0	6.0	—	—	Packard & Packard, 1983
<i>Tortoise</i>							
<i>Testudo graeca</i>	.. A?	—	90.0	trace	—	—	Needham, 1931 (Table 164)

TABLE 6. Partition of nitrogen in the urine of turtles (in per cent of total nitrogen excretion). The most aquatic species excrete almost no uric acid, where as this compound dominates in the most terrestrial species (Moyle, 1949)

Species	Habitat	Urine component *				
		Uric acid	Ammonia	Urea	Amino acids	Unaccounted for
<i>Kinostemon subrubrum</i>	Almost wholly aquatic	0.7	24.0	22.9	10.0	40.3
<i>Pelusios derbianus</i>	Almost wholly aquatic	4.5	18.5	24.4	20.6	27.2
<i>Emys orbicularis</i>	Semiaquatic; feeds on land in marshes	2.5	14.4	47.1	19.7	14.8
<i>Kinixys erosa</i>	Damp places; frequently enters water	4.2	6.1	61.0	13.7	15.2
<i>K. youngii</i>	Drier than above	5.5	6.0	44.0	15.2	26.4
<i>Testudo denticulata</i>	Damp, swampy ground	6.7	6.0	29.1	15.6	32.1
<i>T. graeca</i>	Very dry, almost desert conditions	51.9	4.1	22.3	6.6	4.0
<i>T. elegans</i>	Very dry, almost desert conditions	56.1	6.2	8.5	13.1	12.0

\* There were small amounts of allantoin, guanine, xanthine and creatinine and variable amount not accounted for.

3. The habitat of the adult is aquatic and the method of excretion in the adult must be ureotelic which is also reflected in the developing eggs.
4. Data on utilization of protein during development is not available for this species; but in the two marine turtles that have so far been analysed, namely *T. corticata* (Japanese workers, 1929) and *L. olivacea* (Silas *et al.*, 1984) a good amount of protein is utilized during growth of the embryo which is quite evidently not a cleidoic property.
5. Unless subjected to very extreme condition of desiccation the eggs will not resort to uricotelic since the energy requirement for this is extremely high (Needham, 1931). We do not feel that with water available in the surroundings and absorption of water possible through the shell, the *T. spiniferus* egg would have been subjected to extreme water scarcity.

It is our feeling, that the egg of the spiny softshelled turtle *T. spiniferus*, even though possessing a hard shell, should, in view of the points raised above, be classified as non-cleidoic and this will account for the ureotelic nitrogen excretion.

#### CONCLUSION

The most fundamental need of the non-cleidoic egg is for water (Needham, 1942). We have seen that all

turtle eggs, flexible shelled or rigid shelled, studied so far do take in water during incubation, which clearly defines the turtle egg as non-cleidoic. The metabolic properties exhibited by eggs of turtles that have been studied so far—*T. corticata*, *L. olivacea* and *T. spiniferus* (nitrogen excretion only)—are truly non-cleidoic. Since the nitrogen excretion in adult turtles that have some association with water are predominantly ureotelic, the eggs of these also may exhibit the pattern of ureotelic excretion, which is a non-cleidoic property. Based on all these informations we would classify the turtle eggs—marine or fresh water—as non-cleidoic. There is no data, except for nitrogen excretion in the adults which is predominantly ureotelic, on the uptake of water of metabolic properties of egg in the tortoise that live in very dry, almost desert conditions, to classify them as cleidoic or non-cleidoic. But if the ureotelic nitrogen excretion of the adult is an indication the tortoise that experience extreme water scarcity may be laying cleidoic eggs.

We would strongly urge that studies on the eggs of other species of turtles and tortoises be undertaken to elucidate water uptake, protein and lipid metabolism and nitrogen excretion. There is a need for understanding variabilities in these parameters for eggs of different species of turtles and tortoises to ascertain whether eggs of all species could be clearly denoted as cleidoic or non-cleidoic or as 'intergrades'.

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## FOOD INTAKE AND CONVERSION IN HATCHLINGS OF OLIVE RIDLEY *LEPIDOCHELYS OLIVACEA* FED ANIMAL AND PLANT FOOD

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### ABSTRACT

Effect of starvation, onset of feeding after emergence, food preference, food intake, absorption and conversion have been studied in hatchlings of olive ridley, *Leptochelys olivacea*, fed clam meat (*Meretrix casta*), sea grass (*Hallophylla* sp.) and a combination of both, reared individually and in groups. The hatchlings started feeding only on the 6th day after emergence even though they had free access to both animal and plant food. Absorption efficiency in terms of calories and protein was higher than that for dry matter in both animal and plant fed hatchlings. Conversion efficiency ( $K_1$ ) was maximum in *ad libitum* clam fed hatchlings viz.,  $23.15 \pm 2.54\%$  (dry matter);  $25.13 \pm 0.24\%$  (calories) and  $26.38 \pm 1.52\%$  (protein). The hatchlings converted calories and protein more efficiently than dry matter of food. Metabolic rate of the hatchlings was also calculated using food intake-conversion values. Survival rates of hatchlings starved from the time of emergence were also estimated. The study indicated that olive ridley hatchlings are obligatory carnivores and may not have the 'digestive climate' to utilize plant food exclusively. Size hierarchy effects observed in the course of group rearing has also been discussed in detail.

### INTRODUCTION

Information on food intake and conversion efficiency in hatchlings of sea turtles is extremely scarce (McVey, 1972). In the recovery programme for olive ridley currently being undertaken by the Central Marine Fisheries Research Institute at Kovalam, Madras, a study on this aspect was taken up. The objective of the study was to find out the onset of feeding after emergence, food preference of hatchlings when they start feeding and food conversion efficiency. Needless to say, studies of this nature may have some inherent drawbacks such as (a) that the hatchling is not in its natural environment where, in the course of its vigorous swimming movements, it could seek its food or encounter it at the right time to sustain life, (b) the quality of food given is an experimental feed and not an item of its natural food, (c) stress due to impairment of metabolic activity and other functions while in captivity and (d) group or individual rearing being atypical as compared to hatchlings feeding in nature.

Nevertheless, in benign research, it is essential to find out the general food preference of the hatchlings when they first start feeding; whether the intake pre-

ference is of plant or animal origin; and whether they are able to survive and show good growth on selected feeds. The young olive ridley is reported to be carnivorous while the adults are predominantly herbivorous, consuming algae and animals such as crustaceans, bivalves, echinoderms and coelenterates (Deraniyagala, 1939, Carr 1952). The present work was undertaken to study the pattern of energy utilization in hatchlings of olive ridley.

In addition, food intake-conversion estimates are considered better parameters for assessing metabolic rates (Kinne, 1960). According to Pandian and Vivekanandan (1976) this kind of assessment provide (1) less restricted maintenance condition during feeding experiments; (2) the possibility of repeatedly observing one and the same individual over a period of time; (3) the possibilities of measuring the effect of quantitative feeding on metabolism (Paloheimo and Dickie, 1966 a, b); and (4) the possibility of measuring total metabolism including the energy expended on part or total anaerobiosis (Blazka 1958, Kutty 1968, 1972). The metabolic rate of *L. olivacea* hatchlings has also been estimated here using food conversion values.

Our findings also throw light on the establishment of size hierarchy in cases where rearing in groups was undertaken.

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#### MATERIAL AND METHODS

For individual rearing, the hatchlings of *L. olivacea* were collected from a single clutch transferred to the turtle hatchery of the Central Marine Fisheries Research Institute at Kovalam, Madras.

Initial trials were carried out to find out the time of onset of feeding after the hatchlings emerge from the nest. The hatchlings, with a fair amount of unutilized yolk as energy reserve, did not consume any food, animal or plant matter, until the 6th day after emergence. Hence the feeding experiments were started on the 6th day after emergence.

Thirty healthy individuals were selected, 24 of which were equally divided into 4 groups and reared individually in separate plastic troughs of 10 litre capacity and the rest taken for initial chemical analysis. The first group was starved while the II, III and IV groups were fed respectively on meat of clam (*Meretrix casta*), sea grass (*Halophilla* sp.) and a combination of both these. Thus six replicates were run for each of the four groups. Groups II to IV were fed *ad libitum* on their respective diets. In the IV group it was observed that the hatchlings consumed maximum quantity of clam meat and almost ignored the sea grass. Hence after the 15th day of the commencement of feeding, clam meat was restricted to approximately 5% of live body weight of the hatchlings in this group and sea grass was given *ad libitum*.

The turtles were fed once a day at 1000 hrs and feed remains and faeces were removed by siphoning and pipetting at 1600 hrs. After removing leftovers and excreta, water was changed completely with filtered sea water. For starved groups also water was changed simultaneously. Faeces were removed again on subsequent day morning before feeding, and were collected in No. 21 bolting silk, washed with minimum quantity of distilled water and then transferred to

petridish. The loss of some constituents due to leaching cannot be ruled out. Faeces for the whole experiment was collected in the same petri dish which was stored in an electric oven at 60°C. Feed remains were also dried in an oven at 60°C for 24 hrs and the weight was subtracted from the total amount offered. To find out slight decrease in weight in clam meat and sea grass during feeding period weighed samples were placed in an aquarium and collected after 6 hrs and dried for 24 hrs at 60°C. Based on this, appropriate corrections were applied to the quantity of food consumed by the animal. Sea grass was washed thoroughly before feeding to remove associated animal matter, if any, attached to it. Clam meat was chopped and fed while sea grass was given in small tufts.

Salinity of sea water varied between 32-35‰ and the water temperature was  $27.8 \pm 1.7^\circ\text{C}$  throughout the experimental period which lasted 61 days for individual rearing and to 63 days for group rearing.

Chemical analyses were performed on material dried to constant weight at 60°C. The entire dry material was minced and ground to fine powder and dried again for an hour before packing in airtight bottles. It was then stored in desiccator. Aliquots were taken from such samples to determine caloric value and protein.

Caloric content was determined by Parr Oxygen bomb calorimeter (Parr Instrument company, Technical manual, 120) and protein by modified Biuret method (see Sumitra Vijayaraghavan and Vijayakumaran, 1976). Since consumption of food (C), production (P) and faeces (F) are measured it is possible to estimate the rate at which the turtle metabolised and released energy or respiratory metabolism (M) i.e.,  $M = C - (P + F)$  (see Petruszewicz and MacFadyen 1970). Metabolism is expressed in terms of oxygen uptake (ml  $\text{O}_2$ /g/live weight/hr), considering the expense of 4.8 cal as equivalent to 1 ml of  $\text{O}_2$  uptake (Engelmann 1966). For want of data on quantities of ammonia, urea and other soluble excreta produced, for calculation of metabolic rate, a 10% reduction was made in the absorbed food as the correction factor for finfish (Solomon and Brafield 1972, Pandian and Vivekanandan 1976) and this is taken as a measure since there is no data on sea turtles.

Experimental design adopted was the 'Sacrifice method' of Maynard and Loosli (1962). Absorption efficiency was estimated by relating the quantity of food absorbed (food consumed—faeces) to the quantity of food consumed. Conversion efficiencies  $K_1$  and  $K_2$  were estimated relating the growth of the animal to the quantity of food consumed and absorbed, respectively Pandian 1967).

Another experiment was conducted simultaneously to study the effect of quantity and quality of food, clam meat and sea grass, on group rearing of turtle hatchlings. Three batches of twenty numbers each of 6 days old hatchlings were reared in three 4' dia. polythene liner tanks containing 400 litres of sea water. Hatchlings in each tank were from different clutches. The clam meat was given in plastic trays just below the surface and the sea grass was tied in tufts and floated on the surface. One group was fed *ad libitum* with clam meat once daily in the morning. To the second group a restricted ration of 5.26% body weight clam meat was fed and to the third group 3.4% body weight clam meat plus *ad libitum* sea grass was given. Feed remains were removed in the evening and the entire water was changed thereafter.

### RESULTS

Hatchlings survived on yolk material for the first 5 days and did not accept the food offered. During this period the live weight increased from  $17.45 \pm 1.53$  g on the day of emergence to  $18.13 \pm 1.65$  g. on 6th day. The water, protein and caloric content did not vary significantly during the 5 days of non-feeding (Table 1).

The turtles consumed  $16.39 \pm 1.64$  mg/g live wt/day of dry food when fed *ad libitum* on clam but only  $1.37 \pm 0.21$  mg/g live wt/day when sea grass was given *ad libitum*. On mixed food the feeding rate was  $14.43 \pm 0.75$  mg/g live wt/day of which only  $0.2 \pm 0.1$  mg was contributed by sea grass (Table 2). Absorption efficiency of dry matter of food ranged from  $87.85 \pm 8.04\%$  for plant food to  $99.56 \pm 0.23\%$  for clam fed *ad libitum*. Conversion rate was maximum being  $3.75 \pm 0.30$  mg/g live wt/day on clam fed *ad libitum*. The mixed food gave a conversion rate of  $2.88 \pm 0.28$  mg/g live wt/day. Interestingly the loss of weight in sea grass fed turtle ( $-3.03 \pm 0.64$  mg) was more than that in the starved ones ( $-2.74 \pm 0.40$  mg/g live wt/day) and a possible explanation is given elsewhere in this account.

When calculated in terms of calories and proteins, rates of feeding, absorption and conversion and efficiencies of absorption and conversion followed a similar pattern (Tables 3 and 4) as was observed in the case calculation on dry weight basis. Absorption efficiency (%) did not vary much among the groups when calculated in terms of calories or protein but the efficiency of dry matter absorption was significantly low in the group fed with sea grass ( $87.85\%$ ;  $t = 3.226$ ;

TABLE 1. Body weight, composition of water, protein and energy in the newly emerged and 6th day hatchlings of *L. olivacea*; each value represents average of 4 (for chemical analysis) and 25 (for initial body weight) individuals;  $\pm$  indicates SD

	Live weight (a) (g)	Dry weight (g)	% Water	Protein % in dry weight	Energy K. cal/g dry weight
Newly emerged hatchling	$17.45 \pm 1.53$	$4.40 \pm 0.39$	$74.78 \pm 3.25$	$51.9 \pm 2.41$	$5.86 \pm 0.13$
6th day hatchling	$18.13 \pm 1.65$	$4.52 \pm 0.41$	$75.12 \pm 1.56$	$55.0 \pm 2.04$	$5.73 \pm 0.21$

TABLE 2. Rates and efficiencies of feeding, absorption and conversion (on dry weight basis) in hatchlings of *L. olivacea* offered animal and plant food; each value represents average of 5-6 individuals;  $\pm$  represents SD.

Parameter	Starved hatchling	Clam fed hatchling	Seagrass fed hatchling	Clam + sea grass fed hatchling
Feeding rate (mg/g live body weight/day)	..	$16.39 \pm 1.64$	$1.37 \pm 0.21$	$14.43 \pm 0.75$ Clam: $14.23 \pm 0.73$ Sea grass: $0.2 \pm 0.1$
Absorption rate (mg/g live body weight/day)	..	$16.29 \pm 1.65$	$1.20 \pm 0.18$	$14.34 \pm 0.74$
Absorption efficiency (%)	..	$99.56 \pm 0.23$	$87.85 \pm 8.04$	$99.41 \pm 0.20$
Conversion rate (mg/g live body weight/day)	$-2.74 \pm 0.40$	$3.75 \pm 0.30$	$-3.03 \pm 0.64$	$2.88 \pm 0.28$
Conversion efficiency $K_1$ (%)	..	$22.98 \pm 2.52$	..	$20.71 \pm 1.28$
Conversion efficiency $K_2$ (%)	..	$23.15 \pm 2.54$	..	$20.83 \pm 1.29$
Conversion factor	..	$4.39 \pm 0.43$	..	$4.84 \pm 0.30$

$p < 0.05$ ) compared to the clam fed group. Conversion efficiency ( $K_2$ ) also was significantly more in both clam fed and mixed food fed groups when calculated in terms of calories and protein compared to the same values for dry matter.

Sea grass fed turtles spent 1.7 cal/g live wt/day more than the starved ones for the exercise of feeding and digestion. In terms of  $O_2$  consumption also the sea grass fed group spent more energy (0.176 ml  $O_2$ /g live wt/hr) than the starved ones. The metabolic rates of clam fed and mixed food fed groups were 0.419 and 0.379 ml  $O_2$ /g live wt/hr respectively.

Final body composition of water, protein and calories are given in Table 5. Percentage of water and protein content did not show any difference among the 4 groups. Energy value (K.cal/g dry weight), however, reduced from 5.73 in 6 days old hatchling to 5.08 in *ad libitum* clam fed turtle and to 4.48 in starved turtles. The reduction was maximum in starved turtles.

#### Group rearing

Mean increase in total live weight per individual, conversion rate and conversion efficiency ( $K_1$ ) in terms of dry weight for the groups fed on clam meat and sea grass are given in Table 6. At a feeding rate of 13.67 mg/g live wt/day (which is equivalent to 5.26% live weight)  $K_1$  was maximum (20.56%). This is comparable to the value obtained in the individual rearing (20.71%) on mixed food where feeding rate was 14.34 mg/g live wt/day. In the *ad libitum* clam fed group the feeding rate was considerably higher 20.53 mg/g live wt/day than in individual rearing (16.39 mg) but the conversion efficiency was very much reduced (16.07% compared to 22.98% in the former group). Lowest conversion efficiency (15.10%) in group rearing was recorded in the group fed lowest ration (feeding rate 9.47 mg equivalent to 3.6% live body weight). Survival was 100% on *ad libitum* feeding and 70% and 65% respectively for other groups fed 5.26% live weight per day and 3.6% live weight per day.

One of the most striking observations made on hatchlings reared together under laboratory conditions is the increasing range of size (Table 7 and figure 1) with advancing age. The coefficient of variation (cv) which was 6.32% in the 6 day old hatchling, increased to 32.40%, 34.60% and 19.16% in clam fed *ad libitum*, clam restricted (5.25% of body weight); and clam (3.4% of body weight) and sea grass (*ad libitum*) fed hatchlings respectively after 63 days.

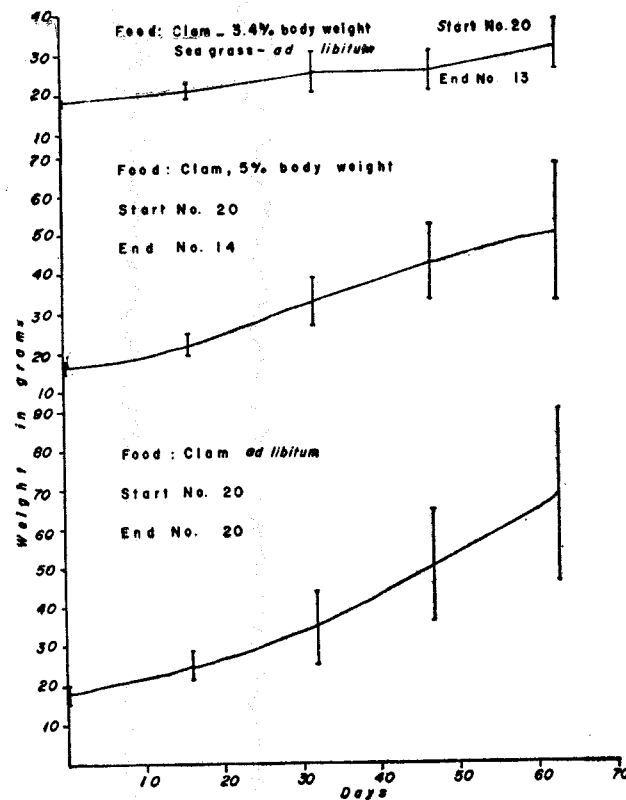


Fig. 1. Increase in weight in hatchlings of olive ridley *L. olivacea* reared in groups of 20 and fed with different quantities of clam meat and sea grass.

#### DISCUSSION

During emergence *L. olivacea* hatchlings retain considerable quantum of yolk energy (16.0% initial yolk wet weight; 25.9% of dry weight and 26.2% in terms of calories) for post emergence utilization. This forms 17.2% of live weight (or 33.9% of dry weight; 34.8% of calories) of emerging turtles (Silas *et al.*, 1984). The initial 5 day non-feeding period may be a crucial stage for adjustment and orientation to the new environment. The first instinct of newly emerged *L. olivacea* is probably to reach the right type of habitat and it does not bother about feeding even if food is available in plenty. This is evident from the present study where hatchlings started feeding only on the 6th day or after even though they had free access to both animal and plant food. During this period the hatchling survives on the yolk reserves and it utilizes about 40% of this reserve by the time it starts feeding (Silas *et al.*, 1984). Even though the young ones are not consuming food up to the 6th day after hatching, live weight increases. The increase in live weight is not entirely due to water absorption alone since there is only modest increase in per cent water content in the animal. The increase in dry

TABLE 3. Rate and efficiencies of feeding, absorption and conversion (on the basis of caloric content) in hatchlings of *L. olivacea* fed animal and plant food; each value represents average of 5-6 individuals;  $\pm$  represents SD.

Parameter	Starved hatchling	Clam fed hatchling	Sea grass fed hatchling	Clam + Sea grass fed hatchling
Feeding rate (cal/g live body weight/day) ..		74.5 $\pm$ 4.4	3.5 $\pm$ 2.1	65.0 $\pm$ 3.3 Clam : 64.6 $\pm$ 3.4 Sea grass : 0.5 $\pm$ 0.3
Absorption rate (cal/g live body weight/day) ..		74.4 $\pm$ 7.4	3.35 $\pm$ 0.2	64.9 $\pm$ 3.3
Absorption efficiency (%) ..		99.88 $\pm$ 0.05	95.84 $\pm$ 2.72	99.90 $\pm$ 0.02
Conversion rate (mg/g live body weight/day) ..	-15.2 $\pm$ 2.2	18.7 $\pm$ 1.8	-17.2 $\pm$ 3.6	14.8 $\pm$ 0.5
Conversion efficiency K <sub>1</sub> (%) ..		25.06 $\pm$ 1.46		22.75 $\pm$ 1.55
Conversion efficiency K <sub>2</sub> (%) ..		25.13 $\pm$ 0.24		22.80 $\pm$ 0.02
Conversion factor ..		4.10 $\pm$ 0.15		4.41 $\pm$ 0.30
Metabolic rate (ml O <sub>2</sub> /g live body weight/hr) ..	0.135	0.419	0.176	0.379

TABLE 4. Rates and efficiencies of feeding, absorption and conversion in terms of protein in hatchlings of *L. olivacea* fed animal and plant food, each value represents average of 5-6 individuals;  $\pm$  represents SD

Parameter	Starved hatchling	Clam fed hatchling	Sea grass fed hatchling	Clam + Sea grass fed hatchling
Feeding rate (mg/g live body weight/day) ..		8.87 $\pm$ 0.88	0.29 $\pm$ 0.17	7.73 $\pm$ 0.39 Clam : 7.69 $\pm$ 0.39 Sea grass : 0.04 $\pm$ 0.02
Absorption rate (mg/g live body weight/day) ..		8.86 $\pm$ 0.88	0.28 $\pm$ 0.16	7.68 $\pm$ 0.38
Absorption efficiency (%) ..		99.95 $\pm$ 0.02	96.78 $\pm$ 2.13	99.3 $\pm$ 0.51
Conversion rate (mg/g live body weight/day) ..	-1.5 $\pm$ 0.22	2.33 $\pm$ 0.16	-1.67 $\pm$ 0.35	1.94 $\pm$ 0.07
Conversion efficiency K <sub>1</sub> (%) ..		26.37 $\pm$ 1.52		25.11 $\pm$ 1.57
Conversion efficiency K <sub>2</sub> (%) ..		26.38 $\pm$ 1.52		25.26 $\pm$ 0.38
Conversion factor ..		3.80 $\pm$ 0.21		3.99 $\pm$ 0.25

TABLE 5. Initial and final weights and body composition values of hatchlings of *L. olivacea* starved and fed on animal and plant food, for 61 days; each value represents average of 4-6 individuals;  $\pm$  represents SD

	Initial	Starved hatchling	Clam fed hatchling	Sea grass fed hatchling	Clam + Sea grass fed hatchling
Initial weight (g) ..		17.79 $\pm$ 1.34	18.96 $\pm$ 1.65	18.44 $\pm$ 1.71	16.76 $\pm$ 1.17
Final weight (g) ..		15.78 $\pm$ 1.34	123.04 $\pm$ 19.15	15.60 $\pm$ 2.42	80.66 $\pm$ 3.49
Water (%) ..	75.12 $\pm$ 1.56	82.83 $\pm$ 1.76	82.62 $\pm$ 0.66	82.82 $\pm$ 1.12	83.2 $\pm$ 1.05
Protein (%) ..	55.0 $\pm$ 2.04	64.90 $\pm$ 5.96	63.90 $\pm$ 5.49	65.25 $\pm$ 3.5	65.00 $\pm$ 4.05
Energy (K. cal/g) ..	5.73 $\pm$ 0.21	4.48 $\pm$ 0.15	5.08 $\pm$ 0.15	4.66 $\pm$ 0.1	4.96 $\pm$ 0.09

TABLE 6. Feeding and conversion rates and conversion efficiencies ( $K_1$ ) of hatchling of *L. olivacea* reared in groups of 20 individuals on different quantities of animal and plant food

Treatment	Initial weight (g)	Final weight (g)	Increase in weight (g)	Food consumed mg/g live body wt/day	Conversion rate mg/g live body wt/day	$K_1$	% survival
CLAM ( <i>ad libitum</i> ) CV (%)	17.02 ± 1.82 10.26	67.83 ± 21.88 32.40	50.81	20.53	3.30	16.07	100
CLAM (Restricted ration) CV (%)	16.56 ± 0.89 5.37	50.37 ± 17.43 34.60	33.81	13.67	2.81	20.56	70
CLAM (Restricted) + (seagrass <i>ad libitum</i> ) CV (%)	18.36 ± 6.10 3.32	31.58 ± 6.05 19.16	13.22	9.47	1.43	15.10	65

CV - Coefficient of variation.

TABLE 7. Mean increase in live weight and percentage of survival in hatchling of *L. olivacea*, reared in groups of 20 on different quantities of animal and plant food

Food	Initial weight (g)	16th day weight (g)	32nd day weight (g)	47th day weight (g)	63rd day weight (g)	No of turtles (initial)	No. of turtles (final)	% survival
CLAM ( <i>ad libitum</i> ) CV (%)	17.02 ± 1.82 10.26	24.72 ± 3.64 14.72	34.35 ± 9.05 26.35	49.79 ± 14.09 28.30	67.83 ± 21.88 32.40	20	20	100
CLAM (Restricted) CV (%)	16.56 ± 0.89 5.37	21.74 ± 2.67 12.28	32.89 ± 5.94 18.06	43.05 ± 6.69 22.51	50.37 ± 17.43 34.60	20	14	70
CLAM (Restricted) + SEAGRASS ( <i>ad libitum</i> ) CV (%)	18.36 ± 0.61 3.32	20.79 ± 1.99 9.57	25.34 ± 4.81 18.98	25.60 ± 4.81 18.79	31.58 ± 6.05 19.16	20	13	65

CV - Coefficient of variation.

weight may be due to the absorption of minerals from the medium. Increase in protein content from 5.91% to 55.0% and the reduction in caloric value 5.86 K cal/g dry weight to 5.73 is explained by the loss of yolk which contains about 33% lipid (Silas *et al.*, 1984).

As the turtle commences feeding it predominantly consumes carnivorous food and later switches over to predominantly herbivorous diets (Mahmoud and Klicka 1979). Carr (1967) reported that young green turtle must be pelagic relying on floating or close to surface food including small vertebrates. When the turtle reaches 4.5 kg they begin making transition to grazing. These observations lead one to believe that the food preference of the young turtle is influenced greatly by the availability of food in the habitat and that the turtles develop structural adaptations to feed particular type of food after certain age. The present study

reveals that given an option of plant and animal food the young *L. olivacea* opted for the animal food. The young turtles may be obligatory carnivores and may not have the mechanism to utilize plant food. It will be a worthwhile study to find out at what stage of growth cellulose digestion is possible. Menzel (1959) and Mathavan *et al* (1976) have reported that certain herbivorous/omnivorous fishes do not possess the 'digestive climate' necessary for the 'true growth' (Gerking 1952), when they are exclusively fed on plant material and a complement of animal food is necessary for 'true growth'. The young turtles also may not have the 'climate' to digest the plant material, which is evident from the low absorption efficiency exhibited by the animal when fed exclusively on sea grass. However, a detailed study on secretion of digestive enzymes and presence of microflora in the gut of young and adult turtles is necessary.

It is interesting to note that the metabolic rate of young turtle fed on plant material was high compared to those starved, the reason being the plant fed group expended 1.7 cal/g live wt/day in the process of feeding and digestion of the plant material.

Conversion efficiency ( $K_2$ ) increased with increase in consumption. The efficiency was maximum when clam meat was given *ad libitum*. Conversion efficiencies recorded for mixed food is essentially that of clam since the amount of sea grass ingested was negligible. *L. olivacea* hatchlings could convert calories and protein more efficiently than dry matter in both mixed food and *ad libitum* clam feed. Maximum utilization, however, was that of protein.

The starved hatchlings could survive upto  $36.83 \pm 3.54$  days while those fed only sea grass survived for  $39.60 \pm 1.0$  days.

In the light of the present study it may be interesting to see whether the conversion efficiency in individual versus those showing accelerated growth in groups could be compared for understanding social behaviour. The establishment of size hierarchy effects in group rearing may be due to direct competition for food or by social interaction as observed by Jobling (1982) in fish and reviewed by Marion Harles (1979) in turtles. In the case of hatchlings of *L. olivacea*, size hierarchies have developed even in the presence of excess food. Group rearing therefore poses many problems as observed in this study. Briefly enumerated they are :

1. Any rationing of food for minimum maintenance requirements may lead to infighting and cannibalism or severe injuries leading to ulceration and infection.
2. In group rearing intensive competition for getting at the food and aggressive behaviour of biting by those which are not able to reach

the food may result in injuries even when food is given in excess. But we have not observed cannibalism in such cases.

3. We do not know whether the presence of larger individuals in the groups could inhibit the food consumption in some resulting in their slow growth.

Research of this nature give us an indicative idea of the food preference and utilization in hatchlings once they start feeding activity on their own, despite being also sustained on part of the reserve yolk. This information is useful since, in nature, we have a large gap in our knowledge as to what is happening to the hatchlings once they enter the sea. The olive ridley hatchlings seem to evince a distinct preference for food of animal origin. Such information becomes useful if at a later stage we are to think of turtle mariculture.

We note that the hatchlings can survive on starvation for periods upto or beyond 30 days. In the natural environment it is unlikely that the animal would survive that long. However, the capacity for prolonged starvation could be a built in mechanism for reaching the growout and feeding grounds.

Aggregation in some of the sea turtle is characteristically seen at the time of emergence of hatchlings, and at the time of mating and nesting. Little is known about group behaviour in feeding grounds. Group rearing of olive ridley has clearly shown size hierarchy occurring. This is again indicative that such attempts should be made with optimum numbers in given volume of water or area to minimise or prevent hierarchy. This is a point which may have to be noted in turtle mariculture.

We would urge more research on hatchlings, particularly the first few months of their life in the sea. The transition from carnivorous to omnivorous/herbivorous diet also needs further study.

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## STUDIES ON THE GROWTH OF OLIVE RIDLEY *LEPIDOCHELYS OLIVACEA* IN CAPTIVITY

M. RAJAGOPALAN

### ABSTRACT

The growth of olive ridley *Lepidochelys olivacea* in captivity has been studied from emergence to 47 months. The carapace length increased from 37 mm at the time of emergence to 528 mm in 47 month old turtle and the weight increased from 16.3 gm to 19.5 kg. The growth recorded here is higher than those reported by previous authors. Sex could not be differentiated externally even in 47 month old olive ridley.

### INTRODUCTION

The growth of olive ridley *Lepidochelys olivacea* in captivity has been reported by Deraniyagala (1939) from emergence to a period of six months and by Whitaker (1979) for 22 months. The present paper embodies growth data of olive ridley reared in captivity, in two groups, for 32 and 44 months from emergence.

I am thankful to Dr. E. G. Silas, Director, Central Marine Fisheries Research Institute, Cochin for his constant encouragement and help during the course of this study. My thanks are due to Sri R. Thiagarajan, Dr. E. Vivekanandan and Sri M. Vijayakumaran, Scientists of CMFRI for their help in preparation of the manuscript. I wish to express my sincere thanks to the Chief Wildlife Warden, Forest Department,

Government of Tamil Nadu for permission given to the Institute to collect olive ridley eggs for studies relating to recovery programme of the species.

### MATERIAL AND METHODS

Hatchlings of *L. olivacea* belonging to 1980 and 1981 seasons were reared in the Kovalam Field Laboratory of Central Marine Fisheries Research Institute, Madras, and in two pens (area : 7.5 × 2.5 m ; depth of water : 0.7 to 2.5 m) at the Mariculture Farm of Central Marine Fisheries Research Institute, Muttukadu, Madras. The number of individuals, conditions in which they were reared, food offered and other environmental parameters during the growth period are presented in Table 1. While in the laboratory the animals were

TABLE 1. Rearing condition, food offered and environmental parameters during growth period of olive ridley *Lepidochelys olivacea*

Group	Number of individuals	Rearing condition	Food offered	Total growth observation	Temperature (°C)	Salinity (‰)
1980	15	a. Group rearing from emergence to 15 months in polythene liner tank at Kovalam Field Laboratory	clam & fish		25.7-28.3	21.6-37.2
		b. Individual rearing during subsequent 12 months in plastic containers at Kovalam Field Laboratory	fish	44 months	25.9-29.5	27.7-34.8
		c. Group rearing thereafter for 17 months in pen at Mariculture Farm, Muttukadu	fish		27.6-32.3	21.2-47.9
1981	19	a. Individual rearing from emergence to 14 months in clam & plastic containers at Kovalam Field Laboratory	fish	32 months	25.9-30.0	27.7-35.6
		b. Group rearing thereafter for 18 months in pen at Mariculture Farm, Muttukadu.	fish		27.6-32.3	21.2-47.9

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reared in plastic containers as well as in 4' diameter polythene liner tank. Food was offered for about 12 hours daily and sea water was changed completely after removing the feed remains. Water was changed again before the next feeding. Growth characters such as carapace length, carapace width, plastron length and plastron width (all curved measurements) and total weight of the animal were recorded at periodic intervals.

## RESULTS

### (a) Relationship among growth characters:

The relationships between carapace length and width, carapace length and plastron length, carapace length and plastron width and carapace length and total weight of turtles of 1981 season reared in captivity are plotted in Figs. 1 to 4. A simple regression  $Y = a + bX$  has been fitted to understand the relationship between variables. The  $a$ ,  $b$  and  $r$  values of the different relationships are presented in Table 2. All these characters exhibited a linear relationship.

TABLE 2. Values of  $a$ ,  $b$  and  $r$  for different growth characters of *Lepidochelys olivacea* ( $N = 19$  individuals)

Characters	$a$	$b$	$r$
1. Carapace length & Carapace width	-15.9856	1.0216	0.998
2. Carapace length & Plastron length	2.9151	0.8567	0.999
3. Carapace length & Plastron width	-27.9218	0.8557	0.984
4. Carapace length (log) & Total Weight (log)	- 3.1552	2.7875	0.999

### (b) (i) Growth studies in 1981 group :

The increase in growth in carapace length and width, plastron length and width of 1981 group (reared for 32 months) are plotted in Figs. 5 and 6. The  $a$ ,  $b$  and  $r$  values for the relationship between the growth characters and the age are presented in Table 3.

TABLE 3. Values of  $a$ ,  $b$  and  $r$  for different growth characters against age of *Lepidochelys olivacea* ( $N = 19$  individuals)

Characters	$a$	$b$	$r$
Age & Carapace length	22.6195	0.4414	0.992
Age & Carapace width	6.6509	0.4521	0.993
Age & Plastron length	21.8967	0.3792	0.994
Age & Plastron width	- 7.8813	0.3759	0.972

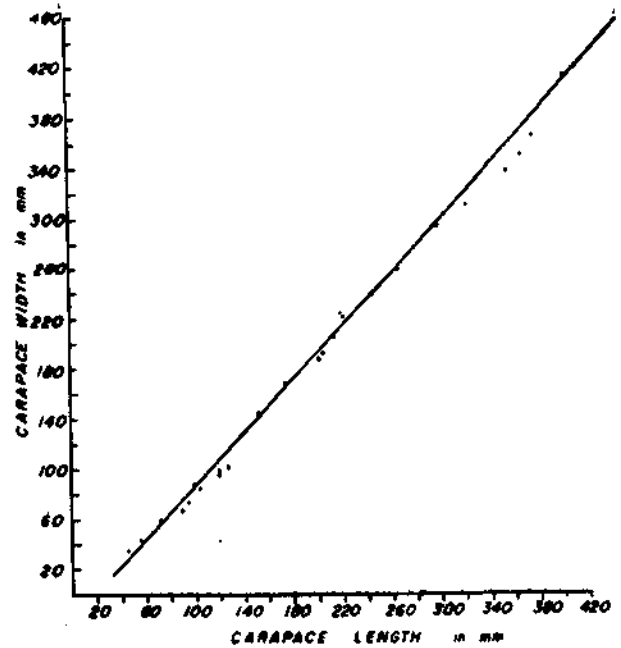


Fig. 1. Relationship between carapace length and carapace width of olive ridley *Lepidochelys olivacea*. The values are mean of 19 individuals.

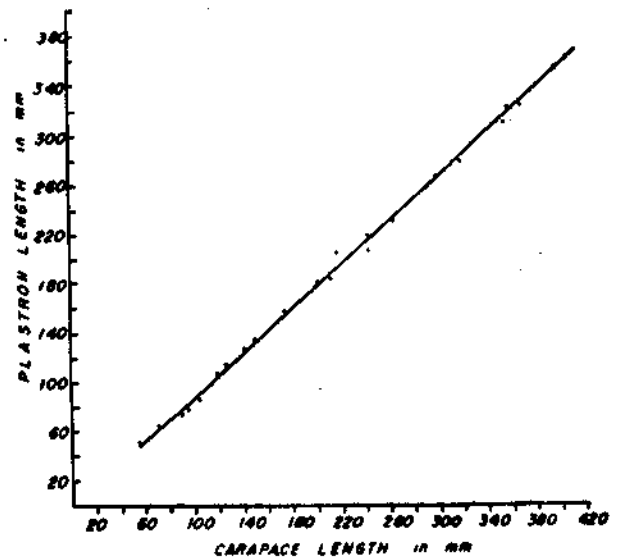


Fig. 2. Relationship between carapace length and plastron length of olive ridley *Lepidochelys olivacea*. The values are mean of 19 individuals.

The mean carapace length of newly emerged hatchlings of olive ridley was 37.8 mm. At the end of 12 months the carapace length increased to 192 mm and further increased to 342 mm at the end of 24 months and reached 420 mm in 32 months; the corresponding values for carapace width were 28.2, 174, 333 and 414 mm respectively. The plastron length increased from 31.8 mm in hatchlings to 171, 318 and 396 mm and

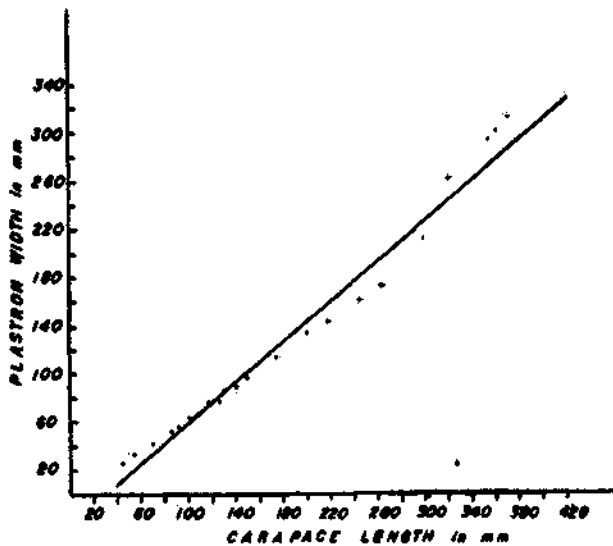


Fig 3. Relationship between carapace length and plastron width of olive ridley *Lepidochelys olivacea*. The values are mean of 19 individuals.

the plastron width from 25.6 mm to 129, 264 and 333 mm in 12, 24 and 32 month old animals respectively.

The weight increment with advancing age of the olive ridley is plotted in a semi-logarithmic graph in Fig. 7. The mean live body weight of freshly emerged hatchling was 16.3 gm. The body weight increased to 1,125, 9,925 and 14,500 gm at the end of 12, 24 and 32 months respectively.

(ii) *Growth studies in 1980 group :*

The 1980 group of hatchlings (mean weight : 17.5 gm) weighed 460, 4,375, 13,400 and 19,000 gm at the end of 12, 24, 36 and 44 months respectively (Fig. 7). The carapace length (mean values) increased from 37.8 to 497 mm in 44 months.

**DISCUSSION**

The growth increment observed in two batches in the present study is variable, compared to the previous observations on growth of *L. olivacea*. Deraniyagala (1939) gave the linear measurements of carapace length for one animal at about 6 months as 74 mm and its weight as 76 gm. Whitaker (1979) recorded the carapace length at 6 months growth as varying from 83 to 95 mm with the mean at 89 mm and the weight varying from 100 to 175 gm. For a similar period of six months in the present study the carapace length (curved measurements) varied from 102.4 to 119.2 mm and the mean weight was 280 gm (1981 group). Similarly the 22 month old olive ridley in the present study registered a growth (mean weight : 3,300 gm in 1980 group and 7,800 in 1981 group) as compared to 2,100 gm (mean) recorded by Whitaker (1979).

It is apparent from Fig. 7 that after one year the 1981 group olive ridley has exhibited substantial growth (the weight increased from 1,125 gm to 9,100 gm at the end of second year). This may be because the animals were transferred from the plastic containers at Kovalam Field Laboratory to spacious pens in the Mariculture Farm, Muttukadu. A similar spurt in growth was seen in the 1980 group once it was introduced into the pen after 27 months.

The 1981 group grew faster throughout the rearing period than the 1980 group (Fig. 7). The obvious reason is that until transferring into pen the 1981 group was reared individually whereas the 1980 group was reared in one 4' diameter polythene liner tank for the first 15 months (Table 1). Vijayakumaran *et al.* (1984) too observed that group rearing of hatchlings of olive ridley retarded the growth rate considerably. They suggested that group rearing invokes a social hierarchy which is evident in the present study also. The growth among 1981 group turtles when reared individually (mean weight of 220 day old turtles : 460 gm ; range 380-580 gm) did not vary much whereas when group rearing was resorted to, the variation in growth among individuals was enormous (mean weight of 830 day old turtle : 9,500 gm ; range—5,800-13,500 gm).

At the end of 32 and 44 months the 1981 and 1980 groups of olive ridley attained 14.7 kg and 19.0 kg respectively. The olive ridley may continue to grow at this fast rate for a few more months, as evidenced by the measurements and weight taken at the end of 47 months on 22nd Feb. 1984 (Table 4).

TABLE 4. Carapace length, carapace width and total body weight of 47 and 35 month old olive ridley *L. olivacea*

	47 month olive ridley (1980 group) N = 11	35 month olive ridley (1981 group) N = 17
<b>(a) Curved measurements</b>		
Carapace length (mm)	490 - 551 (528)	445 - 510 (467)
Carapace width (mm)	510 - 585 (549)	470 - 520 (498)
Weight (kg)	15.5 - 23.0 (19.5)	13.0 - 19.0 (15.8)
<b>(b) Straight line measurements</b>		
Carapace length (mm)	445 - 535 (484)	410 - 495 (447)
Carapace width (mm)	425 - 501 (468)	375 - 455 (415)

Values in parentheses indicate mean

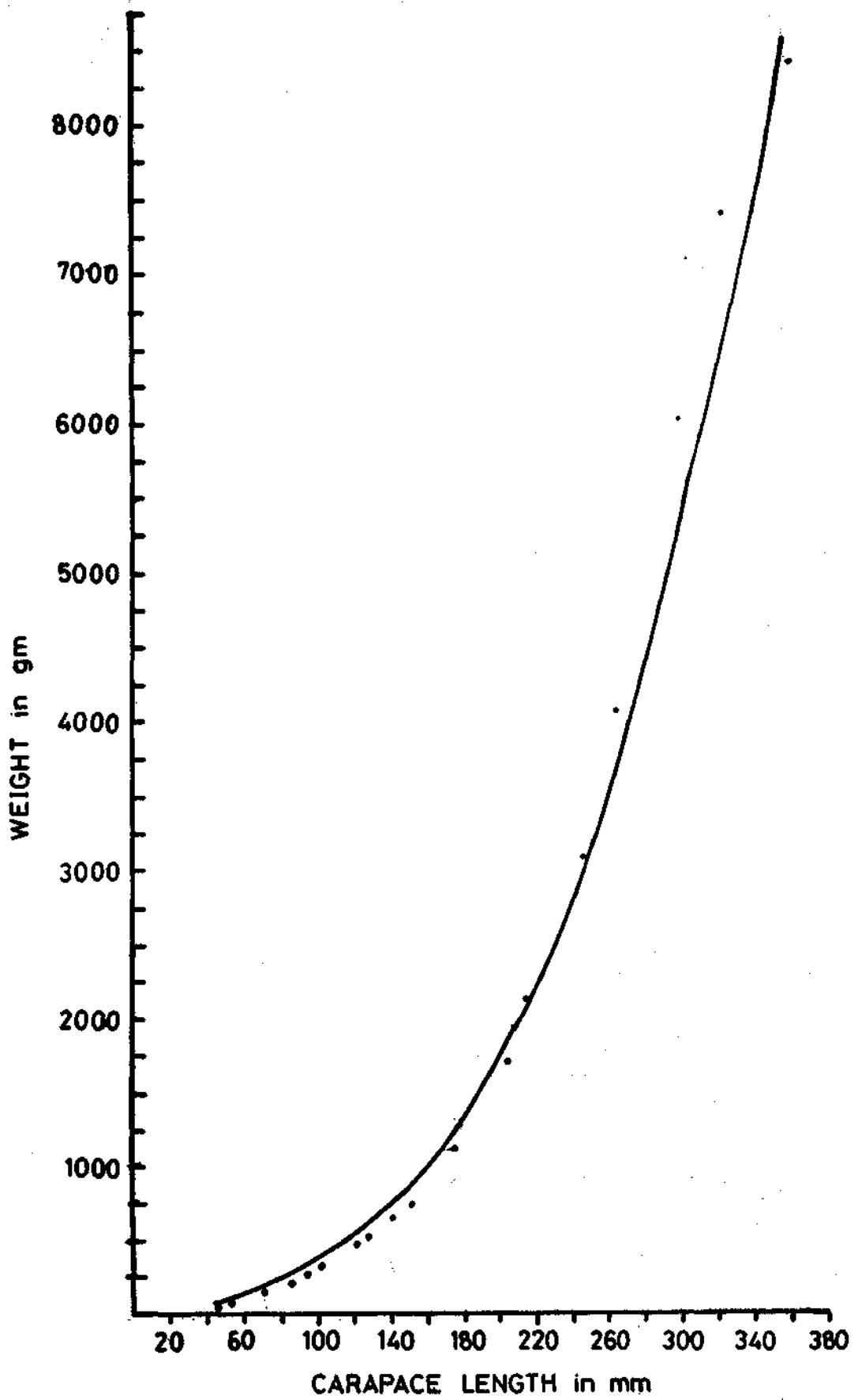


Fig. 4. Relationship between carapace length and total live weight of olive ridley *Lepidochelys olivacea*. The values are mean of 19 individuals.

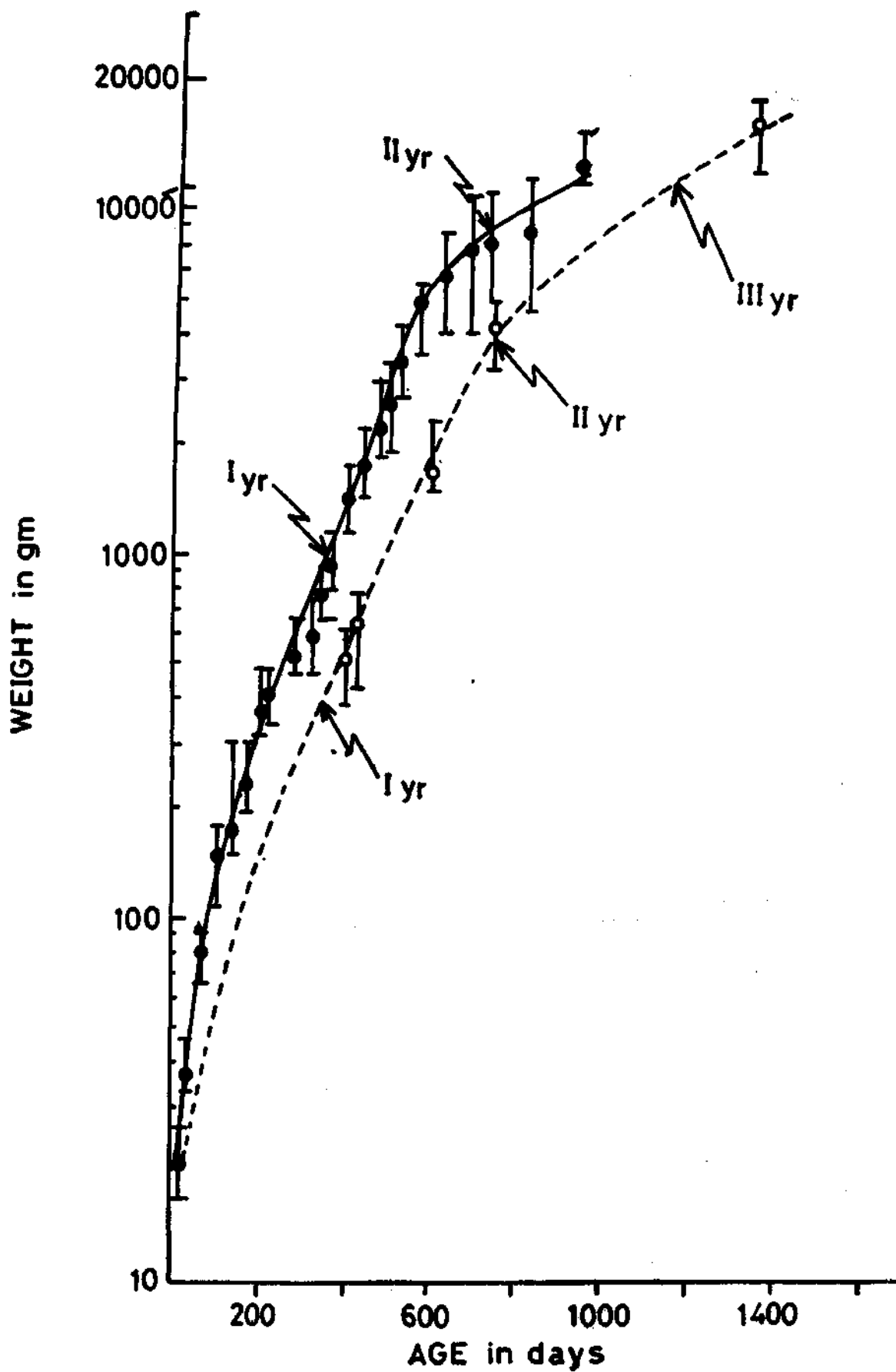


Fig. 7. Increase in live body weight of 1981 (●—●) and 1980 (○—○) groups of olive ridley *Lepidochelys olivacea* with advancing age. The values are mean of 15-19 individuals; the vertical line represents the range.

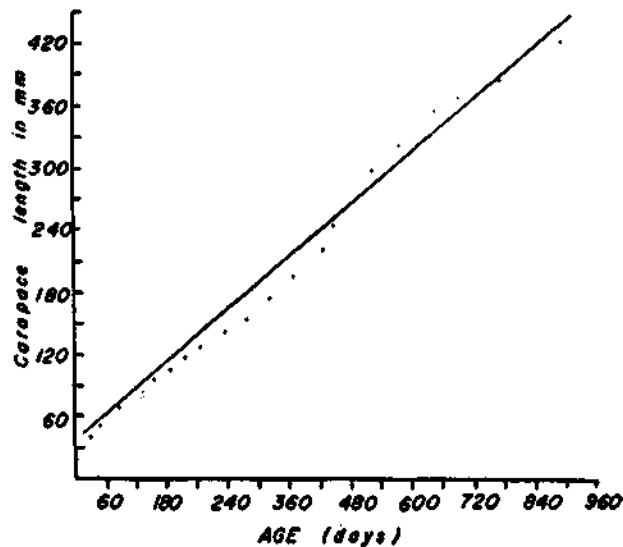
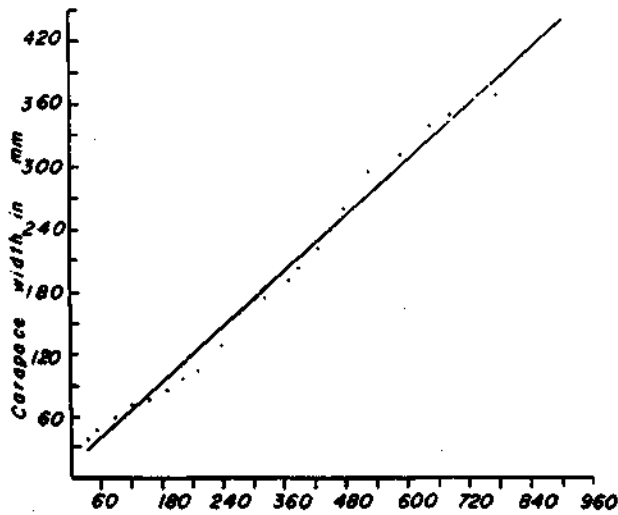


Fig. 5. Increase in carapace length and width of olive ridley *Lepidochelys olivacea* (1981 group) with advancing age. Each value represents the mean of 19 individuals.

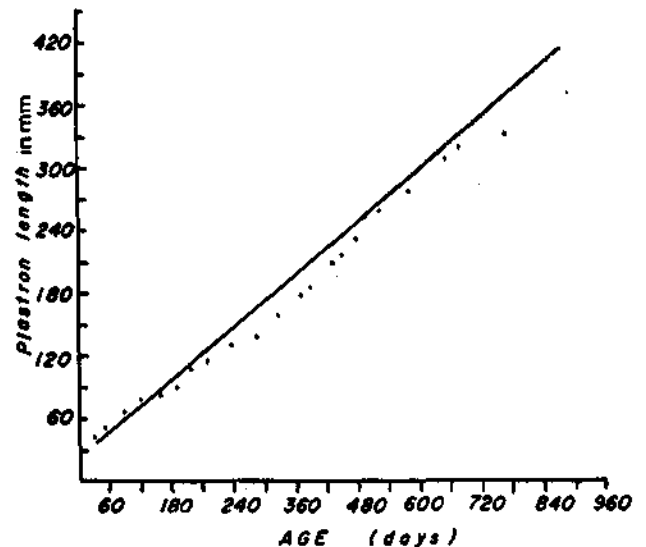
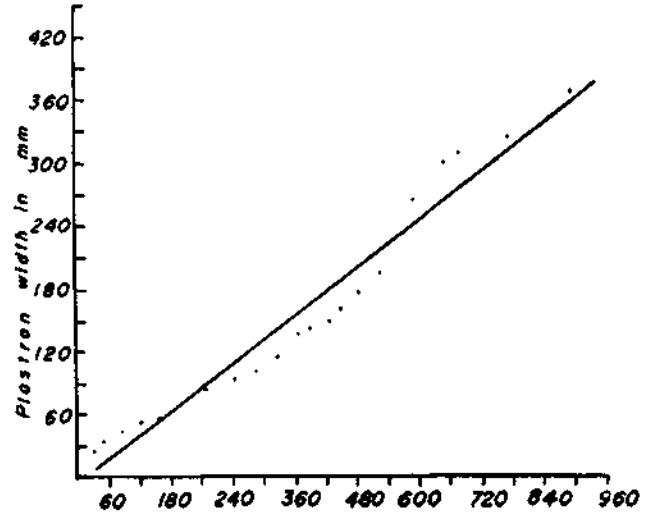


Fig. 6. Increase in plastron length and width of olive ridley *Lepidochelys olivacea* (1981 group) with advancing age. Each value represents the average of 19 individuals.

Even after 47 months it has not been possible to externally identify the sexes of olive ridley. Further rearing will provide information on the first appearance of secondary sexual characters. Rearing these turtles

is continued in the pens at Muttukadu to collect information on aspects such as growth, appearance of secondary sexual characters and age at first maturity.

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## SOME HEALTH PROBLEMS OBSERVED IN THE HATCHLINGS AND JUVENILES OF SEA TURTLES IN CAPTIVITY

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AND A. BASTIAN FERNANDO\*\*

### ABSTRACT

Some health problems of turtles encountered while rearing them (*Lepidochelys olivacea* and *Eretmochelys imbricata*) in captivity are recorded here. Most of the problems occurred in the group rearing of the hatchlings and were connected with water quality, availability of food, feed quality and stocking density. Successful treatment for some of the infections are also discussed.

### INTRODUCTION

A few of the olive ridley and hawksbill turtle hatchlings from Kovalam turtle hatchery and Tuticorin hatchery of the Central Marine Fisheries Research Institute were retained in order to study their behaviour in captivity as well as aspects of biology including food preference and growth. In the course of first hand observations on individual as well as group rearings a number of health problems were seen associated with the quality of water, degree of food intake, feed quality and stocking density. Although the field laboratories did not have adequate facilities for pathobiological investigations it was felt that a record of the finding would be an useful guide for the future. This account thus embodies only preliminary observations on the health problems in the olive ridley and hawksbill turtle hatchlings and juveniles in captivity.

We are thankful to Dr. E. G. Silas, Director, Central Marine Fisheries Research Institute, Cochin for his constant encouragement and help in the preparation of this manuscript and to Shri K. Nagappan Nayar, Tuticorin Research Centre of CMFRI for his help during this work. We also express our thanks to the Chief Wildlife Warden, Forest Department, Government of Tamil Nadu for granting permission to the Institute to collect turtle eggs for studies relating to recovery programme.

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### OBSERVATIONS ON OLIVE RIDLEY

#### *Lepidochelys olivacea*

#### *Individual rearing*

No serious pathological conditions were encountered when the turtle hatchlings were reared individually and fed *ad libitum* on clam meat and good water quality was maintained. However, occasional mortality occurred due to the following problems: 1. Some hatchlings were choked to death when they tried to swallow large pieces of clam meat. 2. Post mortem examination of some dead hatchlings, which were found floating in water, showed full distention of the entire alimentary canal which was filled with gas. Lungs were either inflated or shrunken. Whether these changes happened before or after death could not be ascertained.

#### *Group rearing*

Group rearing posed many health problems in hatchlings, juveniles and sub adults of olive ridley. Major problems are listed below:

#### (a) Injury caused by infighting

When food is given *ad libitum* hatchlings were seen to chase and bite those with food in their mouth. When food was available in plenty, the chasing and biting stopped as soon as all the hatchlings were able to get a mouthful. Infighting was severe when food supply was restricted. Bitings caused deep wounds in the neck, flippers and along the margins of the carapace (Plate IA). Often the wounds got aggravated and the wounded hatchlings were unable to move freely. Such hatchlings

were sometimes attacked and completely eaten up by others thereby exhibiting cannibalistic behaviour. In most of the cases the wounds got infected and fungal growth was seen around the wounds and the infection spread to other areas also.

(b) Fungal and bacterial infections.

Three types of fungal and bacterial infections were noticed in the olive ridley hatchlings.

(i) In some hatchlings round or crescent-shaped yellow patches were observed around the neck and at the joints as well as on the flippers (Plate I B, C). These patches later spread to other areas also. Whitaker (1979) reported appearance of yellow patches in olive ridley reared in captivity and suggested that the yellow fungus may possibly be *Mucor* sp. Even though the occurrence of these patches did not prove fatal, the affected hatchlings were attacked by others in group rearing, causing greater injury which finally resulted in their death. When hatchlings with yellow patches were isolated and provided clean water and *ad libitum* food they recorded near normal growth rate and activities. Only in very few cases the infection was seen to spread

(ii) In some hatchlings white patches appeared around the eyes which later spread over the eye and sometimes formed a thin film over it. The infection slowly spread to other parts of the head and sometimes resulted in mortality. Such hatchlings were also attacked by others in the group.

(iii) White patches were observed on the carapace (Plate ID) and on the edge of the carapace and the flippers in some young turtles. These patches did not cause any serious health problem and disappeared later in almost all cases.

(c) Infection of the cloaca

In some hatchlings the cloaca became reddish, swollen and protruded. When isolated and reared separately providing clean water and adequate food these hatchlings were completely cured.

(d) Bulging of the alimentary canal

As reported in individual rearing, in group rearing also some dead hatchlings were found with greatly distended alimentary canal and shrunken lungs.

(e) Growth of algae on the shell

Dense algal growth on the carapace of some of the hatchlings was noticed both in laboratory reared and those reared in the Muttukadu lagoon. Mahmoud

and Klicka (1979) reported that under natural conditions this association appears to cause no harm to the turtle and even becomes beneficial since the algae provide a degree of camouflage. But in the laboratory condition the excessive algal growth may cause damage to the shell and even result in mortality (Mahmoud and Klicka, 1979). At Kovalam no mortality due to excessive algal growth was recorded in the laboratory, probably due to the periodical cleaning of the carapace. However, eight hatchlings reared in a shallow (2' deep) pen in the mariculture farm at Muttukadu died 10 days after introducing them in the pen due to excessive algal growth all over the body which completely hindered their movements.

Treatments

Some of the infected hatchlings such as the ones with cloacal protrusion got cured without any treatment but by segregating them individually and by maintaining good water quality and adequate food. But those with physical injury, which later became infected and those with fungal and bacterial infections had to be treated for complete cure. The treatments were :

1. dip treatment in 10 ppm Malachite green solution,
2. dip treatment in 5 ppm potassium permanganate solution and
3. application of fungicide, Tinaderm (tolnaphthate 1% solution). The first two treatments were found ineffective while the third, application of 'tinaderm', was extremely effective for curing physical injuries and yellow and white fungal patches.

Three experiments were conducted to study the effect of tinaderm treatment, on young infected *L. olivacea*. The hatchlings were reared individually in 10 litre aquaria and fed *ad libitum* on clam (*Meretrix casta*) meat. Measurements were taken initially and the condition of the animals was noted. Treatment was given daily in the morning. The hatchlings were removed from seawater and the affected portions were dried with clean cotton swab. Tinaderm was then applied on the entire affected area. The hatchlings were kept outside water for 1 hour after application of the medicine and then released back in the tank. Controls were maintained without treatment. Water quality was maintained throughout the experimental period, by changing twice a day, which lasted 10 to 14 days. The health conditions of the hatchlings were recorded daily. All the affected hatchlings were completely cured by 10-14 days of treatment while the controls were in the same conditions as at the start of the experiments. The final measurements of the hatchlings indicate atypical cases as given in foot note to Table 1. The paucity of number

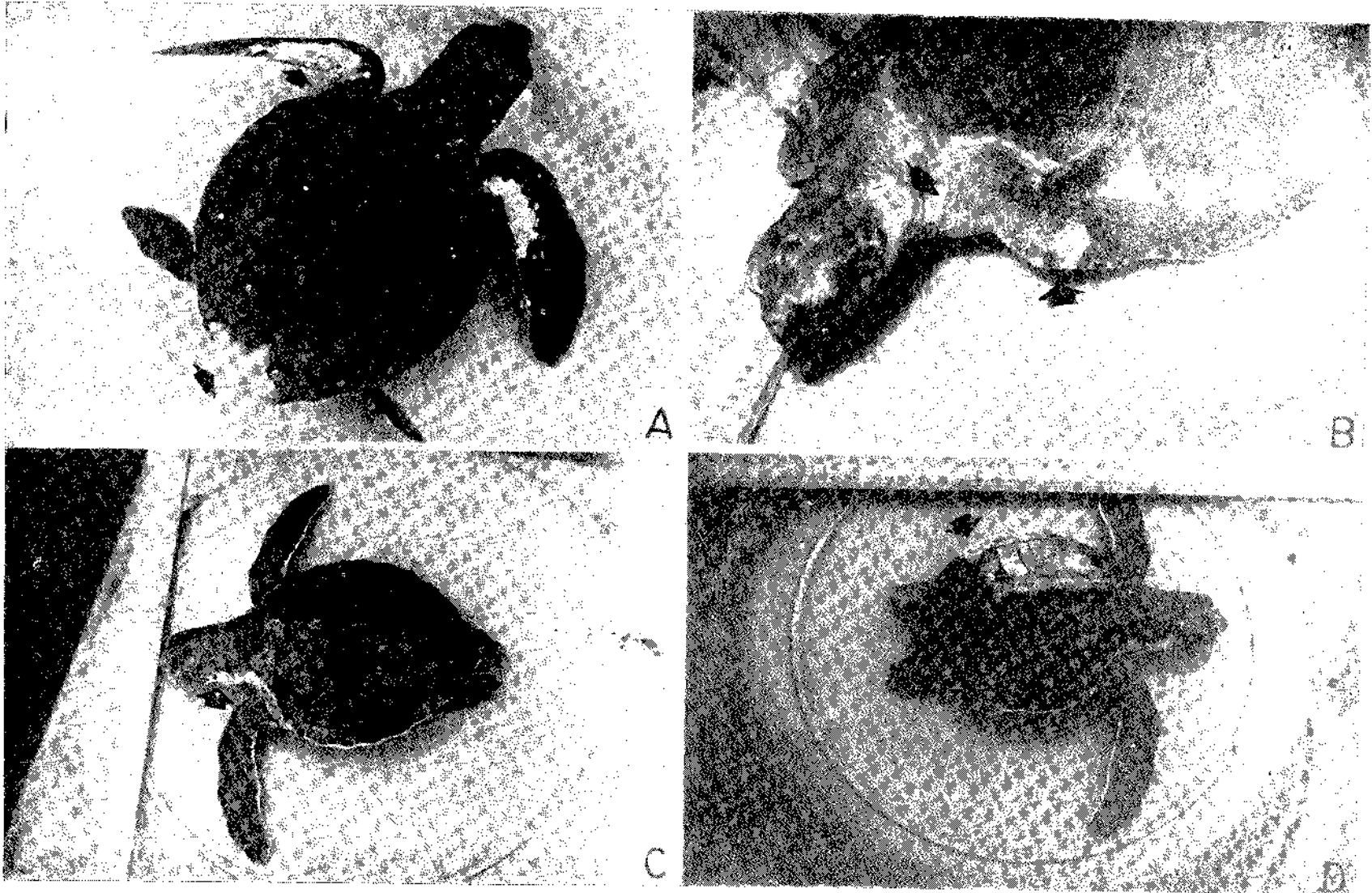


PLATE 1 *Lepidochelys olivacea*: A. Wounds on the flippers and margin of carapace caused by biting of other turtles, B & C. Round or crescent shaped yellow patches around the neck and on the flippers caused by fungal infection and D. White patches observed on the edge of the carapace.



TABLE 1. Growth of treated (with 'Tinaderm') and untreated hatchlings of *L. olivacea* after 14 days, when all the treated ones were cured of wounds and infection (Values in parenthesis indicate mean)

Parameter	Treated animals (N. 7)		Untreated Controls (N. 3)	
	Initial	Final	Initial	Final
Carapace length (mm)	.. 59.2-70.9 (63.5)	68.0-80.5 (72.9)	59.6-64.0 (61.9)	70.0-75.0 (72.0)
Carapace width (mm)	.. 49.5-55.0 (51.3)	61.0-67.5 (64.9)	48.6-52.0 (51.0)	62.5-64.0 (63.5)
Plastron length (mm)	.. 48.2-60.4 (54.3)	61.0-67.0 (63.1)	47.4-56.6 (53.3)	61.0-69.5 (65.8)
Plastron width (mm)	.. 46.2-55.4 (50.9)	56.5-64.5 (60.1)	38.8-52.6 (47.9)	57.7-65.5 (60.8)
Weight (g)	.. 48.0-94.0 (66.4)	67.0-96.0 (80.1)	53.0-71.0 (63.3)	71.0-81.0 (75.7)
Increase in weight (g)	.. ..	2.0-24.5* (13.7)		-4.0-26.0** (12.4)

\* In one hatchling the increase in weight was only 2 g; in all others it ranged from 11.5 to 24.5 g (15.75 g average).

\*\* Reduction in weight (-4 g) was observed in one hatchling while the others increased their weight by 15.0-26.0 g (Average 20.5 g).

of specimens in the sample does not permit us to give any conclusive result in the weight increment of treated and untreated hatchlings. After this trial, all the affected hatchlings were also treated and cured. In all cases the affected skin peeled off leaving no injury.

#### OBSERVATIONS ON HAWKSBILL TURTLE

##### *Eretmochelys imbricata*

During the 1981 season Fernando (1983) reported the hatching of a clutch of hawksbill turtle *Eretmochelys imbricata* collected along the Tirunelvely coast (Manapad). After releasing 32 hatchlings into sea remaining 31 hatchlings were retained at the field laboratory of Tuticorin Research Centre of Central Marine Fisheries Research Institute for rearing and observations and for conducting feeding and growth experiments. 31 hatchlings were group reared at the research centre. The hatchlings started taking food from the third day after emergence.

For the first two months the feed given *ad libitum* consisted of partially cooked and chopped meat of clam (*Donax* sp.), fresh lesser sardines and finely chopped meat of freshly caught prawn *Penaeus indicus*, oyster *Crassostrea madrasensis* and sea weed *Gracilaria* sp. The feed were given separately on a schedule viz., at 9 a.m., 12 p.m. and 5 p.m. After each feeding operation the water was completely changed. Upto this point of

time the hatchlings did not show any health problems. However, after two months the hatchlings were fed with minced meat of lesser sardines (*Sardinella albella*) and bye catch from trawlers (*Scolopsis* sp.). With this change to complete fish diet it was seen that the hatchlings developed symptoms of pathological conditions which are detailed below.

##### (a) Fungal infection

(i) In a few hatchlings fungal growth appeared as a yellow patch on the neck and gradually grew thicker forming practically a very thick rubbery covering around the entire neck region. Some of the affected hatchlings were segregated from the group and reared individually in plastic troughs of 10-litre capacity. It was seen that this extraordinary thickening of the neck region did not interfere with feeding and other activities.

(ii) Fungal infection of scutes : White fungal patches appeared on the head and carapace of 3 hatchlings. The affected areas were attacked by the healthy hatchlings which even ate off frontal and parietal scutes on the head.

(iii) Softening of scutes : In six of the hatchlings which had grown to 4 months (20 cm carapace length) the scutes on the head and carapace became soft. Some of the scutes began to peel off. One of the hatchlings thus affected died within a week.

(b) *Infection of the eyes*

A cheese-like cream coloured growth began to appear around the eye in as many as 11 hatchlings. It was seen that the unaffected hatchlings attacked the affected eye of the infected animals resulting in the loss of one eye followed by death of one animal. This ailment also did not interfere with the feeding of the turtles.

(c) *Infection of the cloaca*

In three of the hatchlings the area around the anus and a small portion of the cloaca was exposed.

*Treatment*

In fungal infection affecting the neck it was found that applying common salt and a daily injection of 100 I.U. of water soluble Vitamin A given intramuscularly resulted in the detachment of the fungal affected skin within a week leaving fresh and newly formed neck skin with no scar mark.

In the case of eye infection deficiency of Vitamin A was suspected and so a daily intramuscular injection of 100 I.U. of water soluble Vitamin A per 100 gm of body weight was administered. This was further supplemented by a feed consisting of common starch mixed with shark liver oil in the form of pellets. This

treatment resulted in complete cure. The cheese-like covering over the eye shed off and the closed eye gradually opened and the animal was normal after the 15th day.

In the case of white fungal patches on the scutes the specimens were exposed to direct sunlight in a shallow trough of water for an hour and were also given an intramuscular injection of vitamin A (100 I.U./100 gm body wt) per day. The affected scutes on the head shed off in 4 to 7 days and new scutes were formed very gradually.

In the case of softening of scutes the treatment was an administration of 100 I.U./100 gm of body weight of Macalvit (Vitamin A and D with calcium) manufactured by Sandoz India Ltd. This treatment was found to be very effective. It takes about a month for the turtle to recover. It was felt that the segregation of diseased animal was necessary as it prevents others from nibbling at the wounds or affected parts.

The above mentioned observations on olive ridley and hawksbill turtle are only indicative of the type of problems that may be encountered in captive rearing of hatchlings and early juveniles. Any programme for the development of mariculture of turtles will have to give serious consideration for the pathological aspects.

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## OBSERVATIONS ON TURTLES AT SEA AND IN THE LAKSHADWEEP

E. G. SILAS

### ABSTRACT

A few occurrences of sea turtles (*C. mydas* and Sp. ?) from the waters along the continental shelf edge and the high seas of the West Coast of India are recorded. The nesting of *D. coriacea* on Pitti Island, Lakshadweep is also reported here.

Sighting of turtles in the high seas outside the continental shelf edge is not a common phenomenon. In coastal waters occasionally they are sighted during the nesting season or in the feeding grounds. Often they are taken as incidental catch in fishing operations. Sea turtles do undertake long migrations and any information on their occurrence and behaviour in the open seas or coastal water may add considerably to our knowledge on their life history and habits.

**A. West Coast :** During the sixties and early seventies I had the opportunity to spend long spells in the Sea participating in the fishery oceanographic cruises on board R.V. *VARUNA* of the erstwhile Indo-Norwegian Project, Cochin. These cruises covered the Gulf of Mannar, Wedge Bank, Eastern Arabian Sea and the Lakshadweep Sea. Spare time was spent on whale watching and sea bird studies. Going through my notes, I find that on a few occasions the occurrence of sea turtles, mainly the green turtle *Chelonia mydas* was noted chiefly outside or along the edge of the Continental Shelf. Since the time of occurrence and location may be of interest in future studies I take this opportunity to record these here.

1. Date : 26-10-1965. Position Eli Kalpeni Mt. 11° 13' N and 74° 05' E. Time 1045 hrs. One specimen of *C. mydas* floating passively ; good growth of barnacles on carapace ; vessel slowed down to investigate but the turtle turned and moved away ; no other organisms seen in association.
2. Date : 26-10-1965. Position 11° 16' N and 74° 03' E. Time 1130 hrs. One large *C. mydas*

seen swimming at surface below which one small shark along with 2 sucker fishes and one pilot fish were seen. Vessel followed for a few minutes.

3. Date : 29-11-1965. Position 11° 16' N and 74° 50' E. Time 1115 hrs at shelf edge above 250 m depth off Calicut—one *C. mydas*.
4. Date : 29-11-1965. At 1230 hrs 11° 15' N and 74° 54' E, depth 180m among floating cuttle bones sighted one turtle swimming at surface. Species not identified ; probably *C. mydas*(?)
5. Date : 15-3-1969 Position 8° 07' N and 76° 51' E over 140 m depth ; time 0815 hrs ; one turtle floating passively ; vessel slowed to investigate, but turtle sounded and moved away. Sp ?

These are disjunct observations. However, the sighting of the turtles off the West Coast in the months of October and November, that too, two within an hour of each other should be of interest (Fig. 1)

**B. East Coast :** Shri A. Bastian Fernando of Mandapam Regional Centre has passed on the following information to me which should be of equal interest. This pertains to sighting of a number of sea turtles observed from the ship M.V. *VISHWA KANTI* during its passage from Colombo to Visakhapatnam. An extract of the letter from the Deputy Director General of Observatories (Forecasting) Poona—5 dated 25-2-1971 reads as follows :

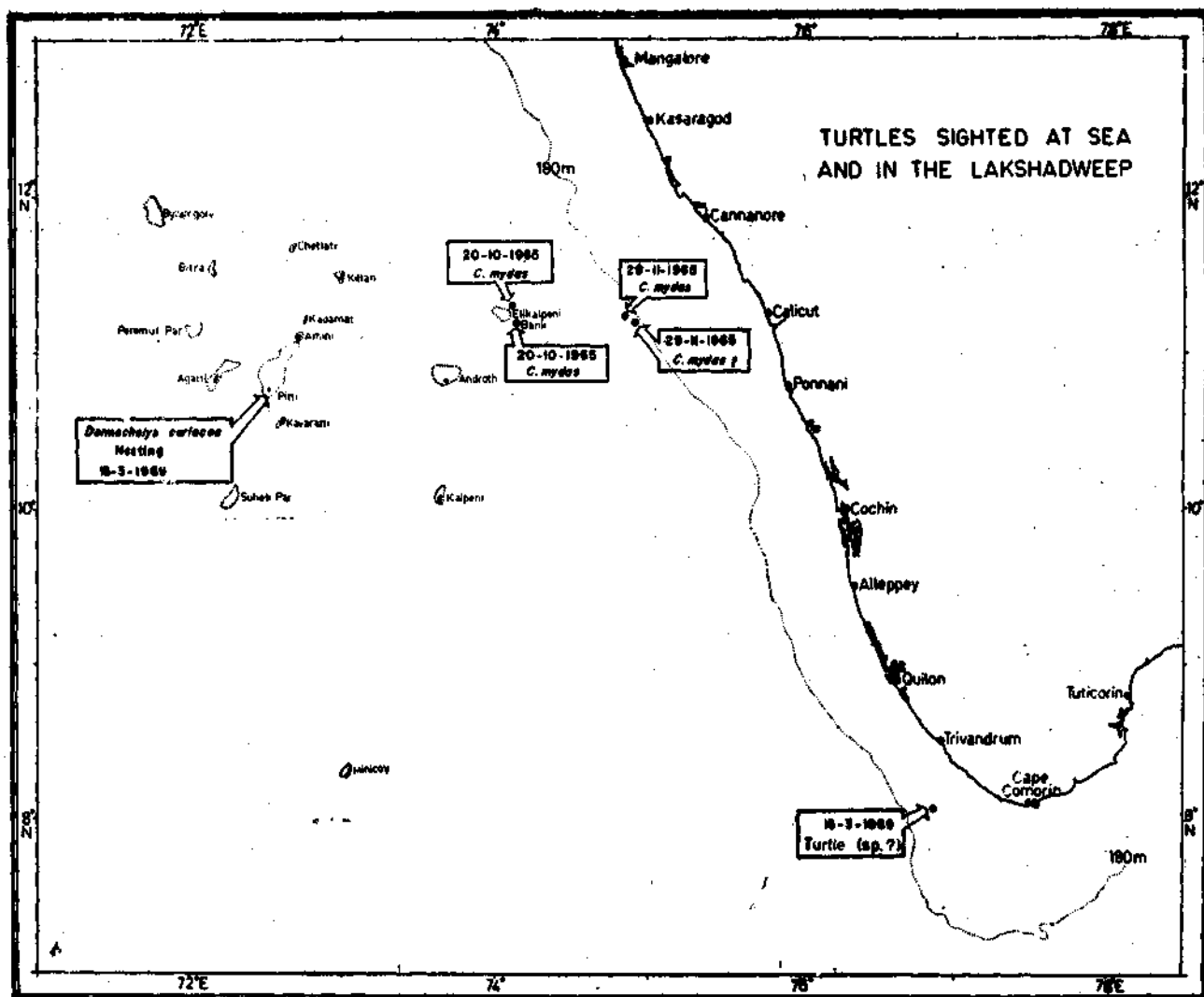


Fig. 1. Turtles sighted at sea and in the Lakshadweep

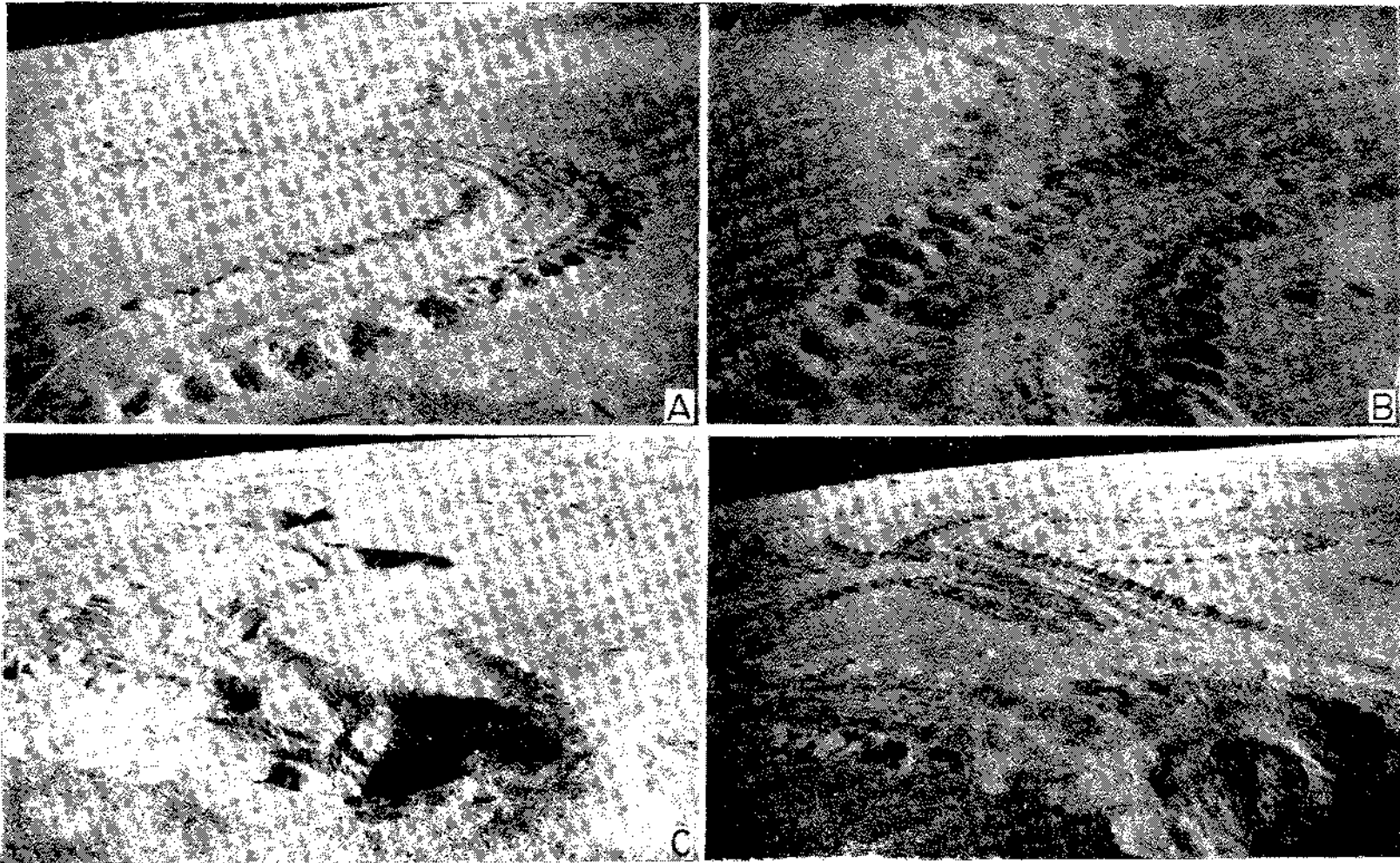


PLATE I A-B. Crawl tracks of *Dermochelys coriacea* (?) on Piti Island, Lakshadweep; C. view of three pits and D. close up of one of the nests. Note the circular nature of the crawl track.

The following is the text of the report on an abnormal number of turtles sighted by the ship M. V. *VISWA KANTI*. An abnormal number of turtles were seen floating on the surface of the sea at a distance of 100 to 200 yards from each other on 8th February 1971 between 04.00 hrs GMT and 07.00 hrs. GMT. They occasionally clustered in two's and three's and appeared muddy yellow in colour. The length of each animal was about 1½ to 2 feet and breadth was ½ feet. The turtles were very lethargic and made no effort to move away from the ship when the ship was plying in the vicinity of them. They all appeared to move in a southerly direction. Weather condition and other particulars are given below :

Passage	: Colombo to Visakhapatnam
Position	: at 04Z
True course	: 010
Ship speed	: 11 knots
Wind	: Light N to NE
Sea	: Calm to ripple
Sky	: Faintly cloudy
Visibility	: Good
Barometric pressure	: 1014.7 mbs
Dry bulb	: 28°C
Wet bulb	: 23.3°C
Sea temp.	: 28°C

The details do not permit fixing of exact location of the sighting. However, the time of the year and the numbers seen are of great interest. They could as well be the olive riddley on their way back from the nesting beaches.

C. On Pitti Island, Lakshadweep : Between 1963 and 1972 I was able to visit Pitti Island a small out-crop of hardly 3.5 ha in the Lakshadweep on four occasions, mainly for studying sea bird populations and their breeding. On one such visits on 5 February 1967, I came across the crawl tracks of a very large turtle(s) which was very conspicuous on this tiny Island. The circular and crisscrossing pattern of the tracks (Fig. 1 and Plate I, A-D) were very characteristic.

In my field notes I had indicated it as that of the leathery turtle, *Dermochelys coriacea*.

Three pits were noticed, but none had eggs. It is not unlikely that the islanders from Kavarati who frequent the island could have collected the eggs. It was not clear whether the crawl mark was made by a single or more than one nesting female. Information on nesting grounds of *D. coriacea* have been very few as compared to *C. mydas* and *Lepidochelys olivacea*. Pritchard (1982) mentions that 'Leatherback tracks were easily distinguishable from those of *Chelonia agassizi* and *Lepidochelys olivacea* by the much greater width and characteristic sinusoidal form of the track and frequent evidence of the animal having turned in one or more complete circles over the nest site.' The pattern seen on Pitti island, Lakshadweep is very much as that of *D. coriacea*. In the Lakshadweep they are hunted for their oil for use in boat maintenance. Frazier (1980) mentions that the species occur as vagrant in the Indian territory. Pritchard (1982) has given the lower range of the world population of leatherback turtle as 108,000. According to Carr (1972) the leatherback is the least endangered of species of the marine turtles since commercial products from it are virtually non-existent. However, opinion differs (Bustard, 1972).

#### CONCLUSION

As mentioned earlier, the systematic observation on turtles at Sea could add a fund of information on their behaviour and life habits. The National Marine Living Resources Data Centre at the Central Marine Fisheries Research Institute, P. B. No. 1912, Cochin 682 018 will be greatly interested to receive any information on sighting of turtles in the Sea from fishing vessels and the merchant vessels and Coast Guard ships plying in the Arabian Sea and the Bay of Bengal. It is our intention to disseminate this information through the 'Sea Turtle News' in the Marine Fisheries Information Service—Technical and Extension Series published monthly by the Central Marine Fisheries Research Institute.

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## TURTLE POISONING

E. G. SILAS AND A. BASTIAN FERNANDO\*

## ABSTRACT

Turtle poisoning or chelonitoxication have been reported from the tropical and subtropical Atlantic, Pacific and Indian Oceans and the species of turtles responsible for the same are also known. While the clinical characteristics of the disease have been reported from time to time, nothing much is known about the pharmacology or chemistry of the toxins. To date there are no known antidotes to combat chelonitoxin. By far the largest number of instances of turtle poisoning are from the Indian Ocean and Western Pacific. Some observations on instances of turtle poisoning in India involving fatalities is reported here with a brief review.

## INTRODUCTION

The study of marine turtles has been receiving more attention in recent years, more so as they have come under the category of endangered species needing urgent conservation and management measures to ensure their protection. A subsistence level fishery for turtles exist in some areas, and in other coastal areas where intensive inshore fisheries exist, incidental captures in fishing gears are not infrequent. While measures for the protection of the nesting sites, implementation of ban on fishing turtles and attempts at headstarting or sea ranching for augmenting turtle resources may be under way, turtle flesh is still consumed from fresh catch in some places thereby exposing people to accidental cases of poisoning. We have here

used the term turtle poisoning to denote this condition, Halstead (1956, 1959, 1970) has reviewed the problem of turtle poisoning or chelonitoxication and has listed the following species of turtles which may be poisonous during certain periods in some areas.

*Caretta caretta gigas* Deraniyagala  
*Chelonia mydas* (Linnaeus)  
*Eretmochelys imbricata* (Linnaeus)  
*Dermochelys coriacea* (Linnaeus)

Besides these, among the Trionychidae, *Pelochelys bibroni* (Owen) from the rivers and sea coasts of South East Asia, Indonesia, Philippines and New Guinea is also known to be responsible for turtle poisoning. Cases of turtle poisoning from the Indian Ocean are not many but a large number of fatalities have been reported from a few places from India and Sri Lanka.

The major outbreaks of turtle poisoning in these two countries are as follows :

\* Present address: Regional Centre of the Central Marine Fisheries Research Institute, Marine Fisheries P.O., Mandapam Camp, Tamil Nadu.

Location	No. of cases	No. of deaths	Species	Remarks
1. Panatura, S. of Colombo, Oct. 1840	.. 28	18	<i>Chelonia mydas</i>	Tennant (1861)
2. Karuppankudiyiruppu, Sri Lanka, 27 June, 1888	.. —	12	<i>Eretmochelys imbricata</i>	Deraniyagala (1939)
3. Mandativu, Jaffna, Sri Lanka, June 1921	.. —	7	<i>Eretmochelys imbricata</i>	Deraniyagala (1939)
4. Vaddukoddai, Northern Province, Sri Lanka April, 1923	.. —	4	<i>Eretmochelys imbricata</i>	Deraniyagala (1939)
5. Tuticorin, Tamil Nadu, India, 2 January, 1961	.. 9	3	<i>Eretmochelys imbricata</i>	Present report
6. Sakthikulangara, Quilon, India, 27 May, 1961	.. 130	18	<i>Eretmochelys imbricata</i>	Pillai <i>et al.</i> , 1962 & present report
7. Punnaikayal, near Tuticorin, India, 19 April, 1977	.. —	5	<i>Chelonia mydas</i>	Present report
8. Manapad, near Tuticorin, India, 3 August, 1977	.. 300	10	<i>Eretmochelys imbricata</i>	Present report
9. Tuticorin, India, June 1980	.. —	10(?)	<i>Eretmochelys imbricata</i>	Present report
10. Moolachi, Kanyakumari Dist., India, 1979	.. —	4	?	Present report
11. Tuticorin, India, 22nd May, 1983	.. 6	4	<i>Chelonia mydas</i>	Present report

As far back as 1861, Tennant mentions that 'At certain seasons the flesh of turtle on the south-western coast of Ceylon is avoided as poisonous, and some lamentable instances are recorded of deaths ascribed to its use. At Panatura to the south of Colombo, twenty-eight persons who had partaken of turtle in October, 1840, were immediately seized with sickness after which some survived and eighteen died during the night. Those who survived said that there was nothing unusual in the appearance of the flesh except that it was fatter than ordinary. Other similarly fatal occurrences have been attributed to turtle curry; but as they have never been proved to proceed exclusively from that source, there is room for believing that the poisons may have contained in some other ingredient.' These early comments are interesting and as we shall see from the present reports, Medical Science has yet to come up with a good remedy for chelonitoxication.

Some of the earlier workers including Deraniyagala (1939) have attributed faintly toxic properties to the meat of *D. coriacea* when eaten during some seasons along the southern coast of Sri Lanka. Feeding on certain toxic marine algae or ascidians or the Portuguese man-of-war (*Physalia*) is the reason attributed to the flesh of *E. imbricata* acquiring poisonous qualities. No studies have been carried out on this, although most of the fatalities due to turtle poisoning in India and Sri Lanka have been due to eating the flesh of this species. There is no sure way of telling when the turtle flesh would be poisonous or not. According to Deraniyagala (1939) experienced fishermen are said to chop off the liver of *E. imbricata* and feed it to the crows and if they discarded the liver the animal was considered poisonous. Feeding of turtle meat to dogs and cats for reactions has been reported from New Guinea (Bierdrager, 1936). The origin of chelonitoxin is still unknown. Turtle poisoning shows some similarities to ciguatera and could occur during any season and hence considered most probably due to the food ingested by the turtle.

The clinical characteristics of marine turtle poisoning have been reported by some workers and reviewed by Halstead (1970) from which the following is taken. The symptoms which develop from within a few hours to even a week after the ingestion of poisoned turtle flesh are reported to consist usually of 'nausea vomiting, diarrhoea, facial tachycardia, pallor, severe epigastric pain, sweating, coldness of the extremities and vertigo.' Acute stomatitis consisting of a dry burning sensation of the lips, lining of the mouth and throat is sometimes reported; so also in some cases, a sensation of tightness in the chest. Though there is pro-

nounced hypersalivation, swallowing becomes difficult and the patient may be lethargic and unresponsive. The oral symptoms are said to develop gradually and become increasingly severe after a few days resulting in the tongue developing a white coating and eventually becoming covered with multiple pinhead size reddened pustular papules. The pustules may break down into ulcers or persist for several months. Deep reflexes may be diminished. In severe cases somnolence is pronounced. It may be difficult to awaken the patient who gradually lapses into coma which is rapidly followed by death.

Pathological reports based on autopsy are few (Bierdrager, 1936; Siegenboek van Henkelom, 1936; Kinugasa and Suzuki, 1940; Romeyn and Hanefeld, 1956; and Pillai *et al.*, 1962). The treatment is symptomatic as to date there appears to be no known antidotes for chelonitoxin. Hardly any attempts have been made to test the toxic properties of the flesh or blood of poisonous sea turtles experimentally on laboratory animals. The attempts of Kinugasa and Suzuki (1940) in this regard using guinea pigs, mouse and frogs as test animals have not been very conclusive. There is complete lacunae regarding the pharmacology and chemistry of the toxin involved. Thus it will be seen that there are large gaps to be bridged and hence the need for proper documentation of data if any unfortunate incident, however, small should occur.

## 1. TURTLE POISONING AT TUTICORIN, TAMIL NADU, INDIA

Place : Fishing village off North Beach, Tuticorin.

Date : 2 January, 1961.

No. of cases : About Nine

No. of deaths : Three (One adult and two children)

Species of turtle eaten : *E. imbricata*

A turtle (*E. imbricata*) caught in fishing nets on 2 January morning was cooked and eaten for lunch. Among those who took part in the meal, an infant aged 1½ years who was fed some meat and another aged 3 years died on 5-1-61 and 6-1-61 respectively. They started vomiting from the night of 2-1-61 and despite local medication they did not survive. By 3-1-61 all those who had eaten the turtle meat developed symptoms. The case of Shanmugham aged 20 years was as follows : the onset of symptoms occurred on 3rd afternoon while he was at sea where he had earlier in the day made some dives and picked up 13 chanks from waters 3 to 4 meters in depth. Throughout the day he had no appetite, but by noon felt giddiness and nausea. On return to land early in the afternoon he complained



of pain in the chest and started vomiting frequently. Food or fluids taken could not be retained. On 4-1-61 the symptoms persisted and there was ulceration in the mouth and inner side of lips. Despite local treatment, the nature of which was not divulged, there was steady deterioration in his condition. Alarmed at what was happening, on 5-1-61 noon he was taken to Tuticorin General Hospital in coma and expired in the early hours of 6-1-61.

A dog which had eaten the uncooked leftovers and the blood of the turtle and a goat which drank the water in which the blood of the turtle was mixed by washings of the meat died within 24 hours. This did create some panic among the villagers. On 19-1-61 one of the dogs of the family which had eaten some of the cooked leftovers of the turtle meat was found in a very emaciated state, with ulceration in the mouth and unable to consume food. It died three days later after the photograph was taken by one of us (E. G. Silas). (Plate )

*Symptoms* : Only on 5-1-61 did they think of going to the Government Hospital for treatment. Even after a fortnight some of the survivors were having spells of nausea and vomiting ; pain in the joints ; burning sensation in the stomach every now and then ; scratching all over the body, especially at night and insomnia. The urine was deep yellowish red. The ulceration in the mouth and longitudinal fissures on the tongue which was heavily coated white to bluish appeared characteristic. (Plate )

## 2. TURTLE POISONING AT SAKTHIKULANGARA, QUILON, KERALA, INDIA

Place : Sakthikulangara, Quilon, Kerala

Date : 27-5-61

No. of cases : 130

No. of deaths : 18

Species of turtle : *E. imbricata*

Pillai *et al* (1962) have reported on some aspects of this incident which occurred on and after 27 May 1961 involving 130 persons who had consumed turtle meat resulting in the death of 18 adults and children.

On 27-5-61 three turtles (two *C. mydas* and one *E. imbricata*) were landed in the forenoon at Marathadi close to Sakthikulangara, Quilon. The meat of the three turtles were distributed amongst several families totalling 130 members including children. No symptoms were apparent on Saturday, the 27th. However, by 28th many were sick from vomiting and nausea and resorted to

medication from local physicians. There was no relief and on Monday 29th a man and two children died. This was followed by two more deaths the same day with still many afflicted with the poisoning. The health authorities took prompt action to see that all those who had taken turtle meat on 27th were rushed to the Government Hospital, Quilon for observation. Enquiries revealed that those who had consumed the flesh of *E. imbricata* were the ones affected. Despite all efforts the following 13 victims died in the hospital taking the death toll to 18.

Name	Age	Sex	Date of admission	Date of death
1. Sulochana	14	F	29-5-61	6 AM 30-5-61
2. Usha	9	F	..	5.05 AM 30-5-61
3. Sreedharan	35	M	..	6.30 AM 30-5-61
4. Bhargavi	30	F	..	4.15 PM 30-5-61
5. Mone	2	M	..	1.30 AM 29-5-61
6. Ummini	45	F	..	4.45 AM 30-5-61
7. Sarojini	33	F	..	2.10 PM 31-5-61
8. Nirmala	6	F	30-5-61	9 AM 31-5-61
9. Stella	17	F	..	11.55 PM 31-5-61
10. Mary	8	F	..	5.20 AM 31-5-61
11. Lazar	18	M	..	11.00 AM 1-6-61
12. Karmali	23	F	..	7.15 PM 1-6-61
13. Margaret	55	F	..	8.30 PM 2-6-61

It is felt that the report by Pillai *et al.*, (1962) is extremely important, though not easily accessible to turtle workers. In view of this, relevant part of this report is cited below :

\* On the morning of Saturday (27-5-1961), 5 turtles were caught alive by fishermen. The flesh of one of them which alone proved poisonous was shared by 12 families and was consumed the same afternoon. The preparation made was a curry which in some houses was prepared after boiling and decanting. No incidence of poisoning occurred in these families and in those who ate the other four turtles. Among those poisoned all had taken curries prepared without decanting after boiling but were symptom free on the first day except one child, who vomited several times the same evening. Another child from the same family started vomiting on Sunday morning i.e., on the next day and later developed fits and died on the way to hospital. It was on Sunday that most of the persons who consumed the flesh of the poisonous turtle without decanting after boiling, started vomiting.

### Symptoms

The presenting symptoms in all these cases were vomiting and severe constipation. Vomitus was bilious in nature and contained plenty of mucus, but no blood. All of them complained of pain in the throat and general weakness. Even those persons who were admitted with mild symptoms had pain in the throat. Six of the patients who were pregnant women aborted before death. One case, an adult male, who was convalescing, suddenly developed behaviour disorder, but improved later with treatment.

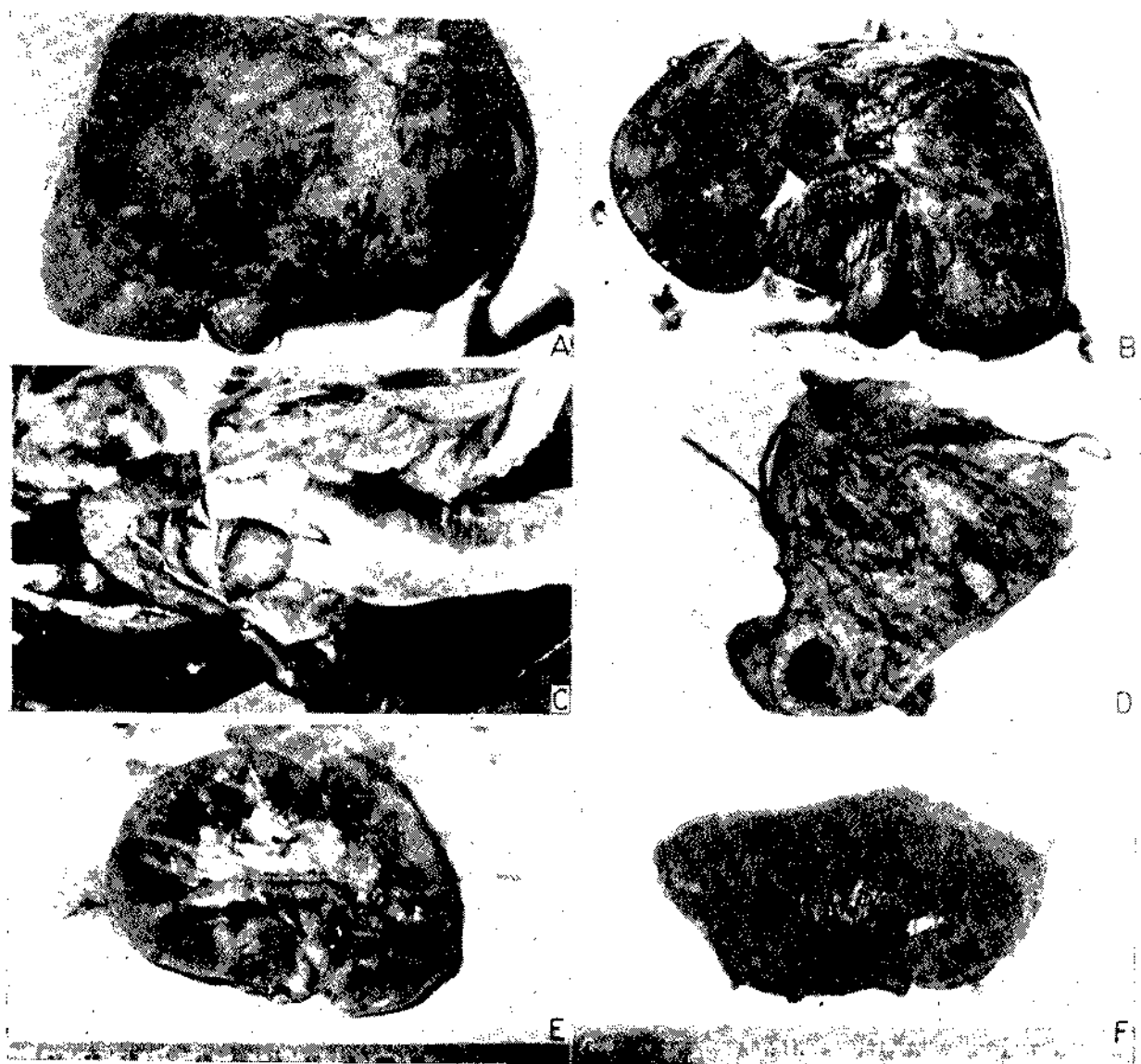


PLATE I. Autopsy of an 18 year old : A, B. Liver showing haemorrhagic discoloration and distended gall bladder ; C. Close up view of distended gall bladder ; D. Inner view of stomach showing patches of haemorrhage and congested gastric mucosa ; E. Kidney intensely congested and F. Enlarged spleen. (Photo : E.G.S.).

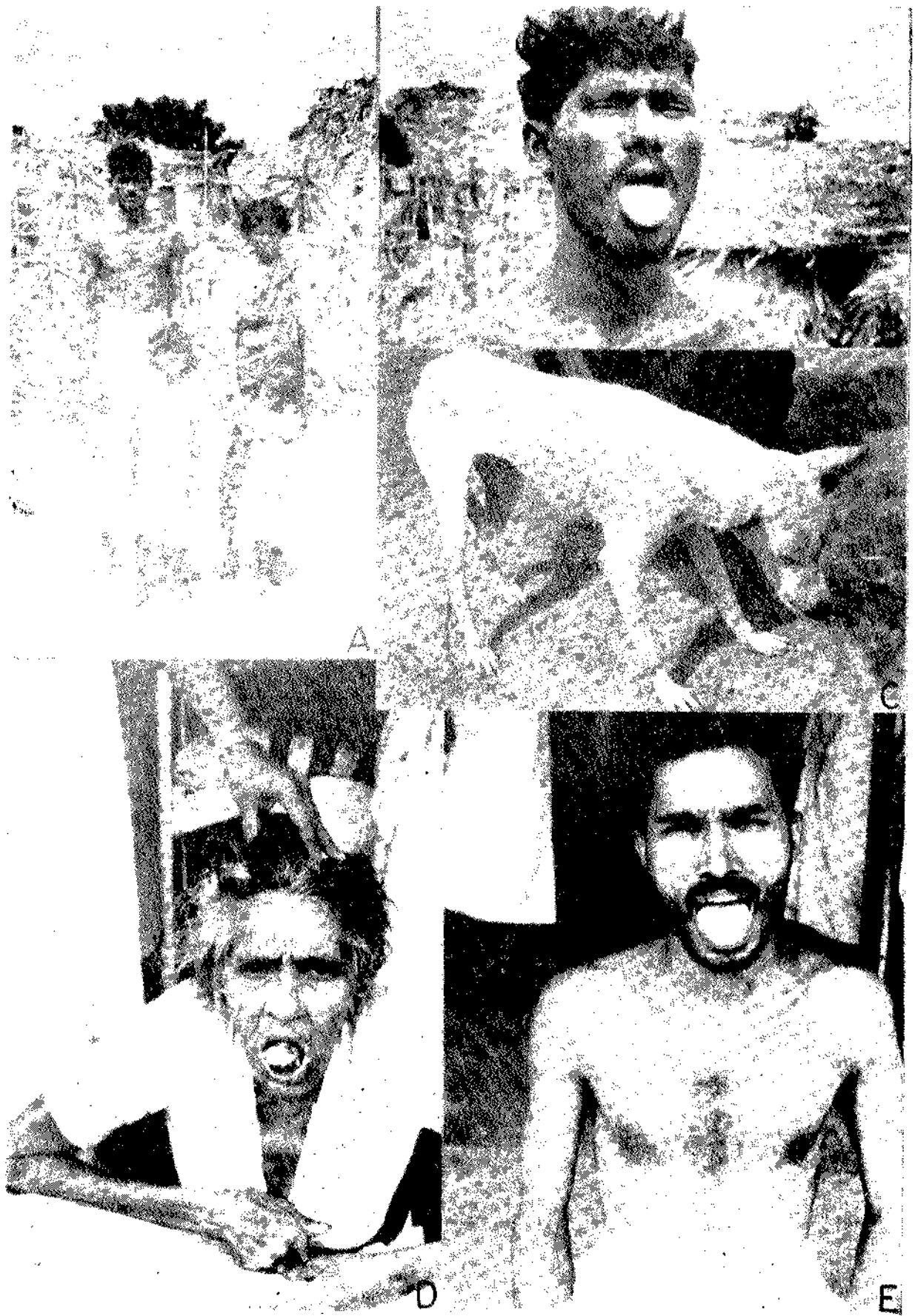


PLATE II. A-E. Victims of turtle poisoning : A. Family which survived after consuming poisoned flesh of hawksbill at Tuticorin in 2nd January 1961 : B. Man with ulceration of mouth and white coated tongue with deep fissures (not clear in Plate); C. Dog which had consumed poisoned hawksbill flesh in weak state and died three days after the photograph was taken. D and E. Two of the survivors of turtle poisoning incident at Sakthikulangara, Quilon in May 1961. Characteristic ulceration of mouth and fissured tongue in recovering patients even two weeks after the incident. (Photo : E.G.S.).

### Physical findings

Thirty-two of the patients were drowsy with sunken and congested eyes and had moderate fever, the temperature varying between 99-101 degree F. No allergic manifestations were noted in any of the cases.

**Alimentary system:** Tongue was dry and coated and longitudinally fissured. Two or three days later all showed severe glossitis. This finding was also seen in the 98 cases admitted with mild symptoms. Throat was congested. Abdominal examination did not reveal anything abnormal in the beginning except in one boy who had a palpable, firm liver which was not tender. In the 2nd week, in 32 patients the liver was found to be palpable upto three-fourth of an inch below the costal margin, but it was not tender.

**Cardiovascular System:** Slight tachycardia was noted in all the 32 cases with fall of B.P. (systolic pressure varying between 84-94 mm of Hg.). Nothing else abnormal was noted. E.C.G. was normal.

**Respiratory System:** Did not reveal anything abnormal except in 18 of the comatose patients who had pulmonary oedema just before death.

**Central Nervous System:** All were drowsy, 18 of them were comatose. Two cases (both children) had convulsions before death. Pupils were not reacting to light in 32 cases with severe symptoms. Deep reflexes were diminished. Plantar reflex was flexor. Fundus oculi was normal in all the cases.

**Genito Urinary System:** Nothing abnormal was detected.

### Course and Complications

Children developed convulsions before death and adults died of coma. The total mortality in this series amounted to 18 and all died due to respiratory paralysis, the pulse and the heart sounds were good till the end and the ECG taken 30 minutes before death in one case was normal. Others who were serious in the beginning improved with the symptomatic treatment given, but as mentioned earlier, liver became palpable in 32 of them.

### Investigations

1. Urine: Normal in all cases.
2. Blood: (a) Total leucocyte count 6,000-7,500/cmm., (b) differential count was normal, (c) E.S.R. 10-15 mm/1st hr., (d) Westengren Blood Urea—was raised in five cases but not significantly.
3. Liver function tests—normal.
4. C.S.F.: The tension was raised in five cases, but biochemical analysis showed nothing abnormal.
5. E.C.G.—normal.
6. Report from Public Health Laboratory:
  - (A) Bacteriological and serological examination from blood and motion for common food-poisoning salmonella and other organisms proved negative.
  - (B) Chemical analyser's report:

The usual inorganic or organic poisons were not found but the extract of the stomach contents

and liver on injecting into mouse and frog killed them. Control animal showed no symptoms.

7. Autopsy findings in 5 cases (1 woman, 1 child and 3 men): Serious cavities contained slight excess of fluid. Oesophagus showed ulceration of mucosa. Gastric mucosa was congested and oedematous. Small intestines contained thick bile. The intestinal mucosa and sub-mucosa showed marked oedema. The muscle bundles were separated out by oedema fluid. Large intestine contained thick mucus and bile and the mucosa showed oedema and ulceration. Liver: soft, friable, showed patchy congestion. Microscopy showed practically all the liver cells to have fatty changes with formation of fat cysts. There was centrilobular congestion and necrosis of the adjacent liver cells. Heart was flabby and showed subepicardial petechial haemorrhages. Kidneys were intensely congested and tubules showed cloudy swelling. The cerebral cortex was oedematous. The cortical vessels were intensely congested. The floor of the fourth ventricle showed congested vessels and petechial haemorrhages. The neurones showed degenerative changes.

The following notes based on personal observations by one of us (E. G. Silas) at the time of the incident and visits to the Hospital and Village supplement observation of Pillai *et al.* (1962).

1. Three turtles, 2 *C. mydas* and one *E. imbricata*, the latter locally known as 'Alungu-aama' were caught on 27-5-61 and *E. imbricata* was eaten by members of about 15 families for lunch. Symptoms started appearing on Sunday 28-5-61 when some felt nausea, vomiting and developed pain all over the body. Local medication gave no relief and deaths were reported from 29th, when all those who had eaten meat of the three turtles were rushed to the Government Hospital, Quilon for observations.

2. By 1st June '61 the death toll had risen to 18 and 6 more were on the critical list.

3. The onset of the symptoms were delayed by even 4 or 5 days and nausea and vomiting were the first signs of the illness.

4. Those who had taken turtle meat on a full stomach were said to be less affected.

5. According to the Hospital authorities, those who ate the meat from the posterior half of the turtle were more severely affected.

6. It was seen that one family boiled the meat thrice and drained off the water each time. None were affected in the family. However, they were not sure whether they had cooked the meat of *C. mydas* or *E. imbricata*.

7. Gastritis is one of the symptoms, but not enteritis. In fact all those who were affected developed constipation in a day or so.

8. Thick white coating and longitudinal fissures on the tongue were noticed in some by the fifth day. Many victims had ulceration of the mouth.

9. Fatalities were more among the younger age group and among females in this case. Death in children was accompanied by convulsions and fits. Death in adults took place usually 4 to 10 hours after the victims had lapsed into coma.

10. Nervous system seems to be affected as a depressor. Reflexes in victims seriously affected are very much diminished.

11. On the fifth day the urine of affected victims was found to be normal and nothing unusual was noted in laboratory examinations. However, in spite of saline transfusion given, the quantity of urine output was less than normal indicating malfunctioning of kidneys.

12. Some of the victims had fever, besides nausea, vomiting and body pain.

13. In the case of one victim (Stella) after the second day (29th May) slight improvement was seen and she was able to walk about freely, but sudden deterioration set in on 31st morning and she expired the same night.

14. Autopsy of an eighteen year old conducted on 1-6-61 showed that :

—There was no ulceration of mouth, tongue or genitals ; lungs collapsed and constricted ; liver slightly enlarged, discoloured and darker in places ; gall bladder exceptionally large and distended ; stomach with patches of haemorrhages ; spleen and kidneys enlarged ; urinary bladder distended ; no changes or ulceration in small or large intestine, but yellowish mucous present in the same (Plate II).

Pillai *et al.*, (1962) have presented photomicrographs of histological sections through oesophagus, small intestine, liver, kidney and heart showing the degree of damage and deterioration in organ tissues from the material from the autopsy. The oesophagus shows hydropic degeneration of epithelium and ulceration. The small intestine shows marked submucous oedema and separation of muscle bundles by oedema fluid. The section through the liver shows fatty changes and commencement of centri lobular necrosis. The kidney shows cloudy degeneration of tubules and the heart section through the floor of fourth ventricle shows subependymal ring haemorrhages.

15. Other points of interest were that in victims the cardiac rate was steady and normal until the last. Death was attributed to respiratory failure.

16. Some of the case histories taken from the records of the Government Hospital, Quilon through the courtesy of Dr. (Mrs.) Sumitra, District Medical Officer are given in Annexure I.

### 3. TURTLE POISONING AT PUNNAIKAYAL, TIRUNELVELY DISTRICT, TAMIL NADU, INDIA

Place : PUNNAIKAYAL fishing village 26 km south of Tuticorin

Date : 17th April, 1977

No. of cases : 250 (approx.)

Deaths : 5 children aged between 1 and 6 years on 19-4-77

#### Names

1. Chitra	Girl	1 yr old	Breastfed baby
2. Jesamma	Boy	1½ yr old	„
3. Amaladasan	Boy	4 yrs old	
4. Thomas	Boy	4 yrs old	
5. Jeeva	Girl	6 yrs old	

Cause of death : Suspected to be the consumption of meat of *C. mydas* captured on 16-4-77 and butchered the next day, the meat being shared by 160 families in small quantities (approx. 200 gm)

Although no death was reported among adults, the men complained of weakness but perforce to earn their daily bread they had to go out for fishing. Some of those who consumed the meat, even after 2 or 3 weeks complained of burning sensation in the lips and had deep fissures on the tongue. Until the deaths on 19-4-77, the causative factor for the symptoms was not known and at first was not connected to turtle meat consumption. But the general concensus among the villagers after the deaths took place was that this was due to the consumption of turtle meat. The symptoms which had developed in the adults persisted 2 to 3 weeks after 17 April. However, we would not want to hazard a guess about the children because two of the children were breastfed babies and they did not consume the meat. Their mothers had eaten the meat, but they were not affected. The doctors at Tiruchendur and Thenthiruperai were unable to throw any light on the actual reasons and were probably under the misconception attributing the deaths to botulism. But botulism normally occurs within hours after consuming any contaminated food. The symptoms in brief shown by the affected children are as follows : nausea and excessive vomiting, slight temperature, fits and spoils

of unconsciousness, hands becoming stiff. To investigate the incident the visits to the village were made on 20-6-77 and two weeks later. The condition of some of the affected adults several days after the incident indicate that this is a case of turtle poisoning, the species involved being *C. mydas*.

#### 4. TURTLE POISONING AT MANAPAD, TIRUNELVELY DISTRICT, TAMIL NADU, INDIA

Place : Manapad

Date : 3-8-1977

No. of cases : 300

Deaths : 10

Species responsible : *E. imbricata*

At the Manapad fishing village in the bottom set gill nets on 2-8-77 the fishermen caught some specimens of *C. mydas* and *Lepidochelys olivacea* and on 3-8-77 two *E. imbricata*. All these turtles were butchered on 3-8-77. The meat was distributed to a large number of families in small quantities, half a coconut-shell measure. It is said that about 300 adults and children ate the meat made into curry on 3-8-77.

The local people by tradition avoided eating the meat of all turtles except the green turtle *C. mydas*. They were also aware of the occasional poisonous quality of the meat of *E. imbricata*. Besides, the meat of the hawksbill is considered to be of poor quality having a repulsive red tint. Being fond of turtle meat, and there having been a paucity in the landings of turtles in the village at that time, casting aside the traditional precaution and with the encouragement from the butcher the meat of all the turtles were distributed for consumption mixing even the intestines and livers which normally are discarded.

The children upto the age of 6 developed symptoms only about 48 hours after consuming the meat and by the noon of 5-8-77 they started vomiting and experienced giddiness. The parents neither paid any serious attention to them nor attributed the symptoms to turtle meat. So the children were treated with folk medicines but on 6th morning the vomiting and giddiness accompanied by severe stomach pain aggravated and so they were rushed to the nearest medical aid centre. Until then neither the doctors nor the parents suspected any food poisoning. Eight children between 8 months and 8 years of age who had been taken to the hospital suddenly developed fits, collapsed and died. The adults, about 75 of them began to feel symptoms of heaviness of head, nausea, exhaustion and exceptional thirst on the noon of 5th August. They attributed these indispositions to the extra long exposure to the sun that day and bit of drinking as most of them were at Tuticorin, 50 km away from their village participating in the 'great festival of golden car.' Solomon 22, who stayed back at the village had excessive vomiting and began to be giddy by 5th noon. So also his one year old daughter who developed symptoms of vomiting and diarrhea had been rushed to the hospital by the neighbours. Solomon lost consciousness and passed away in his house on 6th morning. Enquiry revealed one more adult Lawrence 45, also died in the evening of 6-8-77 evincing the same symptoms. Only at this point of time did people suspect that the cause was the consumption of turtle meat particularly the hawksbill turtle. All adults who had the slightest symptoms were rushed to various hospitals at Tiruchendur, Manapad, Udangudi and Tuticorin in the district. The symptoms of delayed turtle poisoning in the cases of adults were giddiness, heaviness of head, nausea, vomiting and diarrhea. In most of the cases there was burning sensation in the mouth and ulceration of the upper oesophagus, pain in the stomach and extraordinary thirst.

Age Group or Name	Date on which the meat was consumed	Date of developing symptoms	Date of death	Symptoms
8 months	3-8-77 (mother ate meat)	5-8-77	6-8-77	Diarrhea only.
1 year	3-8-77	5-8-77	6-8-77	Vomiting, fits.
1-8 years	3-8-77	5-8-77	6-8-77	Vomiting, giddiness, fits.
Solomon, 22 years	3-8-77	5-8-77	6-8-77	Vomiting, giddiness, coma.
Lawrence, 45 years	3-8-77	5-8-77	6-8-77 (evening)	Vomiting, giddiness, coma.
All adults	3-8-77	5-8-77	recovering	Vomiting, giddiness, loss of appetite, general debility.
All other children more than 8 years old	3-8-77	5-8-77	recovering	Vomiting, giddiness, fits.

### Treatment

The Press reported that one suckling baby (Barbara 8 months) died because the mother had eaten the poisonous meat of turtles. Our enquiries reveal that the child died of severe diarrhoea (no vomiting) and passed away due to dehydration and lack of attention. The doctor who attended to the child at a private clinic considered the case to be one of neglected gastroenteritis. Personal interview with the mother in question showed that though the mother of the baby had consumed the turtle meat she had not developed symptoms even 5 or 6 days after the incident.

We are constrained to note that among the local medical practitioners there has been a complete lack of knowledge about turtle poisoning and its effects. The treatment was only for visible symptoms exhibited by the patients. In two private clinics at Udangudi, the doctors who suspected that the symptom could have been caused through neurotoxin, administered mild purging to eliminate toxins, charcoal tablets to detoxicate and tetracycline as antibiotic and vitamins. One homeopathic practitioner at Udangudi treated 9 severely affected persons (age from 1 to 35 years) successfully with siddha medicine, his own preparation called 'vishakudori' tablets. The medical officer of Government Hospital, Tiruchendur, attributed the 3 deaths which occurred there to respiratory failure. Medical officer at Udangudi Government Hospital said that the nature of the poison corresponds to ptomaines as in the mesocarines. He also reported that the deaths (3) in his hospital were due to respiratory failure.

On 9-8-77 at Kulasekarapatnam Government hospital post mortem was conducted on two of the victims, a girl child and an adult. The results could not be obtained.

### 5. TURTLE POISONING AT TUTICORIN, TIRUNELVELI DISTRICT, TAMIL NADU, INDIA

Place : Tuticorin

Date : June, 1980

No. of deaths : + 10 (?)

Species responsible : *E. imbricata*

Symptoms : Typically as in earlier cases

Among the dead was a breastfed baby about 8 months old and the child died within 24 hours after the mother had eaten the turtle meat curry. The mother was hardly about 18 year old and she was admitted to the Government hospital at Tuticorin and was showing typical symptoms and on the third day after admission to the hospital her tongue had a single, deep furrow

as though it was going to cleave into two. The mouth was ulcerated. This particular case is of special importance in view of the death of her baby which was breastfed. In earlier incidents, the breastfed babies had died after their mothers had consumed turtle meat. However, the mothers had not developed any symptoms of turtle poisoning and the medical reports attributed the deaths of the children as due to other causes. In this incident, among the dead there was only one adult and all others were children under 12 years of age.

### 6. TURTLE POISONING AT MOOLACHI, KANYAKUMARI DISTRICT, TAMIL NADU, INDIA

Place : Moolachi

Date : 1979

No. of death : 4 children

Species : not known

Cause of death : Consumption of turtle meat

Moolachi is a village in the interior part of Kanyakumari District near Thuckalay and the turtle meat was transported by cycle from the coast. The affected children were all taken to local doctors who treated them for gastroenteritis.

Visit to the village was made, 3 days after, as the news appeared in the local press and the interrogation of the affected families revealed that this was a sure case of turtle poisoning. A few adults who consumed the meat also complained of the symptoms of nausea, giddiness, general weakness and had deep furrows in the tongue.

### 7. TURTLE POISONING AT TUTICORIN, TIRUNELVELI DISTRICT, TAMIL NADU, INDIA

Place : Tuticorin

Date : May, 1983

Deaths : 4 children

Species responsible : *C. mydas*

The incident was confined to only one family and a guest child. One of the children who died was one year old and breastfed. The mother had purchased the meat scrappings and leftover meat of some 500 gm for just Rs. 1 only in the noon (1300 hrs), the turtle having been butchered before the sunrise and the meat brought to V.O.C. market. The meat was cleaned for cooking by 1800 hrs i.e. 13 hours after butchering. On enquiry it was said that the meat was purplish in colour, instead of pink, emanating a strong unpleasant odour. The children complained to the mother against the colour and odour of the meat before cooking and

the mother did not heed to it. One of the sons who was playing truant that day was denied turtle curry as a measure of punishment and so he escaped all ill effects and death. Except the father who began to exhibit symptoms the very next morning, all other victims showed symptoms of vomiting only after 24 hours. In two cases, there was no diarrhoea and the end came with fits and coma. However, one of the children aged 6 (Kanishkar) showed symptoms of diarrhoea, vomiting and fits before his death. The parents of the children escaped with inflamed throat and fissures on the tongue. The case histories are given in Annexure II.

While we are sure that the family had consumed the meat of *C. mydas* since no other species is surreptitiously butchered in Tuticorin, we feel that the delayed symptoms point to turtle poisoning rather than that of food poisoning due to consuming putrefied turtle meat curry.

#### DISCUSSION

1. The occurrence of turtle poisoning along the Gulf of Mannar Coast and adjacent areas indicates that despite the Indian Wild Life (Protection) Act 1972, turtles are still being caught for consumption, the species being *C. mydas*, *L. olivacea* and *E. imbricata*. The loggerhead *caretta* may be extremely rare.

2. It is evident that *C. mydas* is also responsible for chelonitoxication besides *E. imbricata*. We note some difference between the time of eating the meat and onset of symptoms in cases where poisoned meat of *C. mydas* and *E. imbricata* have been consumed resulting in fatalities. In two cases where the meat of *C. mydas* was consumed the onset of symptoms were earlier i.e. within 24 hours. In this connection the observations made by Tennent (1981) has some relevance.

3. The death of breastfed babies occurring hardly 24 hours after the mothers had consumed turtle curry, is a point of considerable importance. At this stage we are unable to comment on the implications of this.

4. It is suggested that it is a neurotoxin that causes chelonitoxication. While the general symptoms of chelonitoxication are known, we have yet to develop effective treatment for the same. A wide spectrum of medications have been administered to those affected

at various centres as evidenced from hospital records and enquiries with doctors who treated the victims.

5. In some of the incidents it is seen that death had occurred among children while adults showed delayed symptoms and gradually got over the same. It is not known whether it is due to the consumption of a larger quantity of the turtle curry by the children.

6. The burning sensation in the mouth and deep fissures in the tongue appearing a few days after the consumption of poisoned turtle meat is very characteristic. We find that there is absolutely no follow-up of the patient's condition once they are discharged from the hospital. Whether there are any long range effects on them or irreversible damage done to their vital organs is not known.

7. It is absolutely necessary to get the correct identity of the turtle species involved. It is equally imperative that the tissues/organs of the turtle if it could be retrieved be sent for analysis to determine and confirm the chemical and biological nature of the toxin present.

8. The medical practitioners are by and large ignorant about chelonitoxication. A wider awareness should be created in coastal areas prone to such incidents.

9. Perhaps in the interest of the medical science, with the dispensation from the Wild Life Department, a programme of examining periodically a few hawksbill turtles from the Gulf of Mannar for analysing their body tissues for toxicity and related studies should be carried out. It is necessary that in the non-consumptive utilisation of turtle we give equal attention to this aspect also.

10. It is important that wide publicity be given along the Tamil Nadu, and Kerala Coast to the fact that the flesh of turtles, especially that of the hawksbill and occasionally the green turtle could be poisonous. This measure by itself should act as a deterrent towards the consumption of turtle meat and indirectly help in the conservation programme.

It is a tragedy when chelonitoxication occurs. While prevention is better than cure, if an incident occurs we should by all means be prepared to face such an eventuality by developing an efficacious treatment for the malady.



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ANNEXURE-I

SOME CASE HISTORIES PERTAINING TO THE TURTLE POISONING INCIDENT  
AT SAKTHIKULANGARA (MAY 1961)

1. Name :	SUMATHI (Female) Aged 11. Admitted to hospital on 29.5.1961.	2-6-61 :	Temp. 99.6°F
Complaints :	Nausea, vomiting.	3-6-61 :	No complaint.
History :	On 27.5.1961 ate turtle curry at 1 p.m. At 3 p.m. on the very same day started nausea and vomiting 5 to 6 times. First taken to local allopathic doctor; persisting symptoms and admitted to government hospital.	8-6-61 :	Complaint nil.
Family history :	Mother died on 31.5.1961. Similar complaint. Two sisters died on 28 or 29.5.1961 with similar complaint; father in-patient in the hospital with similar complaint.	O/E :	Liver felt 4 FB below costal margin, firm and tender.
General Exam. :	Moderately nourished girl; not anaemic or jaundiced; No cyanosis; tongue coated and moist.	3. Name :	RAJAMMA (Female) Age. 37 years, Admitted 29.5.1961.
CVS :	Pulse 112/mt. regular. B.P. 80/69 mm Hg. Heart borders with normal limits; Auscultations both sounds heard in all areas; no adventitious sounds heard; respiratory systems normal.	Complaint :	Vomiting, constipation for 5 days.
Al. system :	Liver and spleen not palpable. No other mass felt.	History of previous illness :	Nil particulars.
C.N.S. :	Intelligence and memory good, cranial nerves normal, superficial reflexes present, normal. Pupils light reaction, deep reflexes and normal. Temp. 100.4°F. TC DC. P. 69 L. 26 M 4, E 1.	History of patient's present illness :	Started as vomiting on Sunday afternoon; consumed turtle meat on Saturday; constipated since then; admitted to the hospital on 29.5.61. Given stomach wash and enema; vomited several times even after coming to hospital; passes urine normally; complains of discomfort inside.
3-6-1961 :	Constipation Mist alba 3 III given.	General examination :	Moderately nourished; not anaemic, not jaundiced; no cyanosis; patient looks lethargic; tongue dry coated. Blue in colour (fungal infection ?)
4-6-1961 :	O/E Liver felt 3 FB below costal margin slightly tender, firm.	Temp. 98.4°F	
2. Name :	SUJATHA (Female) Age 12 years. Admitted on 29.6.1961.	Pulse : 104/mt regular. Volume good; tension, poor.	
Complaint :	Vomiting from Wednesday (31.5.1961).	CVS :	Apex beat in the rt. 5th space $\frac{1}{2}$ inch astride mid cl. live. Both sounds heard well in all areas; systolic murmur over apex.
History of present illness :	Treatment on 27.5.1961 Admitted as symptomless case of observation. On Wednesday she developed vomiting thus transferred to this ward; Last night (1.6.1961) vomitted several times.	R.S. :	Lungs clear.
General Examination :	Moderately nourished, looks very ill; not anaemic or jaundiced; not cyanosed; no clubbing of fingers; tongue coated.	C.N.S. :	Pupils reacting to light; deep reflexed all sluggish.
CVS :	P.R. 108/mt. Reg. B.P.	Al. system :	Liver or spleen not palpable; no other palpable mass. vague tenderness all over abdomen.
R.S. :	N.A.D.	1.6.61 :	Investigation
C.N.S. :	Pupils normally react to light; reflexes sluggish. Plantar, flexor.	Blood TC	
Al. systems :	Liver or spleen not palpable; no other palpable mass or tender area.	DC P 68 L 22 M 1 E 9	
DC : P 72 L 24 M 3 E 1		ESK	
		2.6.61	Pulse 102/mt Regular. Very good BP
			Reflexus Biceps +
			Others absent
			Plantar Flexor
			Pupils Contracted—react to light
			Temp. 100° F
		4.6.61	Liver area tender.

4. Name : WILLIAM (Male). Age 24. Admitted on 29.5.61.  
 Complaint : Vomiting and constipation from 29.5.61.  
 Family history : Wife and only child died in food poisoning; consumed turtle meat on 27.5.61. Symptoms developed next day, Sunday: vomiting; Sunday and Monday improved and admitted for observation; again starts vomiting on 1.6.61; constipated shocked of death of child due to same food poisoning.  
 1.6.61 Very weak; general examination: Well built man, slightly anaemic; not jaundiced or cyanosed; no clubbing of fingers tongue moist slightly coated; RVS Pulse 100/mt. B.P. heart sound normal.  
 R.S. : N.A.D.  
 Al. system : Sigmoid colon palpable and tender.  
 C.N.S. : Intelligence and memory good; speech normal; deep reflexes sluggish. (Biceps +, knee fork —, ankle +) abdominal absent in all four quadrants Plantar—flexor.  
 Progress : Pt. contes toxic. Temp. 99°F, Pulse 96/mt  
 2-6-61 regular. B.P. reflexes, biceps present; knee fork absent; ankle fork present; pupil normal; ESR 5 mm Blood picture normal.
5. Name : MALATHI (Female) age 28; admitted; 29.5.61.  
 Complaints : Vomiting twice. Sunday evening; rolling movements in the abdomen.  
 Family history : 2 children died of same complaint, husband seriously ill.  
 History of patient's illness : T.M. 27/5 norm. alright; since Sunday evening she vomited several times and on Monday also and admitted to hospital. Given stomach wash and enema after coming to the hospital; constipated passes urine normally; she is improving after coming to hospital. anenorrhoa—4 months duration.  
 General exam. : Well nourished; not anaemic; nor jaundiced, nor cyanosed; no clubbing of fingers; tongue dry and coated. CVS P.R. 100/mt; Resp V + T good; BP 94/74; apex beat in the ht; 5th space  $\frac{1}{2}$ " inside mid cl. live. Both sound well in all areas. Systolic murmur over all areas. CNS: Intelligence and memory normal; speech normal; pupils normal—reacts to light sluggishly; deep reflexes sluggish; Plantar-flexor.  
 Al. system Liver or spleen not palpable.  
 R. system : no long signs.  
 1.6.61 : Vomited early morning.  
 O/E P.R. 96/mt. regular BP reflexes all sluggish pupils dilated—react to light; D.C. P 66, L 26, M 2, E 6.  
 4.6.61 8 a.m. : Vomited 7 times  
 O/E. Liver flet 3 F.B. below costal margin in the (M C Liver). It is firm and tender.
6. Name : MARGARET (Female) age 55. admitted on 30.5.61.  
 Complaint : Vomiting—duration 4 days; drowsiness 2 days; uneasiness 1 day.  
 History of previous illness : She was taking some Ayurvedic medicines for pain all over the body.  
 History of patient's present illness : Consumed turtle flesh Saturday afternoon; allright till Sunday; then started vomiting. A local medical practitioner treated her symptomatically; given some injection; she was brought to the Govt. hospital as she did not improve; she did not pass motion all these days; became unconscious on 31.5.61.  
 General Exam. : moderately nourished; slightly anaemic; not jaundiced; left eye blinded and shrunken (Panophthalmitis) tongue dry and coated; Temp. 98.4°F.  
 C.V.S. : Apex bent visible in the rt. 5th space in the mid-cl. live, heart sounds—both sound heard well in all areas; systolic murmur over apex; no congestion of jugulars; BP 100/50; pulse 100/mt, regular, very good.  
 R.S. : no lung signs;  
 C.N.S. : unconscious; Rt. pupil contracts, not reacting to light.  
 Reflexes : Biceps absent; knee fork absent; abdominal present in all quadrants; plantar—flexor.  
 Investigations : Blood WBC—TC 5700/  
 DC P 64, L 28, M 6, E 2, ESK  
 Blood urea 52 mgm.  
 2.6.61 8 a.m. : pulse regular. 100 mt; BP 100/70; pupil contracting; react to light; reflexes all sluggish; knee fork absent, Plantar-Flexor.  
 3 p.m. : Throat with secretions; noisy strenuous breathing; lungs, plenty of moist sounds; pupil contracted; no reactions to light; conjunctival reflexes nil; Temp. 100° F. by axilla; ECG at 7.30 P.M. on 2-6-61 normal. Expired at 8.30 P.M. Post-mortem conducted.
7. Name : JANARDHANAN (Male). Age 45. Admitted on 29.5.61.  
 Complaint : Vomiting.  
 History : Started vomiting on 27.5.61 evening; had eaten cooked turtle meat, then taken to private nursing home and afterwards to another private doctor.  
 Family history : Two of his children died on Monday with similar complaints; one of his daughters also here with similar complaint; given treatment; moderately nourished, individual not anaemic nor jaundiced; tongue coated and moist.  
 C.V.S. : Pulse 78/ min.  
 B.P. : 90/70, heart normal, lungs NAD.  
 C.N.S. : Intelligence and memory good; superficial and deep reflexes all present.

Al. system : NAD  
 Investigations : T.C. } P 67, L 25, M 1, E 7.  
 D.C. }

8. Name : RAJAN (Male). Age 12. admitted 29.5.61.  
 2.6.61 : Complaints—headache—and—vomiting.  
 Family history : All members ate turtle flesh ; all of them developed symptoms ; his father and aunt died on 29.5.61 in the village.  
 History : Ate a few pieces of turtle meat on 27.5.61 ; developed vomiting and headache on 29.5.61 morning.  
 General exam. : moderately nourished ; not anaemic, not jaundiced ; tongue coated and moist.  
 C.V.S. : Pulse 96/min ; regular + ; BP 110/80.  
 Auscultations : Both sounds heard ; no adventitious sound heard ; respiration normal.  
 Al. system : liver felt ; 4 FB below costal ; margin of spleen not felt ; (Place most tender).  
 C.N.S. : Intelligence, memory good, deep reflexes normal, superficial reflexes normal ; plantar pupils react to light. Temp. 100°F.  
 Investigations : TC } Bb 5, L31, M1, E3.  
 DCJ  
 Urine : Sugar Nil  
 albumen Nil  
 deposit neg.

9. Name : MONIAMMA (Female). Age 12 years.  
 Admitted on 30.5.61.  
 Complaints : Consumed turtle meat on 27.5.61 (eaten only 4 or 5 pieces). Symptoms : vomiting and constipation developed on 28.5.61 evening.  
 Progress of Symptoms : Starts as fever plus vomiting ; constipation ; became drowsy later.  
 General Exam. : Drowsy ; looks very toxic ; no anaemia or jaundiced ; tongue dry plus thickly coated.  
 C.V.S. : Pulse 100/min. regular V + A good ; BP 90/70.  
 C.N.S. : All reflexes sluggish, Plantar—flexor.  
 Al. system : Liver—  
 Spleen—  
 no other palpable.  
 3.6.61 tongue dry-glossitis +  
 4.6.61 Liver palpable.

10. Name : MARIAPPAN (Male). Age 18. fisherman admitted on 30.5.61.  
 2.6.61 Vomiting 6 days ; constipation 4 days ; weakness 5 days.  
 Complaints :  
 History : Ate turtle meat on 27.5.61 night ; developed vomiting ; (Mucoid, frothy material bile stained) bowels constipated since 5 days ; on 29th morning he was admitted to local nursing home and on 30.5.61 he was transferred to government hospital.  
 Family history : Parents admitted to Govt. hospital under similar condition ; 2 children in that family died ; step-mother also has similar complaint she aborted on 30.5.61.

General exam. : Moderately nourished ; not anaemic ; not jaundiced ; no cyanosis ; tongue coated dry and fissured.  
 4.6.61. Liver felt 2 FB below costal margin tender.  
 C.V.S. : Pulse 80/min. regular volume ; tension good ; BP 118/80. Both sounds heard in all no adventitious sounds heard. R.S. normal. Alimentary-bowels constipated ; liver and spleen not palpable.  
 C.N.S. : Patient is semi conscious ; not responding to questions readily ; pupils contracted but reacts to light ; cranial nerves normal ;  
 plantar. Deep reflexes R L  
 Biceps + +  
 Triceps — —  
 Inspiration — —  
 Knee forks — —  
 Ankle forks — —  
 Urine : reaction acid.  
 Temp. 100° F.  
 albumen—nil  
 sugar—nil  
 DCJ P 65, L 3, M 1, E 3.  
 deposits.

11. Name : K. K. SIVANANDAN, Male 35 years (weaver).  
 Complaint : Thirst and dryness of tongue—5 days, ball rolling movement in the abdomen—2 days, vomiting 2 days, constipation 4 days (31-5-61 vomitted twice).  
 History : Ate turtle meat on 27.5.61 at 1300 hrs. All inmates of the house ate same food.  
 Family history : Wife in-patient in the hospital ; one daughter and one son died on 29.5.61. 2nd daughter admitted in the hospital with vomiting.  
 General examination : Moderately nourished, individual not anaemic or jaundiced ; tongue coated, moist and raw at the periphery ; no cynosis.  
 C.V.S. : Pulse rate 80/ min ; regular ; +vde and tension good ; BP 100/80. Heart borders within normal limits ; auscultation—both sounds heard in all the areas ; no adventitious sound ; respiration normal.  
 C.N.S. : Intelligence and memory normal ; no neck rigidity, knee, negative ; pupils react to light ; superficial reflexes ; abdominal +, crenaester +.  
 Deep reflexes : All present but sluggish.  
 Al. system : No visible puncture seen ; liver and spleen not palpable.  
 2.6.61 9 p.m. : Developed mental symptoms, paraldehyde 7 cc given. 3.6.61 5 a.m. patient restless, 4 cc repeated, liver function test.  
 T.C. 4700/cm.  
 D.C. P 69, L. 26, E 5.  
 4.6.61 Patient drowsy ; glossitis +, Stometitis + liver felt 2 FB between one costal margin.

12. Name : KOCHUNNY, Female, age 65 years, admitted on 29.5.61.  
 Complaints : Vomiting since Sunday.  
 History of previous illness : Nil.  
 History of present illness : Vomiting from Sunday morning; vomited several times, vomitus containing frothy mucous; admitted to hospital 29.5.61 she was very drowsy when she was brought here; became unconscious on Tuesday, constipated; she was given stomach wash and enema; passes urine normally.  
 General exam. : Moderately nourished; comatose; not jaundiced; no cynosis; tongue dry coated; pulse 90/min. Reg. V and T. good; BP 140/90; of HG. Both sounds heard well in all areas.  
 C.N.S. : Unconscious; pupils both react to light; deep reflexes, normal; plantar-Flexor.  
 R.S. : No lung signs.  
 Al. System : NAD  
 2-6-61 Patient in coma; pupil react to light pulse 108/min. BP 140/92 deep reflexes all normal, Plantar-Flexor.  
 E.S.R. : = 10 min.  
 P. 66, L 31, M 0, E 3  
 Bl. urea 97 mg.  
 8-15 a.m. on 4.6.61 Complaints of burning sensation in mouth Patient sits up; answers to questions relevantly.  
 5.6.61 Nil particulars. Condition same as Yesterday.
13. Name : NANOO (Male). aged 43. Admitted on 29.5.61 recovering.
14. Name : SASI (Male) age 10 years.  
 C.V.S. : 86/min. BP 120/70 mb of Hg liver and spleen palpable.  
 urine acidic  
 albumen nil.  
 sugar traces (a result of glucose ?)  
 P 81, L 14, M 3, E 2.
15. Name : PURUSHAN (Male).  
 Age : 7 years.  
 Date : 2.6.61.  
 BP. 90/70.  
 Pulse 96/min.  
 Temp. 99.4°F.
16. Name : SUBHA (Female) 4 years. Admitted on 29.5.61.  
 Elder sister and younger sister both died with symptoms.  
 C.V.S. Pulse 110/min. nothing abnormal.  
 General treatment given at the Government Hospital Quilon  
 — Vitamin B complex 2 cc each/or 2 times a day.  
 — Ca injection.  
 — Acromycin I.V.  
 — Glucose I.V.  
 — Saline drip 3 to 5 bottles per patient.  
 — Chloromycetin 1 cap. 4 times all patients.

## ANNEXURE II

### CASE HISTORIES — TUTICORIN INCIDENT MAY 1983

1. Name : ANTONY PITCHAI (Male)  
 Age : 42 years  
 Height : 5' 5"  
 Complexion : Dark  
 Intelligence : Less than normal  
 Health : Not good, weak; squint eyed, anaemic.  
 Profession : Toddy tapper (coolie).  
 Monthly income : Less than Rs. 75 per month  
 Date of eating turtle meat : 22-5-83  
 23-5-83 0600 hrs complained of vomiting feeling, dizziness, headache. Took rest. 0800 hrs took Tom-Tom tonic, a locally made and bottled folk medicine. 1200 hrs dizziness. By 1700 hrs felt normal.  
 26-5-83 No complaint.  
 27-5-83 Treated by Govt. HQ hospital as out patient. Dr. Laxman, L.M.P. treated him with Buscopan and a shot of terramycin.  
 1-6-83 Tongue deeply fissured; Throat is inflamed. Recovering.
2. Name : MRS. ANTONY PITCHAI.  
 Height : 5' 2".  
 Health : Normal.  
 Intelligence : Normal.  
 Occupation : Sweet toddy hawker during season March-June.  
 Income : Rs. 100 per month.  
 Date of taking turtle meat : 22-5-83.  
 26-5-83 No distressing symptoms; on the way treated by Govt. HQ Hospital as out patient.  
 27-5-83 Dr. Laxman, L.M.P. treated her for some difficulty in breathing, stomach discomfort, difficulty in swallowing. (The doctor opines that during mourning severe chest beating might have caused chest discomfort: virtual starving during these days of anguish might have caused stomach discomfort).  
 She was given Buscopan, Terramycin

- 1-6-83 injection, Glucose (oral therapy) Electral, Soda bicarbonate tablets.  
No fissures on tongue. Anaemic. Sore throat, difficulty in swallowing. Recovering.
3. Name : JEBAMALAI RANI.  
Age : 1 yr. Breastfed baby.  
Sex : Female.  
Date on which the mother ate turtle meat : 22-5-83.  
Date on which symptoms showed up : 25-5-83.  
25-5-83 0300 hrs vomiting intermittently, gasping for breath, wheezing; 0600 hrs treated by a paramedical worker; 0700 hrs became stiff; 1235 hrs admitted into Govt. HQ hospital at Tuticorin with diarrhoea and vomiting. Treatment given—Generous quantity of glucose intravenously. Decadron, ampicillin as antibiotic. Supporting therapy B<sub>1</sub>, B<sub>12</sub> 2400 hrs dehydration.  
26-5-83 0300 hrs. Died.
4. Name : MICHAEL RAJ.  
Age : 7 years.  
Sex : Male.  
Date of eating turtle meat : 22-5-83.  
Date of developing symptoms : 24-5-83.  
0800 hrs headache, took one tablet of Anacin and felt relieved; 0900 hrs vomiting incessantly treated by a paramedical worker for vomiting. 1200 hrs appeared to have recovered completely; 1500 hrs threw fits. Instant death Post-mortem conducted at the Govt. HQ Hospital.
5. Name : ANNAMMAL.  
Age : 4 years.  
Sex : Female.
- Date of eating turtle meat : 22-5-83.  
Date of developing symptoms : 22-5-83.  
0900 hrs child slumped down dead without any prior symptoms. (May be no one noticed or the child did not at all complain of any symptom on the previous day owing to the distress in the family).
6. Name : KANISHKAR.  
Age : 6 years.  
Sex : Male.  
Date on which he took meat : 22-5-83.  
Date of developing symptoms : 26-5-83.  
0300 hrs vomiting, drowsy; 0820 hrs admitted into Govt. HQ Hospital. Drowsy; Tachycardia, Conscious; 1000 hrs drowsy, but answers questions clearly; 1130 hrs burning sensation in the stomach and abdomen; 1200 hrs vomited twice drowsy but rousable.  
27-5-83  
1300 hrs threw fits, sedation given; 1330 hrs slipping into coma; comatose; respiration hurried; pulse feeble; neck stiff; 1535 hrs death. (Therapy Glucose intravenously. Decadron, Ampicillin. Supporting therapy B<sub>1</sub>, B<sub>12</sub>. Sedative (not Siquil).
7. Name : NICHOLAS.  
Age : 5 years.  
Sex : Male.  
Date of taking meat : 22-5-83.  
Symptoms : Till date that is, 1-6-83 had not developed symptoms except sore throat.  
26-5-83 Was treated as out-patient at the Govt. hospital. Dr. Laxman, L.M.P. treated the boy with Glucose (oral) Buscopan (for throat inflammation) Terramycin, Electral. Appears to be in good health.

**OBSERVATIONS ON THE MASS NESTING AND IMMEDIATE POSTMASS NESTING INFLUXES OF THE OLIVE RIDLEY *LEPIDOCHELYS OLIVACEA* AT GAHIRMATHA, ORISSA-1984 SEASON**

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S. S. DAN AND A. BASTIAN FERNANDO

**ABSTRACT**

Observations made during the mass nesting of the olive ridley *Lepidochelys olivacea* during January-February, 1984 at Gahirmatha rookery, Orissa is reported here along with some details on the nature of immediate post-mass nesting influxes. Strangely a large number of abnormal animals were seen to nest during the lean phase of nesting. The nature of the abnormalities, along with likely routes of the breeding migration, non-human predation of nests and environmental problems at Gahirmatha are discussed here.

**INTRODUCTION**

The mass nesting or 'arribada' of the olive ridley *Lepidochelys olivacea* commenced at Gahirmatha this year on 25th January 1984 when about 5000 turtles emerged for nesting. Thereafter, the intensity increased steeply and on the nights of 29th and 30th January in some short stretches of 100 metres about 2000 or more turtles came ashore for nesting. The mass nesting continued until 6th February from which date the numbers very sharply declined to a few hundred and on the night of February 9, there were hardly about 100 turtles nesting. A second minor peak in the breeding is expected around the last week of February or early in March.

Unlike previous years when mass nesting took place along a stretch of more than 10 km of the Gahirmatha Beach, this year it was conspicuously confined to a very short stretch of about 5 km in the northern sector from Ekkula to Ekkulanasi. Here again, the nesting intensity was greater over a stretch of 3 km south of Ekkulanasi, leaving about 200 metres at the northernmost limit where the Ranahansua-Patsala River enters the sea. The latter was due to this stretch of beach becoming inundated during high tide, water entering from both sides. The nesting in the southern sector between Ekkula and Habalikhathi was very sporadic.

A very significant deviation from the previous years was the protracted mass nesting from 25th January to 6th February, viz., 13 nights. Normally the event occurs within a short period of 4-5 nights. A rough estimate was that about 3 lakh turtles would have visited the beach for nesting. More precise estimates are being worked out by the Gahirmatha Marine Turtle Research Centre.

The turtles start emerging from the sea around 2000 hrs and continue until about 0500 hrs, the maximum emergence being after midnight. The animals first propped their heads out of water, rested for a few minutes after coming out of water and proceeded slowly up the beach. They frequently stopped with mild hissing sound, rising their heads and ultimately stopped in a place much above the high water mark to scrap out sand to make the egg pit. The general sequence of events was as that observed for the olive ridley nesting along the Madras Coast with slight variations in individuals movements. Only quantified data will reveal such finite behavioural differences, which may also be associated with factors such as the age of the animal or nature of the substratum. Since Silas and Rajagopalan (1984) have given the general sequences of nest building activity in the olive ridley, this is not repeated here. One difference noted was that due to earlier nesting, very often some of the subsequent

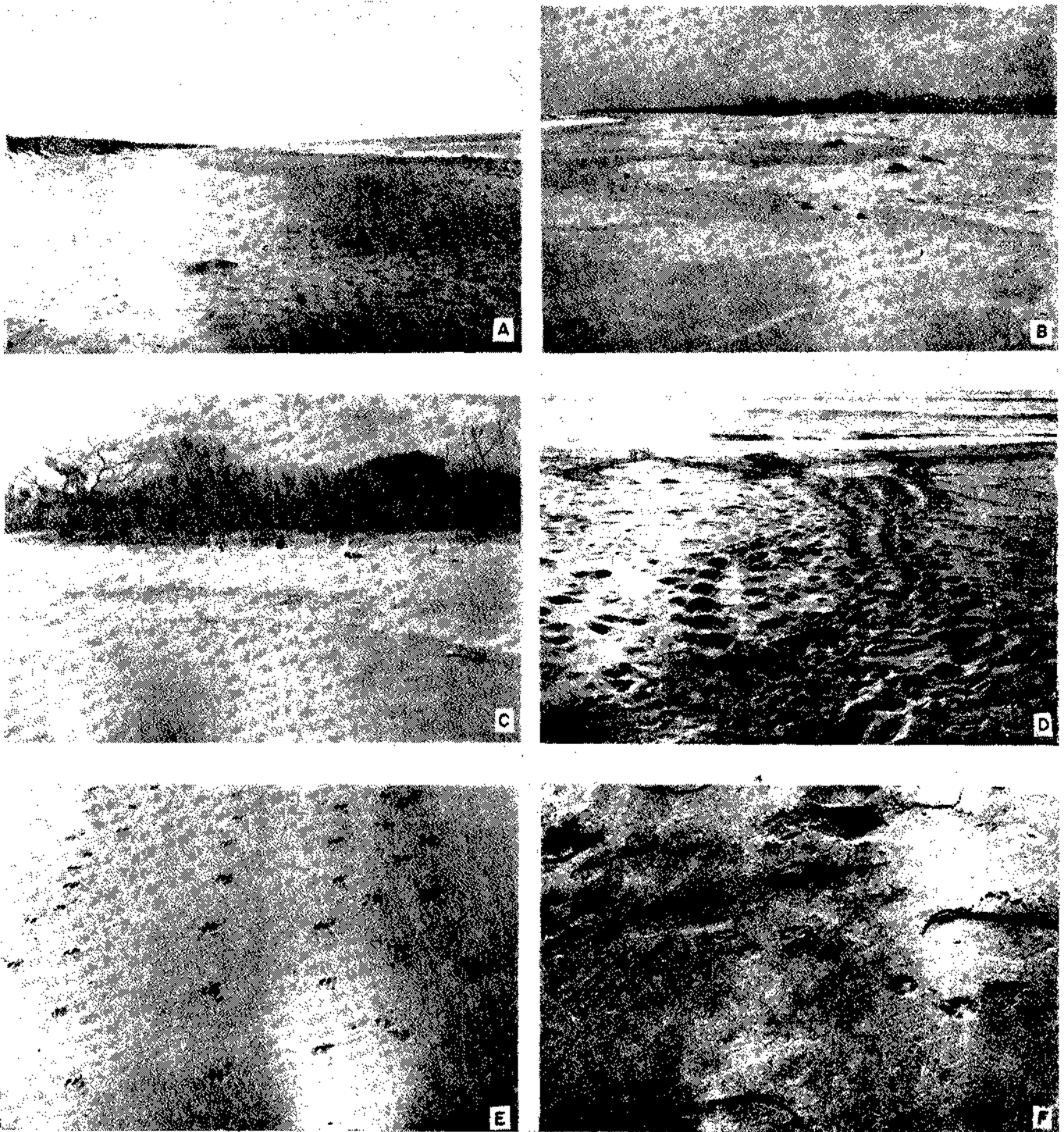


PLATE I A and B. Gahirmatha beach north and south of Ekkula ; C. Outer fringe of withered mangrove vegetation close to Habalikhali due to heavy accumulation of sand resulting from the 1976 and 1981 cyclones ; D. Crawl track of a nesting olive ridley ; E. Hoof prints of wild boar and F. of Jackal at Gahirmatha beach. (Photos E.G.S.)



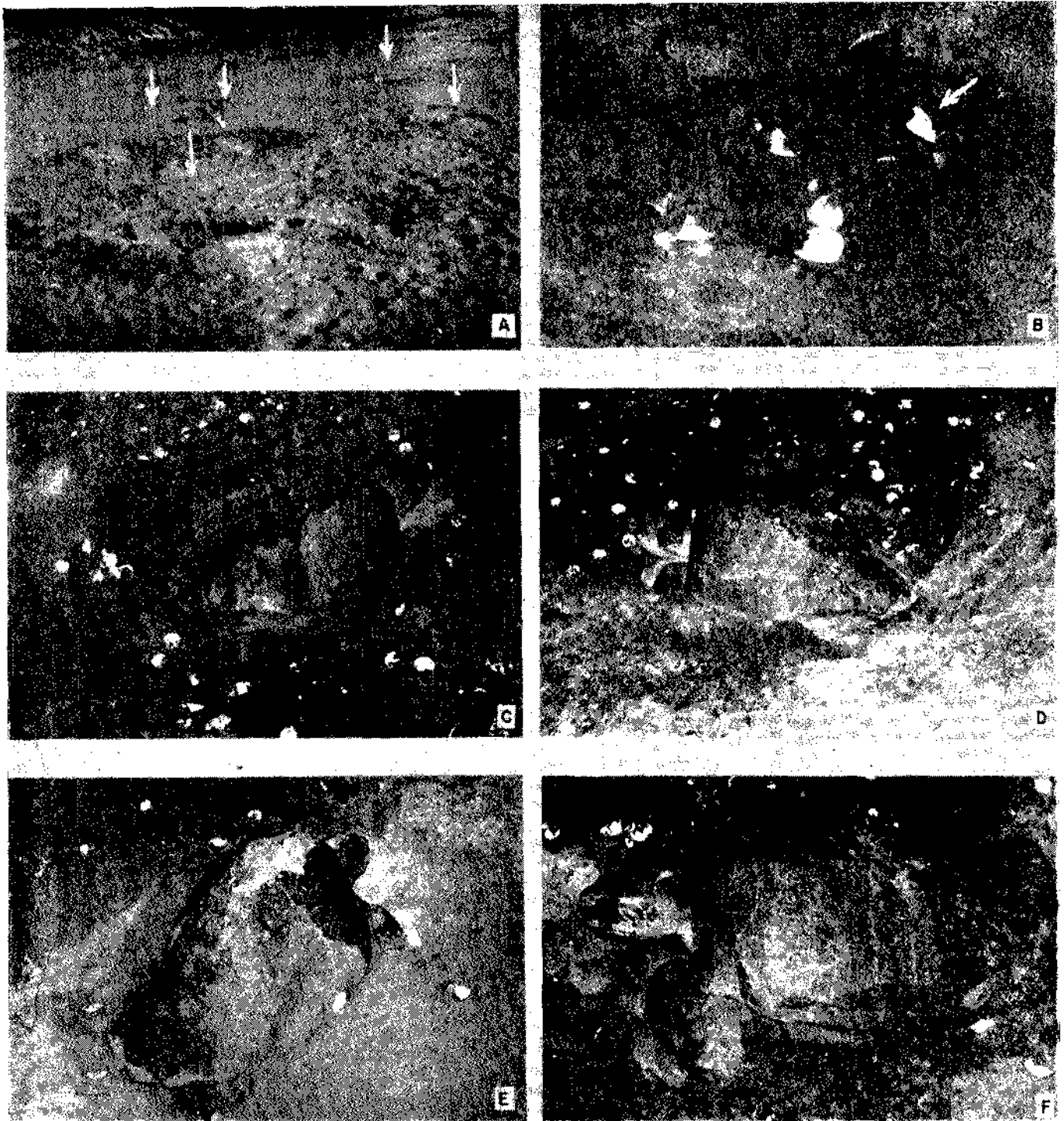


PLATE II Egg predation and destruction of nests and eggs at Gahirmatha beach. A. Arrows indicate dug out nest by jackals and dogs ; B. A ghost crab *Ocypoda macrocera* seen feeding on eggs rapidly entering a burrow ; C-F. Heavy destruction of nests and eggs by subsequent waves of olive ridley during resting activity. (Photos E.G.S.)

nests were shallow, hardly 25 cm deep. In a few clutches observed the numbers varied between 70 and 159 eggs. The carapace length of nesting females was found to vary from 63 to 75 cm with modes at 64-65 and 70-71 cm. Nesting in some places along the beach was even upto 57 metres from high water mark.

#### INCIDENCE OF ABNORMALITIES IN NESTING OLIVE RIDLEY

Abnormalities and teratological conditions were seen in turtles both at the mass nesting phase as well as during the post-mass nesting phase. We found that the incidence was relatively high, being as much as 10 per cent or more in specimens emerging for nesting after the mass nesting phase. We have no quantified data of incidence of such during the mass nesting itself. However, on the night of 9th February 1984, out of about 100 nesting turtles over the 5 km beach north of Ekkula, 74 actual nestings were observed and followed up by us. Of these atleast 12 animals had abnormalities or teratological conditions which we consider as very significant. Some of the turtles were so mutilated that one would shed tears seeing them struggling with their stumpy hind limbs to scarp the sand for nesting. Very often where the hind flipper was badly damaged on one side, for long spells the turtle never felt 'satisfied' by the pit it had dug and in one case went on for over 45 minutes trying to scrape out the sand with one good hind flipper, eventually returning without oviposition.

We feel that there is a priority need for categorising the different types of teratological and damaged conditions due to mutilations and subsequent healing at an earlier stage of life, either as hatchlings or subadults in the sea. Looking at the healed mutilations it is incredible or even astounding how these animals could have survived and maintained normal life habits, though they may be stragglers.

Published literature does not throw much light on such a phenomena. Hence we feel that the whole problem needs a critical indepth study, categorising the different types of malformations, timing the ingression of such animals in relation to the mass nesting and postmass nesting activities and finding the causative factors that may be responsible for such maladies and their overall impact.

On February 1, 1984 the following was noticed :

1. A turtle of 65 cm carapace length was observed returning to sea, with the distal half of the right side of the carapace missing. It is likely that the turtle when young escaped from the predator which could take only

a chunk off the right side of the animal, the damage having healed subsequently, with movements not impaired.

2. A turtle with 72 cm carapace length which came for nesting was found with all the four flippers bifid. This could be a teratological condition.

3. In another instance, a turtle was found labouring hard to make an egg pit with no avail since both the hind flippers were stumpy. The animal could scrape hardly 15 cm shallow depression in which it laid the eggs and returned to the sea dragging itself with the front flippers after making a semblance of covering the nest.

On 9th February 1984, more such instances were observed among nesting females and some were photographed. The types may be categories as follows :

- I. Large chunk of posterior lateral half of carapace missing, but hind flippers normal.

#### *Variabilities :*

- a—Damage on left side.

- b—Damage on right side.

- c—Damage to also hind flipper of both left and right side or only one side.

1. Hind flippers on one or both sides either tapering or mere stumps and most ineffective for digging the nests. Surprisingly without them the animal keeps pace in surviving with normal animals ! How ?

2. Anterior or posterior flippers being either deeply cleft or bifid. They do not appear as being the result of a mark recovery experiment. The extent of the cleft is variable and to what extent this would impair life activities is worth looking at.

3. Damaged or cracked carapace or broken appendages, especially front flippers both of which could be the result of detaching the animal from the fishing gear and letting it off or due to other encounters.

4. Malformations, teratological conditions or external-visible growths.

We have not included here minor malformations such as abnormalities in scute orientations nor internal physical imbalances which may border on diseases.

To be more specific the conditions seen on 9th February 1984 at Gahirmatha are as follows :

a. In three of the nesting females the entire posterior carapace from the 4th posterior costal backwards on the left side was not present exposing the side of the body as well as the hind left flipper (Plate III A-C). In one of these specimens, both the hind flippers were mere stumps hardly 5 cm long, the belly bulging between the carapace and plastron becoming more conspicuous. The animal made long and strenuous efforts to make a nest with no avail. Finally the animal crawled back to the sea.

flipper was also partly damaged. However, the animal was able to successfully nest (Plate III D).

d. In eight nesting animals the posterior flippers had very long notches but this did not impair nesting activity and oviposition which were normal.

e. In one specimen the left anterior costal was cracked and badly damaged and the front flipper was also broken at midlength, the terminal half dragging.

f. A female on its ingress to the sea was found to have a large conspicuous protruding bulge (2 kg in weight) just in front of the left hind flipper (Plate III E,

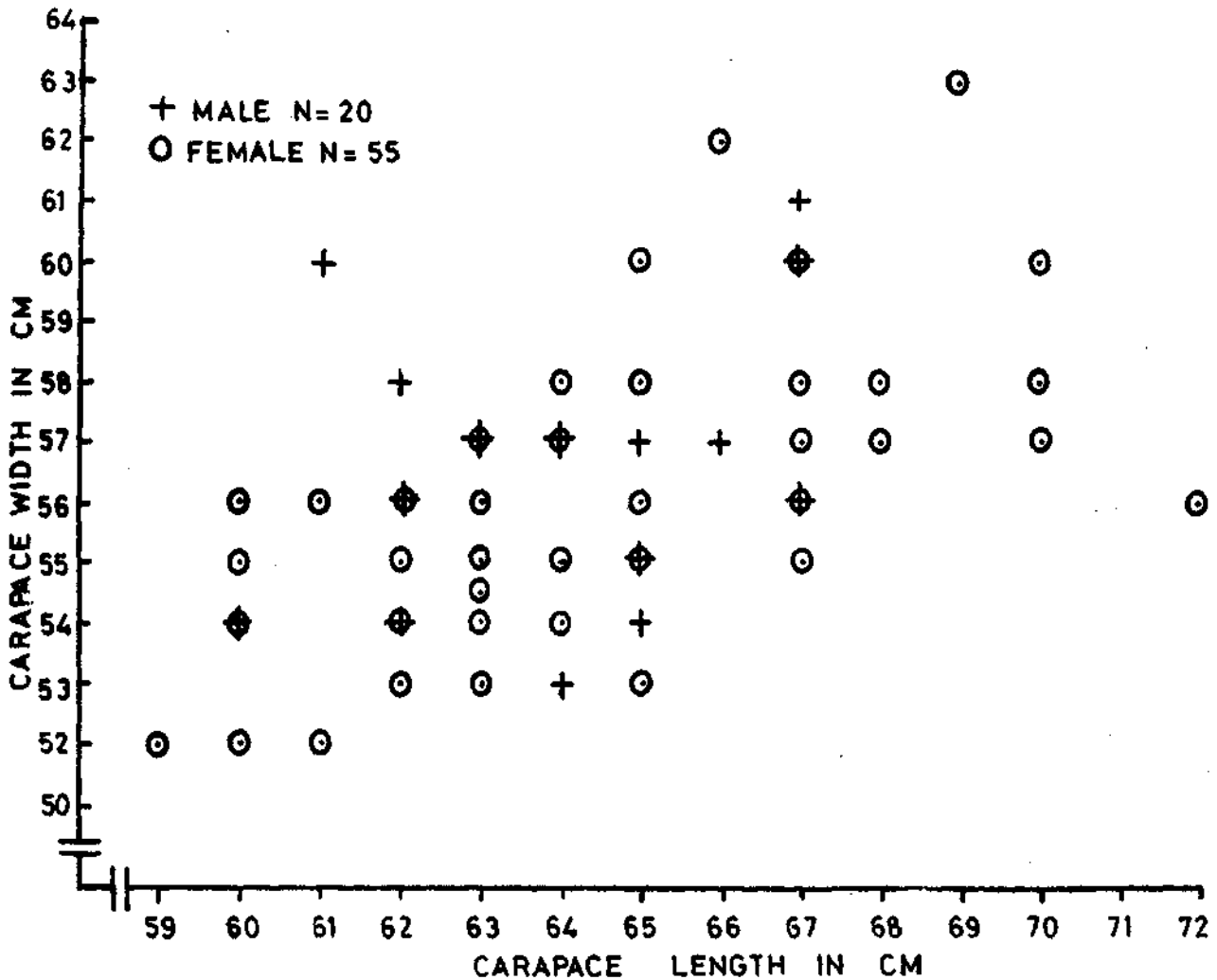


FIGURE 1 Scatter diagram indicating length and width of carapace (straight line measurements) in stranded carcasses of *L. olivacea* at Gahirmatha during the 1983-84 season.

b. In another turtle, when the left hind side was mutilated, but healed, the hind flippers were both tapering to a length of about 12 cm and the animal could not successfully nest.

c. In yet another turtle, with similar carapace damage on the right posterior part, the right posterior

F). The animal had difficulty in crawling and its movements were erratic.

The carcasses were also examined for size measurements and sex (when possible). The larger size of the female is note worthy (Fig 1) to what extent these represent remigrations of older year class is not known,

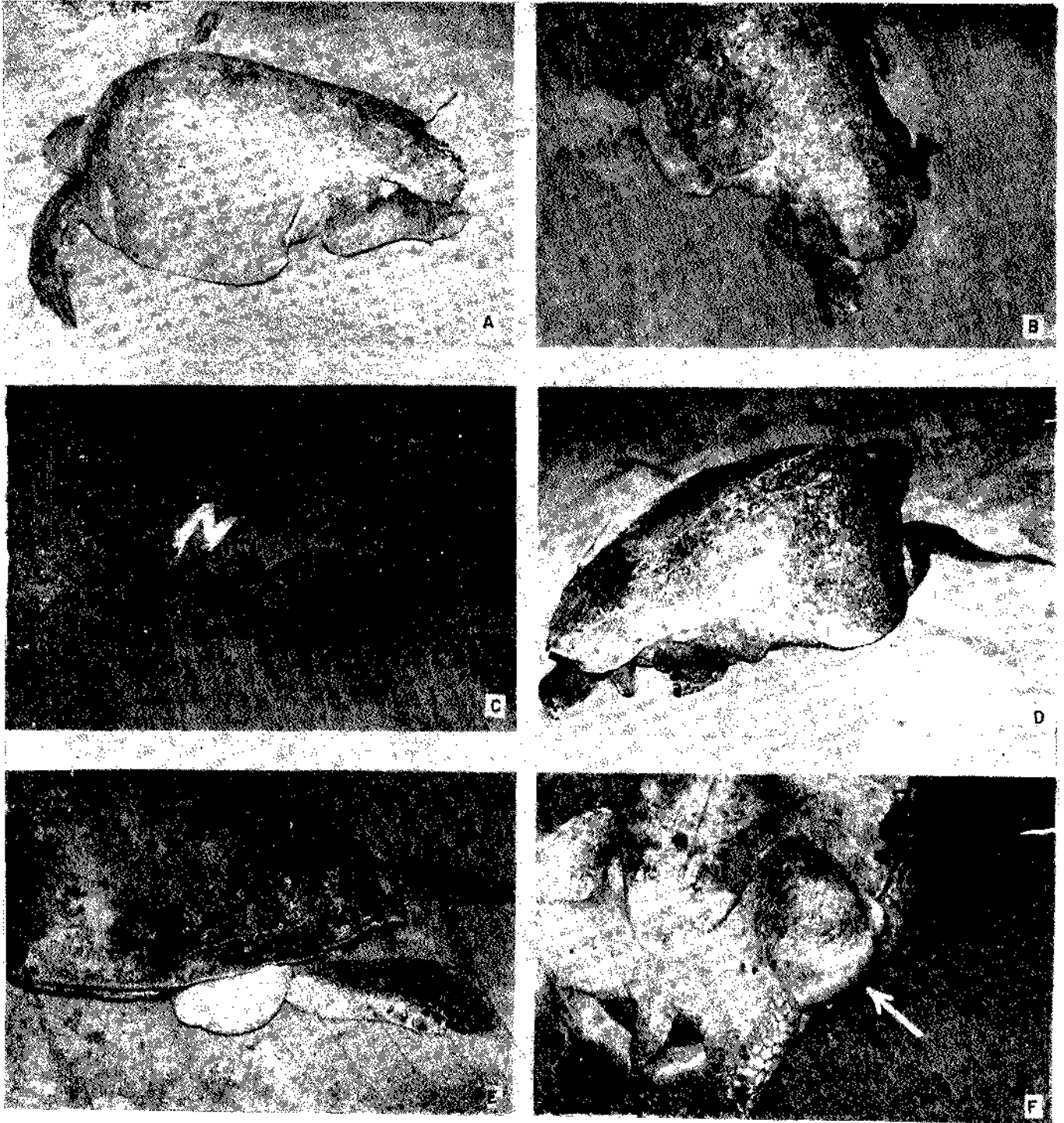


PLATE III A—F. Some of the mutilated and abnormal olive ridley seen nesting on 9th February 1984 at Gahirmatha beach. A and B are the same animal; E and F show a large abnormal growth at the axil of the left hind flipper. (Photos E.G.S.)

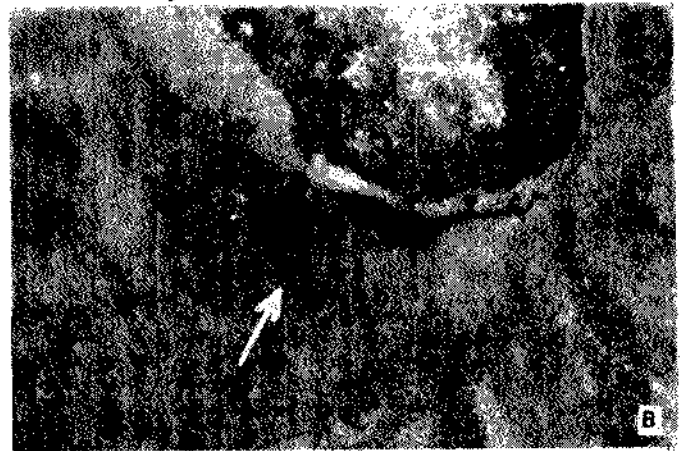
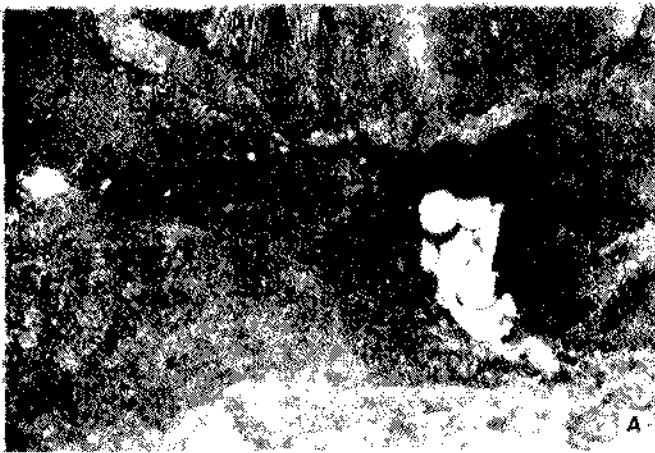


PLATE IV Gahirmatha, Orissa. A. Nest with eggs before completion of oviposition. B. The inward flexing or cupping of the left hind flipper to scoop in sand for covering the nest; D and E. Carcasses of a male and female olive ridley washed ashore respectively; E. Hoof prints of wild boar leading to carcass of olive ridley; and F. Shri Chandrasekar Kar in front of the Gahirmatha Marine Turtle Research and Conservation Centre set up by the Forest Department, Government of Orissa. (Photos E.G.S.)

Interestingly one specimen was found with the left hind side damaged as given under (b) above.

The points which emerge from these observations are :

1. How do these maladies occur ?
2. Do the weaker or affected animals reach the nesting grounds later ?
3. Is courtship and mating possible with their deformities and delayed arrival? In short do they lay fertilized eggs or lay a full clutch ?
4. If they are not able to successfully nest on one emergence, do they return the next day or thereafter or drop the eggs in the sea ?
5. The need for quantified data on the proportion of abnormalities, once they are categorised, should throw some light on whether some of these deformities are present even in the hatching stage caused by stress during development.

#### NEST PREDATION AND OTHER CONSTRAINTS

During our visits we found dogs and jackals, and wolf (?) digging the nests for eggs. While the daily depredation is of a high order, the repeated destruction to nests during the period of incubation of eggs will have a serious cumulative effect. This is one aspect which cannot be ignored and calls for critical assessment. Earlier literature speaks of the non-human egg predators getting satiated after the first few days and the predation level rapidly declining. At Gahirmatha during the mass nesting season, since about fifteen enumerators were working on different stretches of the beach, we felt predation by animals may on these nights be lower, but may continue unabated during day time and at dusk. What could happen in the later half of the incubation period and between pipping and emergence of the hatchlings is a guess. Definitely greater predation is present when the beaches are untended.

Estimation of the number of nests and the approximate number of eggs that may be destroyed will be necessary. A rough survey carried out by us is given in Table 1.

On 10.2.1984 we found some crows picking on eggs from nests which had been earlier dug up by a dog at the Ekkula field centre. During the previous night we also noticed the ghost crab *Ocypoda macrocera* feeding on eggs in one damaged nest.

Unintentional but equally serious, if not of greater consequence, is the damage to nests caused by turtles coming to nest on different nights. This year due to the arribada taking place over a restricted stretch of the

TABLE A. Details for number of destroyed nests observed in February 1984, at Gahirmatha, Orissa

Place	Km	Number of destroyed nests	Date
Ekkula Nasi ..	0-1	24	11-2-84
	1-2	268	..
	2-3	984	..
	3-4	1316	..
	4-5	923	..
Ekkula ..	5-6	972	12-2-84
	6-7	240	..
	7-8	25	..
	8-9	11	..
Habalikhati ..	9-10	7	..
Total ..		4770	

beach over a larger number of days the situation was really bad. Since many of the nests were shallow, nesting turtles were seen to scrape and throw about a large number of eggs and some were invariably damaged or exposed. It is as though the clutches of eggs are packed in close tiers in some places where repeated nestings have taken place. What would this mean in terms of incubation and development, especially at the pipping and emerging stages of the earlier laid batches and the effects on the unhatched upper layers of the eggs? We have no answer. Silas and Rajagopalan (1984) found that unhatched eggs in a clutch at the time of emergence of hatchlings, if disturbed may end up in arrested development. This is one aspect which has to be looked into while estimating hatching success. Considering this, we feel that at Gahirmatha the answer to better management would be the transplantation of eggs in the lesser used stretch of the same beach. This is also very essential that during the arribada some of the turtles nest in the intertidal area, the clutches of which if not transplanted, may result in total loss.

During our visits we found that petromax light and torch light did disorient the nesting and emerging turtles. In one case we noticed a female which had just emerged from the sea turning back due to the light. We wonder whether under stress, turtles drop eggs in the sea! One of us (A.B.F.) has observed such a happening in the olive ridley in a fishing net in the Gulf of Mannar at Tuticorin.

We were glad to notice that the enumerators carrying out the census of the nesting turtles under the supervision of Shri Chandrasekhar Kar did their job with the least amount of use of torches.

#### INFORMATION ON TAGGING AND TAG RETURNS

The Divisional Forest Officer Shri S. K. Mishra at Chandpali told one of us (E.G.S.) that tagging of turtles which commenced during the 1977-78 season had not so far given any encouraging results. In fact as late as the beginning of 1984, there have been hardly about 87 returns of about 15,000 tags used. The re-nesting returns have also shown differences from year to year with practically no returns during the 1982-83 season. Detailed analysis is being conducted by Shri Chandrasekhar Kar who had initiated the programme and who has been involved with the tagging. The tags used by him are the monel metal type which bear a number on one side and the following inscription on the other side :

#### REWARD RETURN CHIEF WILDLIFE WARDEN, BHUBENESWAR, ORISSA, INDIA.

Since no tagging was undertaken during the 1983-84 season by Shri Chandrasekhar Kar, we have used similar monel metal tags from the CMFRI bearing the number on one side and the inscription on the other as follows :

PLEASE RETURN TO  
CMFRI, P.B. 1912  
COCHIN, INDIA

At the Institute a monitoring system for sea turtle caught incidentally in fishing operations along the coast is being developed and in this connection, we are glad to record that one of our staff Shri K. V. Seshagiri Rao has got a tag return from Narasapur Field Centre. He has sent us the information that between 20th and 22nd January 1984 a turtle was caught in shore-seine net at Peddamylavanilanka (South), 24 km south of Narasapur, bearing the number 14938 with the details of returning the tag to the Chief Wildlife Warden, Bhubaneswar, Orissa inscribed. The turtle was released by the fishermen after the tag was removed. The identity of the species is not difficult since only the olive ridley has been tagged with these tags at Gahirmatha. It is hoped that with the strengthening of such a monitoring system along the coast, we will be able to obtain a clearer picture of the migratory route of the nesting turtles during the inter-nesting period as well as much needed information on feeding grounds. 900 CMFRI monel tags have also been left with Shri Chandrasekhar Kar to continue the tagging operations from Gahirmatha beach on the turtles coming for nesting after the mass nesting phase.

Shri S. K. Mishra, informed one of us (EGS) that about the end of November 1983, the Government of Orissa had received a message from the Coast Guard

of the sighting at sea of large number of turtles moving northwards off Pondicherry. It is not known whether these turtles could have reached the Orissa Coast towards the end of December and early January since courtship and mating was noticed off Gahirmatha Coast during the later period. The stranded carcasses of males and females at Gahirmatha Beach, as already mentioned earlier, testified to the occurrences of the species in large numbers off the coast. Fishing being on, the carcasses seen could have resulted from incidental catch. Added to this, the tag recovery from Peddamylavanilanka (South) near Narasapur may be indicative that olive ridley migrates almost the entire length of the east coast to reach the nesting grounds along the Orissa Coast with probably stray numbers digressing to the shores along Tamil Nadu, Andhra Pradesh and south Orissa during this period. At CMFRI we have alerted our field staff to inform the fishermen about the tagged turtles for helping in future recoveries. In the accompanying text figure (Fig. 2) we have presented the major activities of olive ridley discussed above. It will be interesting to know whether the olive ridley mass migration commences from the Palk Bay, Gulf of Mannar and further south and goes on to the Orissa and West Bengal Coasts or whether this is only one of the pathways of part of the population, the others converging from the Bay islands (Andaman-Nicobar area). We feel that there is a need for extensive tagging of this species at different centres so that we will have information not only on the routes of migration and the feeding grounds but also on the strength of annual remigrations over a longer period of time.

Tagging at the courting and mating phase of the olive ridley out at sea will also be necessary and is possible in larger numbers along the Orissa Coast.

#### PROBLEM OF BEACH EROSION

From what we have seen at Gahirmatha, one of the most crucial issues is going to be whether the Gahirmatha beach will still exist a decade hence ! There is heavy erosion on the southern part of the beach which has eaten away hundreds of meters of land. Shri S. K. Mishra, informs us that in the recent past the Forest Department has lost two full blocks due to erosion. We have elsewhere (Silas *et al.*, 1983) reported on the stumps and remains of mangrove in the intertidal region in the southern sector of the Gahirmatha beach close to Habalikhathi. The vast pile up of sand among mangrove vegetation during 1976 and 1981 cyclone which had affected the area is still evident with a broad fringe of withered mangrove over a few kilometres stretch (Plate I, D).

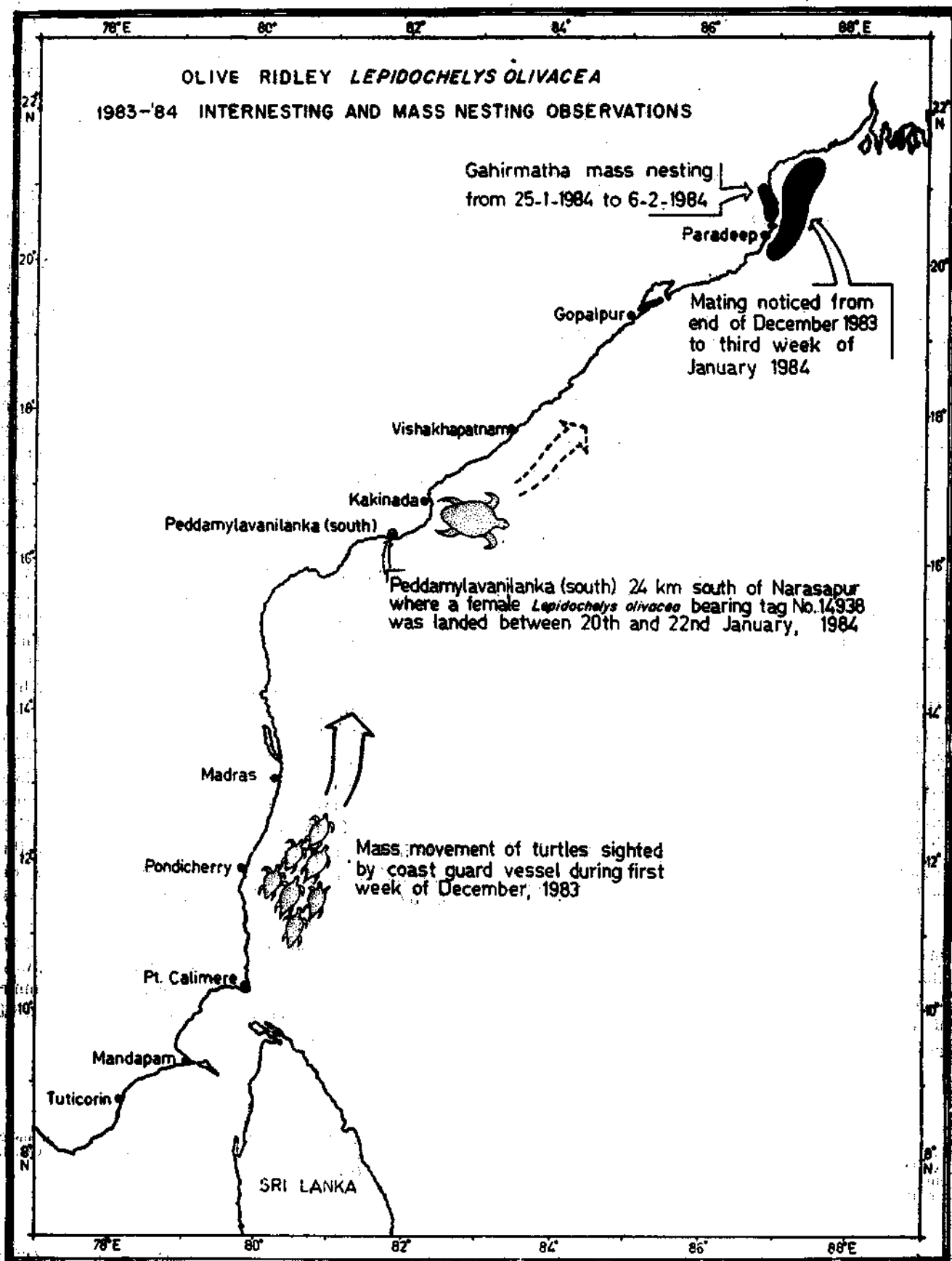


FIGURE 2 Map showing the interesting and mass nesting activity phases of the olive ridley during the 1983-1984 season.



In view of the mass nesting of the olive ridley along this beach, any reduction or changes of beach configuration and profile would also adversely affect the rookery. We would urge that the Government of Orissa take immediate steps to tackle the problem of erosion along this coast so that corrective measures may be taken which may not affect the beach itself. Mining operations if in vogue in adjacent areas or man-made engineering works which could result in erosion and accretion in different places should receive special attention. The expensive sea walls as constructed along Kerala Coast is not going to be a solution to the problem since this will not allow for nesting turtles to come ashore. The matter is one of urgency needing a multidisciplinary approach of hydrological and related studies to ascertain the causative factors for erosion and see how best this could be prevented.

#### POACHING OF TURTLES IN WEST BENGAL 1983-84 SEASON

Unlike the previous years, directed turtle fishing was not carried out this year. But incidental catch from gill nets were hidden and transported in wooden boxes and bamboo baskets in such a way that it is difficult to trace. They appeared at Howrah market in December 1983 at the rate of 7 to 87 per day. The Forest Department of the Government of W. Bengal apparently did not take any action against the storage and sale of turtles at Howrah market during the period. Turtles were observed at Howrah market as follows :

Date	No. of turtles at Howrah market observed
5.12.1983	15-20
6.12.1983	22
7.12.1983	7
8.12.1983	16
9.12.1983	36
10.12.1983	58
11.12.1983	87
13.12.1983	64 (26 Nos. came as fish by relay in baskets)
14.12.1983	33
16.12.1983	15 (tied in bamboo baskets each containing 2-3 animals)

On 30.1.1984 night Forest Department officials of Contai obstructed one truck carrying 74 sea turtles (olive ridley) at Bajkul chekpost of the Forest Department and produced the same before the Judicial Magistrate of Contai. The merchants defended that

the turtles captured are not covered by the Indian Wildlife (Protection) Act, 1972. The Additional Divisional Forest Officer, Midnapur was brought to identify the turtles and these were released into the sea at Junput. The earlier cases pending in the Court have not yet been decided.

#### EVOLVING PUBLIC POLICY ON CONSERVATION OF THE OLIVE RIDLEY

One of the most significant events that happened during the 1984 mass nesting of olive ridley was the visit to Gahirmatha by the Honourable Chief Minister of Orissa to witness the event. On this occasion he made it known that the inshore waters for a stretch of 20 km and width from the coast of 10 km would be prohibited for fishing. This pronouncement certainly had its effect in that the fishing effort was almost nil during the mass nesting period. It is to the credit of both the Government of Orissa and the fishermen sector that without promulgating a regulatory fishing Act they have been able to achieve self-regulation to this extent during the season. This is also evident from the very few carcasses that has been washed ashore during the 1984 season. Our examination of the carcasses indicated that these were washed ashore during December and January when courtship and mating of turtles of Gahirmatha coast was noticed and fishing operations were also in vogue. As on 12th February 1984 the total number of Carcasses between Habalikhathi to Ekkulanasi (10 km stretch of beach) was 392 of which 24 per cent were identified as males. When compared to the 1983 season of over 7500 along a stretch of 15 km, this is only a very small fraction mainly accounted by the pre mass nesting fishing activity. We hope that greater awareness through proper extension programmes at the village level would be initiated in the State so that the artisanal fisheries sector could be fully taken into confidence to also help in the conservation programme. They could certainly do this by voluntary restriction of fishing activities or releasing live turtles from gill nets as soon as they detect the same instead of allowing the net full soaking time. Small steps of this nature would go a long way in strengthening the sea turtle conservation programme and perhaps Orissa could lead the way for the rest of the country in this matter.

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