

OBSERVATIONS ON THE ECOLOGY AND FISHERIES OF THE PULICAT LAKE DURING DROUGHT AND NORMAL PERIODS

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ABSTRACT

A comparative study of various ecological factors of the Pulicat Lake in relation to fishery during a severe drought season in 1975 and a normal season in 1976 is presented. High salinity and temperature condition has affected the plankton production, whereas very low oxygen level has resulted in heavy fish mortality during the closure period of the bar mouth of the lake. For improving the fishery, keeping the present bar mouth permanently open and establishing another connection with the sea at the northern end of the lake are suggested.

INTRODUCTION

LAKE PULICAT, one of the largest salt water lagoons on the east coast of India is an interesting ecosystem with an average water spread area of about 350 km². Its average depth is about 1 m and is connected to the Bay of Bengal through a narrow (200 m) and shallow opening. The lake is subjected to tidal oscillations (30 cm) which is felt upto 8-10 km interior. Detailed description of the lake and its topography have been given by many authors (Chacko *et al.*, 1953; Rao, 1971; Raman *et al.*, 1975). Due to limited freshwater supply and tidal action, the mouth of the lake gets silted up and closed during dry seasons. Chacko *et al.*, (1953) have reported that the mouth of this lake gets closed every five years. But of late due to frequent failure of monsoon in this area, the closure of mouth became almost an annual feature from 1971 to 1975, the period of closure increasing from year to year, resulting in steady decline in fish landings (Anon, 1975). Invariably closure took place around premonsoon period (June/July) and lasted till the outbreak of monsoon (November/December).

The bar mouth plays an important role in estuaries in maintaining a dynamic state of environmental condition induced by tidal incursion from the sea and freshwater discharge from the river. The influx from the sea is greatly responsible for minimising fluctuations in physico-chemical conditions in lagoons (Tampi, 1959). Ingression of fish and prawn seed is effected through the mouth of estuaries and lagoons which form the nursery ground for them to feed and grow. Therefore, it is needless to say that the closure of mouth has a profound influence on the environmental features and fisheries in estuaries and lagoons.

Though lot of work has been done on the hydrography, plankton, primary production, bottom flora and fauna of the Pulicat Lake (Chacko *et al.*, 1953; Michael, 1970; Krishnamurthy, 1971; Rao, 1971; Sreenivasan and Pillay, 1972; Kaliyamurthy, 1973, 1975; Rao, 1974; Raman *et al.*, 1975; Radhakrishnan, 1975), no information is available on the interesting aspect

on the ecology and fisheries of this lake during drought. The year 1975 experienced severe drought, owing to failure of monsoon, and the mouth also remained closed for nearly eight months. So this year was selected for a detailed study in comparison with a normal year (1976 without closure of mouth).

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MATERIAL AND METHODS

Fortnightly observations were made on hydrobiological features. Water samples for physico-chemical studies were collected from five stations in the southern zone and three stations from northern zone and were analysed using standard methods. Plankton samples were also collected simultaneously from the same stations. Methods of collections and analysis are the same as described earlier (Raman *et al.*, 1975). The monthly data collected from stations 1 to 5 and 6 to 8 were grouped to represent southern and northern zones respectively.

OBSERVATIONS

Temperature : The zone-wise surface water temperature (Fig. 1 b) showed no marked trend in its seasonal fluctuations. Due to practical difficulties temperature readings were made at different times of the day in various sampling stations (Raman *et al.*, 1975). This may be the probable reason for the lack of any pattern in its seasonal variations. However, lower and higher values were recorded in monsoon and summer respectively in both the zones. During the period of closure of the mouth (March to October) temperature was uniformly higher when compared with the corresponding period of 1976.

Salinity : As observed by earlier workers, salinity showed very wide variations in its seasonal fluctuations, particularly in the northern zone. Salinity started rising from March, 1975 till it reached the peak in September and a steep fall was noticed particularly in the northern zone in October when the mouth opened due to heavy floods. Though the lake water attains hypersaline even in normal years (Rao, 1971; Sreenivasan and Pillay, 1972; Raman *et al.*, 1975), very high values were recorded during the closure period (Fig. 1 a).

Dissolved oxygen : As in the case of temperature, dissolved oxygen also was recorded during different times of the day. However, a general picture of the oxygen regime could be drawn from the present observations. More or less a negative correlation is seen between dissolved oxygen, salinity and temperature. During the closure period very low (2.1 to 3.2 ppm) values, particularly during May to August in the northern zone, were observed (Fig. 1 c).

Plankton : Generally both phyto- and zoo-plankton were at their lowest ebb during the year 1975 (Fig. 1 d, e). But, during the closure period several collections particularly from the northern zone of the lake contained lot of debris and no plankters. During this period *Oscillatoria*, *Pleurosigma*,

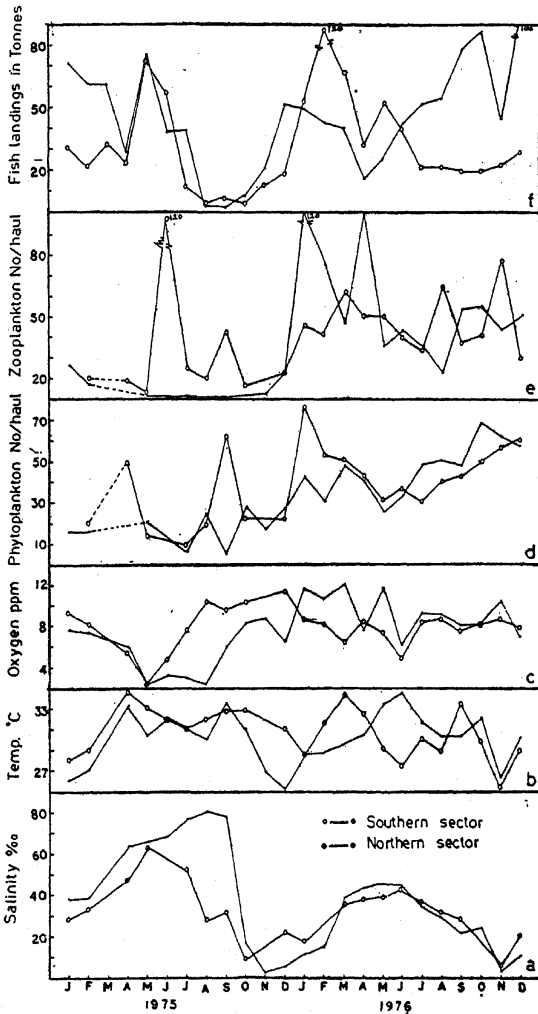


Fig. 1. Seasonal variations : a. salinity, b. temperature, c. dissolved oxygen, d. phytoplankton, e. zooplankton and f. fish landings.

Nitzschia, *Amphora*, *Acartia*, *Mesopodopsis* and nauplii were the plankters occasionally met with, in contrast to normal periods when the plankton was rich both in quantity and quality.

Fisheries : An average of 1000 tonnes of fish is landed annually from this lake. But during the year 1975 landings were only to the tune of 760 tonnes, about 23% less than the previous year. In 1976, 1084.4 tonnes were recorded which could be considered as near normal yield from the lake. The interesting feature of the fishery of the lake during 1975 is a steady fall in landings from May till the bar opened in October, after which the landings gradually improved. During 1976 one peak in January to March and another one in August to December were observed in the southern and northern zones respectively (Fig. 1 f). During the months of May and June 1975 heavy mortality of fishes was noticed. Big-sized dead fishes were found floating in the water. Fishes found dead were mainly *Mugil* spp., *Gerres* spp., *Tachysurus* sp., *Triacanthus* sp., *Brachirus* sp., *Therapon jarbua* and eels (Anon, 1975).

DISCUSSION

From the foregoing account it could be seen that the closure of mouth had lowered the biological productivity by altering the environmental features. During the closure period salinity and temperature were very high and consequently the dissolved oxygen was very low particularly in the northern zone. As mentioned earlier the dissolved oxygen estimations were made during the day time. So it can be reasonably assumed that the oxygen level might be further depleted during night in the northern zone as this area is heavily infested with macrovegetation. Therefore, it can be presumed that the fish mortality observed during May-June might be due to oxygen deficiency than due to higher salinity, since many of the commercially important fishes like *Mugil cephalus*, *Gerres* spp., *Nematolosa nasus*, etc. are known for their tolerance to very high salinities (Nair *et al.*, 1965.)

Sometime after the closure of the bar-mouth, when water level was very much reduced, due to drought fishes congregated in deeper areas and were caught by repeated shore seining which resulted in heavy catches. Later on steady decline in catch was noticed as all the fish were caught already and the remaining were killed by the adverse environmental conditions, particularly low oxygen. This may explain the lowest fish yield recorded during 1975.

Salinity has been found to be an important ecological factor controlling the abundance of many phytoplankton organisms in estuaries. Most of the phytoplankters prefer lower salinities for their growth (Bhattathiri and Devassy, 1975). Though temperature has no apparent effect on the plankton production, uniformly higher temperature will affect it (Qasim *et al.*, 1969). Therefore, very low plankton production recorded during the closure period may be due to higher levels of salinity and temperature.

The present observations show that incursion of sea water through the bar mouth was responsible for maintaining the environmental features without going to extreme conditions, particularly in the tidal southern zone. This is in conformity with the views of Tampi (1959). Occurrence of hypersaline

waters at the northern zone, even during normal years, suggest that the tidal circulation brought about by the present bar mouth is not quite sufficient. Therefore, if another mouth could be established at the northern end at Kodimunai, 40 km from the present mouth, where already a seasonal opening is present (functioning only during flood seasons), and the present one maintained in an open condition by mechanical means, the environmental conditions of the lake could be improved which will result in higher biological productivity and fish yield.

REFERENCES

- ANON. 1975. *Annual Report of Central Inland Fisheries Research Institute, Barrackpore.*
- BHATTATHIRI, P. M. A. AND V. P. DEVASSY 1975. Effect of salinity on the concentrations of some tropical phytoplankters. *Indian J. Fish.*, 22 (1 & 2): 107-112.
- CHACKO, P. I., J. G. ABRAHAM AND R. ANDAL' 1953. *Report on the survey of the flora, fauna and fisheries of the Pulicat Lake, India, 1951-52. Madras.* 20 pp.
- KALIYAMURTHY, M. 1973. Observations on the transparency of the waters of the Pulicat Lake with particular reference to plankton production. *Hydrobiologia*, 41 (1): 3-11.
- 1975. Observations on the Plankton ecology of Pulicat Lake. *Indian J. Fish.*, 22 (1&2): 86-95.
- KRISHNAMURTHY, K. N. 1971. Preliminary studies on the bottom biota of the Pulicat Lake. *J. mar. biol. Ass. India*, 13 (1): 264-268.
- MICHAEL, R. G. 1970. Hydrology of the Pulicat Lake. *Adv. Abstr. contr. Fish Aquat. Sci. India*, 4 (1): 49.
- NAIR, P. V. R., G. LUTHER AND A. CLEMENT 1965. An ecological study of some pools near Mandapam (S. India) formed as a result of the cyclone and tidal wave of 1964. *J. mar. biol. Ass. India*, 7 (2): 420-439.
- QASIM, S. Z., S. WELLERSHAUS, P. M. A. BHATTATHIRI AND S. A. H. ABIDI 1969. Organic production in a tropical estuary. *Proc. Indian Acad. Sci.*, 69: 51-94.
- RADHAKRISHNAN, S. 1975. Some aspects of the distribution and seasonal abundance of macrophytic flora in a brackish lake, Pulicat, India. In: W. Jank [Ed.] *Aquatic Weeds in S. E. Asia*. B. V. publishers, 107-117.
- RAMAN, K., K. V. RAMAKRISHNA, S. RADHAKRISHNAN AND G. R. M. RAO 1975. Studies on the hydrobiology and benthic ecology of Lake Pulicat. *Bull. Dept. Mari. Sci. Univ. Cochin*, 7 (4): 855-884.
- RAO, B. S. R. N. 1971. *Some aspects on the geochemistry and sedimentology of the Pulicat Lake, India.* Ph. D. thesis submitted to the Sri Venkateswara University, Tirupathi.
- RAO, G. R. M. 1974. Observations on the seasonal abundance and distribution of bottom fauna in Lake Pulicat. *Proc. Seminar on Development of Inland fisheries in Tamilnadu.*
- SREENIVASAN, A. AND K. V. N. PILLAY 1972. Hydrology of the Pulicat Lake. *Proc. Seminar Maricult. Mech. Fish.*, 60-66.
- TAMPI, P. R. S. 1959. The ecology of a saltwater lagoon near Mandapam. *J. mar. biol. Ass. India*, 2: 113-130.

ON THE COLLECTION OF STROMBIDAE
(MOLLUSCA : GASTROPODA) FROM BAY OF BENGAL,
ARABIAN SEA AND WESTERN INDIAN OCEAN - 2. GENERA *LAMBIS*,
TEREBELLUM, *TIBIA* AND *RIMELLA*

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ABSTRACT

This paper is the concluding part on the Strombidae of Indian Seas and the first comprehensive report on the species of this region. Fourteen species belonging to four genera namely, *Lambis*, *Tibia*, *Terebellum* and *Rimella* are recorded from the Indian Ocean. Two species of *Rimella* are reported here for the first time from Indian Seas.

INTRODUCTION

THE FAMILY STROMBIDAE is represented by five genera namely, *Strombus*, *Lambis*, *Terebellum*, *Tibia* and *Rimella* in the Indian Seas. The collections in the Zoological Survey of India are well represented in having all the genera. The genus *Strombus* was dealt with in a previous paper (Subba Rao, 1971). The present paper deals with the remaining four genera namely, *Lambis*, *Tibia*, *Terebellum* and *Rimella*.

The author is grateful to Dr. S. Khera, Joint Director-in-Charge, Zoological Survey of India for the necessary facilities. Thanks are due to Dr. R. Tucker Abbott, du Pont chair of Malacology, Delaware Museum of Natural History, Delaware, U.S.A. for supplying the necessary reprints and for encouragement.

Abbreviations used: Coll. - Collector or collected by; ex (s) - example (s); Reg. No. - Register Number; Sta. - Station; Z.S.I. - Zoological Survey of India.

SYSTEMATIC ACCOUNT

Genus *Lambis* Röding, 1798

Lambis Röding, 1798. *Museum Boltenianum* pt. 2. p. 16 (Type by absolute tautonomy; *Lambis lambis* Gmelin = Linnaeus).

Lambis Abbott, 1961. *Indo-Pacific Mollusca*, 1 (3) :147.

Nine species of this genus are reported from the Indo-Pacific region. But the collections studied include only the following seven species from Indian Seas.

Lambis (Lambis) lambis (Linnaeus)

Lambis (Lambis) crocata crocata (Link)

Lambis (Millepes) scorpius indomaris Abbott

ON SOME NEW RECORDS OF CRABS AND LOBSTERS FROM MINICOY, LAKSHADWEEP (LACCADIVES)

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ABSTRACT

New records of brachyuran crabs such as *Grapsus albolineatus* Lamarck, *Cardisoma carnifex* (Herbst), and lobsters *Parribacis antarcticus* (Lund) and *Panulirus homarus* (Linnaeus) from Minicoy Island together with the morphological variations observed in the spiny lobster *Panulirus penicillatus* (Olivier) are reported.

INTRODUCTION

THE BRACHYURAN crabs and lobsters of Lakshadweep have been studied by Alcock (1895, 1896, 1898, 1899 a, b, 1900), Borradaile (1903, 1906) and Chopra (1933). While Alcock reported 41 species of crabs, 52 species of crabs and 2 species of palinurid lobsters were recorded by Borradaile and 1 species of crab by Chopra. Later Sankarankutty (1961 b) added 15 species of crabs. Studies on the collections made during 1973-74 by the senior author revealed the occurrence of *Grapsus albolineatus* Lamarck, *Cardisoma carnifex* (Herbst), *Parribacis antarcticus* (Lund) and *Panulirus homarus* (Linn.) in Minicoy Island for the first time.

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ORDER : DECAPODA

SUBORDER : BRACHYURA

Family : Grapsidae

Grapsus albolineatus Lamarck, 1818

Grapsus strigosus Henderson, 1893, p. 390; Alcock 1900, p. 393; Chopra and Das, 1937, p. 425; Barnard, 1950, p. 115; Pillai, 1951, p. 34; Chharghar, 1957, p. 515.

Grapsus albolineatus Banerjee, 1960, p. 147; Sankarankutty, 1961 a, p. 108.

Material : 2 males 30 mm long and 34 mm broad; 36 mm long and 42 mm broad. 3 females 23 mm long and 27 mm broad; 32 mm long and 36 mm broad; 36 mm long and 42 mm broad.

Locality : Inter-tidal region of the eastern side of the Island.

Remarks : In one of the males in the collection (measuring 42 mm broad), there is an additional spine on the anterior border of the arm of the right cheliped while the left cheliped possesses the normal complement of three spines only.

Distribution. The species is widely distributed throughout the Indo-Pacific region from Red Sea and west coast of Africa to Japan.

the Polynesian Islands and Hawaii. It has been reported from Rameshwaram, Tuticorin (Henderson, 1893), Baluchistan, Sind coast, Andaman and Nicobar Islands (Alcock, 1900), Travancore (Pillai, 1951) and Bombay (Chhapghar, 1957). This is the first record of the species from Minicoy, as also from the Lakshadweep.

Family: *Gecarcinidae*

***Cardisoma carnifex* (Herbst, 1794)**

Cancer carnifex Herbst, 1794, p. 263.

Cardisoma carnifex Alcock, 1900, p. 445; Borradaile, 1903, p. 97.

Cardisoma carnifex Tesch, 1918, p. 137; Barnard, 1950, p. 110; Sankarankutty, 1962, p. 161.

Material: 1 male, 91 mm long and 112 mm

Locality: Sandy beach on the lagoon-side of the Island.

Remarks: The appearance of bristles on the merus of the walking legs agrees with the description given by Alcock (1900). The species is rarely seen in the Minicoy Island. The present specimen was obtained at a distance of about 8 metres above the low water mark and there was no trace of crab castles in the vicinity.

Distribution: Gulf of Mannar (Henderson, 1893); Andamans, Tahiti and Madagascar (Alcock, 1900); Maldives (Borradaile, 1903); East coast of Africa (Barnard, 1950). This is the first record of the species from Minicoy as well as from Lakshadweep.

SUBORDER: MACRURA

Family: *Scyllaridae*

***Parribacus antarcticus* (Lund, 1793) (Fig. 1)**

Scyllarus antarcticus Lund, 1793, p. 22.

Cancer (Astacus) urrus major Herbst, 1793, p. 82.

Parribacus antarcticus Dana, 1952 a, p. 14.

Parribacus ursus major deMan, 1916, p. 93; Barnard, 1950, p. 565.

Parribacus antarcticus Holthuis, 1946, p. 102.

Material: 1 male, total length 181 mm (Carapace length 70 mm).

Locality: From a coral crevice in the lagoon at a depth of 3 meters.

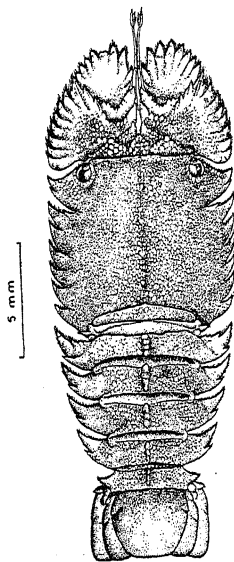


Fig. 1. *Parribacus antarcticus* (Lund) from Minicoy.

Remarks: Since this is the first record of the genus *Parribacus* Dana from Indian waters, a short description of the present male specimen of *P. antarcticus* is given here. Antenna, carapace, abdomen and spiny portion of the telson covered with rounded squamiform tubercles; each tubercle surrounded by a fringe of hairs; rostrum with an indistinct tooth, 4 more teeth before the cervical groove on the mid-line of carapace, of which the last three placed rather close; cardiac tooth distinct and blunt, but not erect; behind the cardiac tooth, 7 groups of submedian teeth; teeth on the orbital margin blunt, but those on the

anterior border are somewhat pointed; totally 8 spines on the lateral border of carapace, of which two are placed before the cervical incision; a narrow groove on the posterior margin of carapace; distal segment of the antenna with 7 large sharply pointed teeth, one inner tooth and 4 smaller teeth on the outer margin; (de Man, 1916) observed 6 and 7 spines on the outer margin of the left and right antennae respectively); exopod of the first, second and third maxillipeds with unsegmented flagellum; transverse groove on the abdominal somites devoid of hairs and tubercles, they are broad in the first two and narrow in the rest of the somites; pereopods slender; sternum with a pit in between the fourth walking legs; pleopods with elongated endopod and exopod which diminish in size from second to fifth abdominal somites. Colour of the specimen at the time of capture was bright yellow with a few scattered brownish blotches on carapace and abdomen; orange spots on the proximal and distal part of the spines of the antennae.

Distribution: The species is known throughout the Indo-Pacific (from east coast of Africa, Mauritius, Sumatra, Philippines, Australia, Formosa to Japan) and in the Atlantic (Caribbean Sea and coast of Brazil). This is the first record of the species from Indian waters.

Family: *Palinuridae*

***Panulirus homarus* (Linnaeus, 1758)**

Panulirus burgeri Calman, 1925, p. 21.

Panulirus dasyopus Gravely, 1927, p. 138.

Panulirus homarus George, 1963, p. 3; George and Rao 1967, p. 331.

Material: I male, total length 188 mm (carapace length 65 mm).

Locality: From coral reef in the intertidal region on the eastern side of the Island.

Remarks: The crenulated grooves of the third, fourth and fifth abdominal somites are interrupted in the midway.

Distribution: Widely distributed in the Indo-Pacific from South Africa through Red Sea, South coast of Arabia and Indian seas to East Indies and Japan. This is the first record of the species from Minicoy.

Along with these new records, specimens of another palinurid lobster, *Panulirus penicillatus* (Olivier) which is the most commonly found in the Island were also collected. Previously Borradaile (1906) recorded the dried shells of the species from this area. The morphological variations observed in *P. penicillatus* of the present collection are given below.

In a specimen measuring 112 mm in carapace length, there is an additional spine along with normal anterior and posterior spines on the right side of the antennular plate. In another specimen measuring 174 mm in total length, the grooves present on the third and fourth abdominal segment are interrupted in the middle. Normally, the interruption of the groove in the midway is known in *P. homarus* among the grooved forms of the genus *Panulirus*. The pleura of somites II to IV of the abdomen showed teeth, which in some specimens, are very distinct, acute and constant in number while in others they are inconspicuous and less in number or totally absent.

REFERENCES

- ALCOCK, A. 1895. Materials for a carcinological fauna of India. 1. The Brachyura Oxyrhyncha. *J. Aasiat. Soc. Bengal*, 64 (2) 2 : 157-259.
1896. Materials for a carcinological fauna of India. 2. The Brachyura Oxystomata. *Ibid.*, 65 (2) 2 : 134-296.
1898. Materials for a carcinological fauna of India. 3. The Brachyura Cyclometopa. Part I. The Family Xanthidae. *Ibid.*, 67 (1) : 67-233.
- 1899 a. Materials for a carcinological fauna of India. 4. The Brachyura Cyclometopa. Part II. A revision of the Cyclometopa with an account of the

families Portunidae, Cancridae and Corystidae. *Ibid.*, 68 (2) 1: 11-164.

——— 1899 b. Materials for a carcinological fauna of India. 5. The Brachyura Primigenia or Dromiacea. *Ibid.*, 68 (2) 3: 123-169.

——— 1900. Materials for a carcinological fauna of India. 6. The Brachyura Catometopa or Grapsidae. *Ibid.*, 69 (2) 6: 279-456.

BANERJEE, S. K. 1960. The genera *Grapsus*, *Geograpsus* and *Metapograpsus* (Crustacea-Brachyura). Biological results of the Snellius Expedition, XVIII. *Temminckia*, 10: 132-199.

BARNARD, K. H. 1950. Descriptive catalogue of South African Decapod Crustacea. *Ann. S. Afr. Mus.*, 38: 1-824.

BORRADAILE, L. A. 1903 & 1906. Marine Crustaceans. In: Fauna and Geography of the Maldive and Laccadive Archipelagos, Part I & II. *Cambridge Univ. Press*.

CALMAN, W. T. 1925. Macrurous Decapod Crustacea collected in South African waters by the S. S. 'Pickle'. *S. African Fish. Mar. Biol. Survey. Rep.*, 4 (3): 1-26.

CHHAPGAR, B. F. 1957. On the marine crabs Decapoda: Brachyura) of Bombay State. *J. Bombay Nat. Hist. Soc.*, 54 (3): 503-549.

CHOPRA, B. N. 1933. Further notes on Crustacea Decapoda in the Indian Museum III. On the Decapoda Crustacea collected by the Bengal Pilot service off the mouth of the river Hoogly. Dromiacea and Oxystomat. *Rec. Indian Mus.*, 35: 25-32.

——— AND K. N. DAS 1937. Further notes on Crustacea Decapoda in the Indian Museum. On three collections of crabs from Tavoy and Mergui Archipelagos. *Ibid.*, 39: 377-434.

*DANA, J. D. 1852a. *Conspectus Crustaceorum quae in Orbis Terrarum Circum-navigazione. Carolo Wilkes Classe Republicae Foederatae Duce, lexit et descripsit. roc. Acad. nat. Sci. Philad.*, 1852, p. 10-28.

DE MAN, J. G. 1916. The Decapoda of Siboga Expedition. Part III. Families Eryonidae, Palinuridae, Scyllaridae and Nephropsidae. *Siboga Exped. Monogr.*, 3a (2): 1-122.

GEORGE, R. W. 1963. Report to the Government of Aden on the crayfish resources of Eastern Eden territory. *Rep. FAO/EPTA* (1960): 1-23.

GEORGE, M. J. AND P. VEDAVYASA RAO 1967. On the decapod crustaceans from the southwest coast

of India. *Proc. Symp. Crustacea, Mar. Biol. Ass. India* Part I: 327-336.

GRAVELY, F. H. 1927. Crustacea in the littoral fauna of Krusadai Island in the Gulf of Mannar. *Bull. Madras Govt. Mus. (n.s.)*, 1 (1): 135-155.

*HENDERSON, J. R. 1893. A contribution to Indian Carcinology. *Trans. Linn. Soc. London. (Zool.)*, 5 (2): 325-458.

*HERBST, 1791-96. Versuch einer Naturgeschichte der Krabben und Krabse nebst einer systematischen Beschreibung ihrer verschiedenen Arten, 2: 1-226.

HOLTHUIS, L. B. 1946. XIV. The Decapoda Macrura of the Snellius Expedition. 1. Stenopodidae, Nephropsidae, Scyllaridae and Palinuridae. Biological results of the Snellius Expedition. *Temminckia*, 7: 1-178.

*LAMARCK, J. P. 1818. Histoire naturelle des Animaux sans Vertèbres, présentant les caractères généraux et particuliers des ces animaux, leur distribution, leurs classes, leurs familles, leurs genres, et la citation des principes espèces qui s'y rapportent; précédée d'une introduction offrant la Détermination des caractères essentiels de L' Animaux, sa distinction du végétal et des autres corps naturelles, enfin, L' Exposition des Principes fondamentaux de la Zoologie. *Hist. nat. Anim. s. Vert.*, 5: 1-612.

*LINNAEUS, C. 1758. *Systema Naturae per Regna tria Naturae, secundum Classes, Ordines, Genera, Species, cum Characteribus, Differentiis, Synonymis, Locis*, Id. 10, 1: 1-824.

*LUND, N. T. 1793. *Slaegten Scyllarus. Iagttagelser til Insekternes Historie. I. Skr. naturh. Selsk. kbh.*, 2 (2): 16-22.

PILLAI, N. K. 1951. Decapoda (Brachyura) from Travancore. *Bull. Res. Inst. Univ. Travancore*, 2 (1) Ser. C: 1-46.

SANKARANKUTTY, C. 1961 a. On some decapoda Brachyura from the Andaman and Nicobar Islands. 1. Families Portunidae, Ocypodidae, Grapsidae and Mictyridae. *J. mar. Biol. Ass. India*, 3: 101-119.

——— 1961 b. On some crabs (Decapoda, Brachyura) from the Laccadive Archipelago. *Ibid.*, 3: 120-136.

——— 1962. On Decapoda Brachyura from the Andaman and Nicobar Islands. 3. Families: Calappidae, Leucosidae, Parthenopidae, Maiidae and Gecarcinidae. *Ibid.*, 4 (1): 151-164.

TESCH, J. J. 1918. The Decapoda Brachyura of the Siboga Expedition. 1. Hymenosomidae, Retroplumidae, Ocypodidae, Grapsidae and Gecarcinidae. *Siboga Exped. Monogr.*, 39 c: 1-148.

* Not referred to in original.