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OBSERVATIONS ON CERTAIN ENVIRONMENTAL PARAMETERS IN RELATION TO SURFACE TUNA FISHERY AT MINICOY ISLAND, LAKSHADWEEP

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Abstract

Environmental parameters *viz.* surface temperature, salinity, dissolved oxygen, zooplankton biomass and availability of forage fishes were studied in relation to surface tuna fishery at Minicoy Island. A surface temperature range of 28°C to 31°C and salinity around 34‰ were found to be optimum for tuna schools. Dissolved oxygen was not found to act as a limiting factor. Zooplankton biomass was found to influence the tuna catch indirectly through the abundance of forage fishes.

Introduction

The abundance of fish depends on the food availability which indirectly depends upon primary production. Primary production directly depends upon the availability of nutrients which is related to the hydrographic conditions. It is a well established fact that the distribution and abundance of tunas is determined mainly by the hydrographic and other ecological factors of the area. A knowledge of the variations of the environmental factors is an essential prerequisite for assessing the availability of tunas and related fishes in space and time. At present in India an organised fishery for tunas exists only in the Lakshadweep region and hence environmental studies in this area is of paramount importance for assessing the fluctuation in the tuna fishery of the area. Jayaraman *et al.* (1959, 1960) initiated detailed investigations on the environmental features of this area. Further studies on the physical, chemical and biological parameters have been done by CMFRI during the cruises of R. V. *Kalava* and R. V. *Varuna*. Other works of oceanographic importance done in the Lakshadweep Sea and adjacent waters are those of Patil and Ramamirtham (1963), Rao and Jayaraman (1966), Sankaranarayanan (1973) and Sen Gupta *et al.* (1979).

In Lakshadweep, on an average of about 3000 tonnes of tunas are annually exploited by the small-scale pole and line tuna surface fishery in recent years. This fishery needs further expansion in view of the vast resource potential of surface tuna resources, mainly skipjack tuna *Katsuwonus pelamis* available in our EEZ. At Minicoy Island (Long. 73° E Lat. 8°17' N) the small-scale pole and line tuna fishery is in vogue from time immemorial. Hence this island deserves much attention while implementing programmes oriented towards the development and expansion of surface tuna fishery in our EEZ. A knowledge of the seasonal variations of various environmental factors affecting the existing small-scale surface fishery will be an useful information for predicting the availability and abundance of the surface tunas in space and time. Hence a study of the various environmental conditions during the peak tuna fishing season of Minicoy, *i. e.* from November to May was attempted during 1985-86, the results of which are presented here.

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Material and Methods

The environmental parameters collected during the present study were surface temperature, dissolved oxygen, zooplankton biomass and availability of forage fish. For hydrography parameters fortnightly collections were made on board a private fishing boat using water sampler from the tuna fishing grounds off Minicoy. Horizontal surface hauls for a duration of ten minutes were taken by No. 3 half metre diameter plankton net and the biomass was taken as the total displacement volume. The live-bait catch fished by the pole and line fishermen is taken as an index of the availability of forage fishes for tunas in the area.

The tuna catch data from November 1985 to May 1986 was collected by undertaking daily trips to fish landing villages on all fishing days and the same was compiled to get the monthly figures.

Results

The results of the influence of physical and chemical factors *viz.* temperature, salinity and dissolved oxygen on the tuna catch is presented in Fig. 1 and that of biological parameters *viz.* zooplankton biomass and availability of forage fishes in Fig. 2.

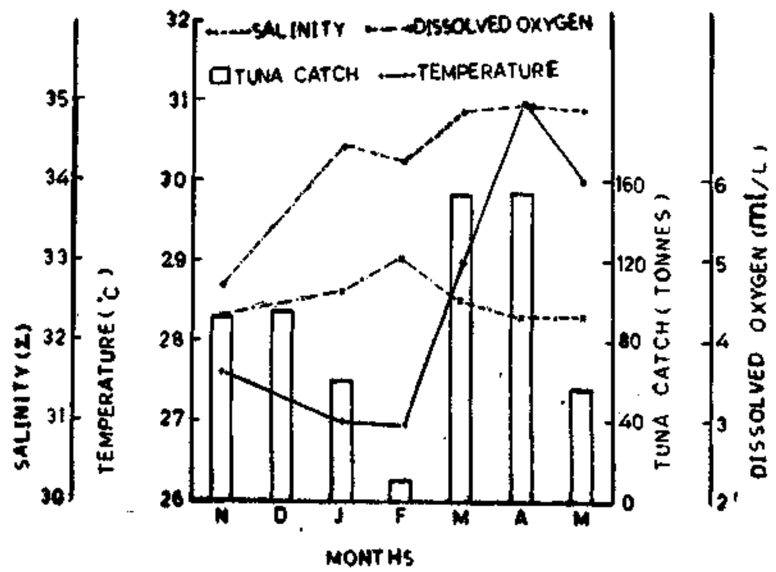

Fig. 1. Fluctuation of surface temperature, dissolved oxygen, salinity and tuna catch during November 1985 to May 1986 at Minicoy.

Surface temperature : The surface temperature varied between 26.9 and 31.0° C, the maximum value was recorded in April and the minimum value in February. Maximum tuna catch was recorded in March and April and minimum in February. It can be seen that a temperature range of 28 to 31° C is optimum for the tuna schools in the area. The minimum tuna catch recorded in February coincided with the minimum temperature recorded during the period of study.

Salinity: The salinity varied between 32.77‰ to 34.95‰, the maximum value was recorded in March and minimum value in November. However, there was not much variation between January and May. Eventhough a clear correlation between salinity and tuna catch was not seen, the best months of tuna catch *viz.* March and April coincided with the salinity values above 34‰.

Dissolved oxygen: The surface dissolved oxygen ranged between 4.28 ml/litre to 5.06 ml/litre, the maximum value was recorded in February and minimum value in May. However, it is seen that the dissolved oxygen ranges noted during the period is not acting as limiting factor for the abundance of tunas in the area.

Zooplankton biomass: The zooplankton biomass ranged between 1.0 ml in April to 19.5 ml in January. Higher biomass was also recorded in February. The influence of secondary production observed was an indirect one, because of the time lag between the peak seasons of productivity of different trophic levels. The higher secondary production noted in January and February might have resulted in the abundance of bait fishes during March-

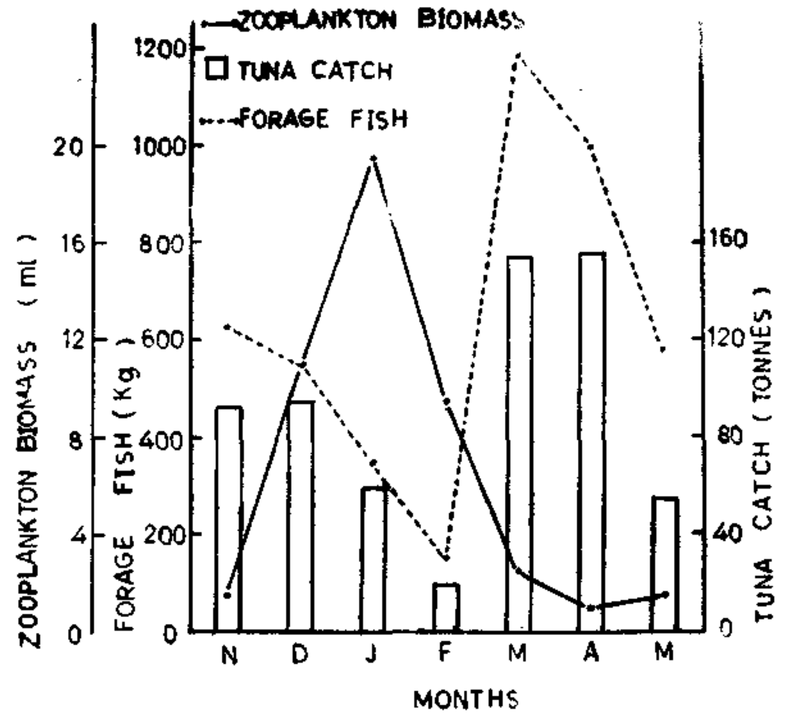

Fig. 2. Fluctuation of zooplankton biomass, abundance of forage fishes and tuna catch during November 1985 to May 1986 at Minicoy.

April which might have resulted in the abundance of tuna schools in the area and the consequent higher catches during March - April.

Forage fishes: The forage fishes were mainly constituted by the sprats *Spratelloides delicatulus, S. gracilis,* apogonids such as *Archamia fucata, Rhabdamia gracilis,* caesionids such as *Caesio caerulaureus, Gymnocaesio argenteus, G. gymnopterus, Pterocaesio tile, P. chrysozona,* pomacentrids like *Chromis caeruleus, Lepidozygus tapeinosoma* and atherinids like *Pranesus pinguis.* The estimated catch of forage fishes varied between 154.0 Kg in February to 1187.5 Kg in March. High bait-fish catches were recorded in March - April and low catches in January and February. It is seen that the abundance of fishes coincided with the abundance of tuna catch. The best months of bait-fish catch were the months of best tuna catch also. Similarly the lean months of tuna fishery coincided with the poor availability of bait fishes in the area. The abundant occurrence of forage fishes in the vicinity of the island causes aggregation of tuna schools in the area which results in better catches.

Discussion

The results indicate that the major factors which directly influence the abundance of surface tuna schools at Minicoy are surface temperature and abundance of forage fishes. This agrees with the observation of Blackburn (1965) that temperature and pelagic food supply have a direct major effect on the distribution of tunas. Sharp (1979) stated that tunas are bound to swim continuously which requires 'finite oxygen availability' and hence their distribution in the ocean is controlled by low temperature and low oxygen levels. However in the present study, both these environmental parameters were not found to act as limiting factors for the availability of tuna schools around Minicoy Island. A preference towards higher temperature range of 28° C to 31° C was seen. Eventhough temperature is not acting as a limiting factor, evens light lowering of temperature is found to affect the abundance of tuna schools around the island. As opined by Sharp (1979) monthly distribution pattern of thermal and oxygen profiles would guide in locating productive tuna fishing grounds.

The food supply is an important criteria next to temperature which influence the distribution and concentration of tunas. As stated by Nair *et al.* (1986 a, b) the presence of divergence and convergence zones in the open ocean near to Minicoy, the presence of upwelling in the close vicinity of Minicoy Island, the eddy systems present there and the presence of relatively low saline waters seen in the surface layers during November - December period contribute to the high productivity of the area. The existence of the anticyclonic eddies around the Lakshadweep Islands in the upper 100 metre support a high productivity. The unit volume production varies from 8 to 34 mg C/m^3/day with the maximum rates at Minicoy. The waters have been found to be highly productive at the secondary level also. Silas (1972) estimated monthly mean standing crop of zooplankton which varied between 26 and 144 ml per 100 m^3 water in the sea around Lakshadweep. Goswamy (1973) obtained higher biomass of 58 ml per 1000 m^3 of water. Madhu Pratap *et al.* (1977) estimated a maximum of 6.2 ml/per 10 minutes surface haul with a square net of 0.0625 m^2 mouth area, from the sea surrounding the atolls. Similar results obtained in the present study indicate as mentioned earlier that the influence of primary and secondary productivity on tuna catch is an indirect one because of the time lag between the peaks of production at different trophic levels. In the present study, the peak secondary productivity values seen during January and February might have resulted in the abundance of forage fishes especially the migratory forms which was directly reflected in the catch of tunas during March - April.

The abundance of forage fishes causes an aggregation of tuna schools around the area. Gopakumar *et al.* (MS) stated that a direct quantitative relationship exists between the bait fish quantity and tuna catch. This coincides with the present observation that the best months of tuna fishing *viz.* March and April were the those of good availability of forage fishes. However, the abundant occurrence of forage fishes in the surrounding waters of the island can also cause a negative chumming response for the tuna schools to the live baits used by pole and line fishermen which can result in poor catches. But, on the whole it is felt that the catches may be comparatively high when plenty of schools are around the island, eventhough some of the schools evoke negative chumming response.

The month-wise fluctuation in salinity is less when compared to coastal waters and hence it is not a limiting factor for the distribution of tunas in the oceanic waters. However, salinity around 34‰ seems to be optimum for the abundance of tuna schools in the area. This agrees with the observation of Seckel (1972) that skipjack tuna landings in the Hawaiian skipjack tuna fishery were high in those years with mean monthly salinity between 34.6‰ and 34.8‰.

At Minicoy, which is one of the important tuna fishing islands of Lakshadweep, the peak tuna fishing season is from November to May. On an average about 600 tonnes of tunas of which about 90% constituting skipjack tuna are caught during the period in recent years. Even during these peak tuna fishing months, abrupt suspension of tuna fishing activities often occurs due to the non-availability of tuna schools around the island. One of the factors for the same may be the fluctuation of the environmental parameters brought out by the various oceanographic processes like current, upwelling, etc. Hence it is felt that while implementing fisheries developmental programmes for increasing surface tuna fishery at Minicoy Island, the results of the present study may throw some light on the environmental parameters which are indicative for locating productive tuna fishing grounds.

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