TECHNICAL SESSION VI

CONTEMPORARY PROBLEMS IN SEA TURTLE BIOLOGY AND CONSERVATION — THE URGENT NEED FOR REGIONAL CO-OPERATION

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— CONTEMPORARY PROBLEMS IN SEA TURTLE BIOLOGY AND CONSERVATION

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— Discussion

CONTEMPORARY PROBLEMS IN SEA TURTLE BIOLOGY AND CONSERVATION

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Introduction

I must clarify from the beginning that I have neither the intention nor the time to give a detailed listing of biological and conservation problems, rather, my purpose is to give some insight of the variety and magnitude of these issues. Two philosophical points are intimately related to the overall topic: First during the course of the last few weeks some dear and respected friends have been introducing me as a 'Sea Turtle Expert'. While I have been actively involved in sea turtle research and conservation in a score of countries, in all oceans, over the past 15 years, I am not a *sea turtle expert* — nor have I ever met one. Yes, I have more experience with this subject than most people, but my knowledge is inadequate to enable me either to consistently make accurate predications about sea turtle biology or to effectively manage stocks of sea turtles. I hope to convince you that it will be a long time before a 'sea turtle expert' walks this planet.

Second, we often fool ourselves into believing that the information relevant to a topic is finite. It is increasingly common for some biologists and administrators to treat biological knowledge as a tangible object subject to property laws and sovereignty. In fact, there are no bounds to biological knowledge — discovering one small fact results in the realization that another dozen questions need to be answered. Indeed, living systems are so dynamic and mutable that there some times does not even seem to be stability in biological knowledge.

Now, if the major benefit of learning about biology is to understand and help manage the living systems of which we are a part and so inextricably dependent, we should strive to make as much biological knowledge available as soon as we can. Two key actions that are required for this end are communication and cooperation. This Workshop is an illustrious example of just these principles, but unfortunately there are many examples in conservation activities where non-cooperation seems to be the dominant factor. This Workshop is an omen that common sense will prevail in dealing with sea turtles here in India.

I am indebted to several colleagues — original members of the Sea Turtle Specialist Group — and organizations for the opportunity to participate in the Workshop; particularly Dr. E. G. Silas and Shri J. C. Daniel for their expert organisational abilities and Shri R. Whitaker for constant encouragement and support. Invaluable facilities and logistic support were provided by the Madras Crocodile Bank and Madras Snake Park. Mrs. Brenda Bhaskar has miraculously transformed quickly scribbled manuscript into readable English.

Contemporary Biological Problems

The contemporary biological problems that I have selected as examples were chosen to illustrate not only the variety of subjects about which we know too little or nothing, but also the fact that many very basic points have yet to be understood. Developing whole fields of knowledge is dependent on understanding these basic points. We can start with the kinds of sea turtles. It is hard to imagine a group of animals that is more distinctive, more easy to recognize. Yet, despite the fact that there are only a few kinds of sea turtles — no one knows exactly how many there are. Seven is the number usually stated to exist, but there might be only 6 or perhaps as many as 8. Without knowing with certainty how to distinguish one kind from another; the information we gather is liable to mix different species, and hence, it will be of little use. Luckily for our purposes, there do not seem to be 'Problem populations' in this region.

The largest of all the sea turtles and all turtles, is the leathery *Dermochelys coriacea* (L.). Besides its size there are several features that make this animal distinctive, including seven longitudinal ridges on the top shell or 'carapace' and an absence of horny scales. Numerous published accounts — by experienced people (*e.g.* Pritchard, 1980) — claim that this turtle has no external keratinous structures. This is mis-information and typifies many of the contemporary biological problems : Although the beak is very reduced, there is a small horny sheath, and hatchling leathery turtles are covered with scales for the first few days of life. This is important because it is critical evidence for a particular evolutionary history-leathery turtles have not omitted the production of external keratin, merely reduced it or gone a step beyond by discarding it.

The beak has deep notches and cusps, completely unique to this turtle. Yet, the function of these is unknown. One would assume the structure to be related to feeding, and although there are detailed analyses of stomach contents of leathery turtles (Brongersma, 1969), there are no detailed osbservations of leathery turtles feeding in the wild (Frazier *et al.*, in press).

At the other end of this turtle are other unique features — the caudal projection and a thick membrane that unites the hind legs and tail. Probably these are locomotory adaptations, one reducing drag and the other providing an unusually large surface for propulsion and/or steering. But, we do not know the answers because no one has recorded the details of how this animal swims in the wild. We lack basic, but careful, observations of feeding and locomotion.

The smallest of the sea turtles, smaller than some of the freshwater turtles in India, is the ridley *Lepidochelys olivacea* (Eschscholtz) which also has several unique features. Flipping it over one finds 4 large scales at the sides of the belly shell, or 'plastron'. These are the 'inframarginals', and each of them has a conspicuous pore. All sea turtles in the family Cheloniidae have pores, a fact which is not widely known, but only ridleys have obvious pores in the inframarginals. In the other species the pores are in the axillary and inguinal scales and they are most visible in small turtles. Is it significant that small individuals of the large species and all individuals of the smallest species have obvious pores? The associated ducts and fatty tissue are sometimes called 'Scent glands' (Smith, 1931) and they may release an offensive chemical to make small turtles less attractive to predators, or they may function in chemical communication. But, we have no direct evidence of their use or purpose.

Despite our ignorance about the function of these pores, they are invaluable for differentiating the ridley from the loggerhead *Caretta caretta* (L.). These two species were confused years ago, for both have relatively large heads and more scales on the carapace than other turtles in this family. The loggerhead can be used to illustrate other kinds of problems; consider the distribution of this turtle: In the East Pacific, although other species are abundant, the loggerhead is rare; from Alaska to Chile no one has ever found one nesting (Frazier and Salas, in press). In the Indian Ocean this turtle is also relatively uncommon. Only areas where nesting regularly occurs is in the southwest (South Africa, Mozambique and Madagascar) and on Masirah Island, Oman. Other species of turtle are widely dispersed throughout the same region. Curiously the Masirah population is the biggest in the world (Frazier, in press). Too little is known about the habitat requirements of this (or any other) turtle to be able to fully explain or understand its geographic distribution.

In the Mediterranean, where the loggerhead is the most abundant sea turtle, it is common to find turtles whose shells are covered with live animals and plants. In fact, the sea turtle is often an island ecosystem. Oysters 12 cm across have been found on these turtles. The occurrence of these epizoa give valuable clues as to the microhabitats where the turtles live, but this information is only now beginning to be collected and analyzed (Frazier *et al.*, in prep.).

The hawksbill turtle is characterised by its thick overlapping scales, the source of 'tortoise-shell'. Yet, no one seems to have pondered the reason for the usually thick shell on the hawksbill.

Is it to protect a turtle which is relatively lethargic and subject to infestations by sessile invertebrates from the ravages of burrowing barnacles ? Too little is known of the turtle and its parasites.

In the western Indian Ocean the hawksbill has the unusual habit of nesting during the day time, but it is unclear why (Frazier, 1984). Indeed, the reason for the more usual nocturnal nesting is not fully understood.

Best known of the sea turtles is the green turtle *Chelonia mydas* (L.). Yet, despite its common name, little attention has been given to the colouration of this turtle. There are marked ontogenetic changes : hatchlings are dark blue/black above ; at six months they have more chestnut-brown, and by one year they are mainly chestnut brown in a pattern of rays ; immatures of several years of age develop the characteristic greenish ground colour found in adults. In addition to age-dependent changes there are sexual differences : females have concentrations of pigment in all scales with most dark pigment in rays ; males often do not have concentrations of pigment and usually have dark pigment in spots. Not only have these obvious features been poorly studied, but there is no good explanation for the colouration (Frazier, 1971).

By pooling information from all species and filling the many remaining gaps by inference and imagination, it is possible to construct a generalized life table. This can be simplistically partitioned into 10 phases : (1) terrestrial nest, (2) sea going hatchling (3) pelagic hatchling in wind rows, (4) pelagic juvenile in open ocean, (5) immature in protected waters, (6) immatures and adults restricted to neritic habitat, (7) reproductively active adults migrating from feeding to breeding grounds, (8) mating offshore of nesting beaches, (9) females leaving the sea to nest on terrestrial beaches and (10) return migration to feeding ground. In fact, very little of this life cycle has been adequately studied, except the nesting phase.

Going briefly through the generalized life cycle innumerable large gaps in our knowledge become obvious. Starting where the most information is available, with the female coming ashore to begin the nesting process, we are ignorant as to which behavioral and physiological cues guide the animal. Somehow a gravid female locates a nesting beach, but not any beach—she will commonly home in on a certain sector of one particular beach (Carr and Carr, 1972). How this is accomplished is unknown.

She climbs the beach, and well above the high water mark locates a nest site. Possibly she is guided by olfactory cues in the sand. Once she has selected the site a series of highly stereotyped behaviours takes over (Carr, 1982). By making swimming movements in the sand, a pit is excavated and the turtle slowly advances into this. The effort and size of the pit varies between species (Hendrickson, 1982), so somehow each species has a similar — yet different — set of requirements in construction of the body pit. At the termination of the body pit, the turtle begins scooping out an egg chamber with alternate movements of the hind flippers. This is done behind its back and the stereotyped nature of the behaviour is evident when watching a turtle that has lost one hind flipper ; it moves the stump in alternation with the good flipper as if both were functioning. Somehow it determines when the egg chamber is of the right size and then immediately begins to lay eggs. Nearly 200 eggs may be laid in about half an hour. Then she kneads sand over the eggs and resumes swimming movements and covers and camouflages the nest. Again, the factors which guide the turtle in this activity are not known, but different species cover for different periods of time. Occasionally a female will go through the entire nesting process, but not lay any egg (Cornelius, pers. comm. ; Whitaker, pers. comm.). If we understood more about physiology and behaviour, these naturally occurring aberations would be invaluable in understanding the norm, but at present we can only call them ' freaks '.

At the end of the nesting the female returns directly to the sea. This behaviour has been well studied and the sea-finding ability of the female, as well as the hatchling, depends on an orientation toward the brightest part of the horizon (Mrosovsky, 1978).

Once back in the sea the female may stay around the nesting area to lay another nest after about two weeks time. Curiously, she does not seem to copulate more than once in a season (Wood and Wood, 1980), so it seems that sperm are stored for as many as consecutive nestings during a single season. Yet, no morphological structures have been found in the female turtle that would suggest an ability to store enough viable sperm for fertilizing hundreds of eggs over a period of several months (Owens, 1980). Another related problem is the way in which ovulation and vitelization occur. It seems that 100 to 200 follicles are ovulated, surrounded with albumen and a calcarious shell all in a period of 48 hours or less. This fact is all the more curious when considering that the oviduct is essentially a thin, straight tube (Owens, 1980).

The eggs left in the beach receive no care from the female; unlike crocodiles and some snakes, lizards, amphibians, no turtles care for their eggs. In fact, a nesting turtle may dig up the eggs of a nest laid earlier. She may even dig up her own previous nest. The eggs which remain undisturbed incubate by the temperature of the sand which is dependent mainly on the amount of solar radiation that strikes the nest site. This temperature in turn determines the length of incubation: The warmer the eggs the faster they develop. Incubation temperature also determines the way the embryos develop: the number and shape of scales and the sex of the turtle are temperature-dependent. At cool temperatures males are produced; at warm temperatures, females (Mrosovsky and Yntema, 1982). We mammals think of this as very odd, but in fact extra-genetic sex determination is the rule in some 'lower animals' and some animals even have sex reversal where they reproduce as females and later as males. We should not let our own egocentrism lull us into determining what are the norms of nature !

The turtles finally hatch, dig out of the nest and run down to the sea oriented by a positive phototaxis (Mrosovsky, 1978). Both on land and in near shore waters hatchling turtles are subject to tremendous numbers of predators. There are few direct measurements of mortality, but there are a variety of 'estimates' which differ tremendously from one to the other (Stancyk, 1982). At this point in the life cycle, the sea going phase, empirical information becomes very scarce. There are observations of newly emerged turtles swimming directly and purposefully out to sea and several people have seen them in lines of floating vegetation (Carr, 1982). We don't know what they eat, how they live or even how long they live on the open sea, but at some point juvenile turtles appear back in coastal waters. It now seems that many very important nursery areas are in protected bays and estuaries. The immature turtles evidently give up their pelagic habits and take up a neritic existence, and each species developes its own specific characteristics — particularly feeding habits and habital preferences. After an unknown period of years, possibly 10 to 30, the animals mature and finally become reproductively active. But no details of any of these phases are known in wild populations.

We do know that reproducing animals will suddenly appear at nesting beaches during the breeding season. Females tagged on the nesting beaches are recaptured from long distances — thousands of kilometres—away, so we infer from this that migrations are made from feeding grounds to breeding grounds and back again to feeding grounds. However, the information is not totally conclusive and some people argue that the average female does not survive to make a return migration (Hughes, 1982). A tremendous effort has gone into investigating the means by which turtles find their way to nesting beaches, but this continues to be a mystery. Inspite of our own ignorance, the turtles normally manage quite well to go through their life cycle and reproduce their numbers.

No matter how incompletely we understand it, several very important points are relevant from the turtles' life history. It is incredibly complicated and extends over tremendous spans of time as well as space. A single individual, in the course of its life, will begin life in a terrestrial environment then live in, and depend on, pelagic, neritic and semi-estuarine environments. During this period the individual will disperse over thousands of km of ocean and when it matures it will make equally large movements from feeding to breeding grounds. This has tremendous implications on management and conservation practices, a subject to which we will return.

There are a number of technical problems in studying and managing sea turtles and these must be solved before further advances are made on many fronts. Individuals have been marked with a variety of tags, mainly metal or plastic, but little attention has been paid to the success of the technique. In some projects half the tags are lost within the first few weeks, so any ecological or behavioural interpretations based on tag recovery are suspect (Mrosovsky, 1983).

Even more problematic is a technique for marking hatchlings. It is difficult to mark an animal that is only 5 cm long, but if it increases its body length by more than a factor of 25 it will be impossible to use conventional marking procedures. The most promise for hatchling tagging is by using skin grafts, a technique developed by Hendrickson and Hendrickson (1984).

Determination of an animal's sex is also problematic, except in adults and subadults. At present the only way to determine the sex of an immature is by examining the histology of the gonads or by radioimmunoassays (Owens, 1982). Determination of a turtle's age is also problematic, there is no technique that gives a precise estimate (Frazier, 1982).

If one had to represent the entirety of marine turtle biological knowledge graphically it would look like a spiders' web or a sponge — more holes than matrix. The significance of this in conservation practice is that we usually have to operate in ignorance. A wildlife or fisheries manager is in many respects a special case of a store keeper. His overall goal is work at a profit and have a constant stock in his store. He will need to know supply rates, consumption rates, shelf life, cost of supply, taxes on various transactions and a great many other things before he can plan his business logically. In economy this may be difficult — in ecology it is impossible. We cannot supply precise information to one of these critical questions.

Take the very obvious questions : where are turtles and how many are there? During the last decade some of the largest populations of 5 species of sea turtles have been 'discovered'. This includes the enormous population at Gahirmatha. Over the last decade Satish Bhaskar and Chandra Shekar Kar have been investigating turtles in India, virtually walking every inch of coast, but despite their boundless energy and dedication, we have only begun to know about where the turtles are in India. As to how many — the estimates can only be very rough at best. And then, we are only able to guess at the number of females that nest in a year ; we are so ignorant about natural sex ratios, generation time, recruitment rates and other critical factors in a basic life table, that we are only able to make the wildest guesses about the number of immatures, subadults and adult males.

Nesting seasons are not fully worked out. For example we are only now beginning to appreciate the intricacies of the ridley season on the east coast of India and it seems that it begins several months earlier in the south.

Nesting is the most conspicuous phase in the turtle's life history, so most of what we know is about nesting. Our knowledge of feeding grounds is very limited. Certainly the marine pastures and coral reefs in Lakshadweep, Gulf of Mannar and Andamans and Nicobars are of major importance to feeding green and hawksbill turtles. Next to nothing is known about the feeding habitats of the other turtles here.

And what about the dispersions and migrations ? from where are the turtles coming when they arrive at the nesting beaches ? and where do they go when they leave ?

We could go on asking these basic, but unanswered, questions, but now you will appreciate that our ignorance is profound and that this is the general situation with sea turtles in the world today.

None the less and thanks to the dedication of some of our colleagues, we know almost a dozen critical areas for sea turtles in India and the main breeding seasons are known for most.

Apart from lack of knowledge, another major problem in conservation is establishment of sanctuaries, parks, reserves and other protected areas. It has been established that there are critical habitats for marine turtles, as well as other endangered animals and plants on uninhabited islands in Lakshadweep and Andaman and Nicobars. A similar situation exists for the Gulf of Mannar and despite years of work by state and central governments, as well as international agencies, these critical areas have still not been protected. Each day their position in resource management is further compromised and devalued.

In addition to habitat preservation there is a need for direct species protection. Nesting females and their eggs are most easily captured, but they are the most important part of the population, for its reproduction and maintenance. Hence, special protection is required on nesting beaches. Where human activities are intense, the coastal zone may be polluted or otherwise modified with constructions so as to render it unsuitable to nesting turtles. Where human densities and pressures are high there may be severe predation on nests.

Protection in these areas runs into direct conflict with other human interests ranging from large capital investments to traditional subsistance level utilization. This problem is well illustrated here in Tamil Nadu, where in the past virtually all nests have been dug up for eggs. Now an ever more active hatchery programme by the Forest Department is collecting eggs in 3 districts. This has involved an annual expenditure of over 3 lakhs of rupees and employed nearly 150 people. Another alternative, involving beach patrols and maintaining nests in their natural sites is unworkable at present.

Hatchery programmes are not without their own special problems. Any form of human manipulation always runs a risk of unwanted effects. For example, handling turtle eggs risks fatally damaging egg membranes. Hatcheries can be located in areas subject to inundation and complete destruction of all eggs. They can also be located where sand and incubation conditions are inadequate, yielding low hatching success. Unsuitable incubation temperatures from inappropriate hatchery sites, unsuitable nest construction or placement can result in highly skewed sex ratios. Unsuitable handling of hatchlings can decrease the chances of their surviving the first weeks of life at sea and the development of appropriate behavioural responses.

There are many examples, all round the world, where dedicated and well intentioned programmes have done more harm than good. This may not be the case here, but I want to make it clear that simply intending to do good is not always sufficient and we must objectively analyse the effect of our actions-despite our intent.

Also seemingly unrelated actions can have tremendous effects. The incidental capture of turtles in trawls is one example. The annual drownings of turtles in the US are in the tens of thousands. Last year thousands of turtles were drowned in Orissa. In most instances the trawlermen would much rather not catch the turtles, for they crush the catch. But despite the true desires of the trawlermen, their actions pose a serious threat to turtles. These problems must be identified and resolved. In this instance the Turtle Excluder Device, developed by the U.S. National Marine Fisheries Service ; may prove useful to both trawler operators and turtle conservationists.

In this last point is a central concept for successful long term conservation — resolving problems with as little conflict as possible. The most direct way to eliminate the problem of accidental catch by trawlers is by excluding their fishing activities from the core areas used by turtles. However, if a compromise can be struck by requiring gear or operational modifications then both parties will come out ahead.

Perhaps the most sensitive issue with sea turtles is how to treat them. In most places of the world they represent traditional sources of valuable and inexpensive proteins. In addition to the ecological and aesthetic benefits they provide — they are truely a food resource for many of the coastal peoples of the world (Frazier 1980). Prohibiting their utilization as a traditional food source often complicates the problem of resource management. The desires and needs for the resource do not diminish so the exploitation becomes clandestine and furtive, which sets up a situation of conflict and makes it nearly impossible to monitor the real situation.

In addition, political pressures ferment in these conditions to the point where they precipitate an abrupt change in policy which often undoes all the good that has been done over many years. What is at the base of this problem is the concept of 'conservation'. If only a few benefit it will be regarded by the majority as an elitist activity. Regardless of whether one advocates right wing or left wing governments, it is clear that where such situations of conflict exist there will be a great element of instability. This is inconsistent with a central premise in conservation — the *sustained* rational utilization of a resource.

I am not advocating a chain of turtle slaughter houses up and down the coast of India. We have seen what happens when these animals are overexploited; there are plenty of examples around the world, including in the Indian Ocean (Frazier, 1980). It is only sensible that we be very concerned and very protective of these animals that have been so badly depleted throughout their range. In our present state of ignorance it would be insane to pretend that we can rationally manage wild stocks of turtles. But our immediate requirements need not restrict our long term goals. I am convinced that for the security and permanency of effective biological conservation we must direct efforts at developing programmes for sustainable rational yields for the benefit of local peoples.

The final point which is absolutely critical to marine turtle conservation is Co-operation and in many respects this deserves a session to itself. We are dealing with animals that have no respect for the political boundaries we draw on maps; they freely cross between districts, states and countries. Like migratory birds or the great whales, sea turtles are truely international animals. No one person or political entity owns them. They are a common heritage of all humanity. Our success or failure in conserving sea turtles will be a pointed indication of our own futures (Frazier, 1983).

References

Brongersma, L. D. 1969. Miscellaneous notes on turtles. *Proc. Kon. Ned Akad, Wetensch., Amsterdam*, **72** : 76-102.

Carr, A. 1982. Notes on the behavioural ecology of sea turtles. *In* : K. Bjorndal (Ed.) *Biology and Conservation of Sea Turtles*, Smithsonian Institution press, Washington D.C., 19-26.

———AND M. H. Carr 1972. Site fixity in the Carribean green turtle. *Ecology*, **53** : 425-429.

Frazier, J. 1971. Observations on sea turtles on Aldabra Atoll. *Phil. Trans. Roy. Soc.*, (b) **260** : 373-410.

——— 1980. Exploitation of marine turtles in the Indian Ocean. *Human Ecology*, **8** (4) : 329-370.

——— 1982. Age determination studies in marine turtles. Final Report to U.S. National Marine Fisheries Service.

——— 1983. Marine turtles as Indicator species for International Conservation. *Proceedings of the Silver Jubilee on Tropical Ecology, Bhopal.*

——— 1984. Marine turtles in the Seychelles and adjacent territories. *In*: D. R. Stoddart, (Ed) *Biogeography and Ecology of the Seychelles Islands*. Junk. The Hague.

——— (in press) The biology and conservation of marine turtles in the Indian Ocean. *Centennial Symposium of Bombay Narural History Society*.

——— AND S. SALAS (in press) Tortugas marinas en el Pacifico Oriental: El Recurso que Nunca Acabra? *Memorias del* IX *Congreso Latinoamericano de Zoologia*.

———, M. MEGITA AND F. ACHAVAL (in press) Clarification on the feeding habits of *Dermochelys coriacea*. *J. Herptol*.

——— *et al*. (in prep.) Epizoan communities on marine turtles. I.Bivalve and Gastropod Mollusks.

HENDRICKSON, J. R. 1982. Nesting behavior of sea turtles with emphasis on physical and behavioral determinants of nesting success or failure. *In*: K. Bjorndal (Ed). *Biology and Conservation of Sea Turtles*. Smithsonian Institution Press, Washington D.C., pp. 53-57.

——— AND L. HENDRICKSON 1984. The Living Tag. *Proceedings of the Western Atlantic Turtle Symposium*.

HUGHES, G. R. 1982. Nesting cycles in sea turtles — typical or atypical? *In*: K. Bjorndal (Ed.) *Biology and Conservation of Sea Turtles*. Smithsonian Institution Press, Washington D.C., pp. 81-89.

MROSOVSKY, N. 1978. Orientation mechanisms of marine turtles. *In*: K. Schmidst—Koenig and W. T. Keeton (Eds.) *Animal Migration, Navigation and Homing*. Springer-Verlag, Berlin.

——— AND C. L. YNTEMA 1982. Temperature dependence of sexual differentiation in sea turtles: implication for conservation practices. In: K. Bjorndal (Ed.) *Biology and conservation of sea turtles*. Smithsonian Institution Press, Washington, D.C.

——— 1983. Conserving sea turtles. *British Herpetological Society*, London.

OWENS, D. 1980. The comparative reproductive physiology of sea turtles *American Zoologist*, **20**: 549-653.

——— 1982. The role of reproductive physiology in the conservation of sea turtles. *In* K. Bjorndal (Ed.) *Biology and Conservation of Sea Turtles*. Smithsonian Institution Press, Washington D.C., pp. 39-44.

PRITCHARD, P. C. H. 1980. *Dermochelys coriacea*. Catalogue of American amphibians and reptiles.

SMITH, M. A. 1931. *Fauna of British India - Reptilia and Amphibia*, Vol. 1.

STANCYK, S. E. 1982. Non-human predators of sea turtles and their control. *In* K. Bjorndal (Ed.) *Biology and Conservation of Sea Turtles*. Smithsonian Institution Press, Washington D.C., pp. 139-152.

WOOD, J. AND F. WOOD 1980. *American Zoologist*, 20.

DISCUSSION

T. SUBRAMONIAM : In the case of invertebrates such as millepedes, they have defence mechanism using phenolic compound showing antipredatory activities. In the case of turtles, the secretions from the marginal pores may have some role to play as a defensive mechanism.

E. PRABHAKARAN : In the case of cockroach also they have the capacity of secreting antipyridic action as defence mechanism.

J. FRAZIER : There is need to make lot of studies on the adaptations.

J. JOHINDRANATH : In the case of turtles, they shed tears at the time of egg laying process. Is there any significance in it?

J. FRAZIER : The excess of salt is being excreted through the lacrymal gland. The secretion is useful in excreting excess of salt but also useful in clearing their eyes when sand particles are adhering in the eye. Continuous wiping of eyes can be observed at the time of nesting in the sandy beach.

J. JOHINDRANATH : How about the turtles coming from deeper areas to surface for breathing?

J. FRAZIER : Sea turtles are not generally seen in the deeper waters. They may go to a depth of 30 metres or so.

V. J. RAJAN : How long can sea turtles remain under the sea without coming to the surface?

J. FRAZIER : They have the capacity of remaining under the water even for months together when they hibernate. In the swimming condition they may be able to remain under the water for few minutes.

P. J. SANJEEVARAJ : How about the differentiation of hatchlings in early stages or during the development using sex chromosomes?

J. FRAZIER : There is no heterozygous sex chromosomes in the case of turtles. So it will not be possible to differentiate using the sex chromosomes. Already methods have been developed using radioimmunological technique.

K. SHANMUGANATHAN : How far does temperature affect the sex of hatchlings?

J. FRAZIER : It is a very critical area and already so much has been studied on the effect of incubation temperature of the eggs on sexual differentiation. Even a change of 1 to 2°C can make a considerable difference to the sex ratio of the hatchlings.