Proceedings of the

FIRST WORKSHOP ON SCIENTIFIC RESULTS OF FORV *SAGAR SAMPADA*

5-7 June, 1989, Cochin

Sponsored by

DEPARTMENT OF OCEAN DEVELOPMENT
&
INDIAN COUNCIL OF AGRICULTURAL RESEARCH
NEW DELHI

Organized by

CENTRAL MARINE FISHERIES RESEARCH INSTITUTE
&
CENTRAL INSTITUTE OF FISHERIES TECHNOLOGY
COCHIN

OCTOBER, 1990

Published by

Dr. P.S.B.R. JAMES
DIRECTOR
Central Marine Fisheries Research Institute
COCHIN - 682 031

Edited by

Dr. K.J. MATHEW
Central Marine Fisheries Research Institute
COCHIN - 682 031

Proc. First Workshop Scient. Resul. FORV Sagar Sampada, 5 - 7 *June,* 1989 : 129 - 136 (1990)

STUDIES ON THE DISTRIBUTION AND ABUNDANCE OF THE GENUS *LUCIFER* COLLECTED DURING THE CRUISES OF FORV *SAGAR SAMPDA*

GEETHA ANTONY, K. J. MATHEW AND T. S. NAOMI

Central Marine Fisheries Reserach Institute, Cochin -682 031

ABSTRACT

Distribution and numercial abundance of the genus *Lucifer* in the eastern Arabian Sea and the Bay of Bengal between 4° 30'N and 23° N latitudes are discussed based on 1086 zooplankton collections from 44 cruises of FORV *Sagar Sampada*. Lucifers were present in 99% of the samples, forming a major component of the planktonic decapods with an abundance of 2,499 per 1000 m^3 of water for the entire region. The average abundance of lucifers was 2,591(number per 1000m^3 of water) for the Arabian Sea and 2,361 for the Bay of Bengal. The density in the shelf area (5,105) was higher than that in the oceanic waters (1,357). The concentration of lucifers observed in the region between 4° 30 'N to 10° N was the highest for the entire region of study; 3,996 for the Arabian Sea and 3,503 for the Bay of Bengal. The number in the shelf area of the Bay of Bengal was the highest (6,461) followed by that recorded in the eastern Arabian Sea (4,382). Their abundance in the oceanic regions was 892 and 1,700 respectively. The highest concentration half-degree wise was observed in the shelf region off Andhra coast (58,524). The numerical abundance of lucifers was almost 64% of the total during the monsoon season. However, their abundance was more during the premonsoon season in the Arabian Sea beyond 15° N latitude. The density of lucifers collected during night time was only marginally higher than that in the day time in the eastern Arabian Sea and the Bay of Bengal but considerably high in the shelf region at night during the premonsoon season.

INTRODUCTION

The species of the genus *Lucifer* (Macrura, Penaeidea, Sergestidae) are warm water epiplanktonic shrimps restricted to Atlantic, Indo-West Pacific and Eastern Tropical Pacific oceans. Of the seven recognized species in the genus *Lucifer*, five are found widespread in the coastal waters of India (Omori, 1977).

Extensive literature available on the seasonal occurrence of *Lucifer* spp. are from the nearshore waters and estuaries of India. Quantitative studies on *Lucifer* spp. encompassing large areas of the Indian waters have been attempted recently from the cruises of RV *Gaveshini*. Works of Paulinose *et al* . (1987) in the Arabian Sea, Nair *et al.* (1981) and Paulinose *et al.* (1988) in the Bay of Bengal and Madhupratap *et al.* (1981) in the Andaman Sea have wider coverage. However, there is a lacuna in the knowledge of the seasonal distribution and abundance of this genus in the seas around India, particularly the oceanic areas of the Indian subcontinent.

The role of *Lucifer* spp. in the zooplankton community is considerable as they play a significant role in the food web of the warm neritic waters, often becoming a major component in the diets of shore fishes and large shrimps (Omori, 1974). The spatial and seasonal distribution of *Lucifer* spp. has great relevance to the fisheries of the region since they have been shown as a good indicator of the presence of a core pelagic fishing ground (Huang, 1987).

MATERIALS AND METHODS

The studies were based on 1086 plankton samples collected since January 1985 to March 1988 in the area within 4°30'N, to 23°N lat. and 75°E to 95°E long. by oblique tows from 150 m to surface using a Bongo - 60 net (mesh aperture 0.33 mm), equipped with a calibrated flow meter. The average No. / 1000 m^3 per half a degree square pooled for 1985 - '88 was taken as the index of abundace wih reference to area and time.

The faunal content of the eastern Arabian Sea (65° to 77°30'E long.) is compared with that of the Bay of Bengal (77° 30' to 95°E long.). Latutudinal variations of the fauna between region I (from 4°30'N to 10°N lat.), region II (10°N to 15°N lat.), region III (15° to 20°N lat.) and region IV (beyond

20°N upto23°N lat.) in the eastern Arabian Sea and the Bay of Bengal are compared. The shelf region of the eastern Arabian Sea or the Bay of Bengal is compared with the respective oceanic region. Premonsoon (Feb. -May), Monsoon (June -Sept.) and postmonsoon (Oct. - Jan.) were the periods identified for comparing the variations between seasons. Samples collected from 0600 to 1800 hrs were taken as day samples and 1800 to 0600 hrs as night samples for studying the day - night variations in distribution.

Observations

Geographical distribution

Lucifers were found distributed extensively all along the Indian coasts with pockets of high abundance along the east coast and off the southwest coast (Fig.1). Along the northeast coast, lucifers were present in dense patches off Andhra and Orissa. The highest concentration in a half-degree square (58,524) was observed between 15° N and 16° N latitudes. Patches of fairly high concentrations were obsereved at the head of the Bay, from Puri to Visakhapatnam with a central core of very high concentration (> 30,000), off Kakinada, in the oceanic region off Madras and in the neritic waters from Pondicherry to Point Calimere. High concentration (28,000) was seen around the peninsular curve including the Gulf of Mannar and the Wadge Bank down to 6° N latitude. The high density area continued and extended along the shelf upto 13° N latitude on the west coast, with a dense patch from Calicut to Mangalore. Pockets of very high densities (23,000-46,000) were present in the oceanic waters off Vizhinjam-Alleppey, between 8° N and 9°30' N latitudes. In the eastern Arabian Sea, apart from pockets of fairly high concentrations observed in the oceanic regions south of Minicoy (8,000), off Mangalore, off Goa and a patch extending along the 200 m depth contour from Bombay to Dwakraka (19° to 22°N lat.), the distribution was only in moderate numbers (1,001-5,000). In the central Bay of Bengal lucifers were sparse (<1000) but they were present in moderate numbers in the seas around Andaman and Nicobar Islands. A pocket of high concentration was observed to the west of Great Nicobar (12,000) and another one of fairly high concentration to the east of South Andamans (5,829).

Numerical abundance

Lucifers were present in 99% of the samples with an average density of 2,499. Not much variation in densities was observed between the eastern Arabian Sea (2,591) and the Bay of Bengal (2,361).

The monthly density distribution for the total area surveyed (Fig. 2) and for the eastern Arabian Sea and the Bay of Bengal (Fig. 3) showed a similarity in the distribution pattern. The major period of abundance was around the monsoon with the peak in June in the Arabian Sea and in October in the Bay of Bengal subsequently falling in November and December respectively. Relatively steady numbers were noticed from December to May.

Lucifers were found distributed in higher concentration on the shelf throughout the year (Fig. 4). The major concentration was found along the shelf region in the Bay of Bengal (6,461). The neritic waters in the eastern Arabian Sea had a density of 4,382. However, while the oceanic waters in the Bay of Bengal had very poor density (892), the oceanic waters in the Arabian Sea supported a moderate population (1,700) (Fig. 5).

A very large population of Lucifers was found to be maintained between 4°30'N and 10°N latitudes in the west (3,996) and the east coasts (3,503) while the abundance for the rest of the regions varied between 1,300 and 2,300.

Lucifers were distributed in high abundance in the shelf waters of the Bay of Bengal during the southwest monsoon season with the peak between 15°N and 20°N latitudes. In the Arabian Sea the monsoon abundance extended from 4°30'N to 15°N latitudes beyond which high abundance was noticed during the premonsoon months. In this region during the southwest monsoon lucifers were observed in more concentrations in the oceanic waters than in the shelf waters.

The density of lucifers in samples collected during night time was more than those collected in the day time. However, this variation was not signficant (Fig. 8). The density of lucifers during night and day varied relatively little in the oceanic region but varied considerably in the continental shelf (Fig. 9). In the shelf waters the genus was more abundant in the night samples during the premonsoon season (73%) and monsoon (57%) but during the post monsoon season they were more abundant in the samples collected during day time (63%).

Discussion

Lucifers were present in more stable numbers

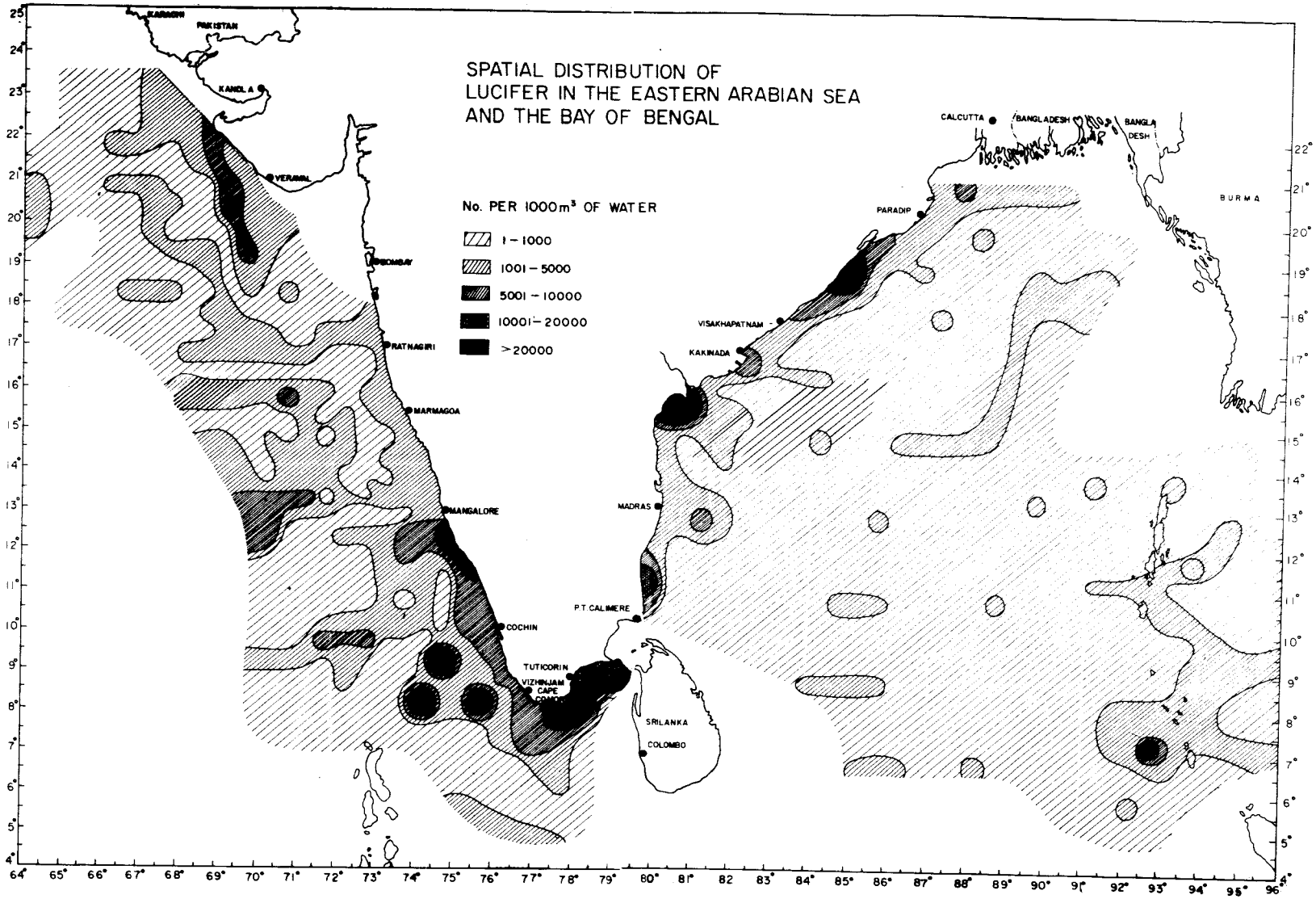

Fig. 1. Spatial distribution of lucifers in the eastern Arabian Sea and the Bay of Bengal.

throughout the year than any other zooplankton group, forming numerically the major component of the planktonic decapods as observed by Menon and Paulinose (1973).

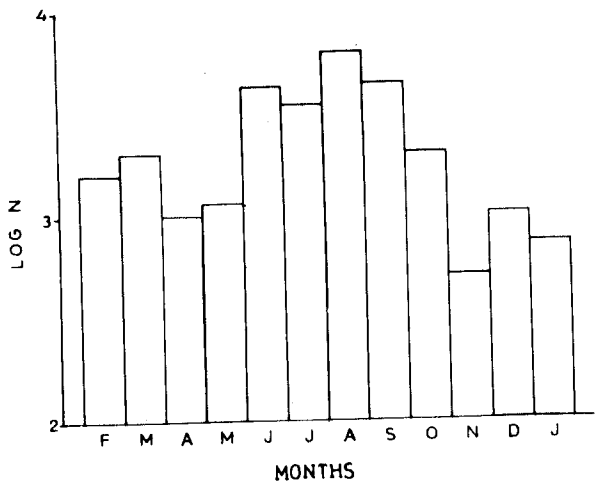

Fig. 2. Monthly variations of lucifers in the seas around India.

The monsoon cycles have been found to play a significant role in the abundance of lucifers in the Bay of Bengal as a whole and in the Arabian Sea upto 15°N latitude beyond which the impact of seasonal cycle was not significant. In the Bay of Bengal this is in agreement with the observations of Menon (1933), Prasad (1954, 1958) Krishnamurthy (1961), Marichamy and Siraimeetan (1979) from the Gulf of Mannar-Palk Bay region andof Sarkar *et al.* (1986) around 21°N latitude. Ganapati and Ramanamurthy (1975) have reported that the major peak of the developmental stages of lucifers off Visakhapatnam was during February-June and that of adults in November. RV *Gaveshini* cruises in the western Bay of Bengal (Achuthankutty *et al.*, 1980; Nair *et al.* 1981 and Paulinose *et al.*, 1988) also confirm large aggregation of lucifers in the coastal waters of the Bay of Bengal during the monsoons. Madhupratap *et al.*, (1981) have reported lucifers as the major group of planktonic decapod around Andaman and Nicobar Islands. Goswami (1983) found lucifers forming 9% of the zooplankton around Lakshadweep. Along the southwest coast in the nearshore waters Menon (1945), George (1953), Mukundan (1967) and George and Paulinose (1973) have reported lucifers to be common throughout the year. Naomi and Mathew (1989 M. S.) found lucifers more abundant during the southwest monsoon off Cochin. The present observations along the northwest coast of India are in agreement with those of Nair *et al.*, (1980), Achuthankutty *et al.* (1981) and Naomi (1986) who have reported lucifers to be more abundant during the premonsoon months (March-April).

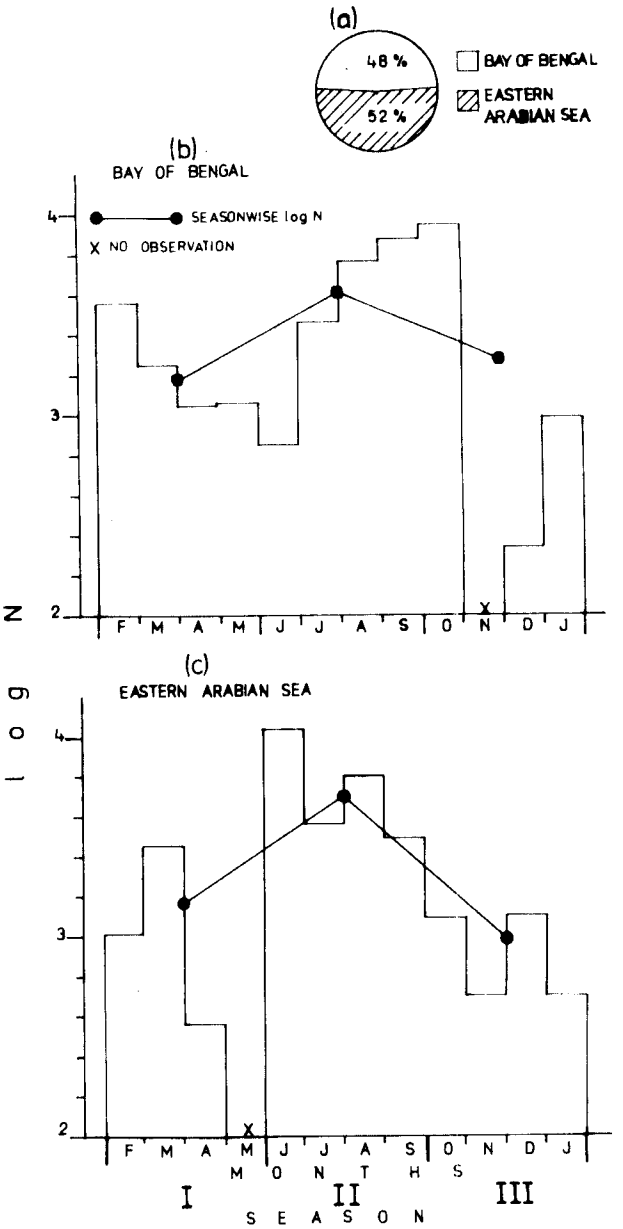

Fig. 3. Abundance of lucifers in the eastern Arabian Sea and the Bay of Bengal (a) Relative abundace. Monthly and seasonal variations in (b) the Bay of Bengal and (c) the eastern Arabian Sea.

All the areas of abundance of lucifers in the shelf along the southwest coast and at localised areas along the east coast (off Madras, Visakhaptanam and Orissa) and around the Andamans

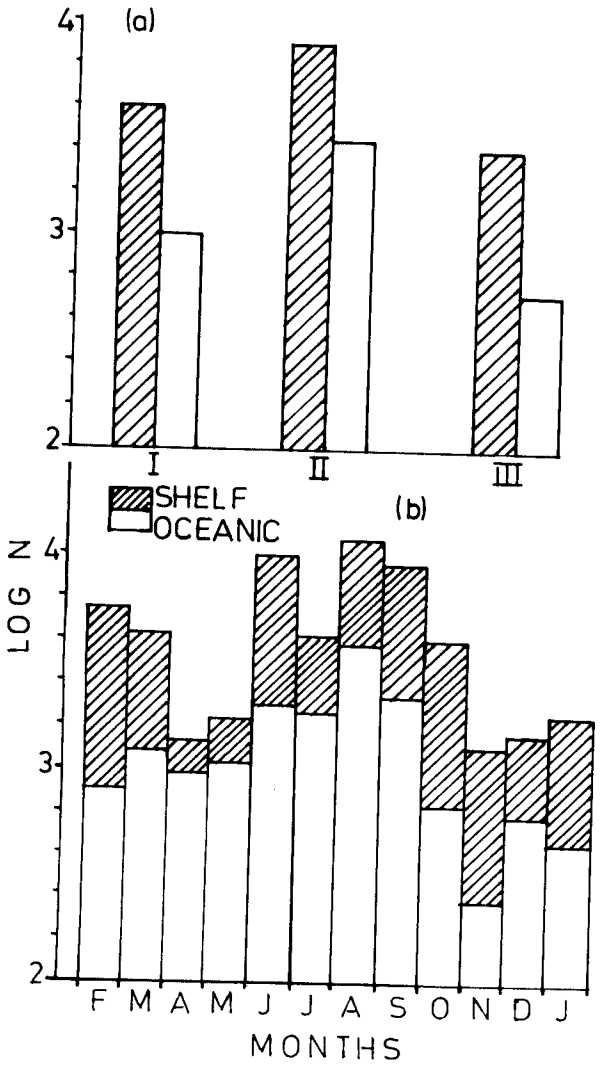

Fig. 4. Seasonal (a) and monthly (b) variations in the relative abundance of lucifers in the shelf and oceanic waters of the seas around India.

appear to be areas where strong upwelling followed by increased production at the primary and secondary levels is reported (Panikkar and Rao, 1973; Subramanyan, 1973; Menon and George, 1977 and Qasim 1977).

The abundance of lucifers was found to decrease with the increasing distance from the coast as indicated by Omori (1974). Their abundance in the oceanic waters of the Arabian Sea was greater than that in the Bay of Bengal but very patchy, containing some of the richest and some of the least abundant areas. The same feature, characteristic of the Arabian Sea is indicated by Ryther and Menzel (1965) who have reported areas of extremely dense plankton blooms which vary in size from 100 yards or less to several miles in diameter and often sharply delineated by extremely clear and unproductive water. Nair *et al.* (1980) found lucifers to be a main component of the Zooplankton during March-April as a result of the enrichment caused by the *Trichodesmium* bloom. In the Bay of Bengal the column productivity in the central areas is reported to be low (Qasim, 1977) and this could be a reason for the very sparse and even distribution of lucifers in the oceanic waters of the Bay.

The present study also revelas that lucifers in the neritic waters of the Bay are 16% more than that of the Arabian Sea. The surface production in the coastal waters in the Bay of Bengal per unit area is reported to be greater than that of Arabian Sea (Qasim, 1977). The concentration of epiplanktonic shrimps is particularly great in waters where the bottom slopes steeply close to the shore and strong upwelling is frequently observed (Omori, 1974). Hence it is logical to conclude that lucifers aggregate in the areas of narrow and steep continental slope of the east coast where intense upwelling, followed

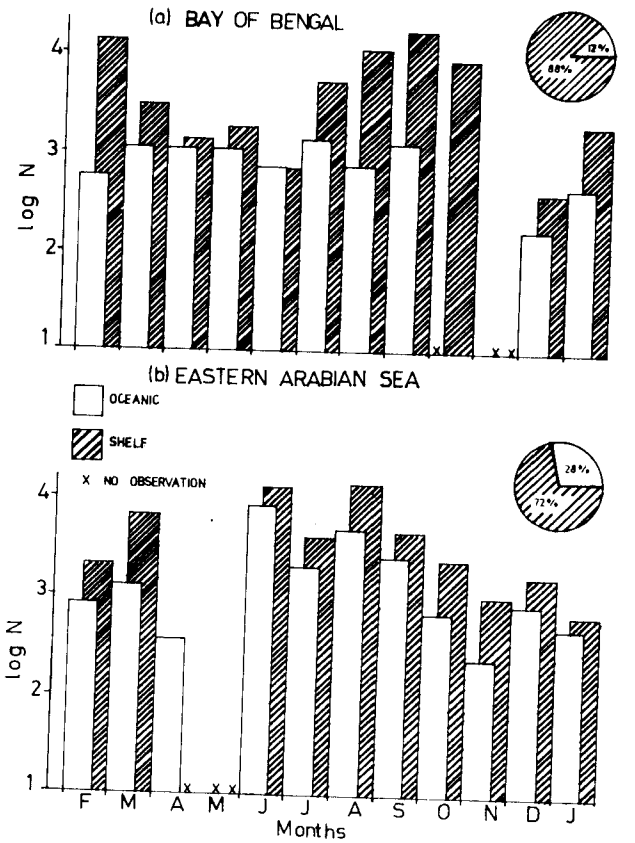

Fig. 5. Monthly variations and the relative abundance of lucifers in the shelf and oceanic waters of the Bay of Bengal (a) and eastern Arabian Sea (b).

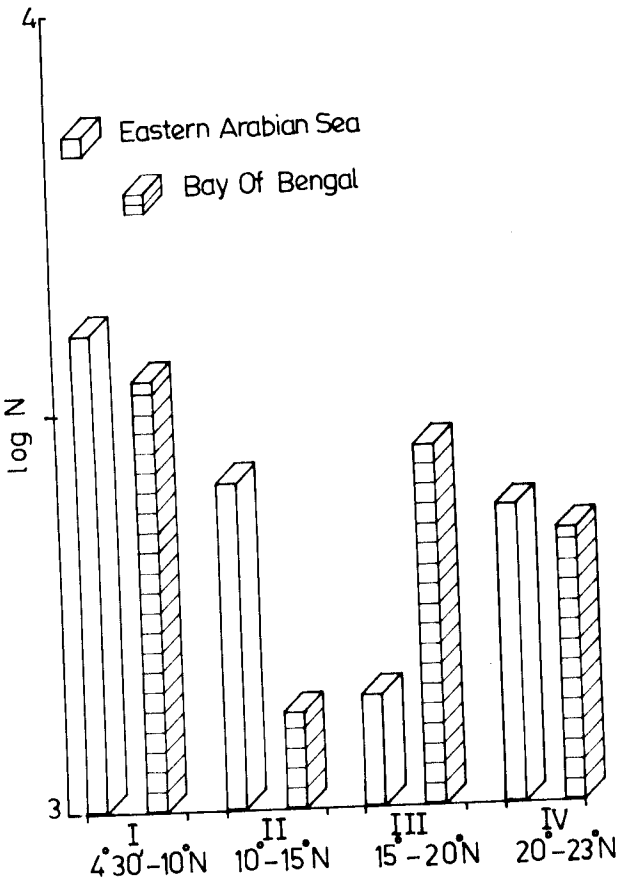

Fig. 6. Regionwise distribution in the abundace of lucifers in the eastern Arabian Sea and the Bay of Bengal.

by very high surface productivity, is reported. Swarms of lucifer around the peninsular curve during the southwest monsoon is probably related to precipitation and direction of the monsoon winds. Furthermore there is less upwelling south of Quilon and the oxygen rich surface layer is much deeper with better environmental condition (Anon., 1976).

In this study diurnal migration of lucifers was not significant, as the main part of the population is in the upper 150-metre layer both at day and night intimately associated with the productive zones where they eat (Omori, 1974). Apart from food supply, light intensity and temperature are regarded as important factors in the vertical distribution of a neritic genus like *Lucifer* (Raymont, 1983). This may be the reason for their lesser abundance in the samples during day time in the premonsoon season when the light intensity is more than during the monsoon and postmonsoon seasons.

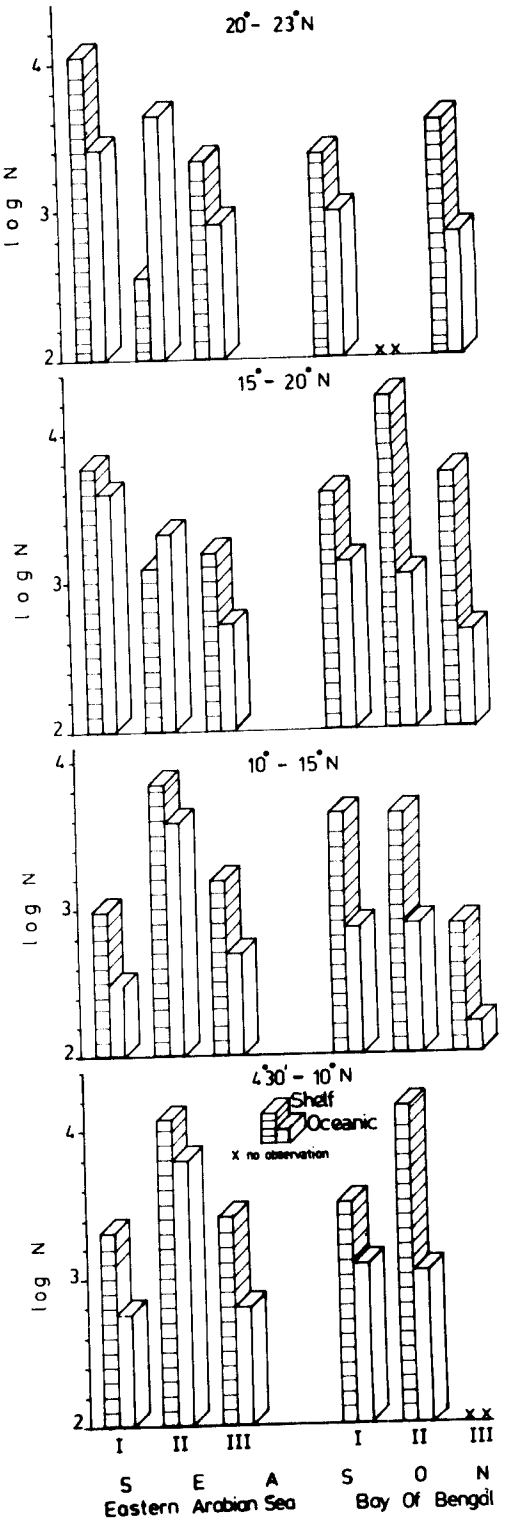

Fig. 7. Regionwise seasonal abundance of lucifers in the shelf and oceanic waters of the eastern Arabian Sea and the Bay of Bengal.

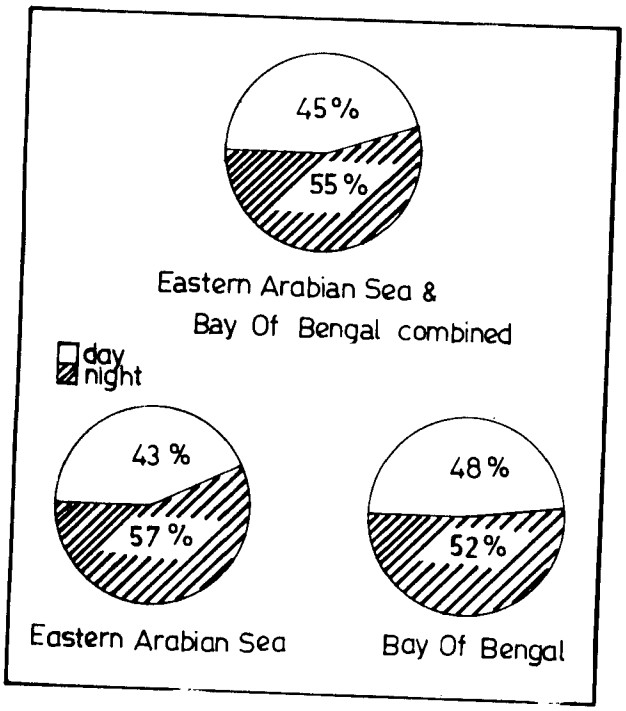

Fig. 8. Variations in the abundance of lucifers during day and night.

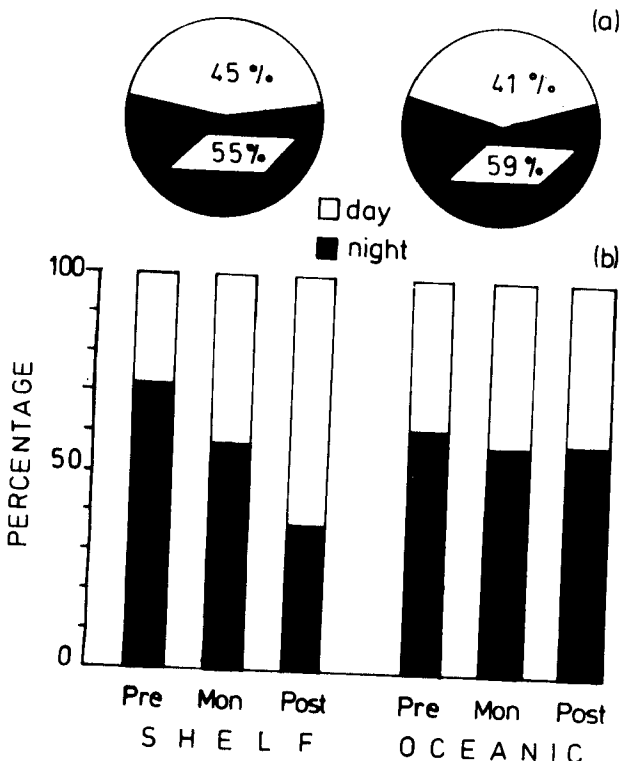

Fig. 9. Day - Night variation in the abundance of lucifers in the shelf and oceanic waters: (a) in the seas around India, (b) seasonal variations.

Lucifer spp. are reported to be very common in the diets of pelagic fishes (Prasad, 1954; Rao, 1962; Nath, 1966; Kagwade, 1967; Sreenivasan, 1979). Huang *et al.* (1987) found the variatons in abundance of lucifers and the catch of *Decapterus maruadsi* similar in the Taiwan waters.

The pattern of distribution and abundance of *Lucifer* reported in this study agrees with the distribution of young fish of several pealgic species reported by the investigations of the UNDP/FAO Pelagic Fishery Project along the west coast of India (Anon., 1975) and also with the areas of high abundance of the fishery resoruces of the Indian EEZ (George *et al.*, 1977). Since lucifers play a signifciant role as food of fish and shrimps in their nursery grounds (Omori, 1974) it seems that the abundance of *Lucifer* spp. may serve as an indicator of these nursery grounds.

Acknowledgements

We are thankful to Dr. P. S. B. R. James, Director, CMFRI for his keen interest shown in this work. Our thanks are also due to Dr. K. S. Scariah and Shri. P. P Pavithran for the help rendered in the computer analysis of the data and to Shri. M. A. Nizar for the various help rendered.

References

Achuthankutty, C. T. , M. Madhupratap, V. R. Nair, S. R. S. Nair and T. S. S. Rao 1980. Zooplankton biomass and composition in the western Bay of Bengal during late southwest monsoon. *Indian J. mar. Sci.*, 9 : 201-206.

Achuthankutty, C. T. and S. R. Sreekumaran Nair 1981. A preliminary account on the distribution of decapod larvae in Konkan waters. *Mahasagar , Bull. natn. inst. Oceanogr.*, 14 (3) : 211-214.

Anon., 1975. Progress Report, UNDP/FAO, Pelagic Fishery Project, No. 10: 14pp.

Anon., 1976. Progress Report, UNDP/FAO, Pelagic Fishery Project, No. 16: 27 pp.

Ganapati, P. N. and K.V. Ramanamurthy 1975. Distribution and abundance of the plankton shrimp, *Lucifer* in the nearshore waters off Visakhapatnam. *Curr. Sci.*, 44 (10): 350.

George, M. J. and V. T. Paulinose 1973. On a collection of planktonic Decapoda (Penaeidea) from the southwest coast of India. *IOBC Handbook*, 5 : 60-69.

George, P. C. 1953. The marine plankton of the coastal waters of Calicut with observations on the hydrological conditions. *J. Zool. Soc. India*, 5 (1) : 76-107.

George, P. C., B. T. Antony Raja and K. C. George 1977. Fishery resources of the Indian economic Zone. Souvenir , Silver Jubilee celebrations of I. F. P . Cochin, India, 79-116.

GOSWAMI, S. C. 1983. Production and zooplnakton community structure in the lagoon and surrounding sea at Kavaratti Atoll (Lakshadweep). *Indian J. mar. Sci.*, 12 : 31-35.

HUANG, M. F. J. 1987. Distribution of *Lucifer* and its relation to fishery in Taiwan Strait and its adjacent areas. *Taiwan Strait /Taiwan Haixia*, 6(2): 107-113.

KAGWADE, V. N. 1967. Food and feeding habits of the Horse - mackerel, *Caranx kalla* (Cuv. & Val.) *Indian J. Fish .*, 14 (1) : 85-96.

KRISHNAMURTHY, K. 1961. Daily variation in marine plankton from Porto Novo, S. India. *J. Zool.* Soc. India, 13 : 180-187.

MADHUPRATAP, M., C.T. ACHUTHANKUTTY, S.R. SREEKUMARAN NAIR AND VIJAYALAKSHMI R. NAIR 1981. Major crustacean groups and zooplankton diversity around Andaman-Nicobar Islands. *Indian J. mar. Sci.*, 10(3) : 266-269.

MARICHAMY, R. AND PON. SIRAIMEETAN 1979. Hydrobiological sutides in the coastal waters of Tuticorin, Gulf of Mannar. *J. mar. biol. Ass. India*, 21 (1&2) : 67-76.

MENON, M. A. S. 1945. Observations on the seasonal distribution of plankton off the Trivandrum coast. *Proc. Ind. Acad. Sci.*, 22 (B) : 31-62.

MENON, M. D. AND K. C. GEORGE 1977. On the abundance of zooplankton along the southwest coast of India during the years 1971-1975. *Proc. Symp. Warm Water Zooplankton*, NIO/UNESCO, 205-213.

MENON, M. K. 1933. The life histories of decapod Crustacea from Madras. *Bull. Madras. Govt. Mus. N. S. Nat. Hist. Sect.*, 3 (3): 1-45.

MENON, P. G. AND V. T. PAULINOSE 1973. Distribution of decapod larvae in the Indian Ocean. *IOBC Handbook* , 5: 163-171.

MUKUNDAN, C. 1967. Plankton of Calicut inshore waters and its relationship with coastal pelagic fisheries. *Indian . J. Fish.*, 14: 271-292.

NAIR, S. R. SREEKUMARAN, VIJAYALAKSHMI R. NAIR, C. T. ACHUTHANKUTTY AND M. MADHUPRATAP 1981. Zooplankton compositon and diversity in the western Bay of Bengal. *Jour. Plank. Res.*, 3 (4) : 493-508.

NAIR, V. R., V. P. DEVASSY AND S. Z. QASIM 1980. Zooplankton and *Trichodesmium* phenomenon. *Indian J. mar. Sci.*, 9: 1-6.

NAOMI, T. S. 1986. On the zooplankton of the inshore waters of Karwar during 1980-'81. *Indian J. Fish .*, 33 (3): 336-346.

NAOMI, T.S. AND K. J. MATHEW 1989 (M.S.) Investigations on zooplankton and secondary production off Cochin.

NATH, P.R. 1966. Biology and seasonal distribution of the pelagic food fishes of Travancore coast. *Bull. of the Department of Marine Biology and Oceanography*. University of Kerala, Special Publication, 1-140.

OMORI, M. 1974. The biology of pelagic shrimps in the ocean. *Adv. Mar. Biol.* , 12, 233-324.

OMORI, M. 1977. Distribution of warm water epiplanktonic shrimps of the genera *Lucifer* and *Acetes* (Macrura, Penaeidea, Sergestidae). *Proc. Symp. Warm Water Zooplankton* , NIO/UNESCO, Goa, 1-12.

PANIKKAR, N. K. AND T. S. S. RAO 1973. Zooplankton investigations in Indian waters and the role of the Indian Ocean Biological Centre. *IOBC Handbook* . 5 : 111-162.

PAULINOSE, V. T., S. C. GOSWAMI AND VIJAYALAKSHMI, R. NAIR 1987. Planktonic Decapoda and Stomatopoda (Crustacea) from the Arabian Sea. *Mahasagar*, 20 (2): 99-107.

PAULINOSE, V. T. , V. R. NAIR AND S.C. GOSWAMI 1988. Studies on the planktonic Decapoda and Stomatopoda (Crustacea) from the western Bay of Bengal. *Mahasagar*, 21 (3) : 135-143.

PRASAD, R. R. 1954. The characteristics of marine plankton at an inshore station in the Gulf of Mannar near Mandapm. *Indian J. Fish .*, 1 : 1-36.

PRASAD, R. R. 1958. Plankton calendars at the inshore waters of Mandapam with a note on the productivity of the area. *Indian J. Fish.*, 5 (1) : 170-188.

QASIM, S. Z. 1977. Biological productivity of the Indian Ocean. *Indian J. mar. Sci.*, 6 (2) : 122-137.

RAO, K. V. N. 1962. Food of the Indian mackerel *Rastrelliger kanagurta* (Cuv.) taken by drift nets in the Arabian Sea off Vizhinjam, South Kerala. *Indian. J. Fish.*, 9 (2) A : 530-541.

RAYMONT , E. G. JOHN 1983. *Plankton and Productivity in the Oceans. Vol. 2- Zooplankton*, Pergamon.

RYTHER, J. H. AND D. W. MENZEL 1965. On the productivity composition and distribution of organic matter in the western Arabian Sea. *Deep Sea Res.*, 12 (2): 199-209.

SARKAR, S. K, B. N. SINGH AND A. CHOWDHURY 1986. Compostion and variation in the abundance of zooplankton in the Hooghly estuary, West Bengal, India. *Proc. Indian Acad. Sci. Anim. Sci.*, 95 (2): 125-134.

SREENIVASAN , P. V. 1979. Feeding biology of the scad *Decapterus dayi* Wakiya. *J. mar. biol. Ass. India*, 21 (1&2) : 97-102.

SUBRAHMANYAN, R. 1973. Hydrography and plankton as indicators of marine resources. *Proc. Symp. Living Res. seas around India*, 199-228.