

CONTRIBUTION OF ZOOPLANKTON TO THE FISHERY POTENTIAL OF SOME ENVIRONMENTS

Vijayalakshmi R. Nair

Regional Centre,
National Institute of Oceanography,
Bombay-400 061

ABSTRACT

Difference in zooplankton production in estuarine, coastal and oceanic realms of the Indian Ocean has been correlated to the fishery potential of the concerned area. In the estuarine habitat the estimated rate of secondary production can not sustain a fishery of the present magnitude. Direct correlation between fish landing and zooplankton is observed in the coastal waters. Compared to coastal waters zooplankton standing stock is low in the open ocean and this low production is compensated by a wider area. The estimated fishery potential of the ocean is much more than what is being exploited.

INTRODUCTION

Zooplankton being a major link in the energy transfer at secondary level plays a significant role in the production potential of any aquatic environment. In short, an estimate of zooplankton standing stock provides an index to the fertility of the sea. To a certain extent the success and failure of fishery particularly that of pelagic fishery is dependant on the availability of plankton. High concentrations of fish occur in areas of high plankton production which in turn are the areas of enrichment. There are a few reports supporting the direct correlation of pelagic fishery to zooplankton production in the Indian Ocean (Sudarsan, 1964; Prasad, 1969; Nair *et al.*, 1978).

1

1982. J. Indian Fish. Ass. 7 : 1-7

In India approximately 54 per cent of the total fish landing is contributed by pelagic fisheries (CMFRI, 1980). A major part of the pelagic fishery is shared by shoaling fishes like sardines, mackerel etc. which are essentially plankton feeders. Variability in zooplankton distribution is a common feature. Basic differences in the abundance and diversity of zooplankton is well marked in estuarine, coastal and oceanic realms. Probably such differences may exert profound influence on the fishery potential. In this communication an attempt is made to correlate the rate of zooplankton production in some tropical environments and its impact on the fishery of the concerned system.

METHODS TO ESTIMATE FISHERY POTENTIAL

Estimate on fishery potential is on the assumption that ecological efficiency from one trophic level to the other is about 10%. In the marine food chain approximately 10% of secondary production (zooplankton production) will be available to the tertiary level (fish). Often the validity of such an estimate has been questioned. Ecological efficiency of the order of 25% is suggested by Chapman (1965). A factor of 7.47 is used to raise the carbon value to obtain the wet weight of fish (Cushing, 1973)

ESTUARY

Estuaries are dynamic ecosystems undergoing considerable variation on account of the constant interaction of sea water and fresh water. The monsoons of the tropics exert further stress on estuarine organisms by bringing about a drastic change in salinity. So most of the estuarine zooplankton are well adapted to cope up with the ever changing environmental conditions. During the most favourable saline period zooplankton maintain a high level of production. Relatively low standing stock of zooplankton is observed during the low saline period. This well defined variability between high and low saline periods is reported for Cochin backwaters (Madhupratap *et al.*, 1977) and Mandovi and Zuari estuaries of Goa (Selvakumar *et al.*, 1980). The seasonal difference in salinity is reflected in total zooplankton production (Table I).

TABLE I. Rate of secondary production ($\text{mg}/\text{m}^3/\text{day}$) during low and high saline periods.

Period	Estuaries		
	Cochin	Mandovi	Zuari
Low saline	8	5.3	4.0
High saline	60	15.3	28.8

There is conspicuous increase of about 3 to 7.5 times more production for the high saline period. Mean production rates for Cochin backwaters and Mandovi-Zuari estuarine complex are 10.5 and 7.1 $\text{mg C}/\text{m}^3/\text{day}$ respectively. Fish landing data for the monsoon period is generally very low. Along with the drastic change in salinity the low fishing activity is also partly responsible for less catch during the monsoon period. An estimate of secondary production and fishery potential of a few estuaries reported by Madhupratap *et al.*, (1977) and Selvakumar *et al.*, (1980) are given in Table II.

TABLE II. Estimated tertiary production from secondary production and fish landing data for Mandovi-Zuari estuaries and Cochin backwaters.

Production/Fish landing	Cochin	Mandovi-Zuari
Secondary production (tonnes carbon/yr)	3770	1078
Tertiary production (tonnes/yr)	2817	805
Fish landing (tonnes/yr)	14 to 17,000	*

* Exact data not available. However, much more than the estimated data.

Exploitation of the fishery of any region is limited to a fraction of the available fish stock. It appears that in these estuaries the available secondary production can not sustain a fishery of the present magnitude. A major part

of the estuarine landing is contributed by prawns, cat fishes, Mugil etc. which are essentially detritus feeders. Even the most carnivorous species of estuarine fish feed on detritus. The total amount of fish landings from Kerala Backwaters is reported to be 14-17000 tonnes (George and Sebastian, 1970). In the backwaters prawns contribute 60-70% of the total landing while catfishes form 9% of the total catch (Madhupratap *et al.*, 1977) and this further substantiates the lesser contribution of zooplankton.

COASTAL WATERS

Neritic and inshore waters of the tropics are highly productive zones and sustain a rich and abundant planktonic life. The coastal waters are influenced by the seasonal variations on account of the southwest and northeast monsoon. Zooplankton distribution in coastal waters is bimodal with two peaks, the major one during the post monsoon period and the other being confined to the premonsoon period. The plankton production triggered during the south west monsoon period (June-September) makes the region an excellent pasturage for the plankton feeders. In the nearshore waters of Karwar zooplankton biomass showed a major peak (10-14ml/100m³) in October/December and a second peak (8 ml/100 m³) in February (Nair, 1978).

In the shelf waters of the southwest coast of India Menon and George (1977) reported peak production of zooplankton from August to September. This was followed by fairly uniform concentration of zooplankton beyond the near-shore waters all along the coast and later until December shoreward shift in the high density was evident particularly along the south. In general, the peak fishing season along the coastal waters coincides with the period of maximum zooplankton production.

The west coast of India is more productive than the east coast both at primary and secondary levels. This is also reflected in the fish landings which are considerably higher from the Arabian sea than from the Bay of Bengal (Prasad, 1969). A detailed studies along the west and east coast of India showed that west coast is twice more productive than the east coast (Nair *et al.*, 1978). Fish landing data for the west coast is 2.7 times more than that of the east coast (Table III).

TABLE III. A comparison of zooplankton biomass and fish landings of the east and west coast for the postmonsoon period Sept. to Nov '76.

Biomass/fish landings	West coast	East coast
Zooplankton production* (mg C/100 m ³ /day)	652	398
Fish landings (in tonnes)	2.94.456	1.07,506

* Secondary production estimated as per the conversion factor given by Nair (1980).

Average production of zooplankton along the western coastal waters of India is reported to be 125 mg C/m² /day. (Qasim *et al.*, 1973). Present exploited yield from the coastal waters is 0.6 million tonnes. The annual sustainable yield from this area is estimated to be 0.8 million tonnes (Qasim *et al.*, 1978). From the theoretical estimate it appears that zooplankton is contributing to a major part of the fish production in the coastal area.

OPEN OCEAN

The tropical sea is a relatively stabler environment. Here zooplankton maxima depend more on the variability of food in time than any other factor. The upwelling areas form the centres from which biological activity springs and the abundance and location of zooplankton distribution is chiefly governed by the current pattern. This is proved by the distribution pattern of various zooplankton groups in the Indian Ocean (IOBC, 1970-1973). The enrichment process initiating the primary production followed by secondary and tertiary productions constitute a biological unit which has its own periodicity.

Zooplankton biomass in the Indian Ocean indicates maximum production off Somalia, off the Arabian coast and off the southwest coast of India (IOBC, 1968). These areas are characterised by upwelling and consequent enrichment leading to an ideal environment for plankton production. Zooplankton biomass in such areas varied from 20-50 ml/200 m³. (IOBC, 1968).

The available data from International Indian Ocean Expedition (IOBC, 1968) indicate that there is gradual decrease in zooplankton biomass from northern to southern Indian Ocean. In the open ocean (north of 10°S)

zooplankton standing stock varied between 10 to 15 ml/200 m³ or the mean production rate amounted approximately to 210 mg C/100m³ when the conversion factor suggested by Nair (1980) is considered. South of 10°S the open ocean sustained an average biomass of about 2.5 ml/100 m³, or 84 mg C/100 m³.

Total zooplankton biomass for the Indian Ocean is about $8 \times 5.19 \times 10^8$ tonnes/yr. and tertiary production estimated from secondary production is 69.3×10^6 tonnes (Qasim, 1977). Assuming that 25% of the total stock is safely exploitable without depleting the stock, the potential yield would be of the order of 17.3 million tonnes. The present fish landing is only 2.8 million tonnes (Qasim, 1977). Hence it appears that the total catch can be increased 4-5 times.

CONCLUSION

Contribution of zooplankton to the fish production varies depending on the environment. In an estuary zooplankton production does not cope up with the present magnitude of the fish landing. It would appear that detritus play a very important role in providing nourishment to the fishes inhabiting the estuaries. Zooplankton production in the nearshore waters is very high and its maxima coincide with the peak fishing activity.

In coastal waters a direct correlation between the fish landing and zooplankton is observed. However, the estimated fishery potential and present catch indicate that much more can not be exploited from this area. Compared to coastal waters zooplankton production is low in open ocean because enrichment of the surface waters with nutrients is more effective in the comparatively shallow waters bordering the landmass. Eventhen, in the open ocean also zooplankton occupies central position in the food chain and its trophic significance is either as consumers or contributors to the next higher trophic level. The major energy pathways in the open ocean is phytoplankton → zooplankton → fish. The relative low zooplankton production in the open ocean is compensated by a wider area to be exploited. As such the fishery potential of the open ocean is much more than what is being exploited. Therefore, fish landing can be enhanced considerably by extending the fishing activity towards the open ocean. This could be achieved only through proper planning and implementation of suitable technology. If it is achieved the under exploited fishery potential of the open ocean can very well bring new dimensions to the available marine food resources.

ACKNOWLEDGEMENTS

The author is thankful to Dr. S. Z. Qasim, Director, National Institute of Oceanography (presently Secretary, Department of Environment, Government of India) for his comments on the manuscript.

REFERENCES

- Chapman, W.M. 1965. *Potential resources of the oceans*. Port of Long Beach, California, Van Camp Sea Food Co., 43 PP.
- CMFRI, 1980. Trends in total marine fish production in India—1979 Mar. *Fish. Infor Serv. T. & E Ser. No. 22*, 1-19.
- Cushing, D. N. 1973. Production in the Indian Ocean and the transfer from the primary to the secondary level. In: *The Biology of the Indian Ocean*. Ecological studies (Ed. Zeitschel) 475-486 Springer — Veriag, Berlin
- George, A. I. and Sebastian, M. J. 1970. Review of the backwater fisheries and brackish water fish culture in the Kerala State. *Symposium on coastal aquaculture, Proc. Indo-Pacif. Fish. Coun. IPFC/C70/SYM 19* (Mimeo).
- IOBC, 1968-73. *International Indian Ocean Expedition Plankton Atlases*. NIO, Goa.
- Madhupratap, M., Rao, T.S.S. and Haridas, P. 1977. Secondary production in Cochin backwaters, a tropical monsoonal estuary. *Proc. Symp. Warm Water Zoopl. Spl. Publ. UNESCO/NIO* 515-519.
- Menon, M.D. and George, K.C. 1977. On the abundance of zooplankton along the southwest coast of India during the years 1971-75. *Proc. Symp. Warm Water Zoopl. Spl. Publ. UNESCO/NIO* 205-213.
- Nair, V. R. 1978. Zooplankton from the nearshore waters of Karwar. *Indian J. mar. Sci.* 7(4): 283-287.
- Nair, V. R. 1980. Organic carbon content of tropical zooplankton. *Indian J. mar. Sci.* 9(2): 114-116.
- Nair, V. R., Peter, G. and Paulinose, V.T. 1978. Zooplankton studies in the Indian Ocean II, From the Arabian sea during the postmonsoon period. *Mahadsagar — Bul. natn. Inst. Oceanogr.* 11 (1&2): 35-43.
- Prasad, R. R. 1969. Zooplankton biomass in the Arabian Sea and the Bay of Bengal with a discussion on the fisheries of the region — *Proc. Nat. Inst. Sci. India*, 50: 115-252.
- Qasim, S. Z. 1977. Biological productivity of the Indian Ocean *Indian J. mar. Sci.* 6. 122-137.
- Qasim, S. Z., Wafar, M.V.M., Sumitra — Vijayaraghavan, Royan, J. P. and Krishnakumari, L. 1978. Biological productivity of coastal waters of India from Dabhol to Tuticorin *Indian J. mar. Sci.* 7: 84-93.
- Selvakumar, R. A., Nair, V. R. and Madhupratap, M. 1980. Secondary production in the estuarine system of Goa. *Indian J. mar. Sci.* 9(1): 7-9.
- Sudarson, D. 1964. Observations on the plankton and trawler catches off Bombay. *J. mar. biol. Ass. India.* 6(2):222-225