TUNA RESEARCH IN INDIA

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EFFECT OF ENVIRONMENTAL FLUCTUATIONS ON COASTAL TUNA FISHERIES

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It is generally recognised that fluctuations in the environmental parameters in the seas have a significant influence on the life history, abundance and migratory habits of fishes. It is well known that along the south west coast of India seasonal abundance and migration towards coastal area by pelagic species such as oil sardine and mackerel are governed by several meteorological and oceanographic parameters such as seawater temperature, salinity, pH, upwelling, nutrient concentration and plankton production which are in turn influenced by wind, rainfall and coastal currents. As regards coastal species of tunas such as *Euthynnus affinis, Auxis thazard, A. rochei and Sarda orientalis*, their abundance as evidenced by their total catch and catch per effort indicate certain seasonal trends. In recent years (1989-91) their monthly catch in a standard gear such as drift net is indicated in Table 1. It can be observed that the best catch rates for theese species are obtained during June to October off Vizhinijam; July to October at Cochin and during August to October at calicut.

An attempt is made to correlate the general environmental parameters with the seasons of abundance of coastal tunas based on the data collected at Cochin, Calicut and Vizhinjam.

Sea surface temperature

Variations in surface isotherms in the Arabian sea during different seasons are given in Fig. 1. Generally surface temperatures are low in November-December in this sea and high during May. In the coastal areas off Cochin, SST mean increases from 27°C in January to 31° in April-May and steadily declines during monsoon months to about 26-27°C in

Table 1. Month-wise average catch (kg) and catch rate (kg) of coastal tunas landed by drift gill netters at Vizhinjam, Cochin and Calicut during the years 1989-91

	Vizhinjam		Cochin		Calicut	
	C	C/E	C	C/E	C	C/E
January	129536	23.0	27195	64.3	11485	16.3
February	124464	22.9	27719	53.3	6685	9.9
March	169640	24.3	21478	42.4	6686	14.0
April	308680	39.3	41761	53.3	6636	15.8
May	286252	26.9	143929	86.9	12729	29.7
June	157960	25.7	118282	85.7	No fishing	
July	195151	23.8	111739	63.2	No fishing	
August	241837	37.1	88709	59.2	25690	71.4
September	238047	24.3	156445	90.9	39722	56.5
October	268298	31.3	106705	89.9	63021	79.2
November	205144	17.8	12324	14.0	15254	18.4
December	135697	17.2	20432	44.2	8287	9.3

August-September. Bottom temperature at 20-30 m depth shows a decline from 29°C in April to 23°C in September. At Calicut, surface temperature rises from 27°C in January to 31°C in Apirl-May and drops to 25°C in July.

Similarly at Vizhinjam the peak of sea water temperature is usually observed in May and the low values during August. A secondary peak in temperature usually occurs in October in these centres.

Salinity values

Surface salinity values reach a peak (34-35‰) during April-May off Cochin and drop to 20-21‰ during the monsoon months. Bottom salinity values range from 34 to 35‰ during this period. At Calicut salinity values decline from 36‰ in April to 29‰ in July. At Vizhinjam salinity values do not show much fluctuation between April and July (34-35‰).

Dissolved oxygen

The surface O_2 values do not indicate much fluctuation at these centres during monsoon months. But the bottom oxygen values show a marked decline from about 2.0 to 1.0 ml/l during July to September.

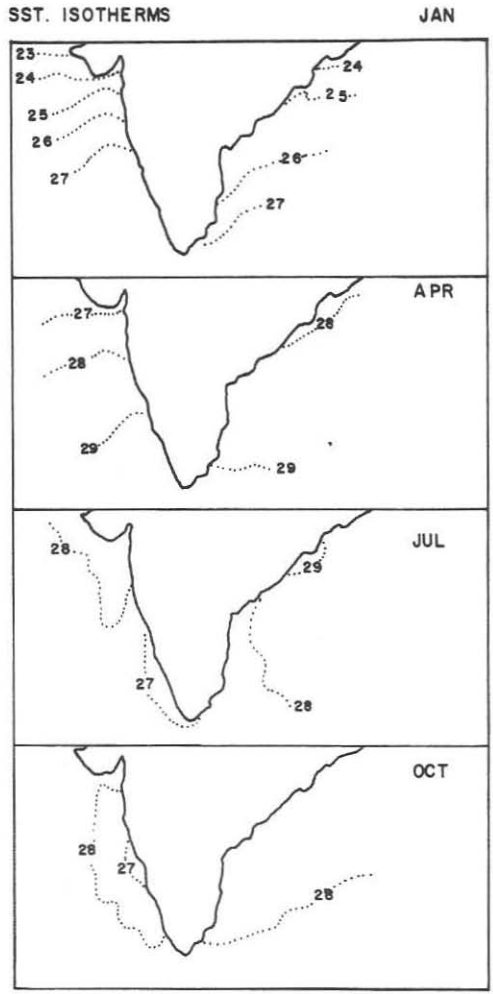

Fig. 1. Seasonal variations in surface isotherms

The above features along the south west coast are indicative of intense upwelling in the coastal region during the monsoon and immediate post-monsoon months.

Primary production

Gross primary production rates show mean values of 0.8, 1.4 and 0.9 gC/m^3/day at 20 m depth stations off Cochin during pre-monsoon, monsoon and post-monsoon respectively. Though some variations have been observed as regards the peak period of primary production, it is generally the monsoon period which accounts for the maximum production. Similar trend is usually observed off Calicut, but not so at Vizhinjam. A close correlation has also been observed between primary production and abundance of nutrients such as phosphates and nitrates during the monsoon months and generally low nutrient concentration during post-monsoon months. The general pattern of primary productivity along our coast is given in Fig.2.

Secondary production

Zooplankton displacement volume generally remain low during April to August but show a significant rise during September to October. This increase coincides with numerically abundant groups such as copepods, chaetognaths, appendicularians, lucifers and fish larvae occurring from October onwards. Blooms of *Fragilaria oceanica* and *Noctiluca miliaris* also occur during July to September-October period.

Surface currents

Seasonal changes in the surface current patterns in Indian Ocean are given in Fig.3. This would indicate the likely influence of coastal currents on environmental parameters and coastal fisheries for tunas.

Discussion

While examining the catch and catch/effort data at Vizhinjam, Cochin and Calicut as a sample case, it is observed that a temperature peak in May coincides with a small peak in C/E rate of coastal tunas at Cochin and Calicut, whereas the C/E ratio reaches a peak in April. The major peaks of C/E occurs in April at Vizhinjam, September at Cochin and October at

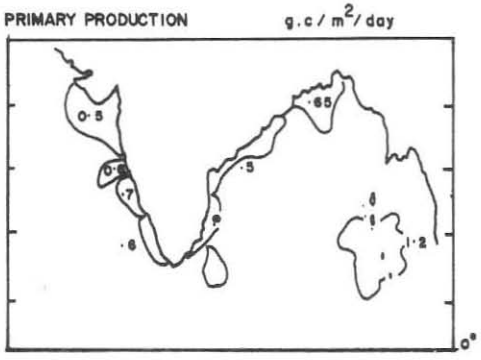

Fig.2. General levels of primary productivity in our coastal waters

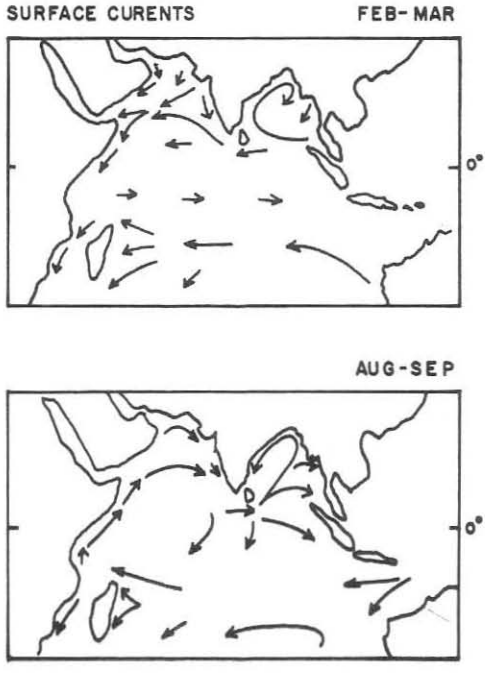

Fig.3. Seasonal changes in surface current patterns in the Indian Ocean

Calicut. At Cochin and Calicut these peaks can be correlated with a secondary peak in temperature.

During April-May salinity values are generally high at Cochin and Calicut and there is a drop in July. There is a corresponding drop in C/E during July at Vizhinjam and Cochin. No fishing was done at Calicut during this period. Due to upwelling the bottom oxygen values are less during July to September. Immediately after this period the C/E rates are high in October at all the above centres.

Levels of primary production are high during monsoon months. Secondary production rates are high during September-October. This peak coincides with high catch of tunas during October.

Also, Silas and Pillai (1982) have drawn attention to wind speeds exceeding a level of 8 m/sec as a constraint of certain fishing operations such as purse seining. While drift gillnets are mainly operated at Cochin and Calicut, hook & line fishing and trolling are also done at Vizhinjam. Wind speeds show some relations to catches during certain months during July-September at these centres.

The common coastal species of tunas such as the little tunny and frigate tuna prefer a temperature range of 17-28°C and the long tail tuna 25-32°C (Sharp, 1979). According to Sharp (1979) the oxygen values are likely to act as a limiting feature for tuna distribution in the northern Indian Ocean. Silas and Pillai (1982) have produced SST isotherm charts for different months. These charts indicate that along the west coast the isotherms 27-28°C prevail during January-March; 29°C during April-May; 27°C during June-September and 28°C during October-December. They have also indicated through charts reproduced from Sharp (1979) the areas where 20°C isotherm and 2.5 ml/l oxygen content emerge to 80-50 m depth and also close to the surface.

This emergence happens during January-March in the northern latitudes along our coast (15-23°); during April along south east coast; June to October along the west coast; also August-September along north east coast and along both the coasts during November.

The depth of mixed layer rises to 20 m along the west coast during July-August and goes deeper to 40 m during September-October. The above features are considered as limiting factors to certain species of tunas.

Generally along the south west coast the post-monsoon months witness

the commencement of good fishing season for major pelagic species such as oil sardine and mackerel. During this period, the effect of upwelling also starts getting minimised and there is a warming of sea surface temperature and less turbidity in coastal waters.

The influence of coastal upwelling on tuna abundance has not been established. But upwelling enriches the production of forage organisms. The time lag between the transformation of primary organisms to forage items of tunas and their transportation have to be taken into account.

The increase in C/E during October at Cochin and Calicut may be attributed to time lag between peaks of primary production and secondary production and the supply of forage organisms for coastal tunas after an upwelling period as pointed out by Blackburn (1965).

In conclusion it may be stated that a range of environmental factors, mutually inter-dependent such as temperature, thermocline, coastal currents, upwelling, primary and secondary production and abundance of forage organisms play important roles in the fluctuations in coastal tuna fisheries.

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