2

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-e, 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 Turicorin 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 efficaceous remedy for certain ailments. Even in the recent past, it was not unusual to see well-todo 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*

* Present address: Madras Research Centre of Central Marine Fisheries Research Institute, 29, Commander-in-Chief Road, Madras-600 105.

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.

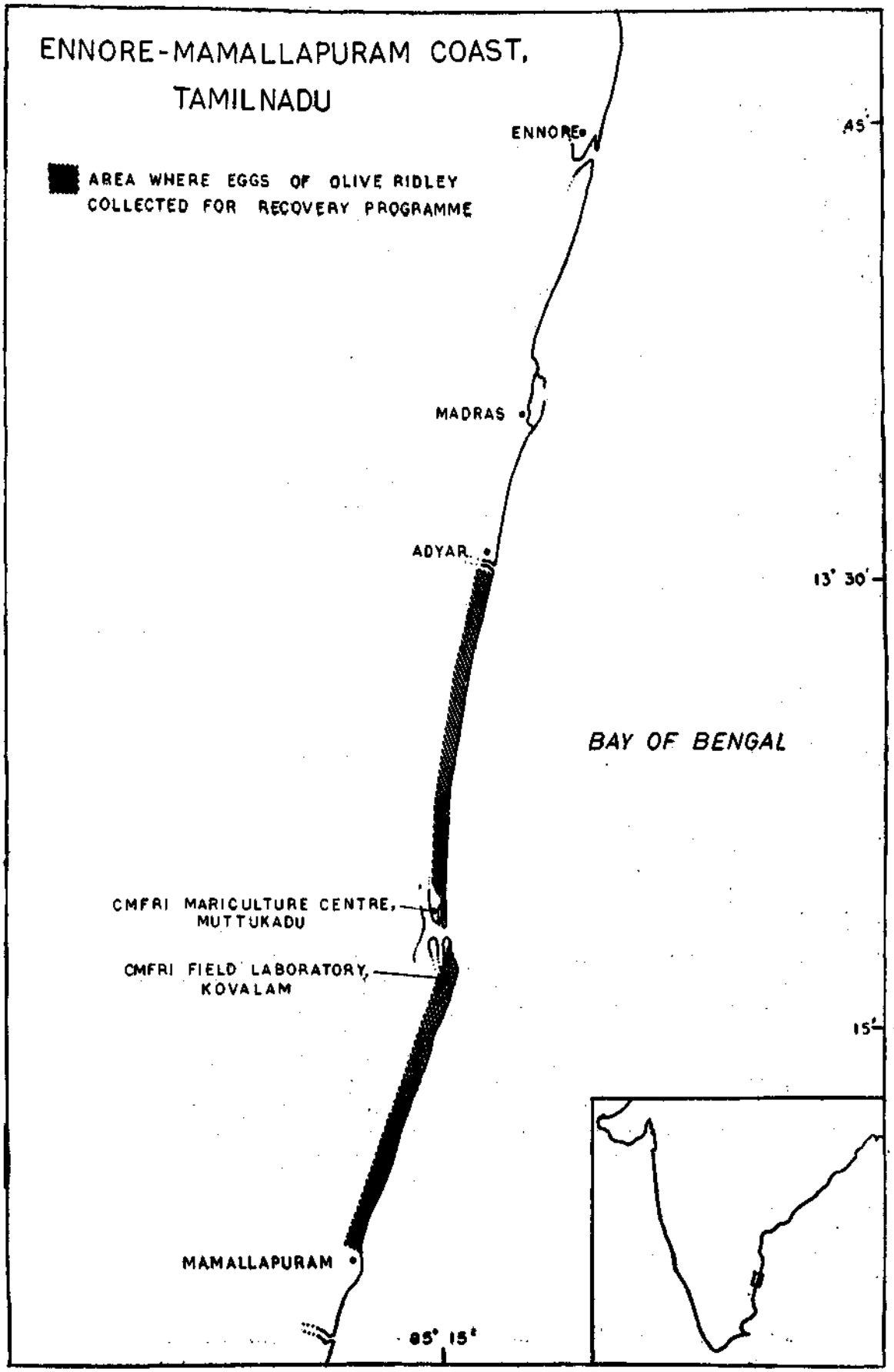


Fig. 2. Map showing the Ennore-Mamallapuram (nesting beaches under study) stretch of coast, showing location of Kovalam Field Labaratory of CMFRI.

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 prominance 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 cartwheeling 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

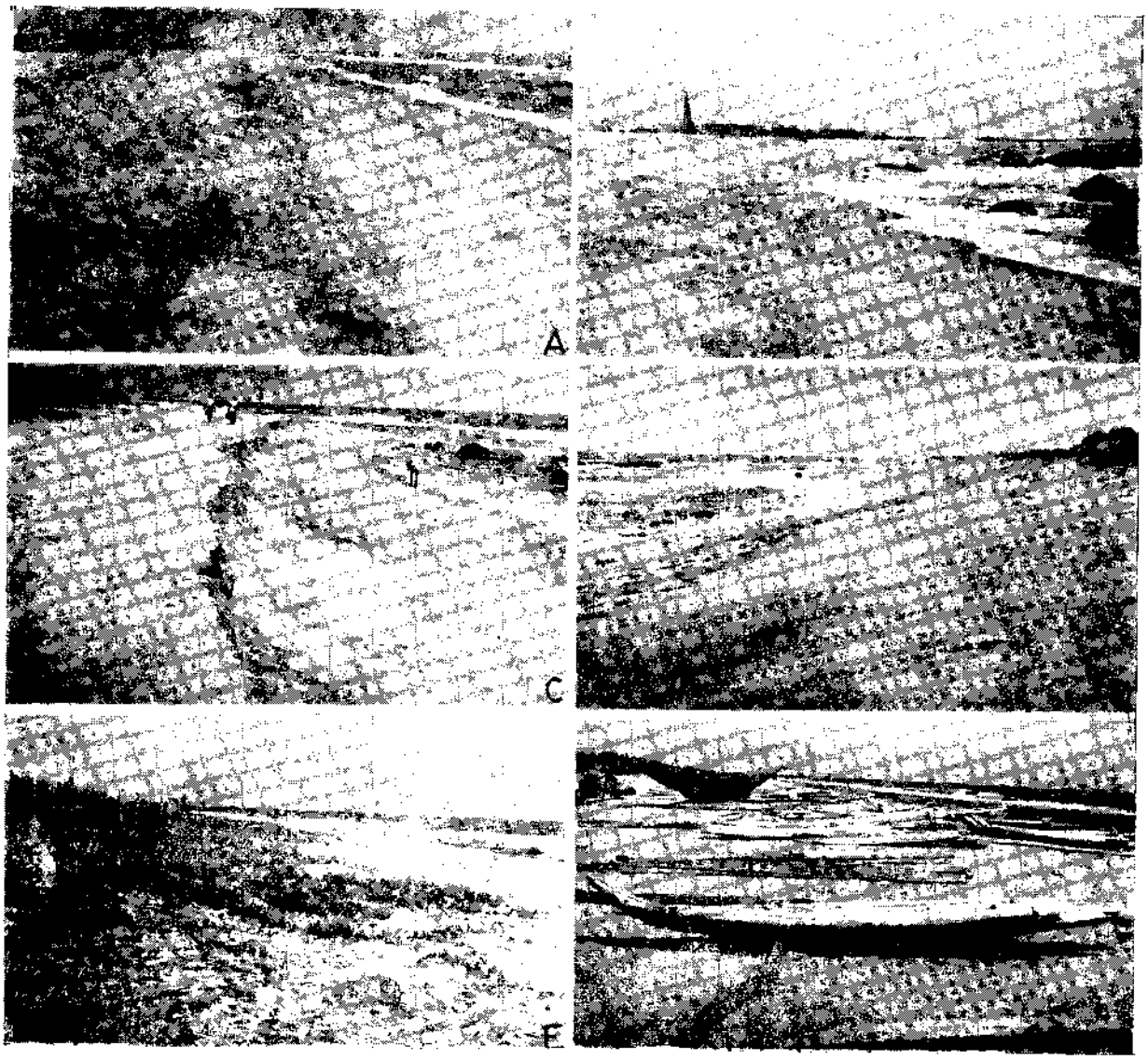


PLATE I. A-E. Beach configuration along the Kovalam-Mamallapuram stretch where olive ridley nests ; F. Nesting of olive ridley was also noticed between beached catamarans at Chemmenieri village.

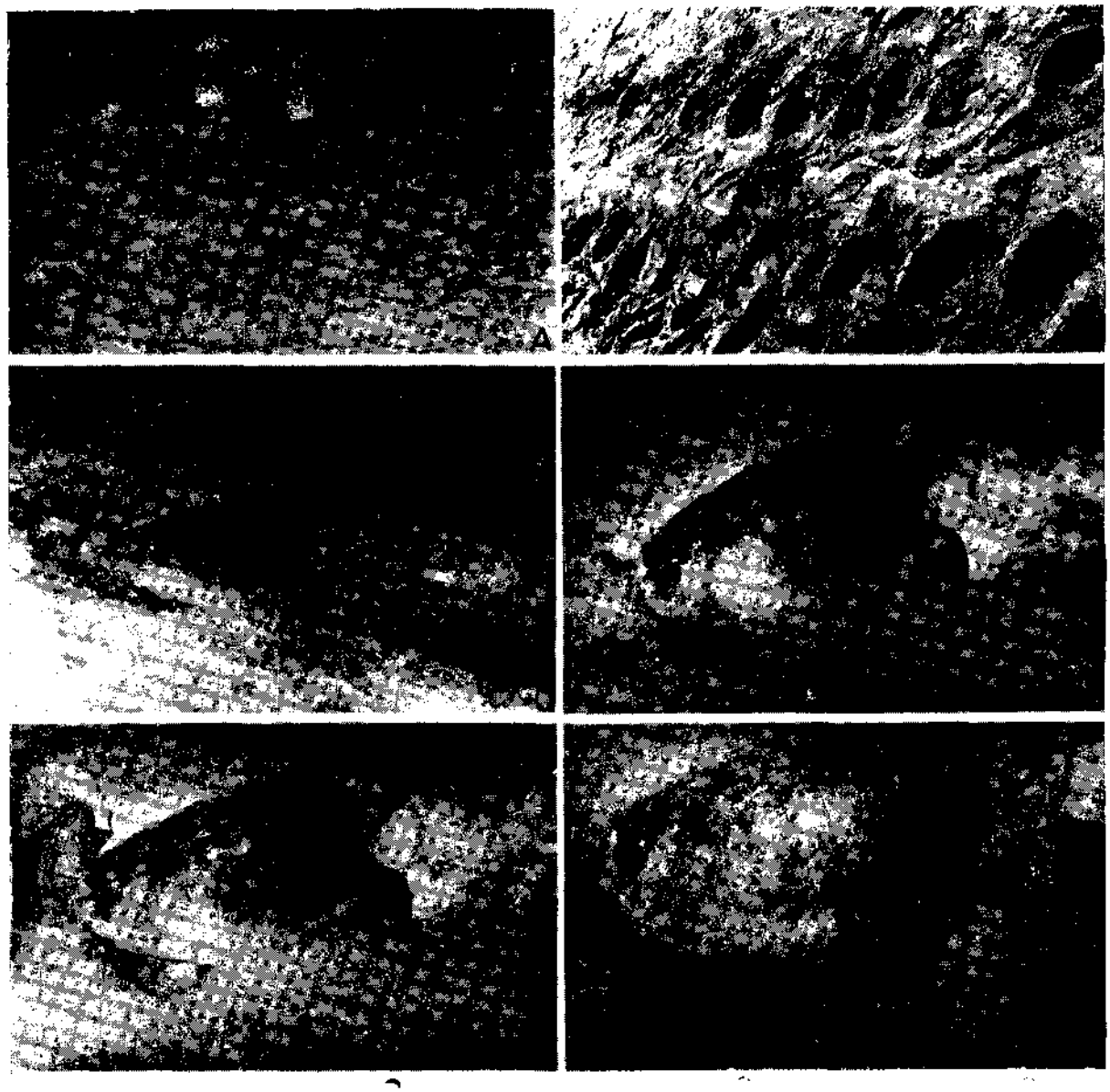


PLATE II. A-F. Nesting of olive ridley: A. Crawl mark on the sandy beach; B. A close up view of the crawl mark; C. Pit digging D-E. Scooping of the sand from the pit and F. Nest ready for laying.

gular prominance to hiss out air noisely. 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 (Plae 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

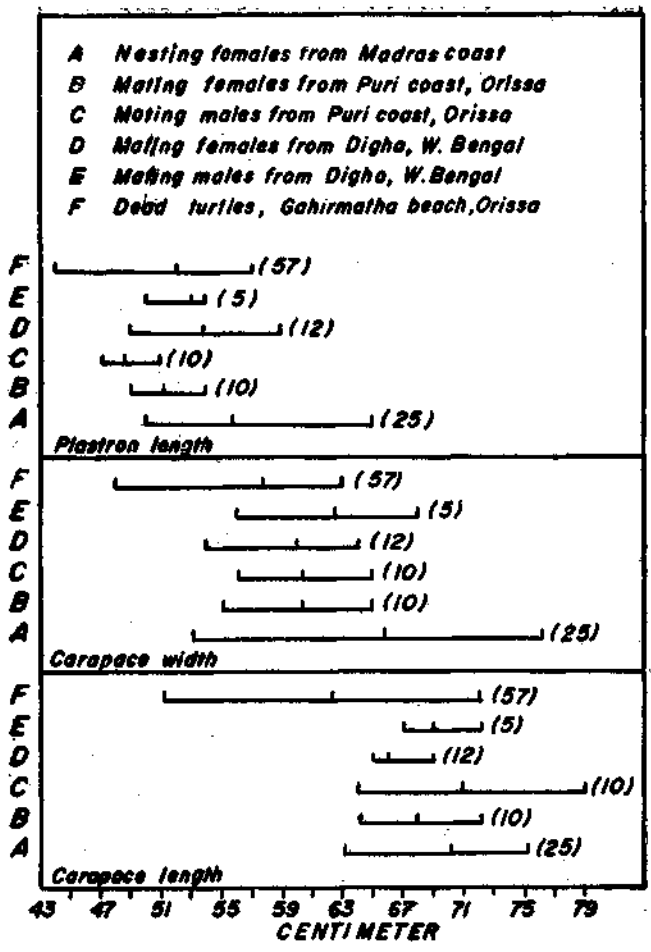


Fig. 3. Comparison of carapace length, carapace width and plastron length of olive ridley observed by the present authors, Valliappan and Whitaker 1974 in Madras coast and Biswas 1981 in Orissa and Silas et al., 1983 in Gahirmatha. (The horizontal line represents the total range; the short vertical line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

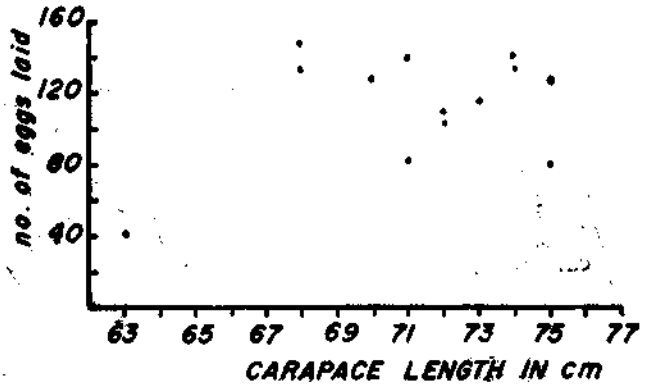


Fig. 4. Relationship between carapace length of nesting females of olive ridley and clutch size.

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

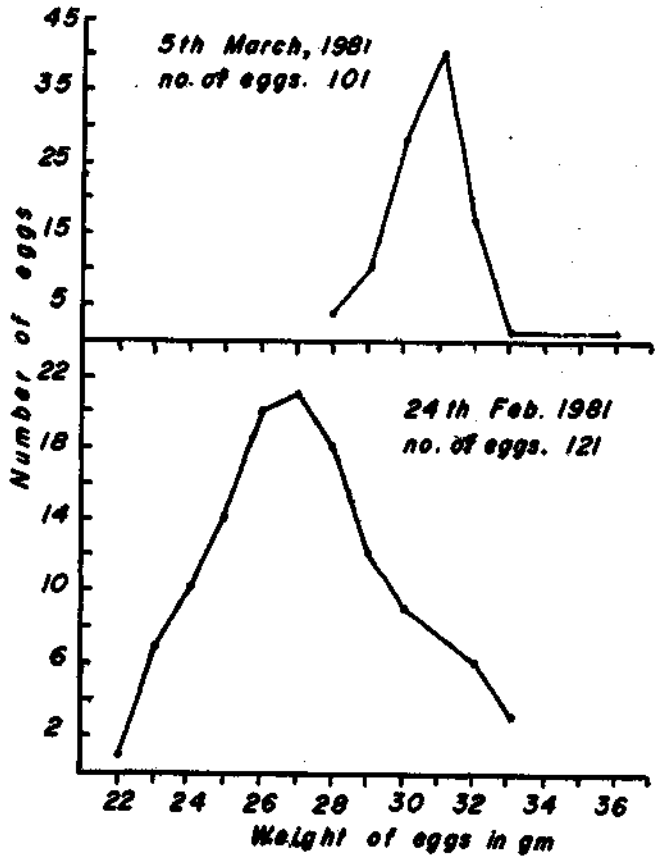


Fig. 5. The frequency of eggs of different weights in two clutches of freshly laid eggs by olive ridley.

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)

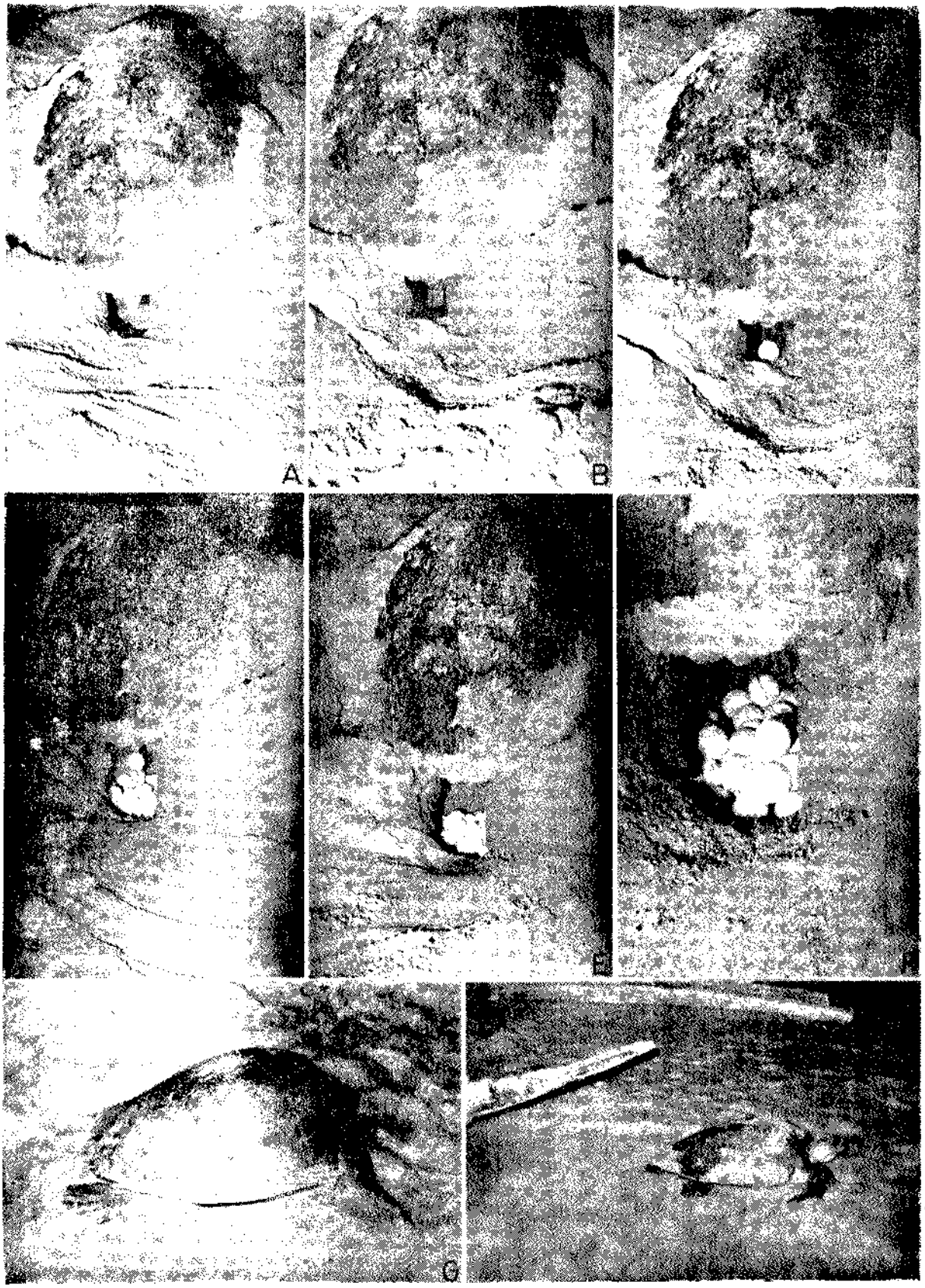


PLATE III. A-F. Process of egg laying ; G. Closing of the pit after egg laying by an olive ridley ; (Note the mucus "string" on the dropping egg in D) and H Same turtle heading back to the sea

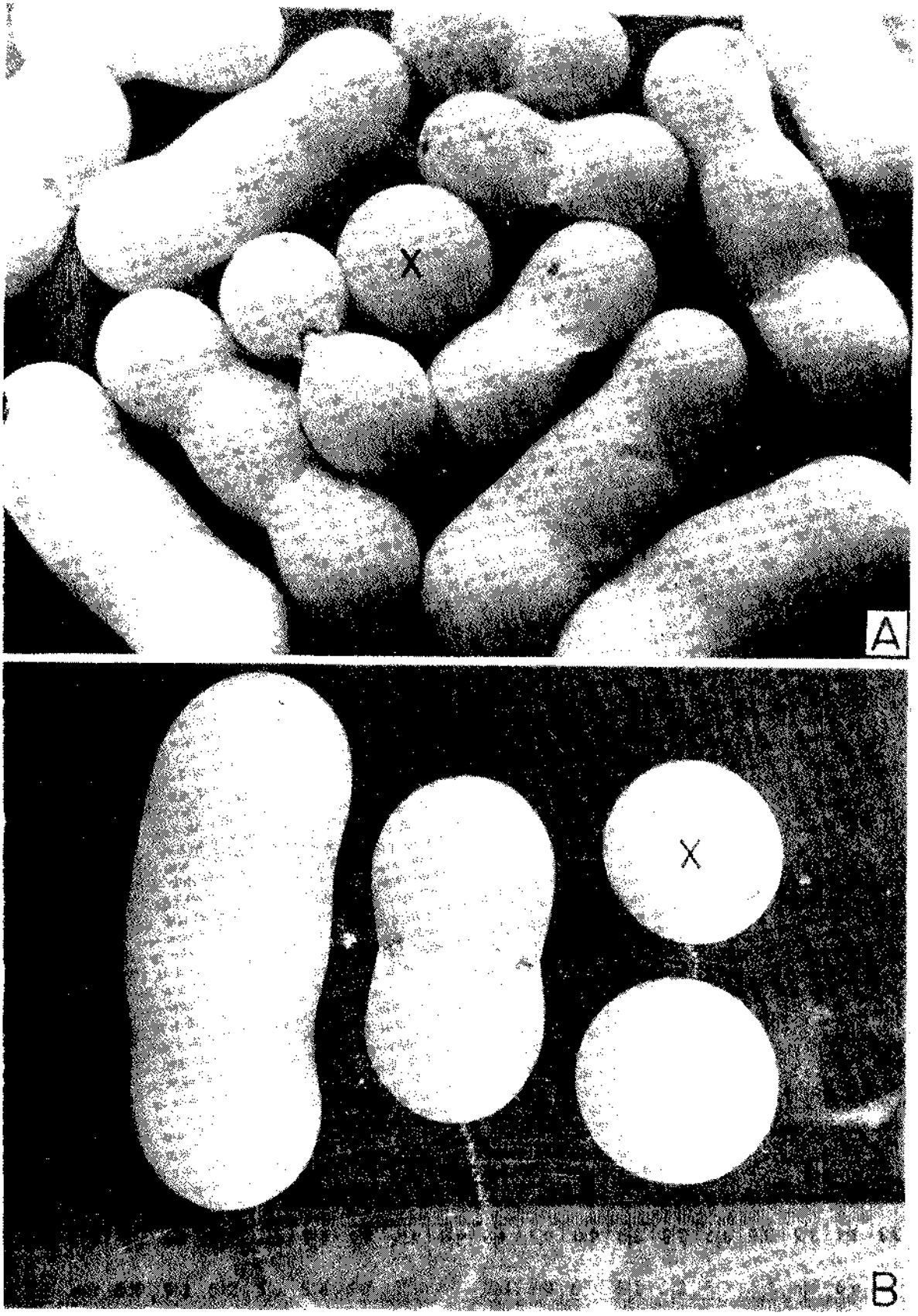


Plate IV Eggs of olive ridley A. Normal (X) and several abnormal eggs from a single clutch and B. Close up view.

PLATE V. Carcass of olive ridley from incidental gillnet catch washed ashore at Kovalam—cut open to show unlaid 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.

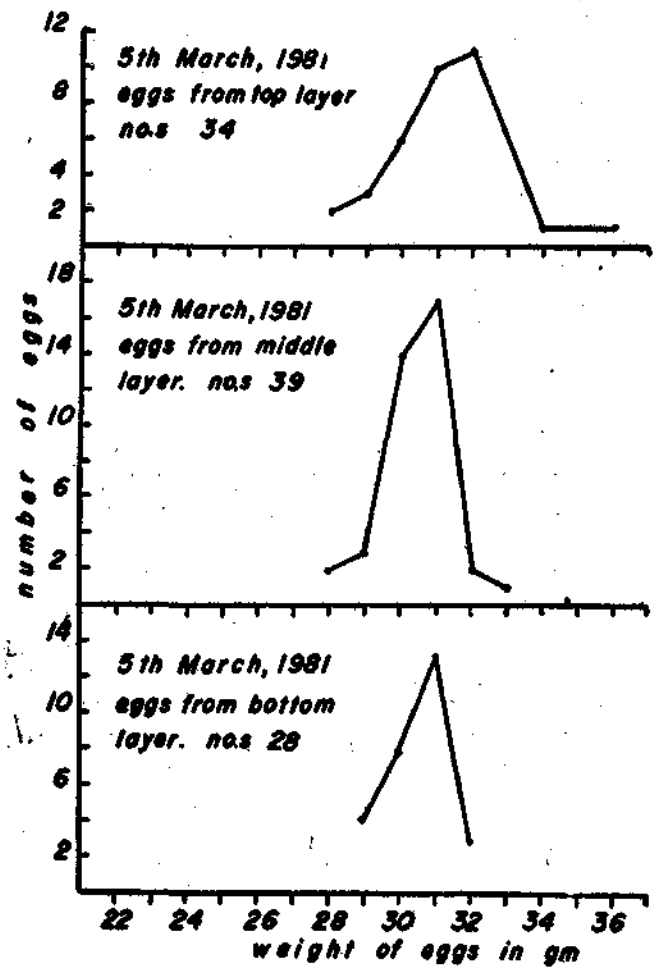


Fig. 6. Egg weight (gm) variability from three different layers of a single clutch of olive ridley.

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 infilterating 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 unlaid 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'.

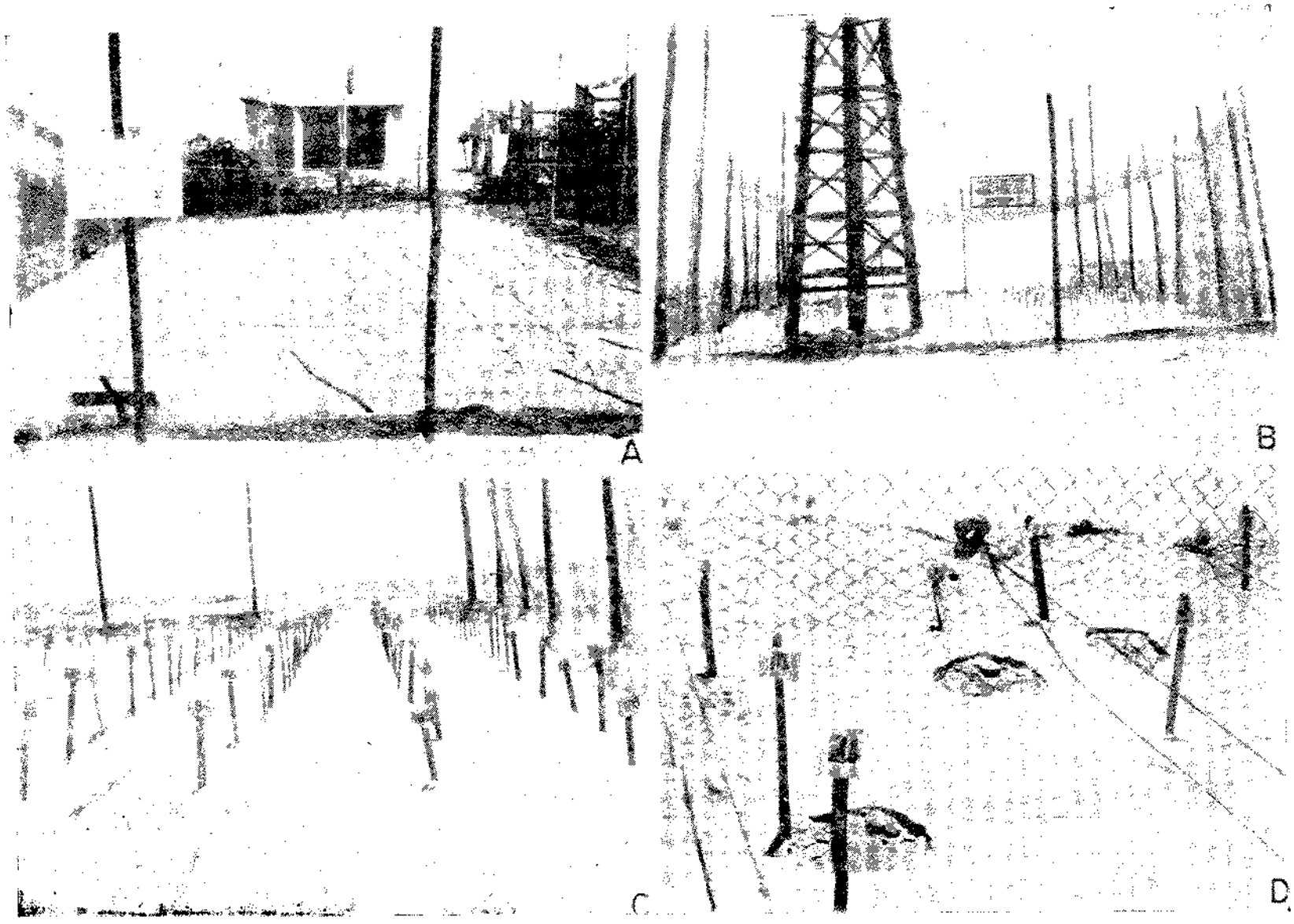
The eggs collected by the professional collectors were sold openly in fish markets in Ennore, Thiruvotriyur, Zam Bazaar, Purusawalkam, Saidapet and Alandur at the rate of 10 to 12 paise per egg. On an average 1000 to 1500 eggs were kept for sale at Saidapet market as late as the 1981 season (Plate VIA, 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 hatchling.s 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 umblicus, 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 and 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).

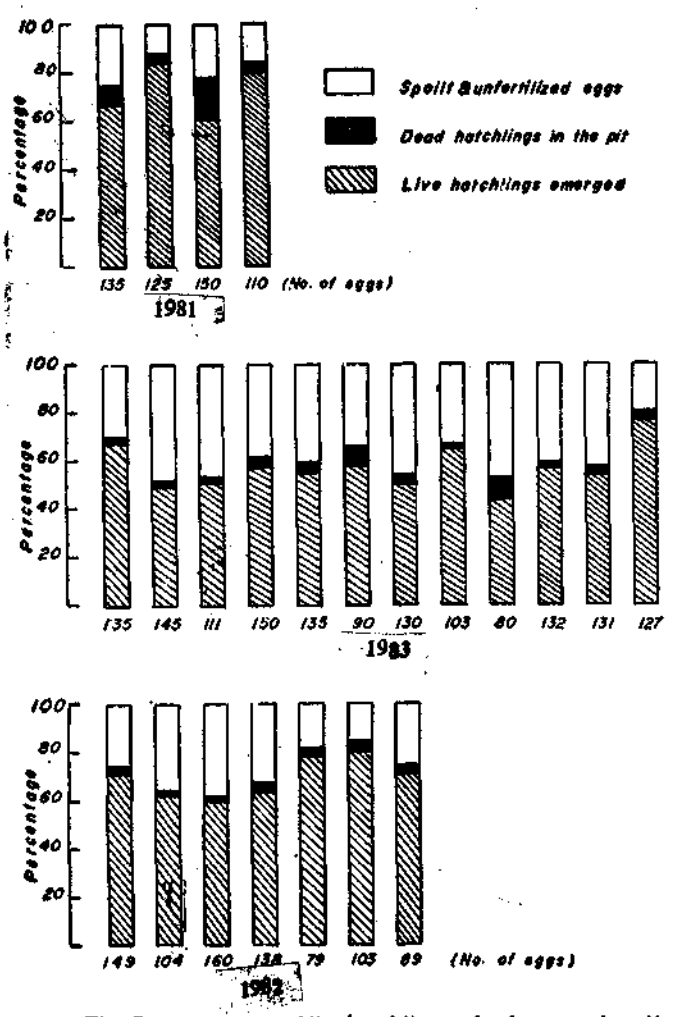


Fig. 7. Percentage of live hatchlings, dead ones and spoilt and unfertilzed eggs observed during 1981-1983 season.

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 ifor 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 inFig. 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 re pectilvey (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 tothe 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 latter 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).

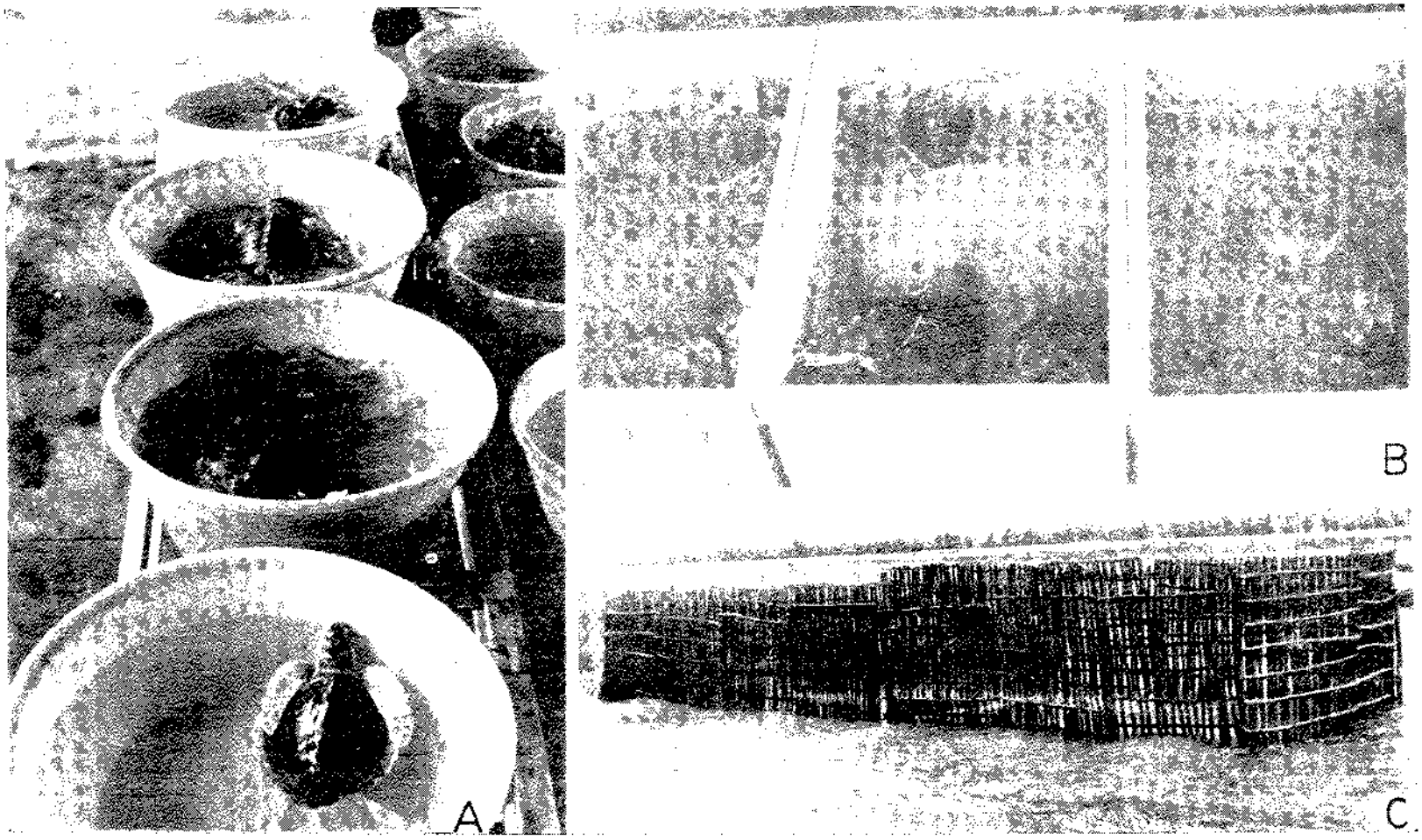


PLATE IX. Rearing of olive ridley in captivity. A-B. Individual and group rearing at Kovalam Field Laboratory and C. Rearing of subadults in pens at CMFRI, Mariculture Farm, Muttukadu.

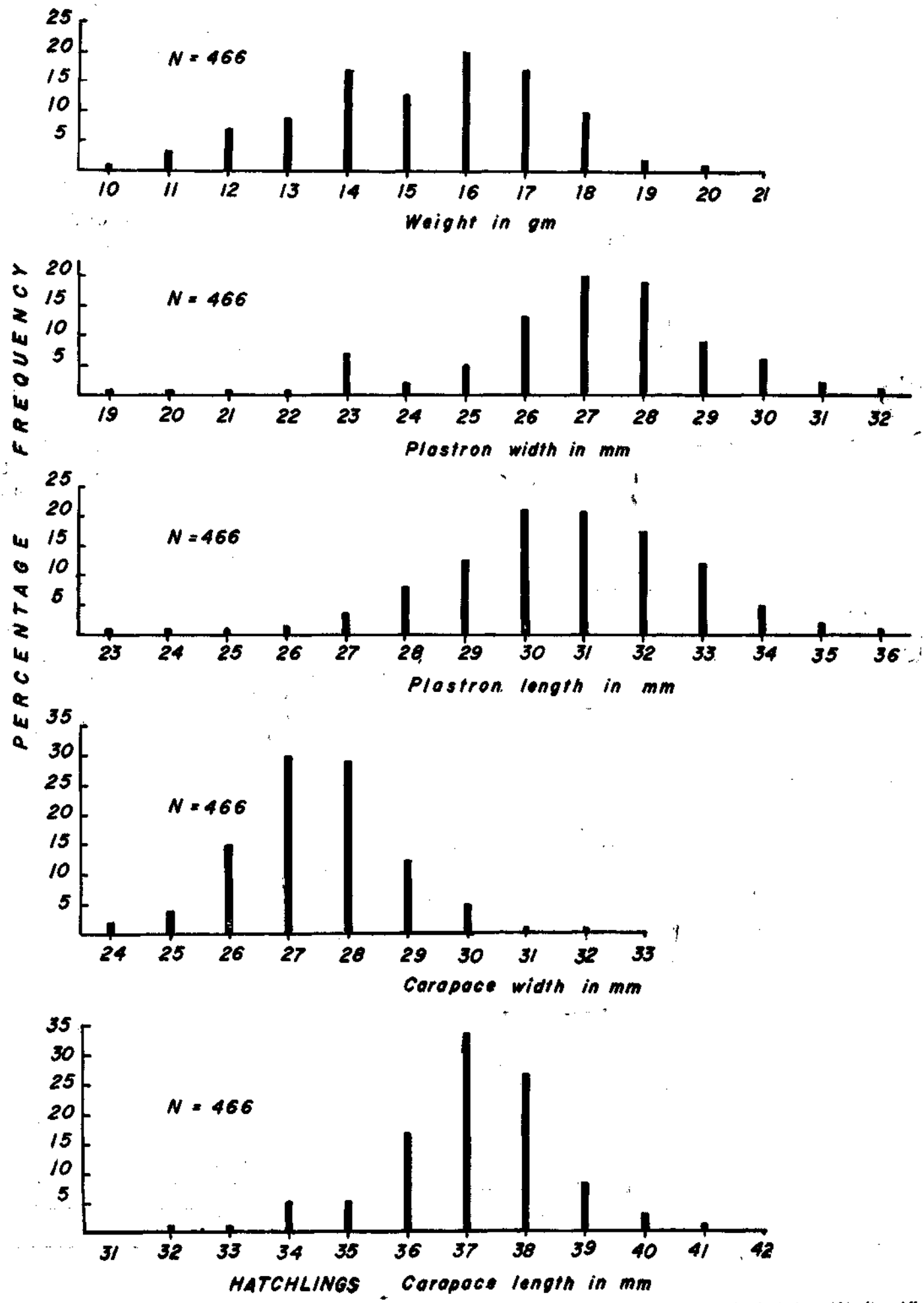


Fig. 8. Percentage frequency of carapace length, carapace width, plastron length (mm) and weight (gm) for 466 olive ridley hatchlings observed at Kovalam.

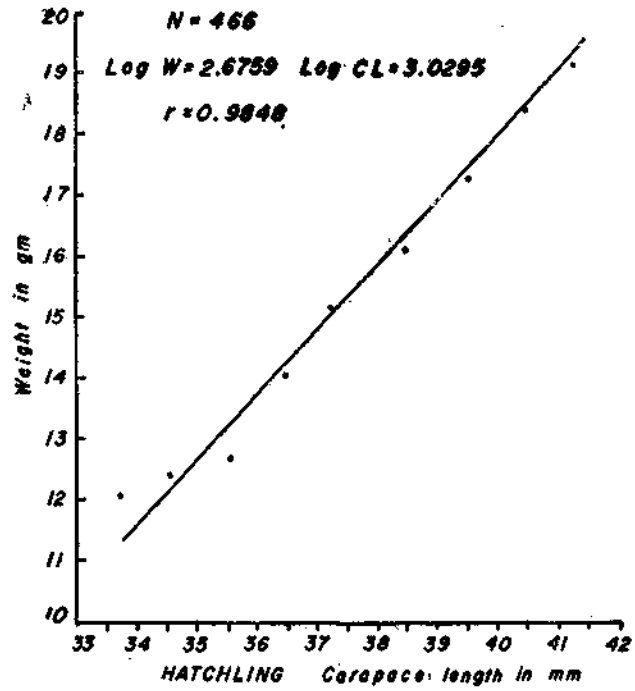


Fig. 9. Logarithmic relationship between carapace length and weight of olive ridley hatchlings.

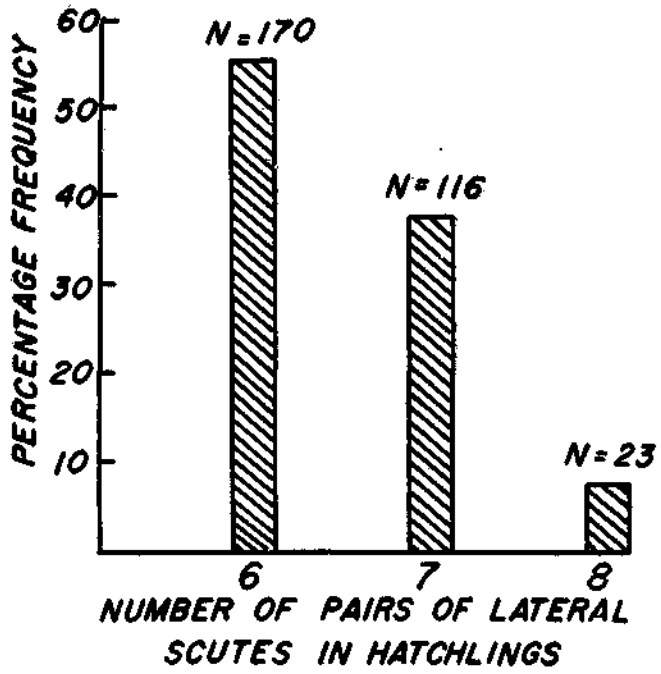


Fig. 10. Percentage frequency of number of pairs of lateral scutes in olive ridley hatchlings.

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 programm esteems 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,

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.

REFERENCES

BHASKAR, S. 1978a. Marine turtles in India's Lakshadweep Islands. *Marine Turtle News letter*, **8** : 5.

——— 1978b. Sea turtles and other marine life in Lakshadweep. *Hornbill* (April-June), p. 21-26,

——— 1978c. Sea turtles in the Arabian Sea Islands of Lakshadweep. In : *Tiger paper, FAO, Bangkok.*

——— 1978d. Notes from the Gulf of Kutch. *Hemadryad*, 3(3) : 9-11.

——— 1978e. Sea turtles in the Lakshadweep Islands. *Madras Snake Park*, pp. 85-115.

——— 1979a. Sea turtles in the South Andaman Islands. *Hamadryad*, 4(1) : 3-5.

——— 1979b. Notes from Lakshadweep. *Ibid.*, 4)3) : 2-23.

——— 1979c. Sea turtles survey in the Andaman and Nicobars. *Ibid.*, 4(3) : 2-23.

——— 1979d. Report on sea turtle and other miscellaneous notes from the Andaman and Nicobar Islands. *Madras Snake Park.*

——— 1979e. Preliminary report on sea turtles in the Gulf of Kutch. *Marine Turtle Newsletter*, **11** : 3-4.

——— 1981. Preliminary report on the status and distribution of sea turtles in Indian waters. *Ind. Fore.*, **107**(11) : 707-711.

BHASKAR, S. AND R. WHITAKER 1983. Sea turtle resources in the Andamans. *Bull. cent. mar. Fish. Res. Inst.*, **34** : 94-97.

BISWAS, S. 1981. A report on the olive ridley *Lepidochelys olivacea* (Eschscholtz) (Testudines : Chelonidae) of Bay of Bengal. *Rec. Zool. Surv. India*, **79** : 275-302.

BUSTARD, H. R. 1976. World's largest sea turtle ? *Tiger Paper*, 3.

CARR, A. 1952. *Handbook of Turtles.* Ithaca, N.Y. Comstock Publ. Association, pp. 1-542.

DAN, S. S. 1982. Large scale destruction of turtles in West Bengal. *Mar. Fish. Inform. Serv. T. & E. Ser.*, **42** : 13-14

DERANIYAGALA, P. E. P. 1939. *The Tetrapod Reptiles of Ceylon*, **1** : pp. 1-412, *Ceylon Journal of Science, Colombo.*

FERNANDO, A. B. 1983. Nesting site and hatching of the hawksbill turtle along Tirunelveli Coast of Tamil Nadu. *Mar.Fish. Inform. Serv. T. & E. Ser.*, **50** : 33-34.

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

JONES, S. AND A. B. FERNANDO 1968. The present status of the turtle fishery in the Gulf of Mannar and Palk Bay. *Proc. living Resources of seas around India*, CMFRI, pp. 772-775.

KAR, C. S. 1980. The Gahirmatha turtle rookery along the coast of Orissa, India. IUCN/SSC *Marine Turtle Newsletter*, **15** : 2-3.

——— 1982a. The Gahirmatha sea turtle rookery, Orissa! *Makara*, 3(1) : 20-23.

——— 1982b. Discovery of second mass nesting ground of the Pacific olive ridley sea turtles *Lepidochelys olivacea* in Orissa, India. *Tiger Paper*, 9(1) : 6-7.

——— 1983. Marine turtles in Andhra Pradesh. *Hamadryad*, **8**(2) : 18-19.

KAR, C. S. AND S. BHASKAR 1982. The status of sea turtles in the Eastern Indian Ocean. In : Bjorndal, K. (ed.) *The biology and conservation of sea turtles.* Smithsonian Institute Press, Washington. pp. 365-372.

RAJAGOPALAN, M. 1983. Leatherback trutle *Dermochelys coriacea* washed ashore at Kovalam, Madras. *Mar. Fish. Inform. Serv. T. & E. Ser.*, **50** : 35-36.

——— 1984. Studies on the growth of olive ridley *Lepidochelys olivacea* in captivity. *Bull. cent. mar. Fish. Res. Inst.*, **35** : 49-

RAJAGOPALAN, M. M., VIJAYAKUMARAN AND A. B. FERNANDO 1984. Some health problems observed in the hatchlings and juveniles of the olive ridley. *Lepidochelys olivacea* and the hawksbill *Eretmochelys imbricata. Ibid.*, 35 :

SCHULZ, J. P. 1975. Sea turtle nesting in Surinam. *Zoologische Verh., Leiden*, **143** : 3-143.

SILAS, E. G., M. RAJAGOPALAN AND A. B. FERNANDO 1983a. Sea turtles of India : Need for a crash programme on conservation and effective management of the resource. *Mar. Fish Inform. Serv. T. & E. Ser*, **50** : 1-12.

———, ———, ——— AND S. S. DAN 1983b. Marine turtle conservation and management : Survey of the situation in Orissa 1980/1982 and 1982/83. *Ibid.*, **50** : 13-23.

———, ——— AND S. S. DAN 1983c. Marine turtle conservation and management : A survey of the situation in West Bengal 1980/82 and 1982/83. *Ibid.*, **50** : 24-32.

———, M. VIJAYAKUMARAN AND M. RAJAGOPALAN 1984. Yolk utilization in the egg of the olive ridley *Lepidochelys olivacea. Bull. cent. mar. Fish. Res. Inst.*, **35** : 22-33.

VALLIAPPAN, S. AND S. PUSHPARAJ 1979. Sea turtles in Indian waters. *Cheetal*, **16**(1) 26-30.

——— AND R. WHITAKER 1974. Olive ridleys on the Coromandel Coast. *Madras Snake Park, Madras.*

VIJAYAKUMARAN, M., M. RAJAGOPALAN AND E. G. SILAS 1984. Food intake and conversion in hatchlings of olive ridely *Lepidochelys olivacea* fed animal and plant food. *Bull. cent. mar. Fish. Res. Inst.*, **35** : 41-48.

WHITAKER, R. 1977. A note on sea turtles of Madras. *Indian For.*, **103**(11) : 733-734.

——— 1979. Captive rearing of marine turtles. *J. Bombay Nat. Hist. Soc.*, **76**(1) : 163-166.