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A STUDY OF SOME OCEANOGRAPHIC FACTORS OFF TRINCOMALEE IN RELATION TO THE FLYING FISH FISHERY**

by

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Abstract: Throughout the year surface water temperature of the coastal waters off Trincomalee increased with distance off-shore as far out as the investigations extended. The temperature maxima were recorded during April/May and November and minima during August / September and February. The salinity of the coastal waters decreased off-shore. The salinity maxima were recorded during February and August / September and minima during April /May and November. During the flying fish fishing (= spawing) season of May, June and July a temperature range of 27.5°C to 29.5°C, salinity of 33.5‰ - 33.7‰ and a very clear water with very low plankton production characterised the waters in which the flying fish *H.coromandelensis* Hornell spawns off Trincomalee, Sri Lanka.

Introduction

Sri Lanka is affected by both southwest and northeast monsoons. As a result the water-mass around the island must undergo changes, with a piling up of water along the west coast during thr southwest monsoon and along the east coast during the northeast monsoon. However, details of any such changes and their consequences are not known; and therefore, correlations between them and our marine fishery resources not posssible. The work reported in this paper attempts to provide some data in this respect, in so far as the sea off the east coast, near Trincomalee is concerned.

According to Parin (1960, a and b) the distribution of flying fishes is dependent on water temperature; majority of species being found in the tropics, in waters usually above 25°C.He reported that *Prognichthys rondeliti* (Breder), which he has termed a "bipolar fish", migrates during the spawning season into sub-tropical waters with temperatures between 18°C and 23°C. However, he mentions that these particular spawning grounds are also very rich in plankton and lie within a convergence. He further states that *Hirundichthys spiculiger* (Cuv. et. Val) avoids warm waters and is distributed within narrow temperature range of 24.5°C - 29.5°C.

** These findings were reported to Section D of SLAAS, 28th Annual Sessions 1972 under the title "Oceanographic factors of the coastal waters off Trincomalee."

A small, established flying fish fishery dependent solely on a spawning stock of *Hirundichthys coromandelensis* Hornell exists off Trincomalee on the east coast of Sri Lanka from mid - May to end of July which is the spawning season of this fish after which no fish of this species is to be found there very few of the other species are found there either (Jinadasa, 1971). There fore, the aim of the present study was to attempt to discover whether any correlation exists between the onset of the spawning, the seasonal limits of the fishery and other factors of the waters off Trincomalee

Rainfall, Wind and Air Temperature.

The rainfall pattern during the three years of this study did not differ very much from that usual for this part of the island as showm by meteorological records over a period of 84 years (Dassanayake, 1956). There is a brief rainy season during October - January with 25 - 40 cm of rainfall per month, little rain falling at any other time, the driest months being during the fishery (Figure-1)

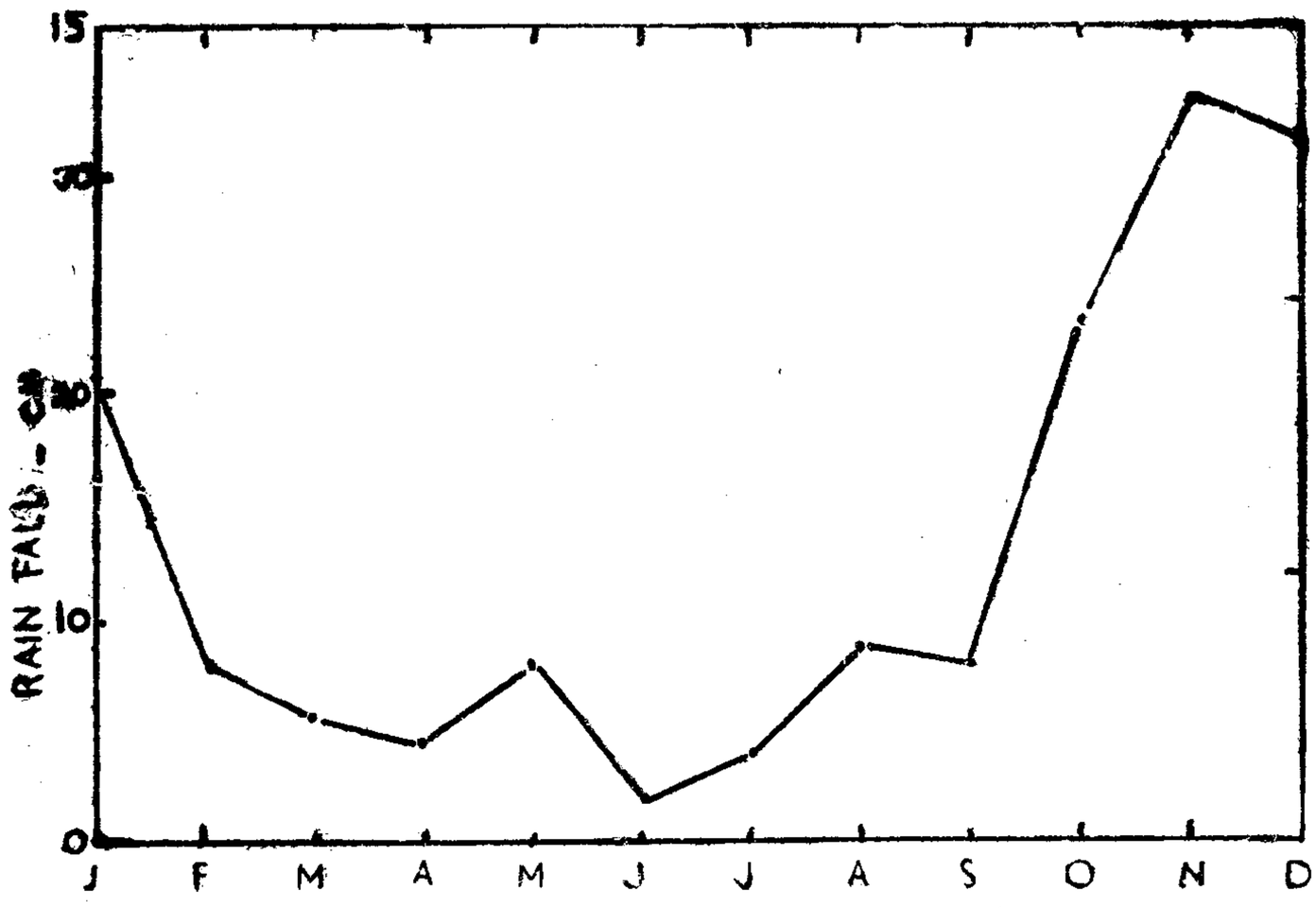


FIGURE 1. Seasonal changes in monthly rainfall at Trincomalee, over a period of 84 yrs.

The wind speeed and air temperature over this particular coast line, as recorded by the meteorological observatory indicates extremely high values for both factors from May-July, the fishing season, with a peak around June

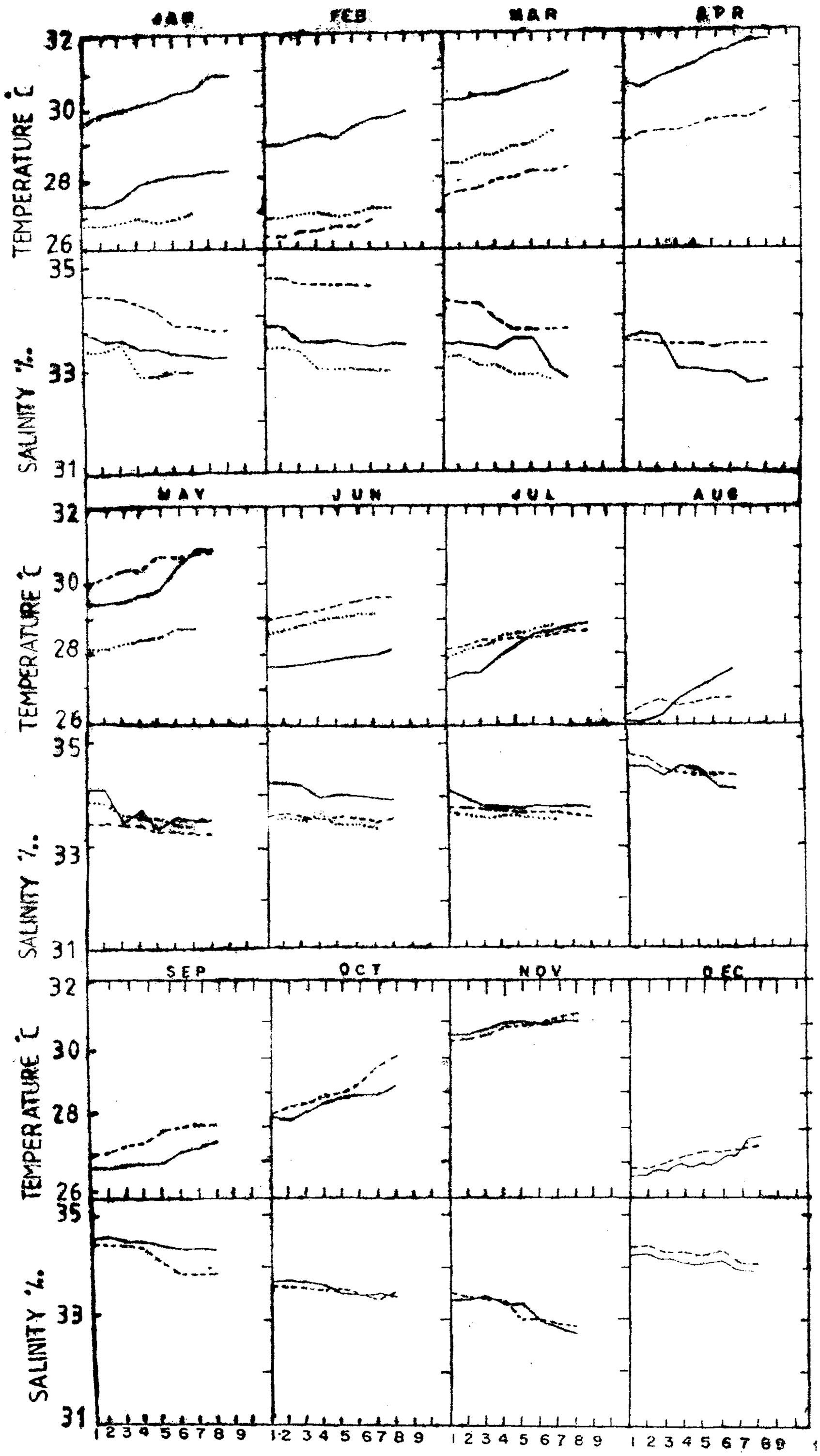


FIGURE 3: Sessional changes in monthly surface temperature and salinity 1969 - 1971

(Figure 2). During this period the wind blows towards the northeast, being the southwest monsoon which has blown across the southwestern part of the island as a wet wind continues to blown across the northeastern part of the island as a dry wind and contributes to the high air temperature. The peak period for these factors coincides with the fishing season for flying fish.

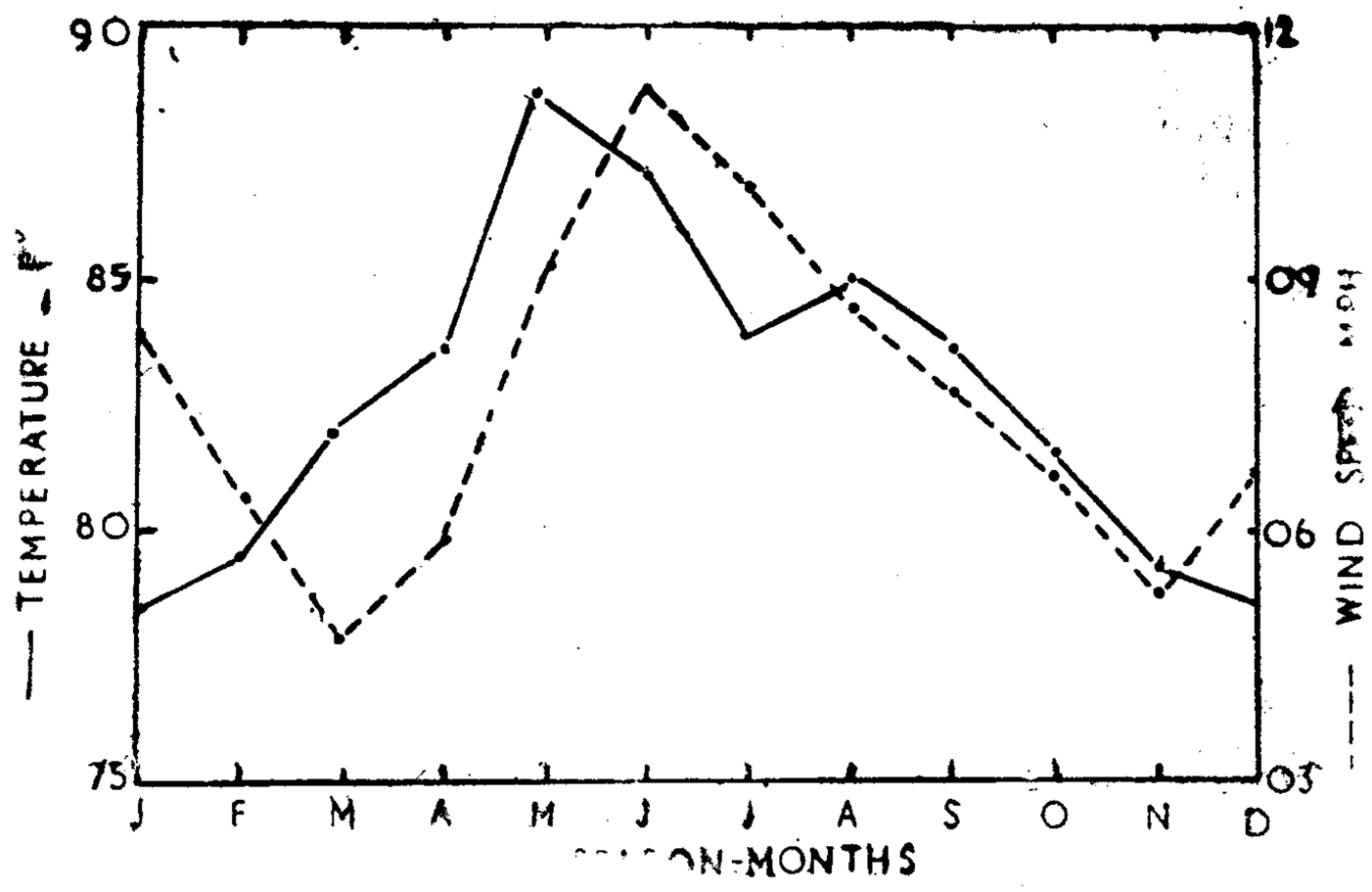
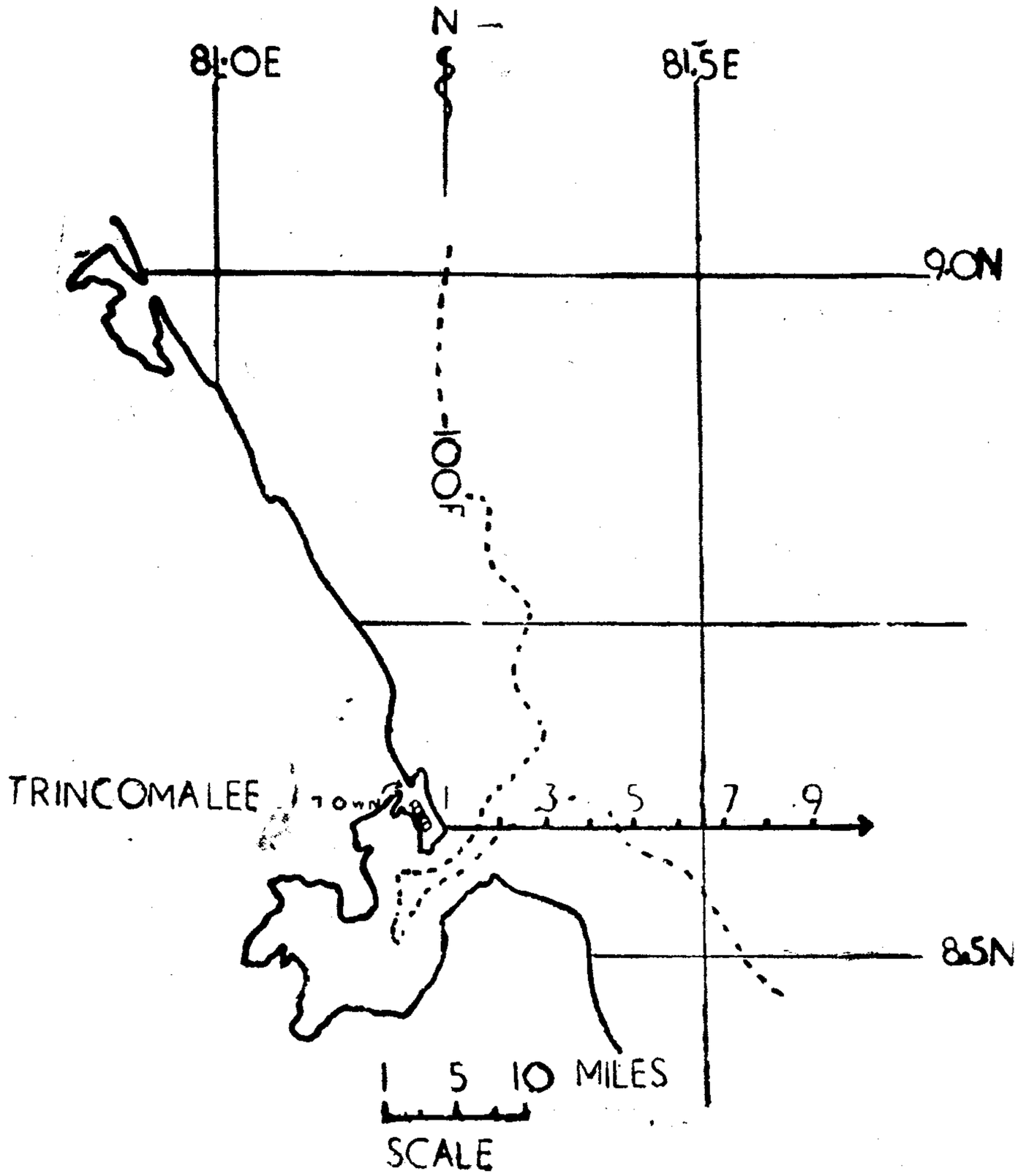


FIGURE 2 : Seasonal changes in monthly surface wind speed and air temperature at Trincomalee, 1969–1971, 1973–1974

Material and Methods.

Small mechanised fishing boats (of length 9 meters, displacement 3½ tons, engine 30 H. P) are used for this fishery and leave for their fishing grounds, 5 - 15 miles away (see station 3 - 5 in Map) daily between 4 and 6 am returning by 4 - 5 pm. Similar boats leaving between 4 and 7 pm operate on the same grounds for other fish during the night. It was therefore possible to take samples both by day and by night by joining one or other of these boats, special arrangements being made with each to go beyond its fishing grounds to permit measurements at stations 6 - 9



MAP: East coast of Sri Lanka (Ceylon), showing Trincomalee harbour and sampling stations 1-9.

Samples and measurements were taken weekly during the fishery, fortnightly during the off season, throughout the $2\frac{1}{2}$ years from January 1969 to July 1971[1]. Surface water temperature, surface water samples and Sacchi disc readings were taken at regular intervals of $\frac{1}{2}$ hour, (i.e. approximately every $2\frac{1}{2}$ — 3 miles) during the outward journey (see station 1-9 in Map). Some temperature measurements in these stations were also made in 1973 and 1979. Water samples were used the following day for salinity determinations by Harvey's method, surface collections of plankton were carried out on the fishing-grounds (stations 3,4,5) during the same trips between 6.30 and 7.30 am, using a plankton net of diameter 22.5 cm at mouth, length 45 cm and mesh 196/cm^2. The plankton collected were fixed in 5% Formalin in sea water and studied at the end of the season in the laboratories of then Vidyodaya University, Nugegoda. The volume of plankton was found by displacement and its species-composition by identification and counting of every specimen in appropriate aliquot parts.

Results.

Surface Temperature.

Throughout the year surface temperature of these coastal waters (Figure 3) increased with distance off-shore as far out as these investigations reached (27-30 miles, station 9). Seasonally from a peak (around 31°C) during April/ May temperature at any station decreased more or less gradually to a minimum (around 27°C) during August / September, increased fairly rapidly to a new peak in November and then decreased again to a minimum in February (Figure 4.) It is noteworthy that the lowest temperature recorded were at the tail ends of the two monsoonal periods and the highest were at the ends of the two inter-monsoonal periods. This pattern is the same at all stations studied, lower temperatures being reached at the inshore stations (1-2) and the highest temperature at the off-shore stations (6-9) beyond the fishing grounds (Figure 4).

1. The attempted insurrection of 1971 and its aftermath prevented field work throughout April that year for which therefore there are no readings.

On the fishing - grounds itself during the fishing season the temperature of the surface water decreased from about 29°C in mid-May to about 27.5°C in mid-July.

Surface Salinity.

The picture in this case is almost reverse of that for temperature. With distance from shore salinity fell as far out as the investigations extended, 27-30 miles (Figure 3).

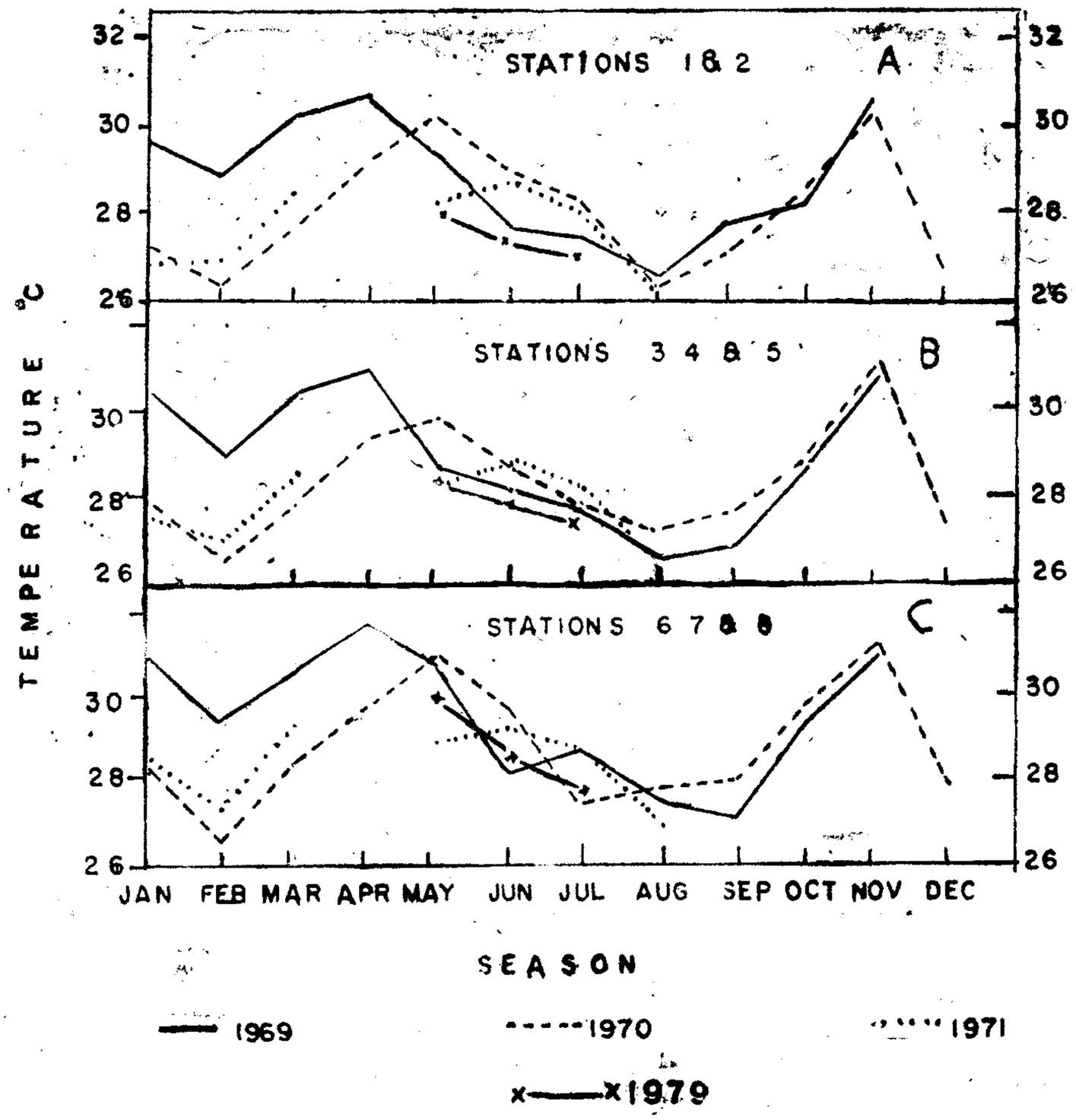


FIGURE 4 : Seasonal changes in surface temperature, 1969-1971 and 1979 ; (A) Inshore, (B) Heart of fishing grounds, (C) Beyond fishing - grounds,

Seasonally, the salinity rose to a maxima (as high as 33.7 ‰ and 34.7 ‰) in February and August/September and fell to a minima (as low as 32.2 ‰) in April/May and November (Figure 5). (The year 1971 was somewhat anomalous in that the February minimum was not found) This means that when surface water temperatures are at their highest their salinities are lowest and vice versa; and that in the months August and September immediately following the southwest monsoonal period the surface waters off Trincomalee are at their coldest and saltiest. One possible explanation for this could be that a movement of surface waters away from the shore was occurring as a result of the three months' steady blowing of the southwest monsoon and that this was producing an upwelling of deeper-lying waters possibly from below the continental edge. And the relatively low salinities of November and December may be the result of heavy rains that usually fall on the east coast of the island during these two months (Figure 1). The data gathered are insufficient to support any more conclusive statement about thse possibilities.

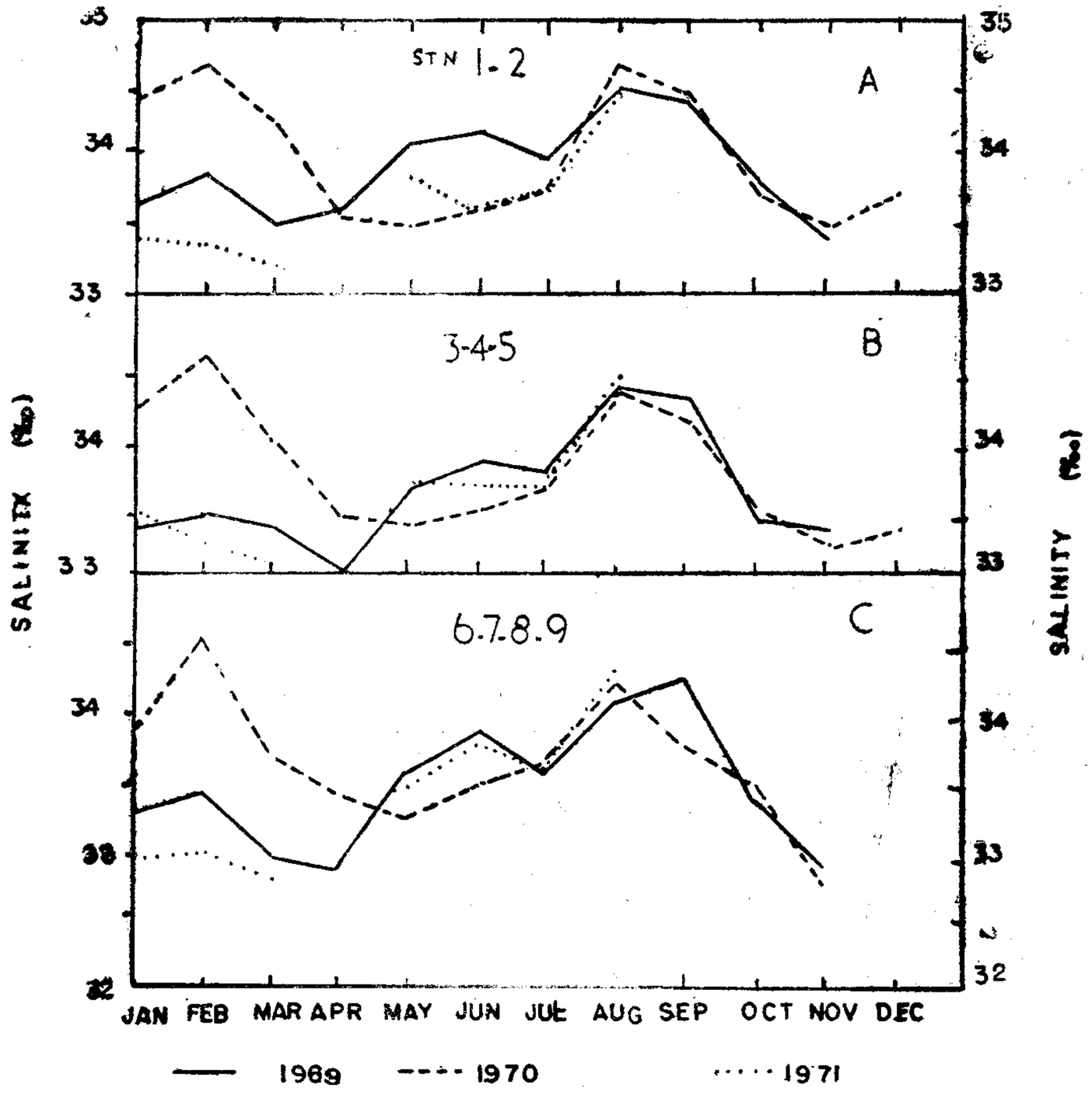


FIGURE 5 : Seasonal changes in surface salinity, 1969–1971 (A) Inshore, (B) Heart of fishing-grounds, (C) Beyond fishing-grounds.

On the fishing-grounds itself during the fishing season the salinity of the surface water increased from about 33.5‰ in mid-May to about 34.5‰ in mid-July. It is noteworthy that the combined temperature and salinity characteristics of water-mass in which fish spawn during May, June, July are not found any other time of the year (see figure 6 which shows these for 1970; value for 1969 and 1971 are similar) and it is likely that it is not a specific range of relatively low temperature that attracts the spawning flying fish but a combination of at least two factors, suitably low temperature and suitably high salinity.

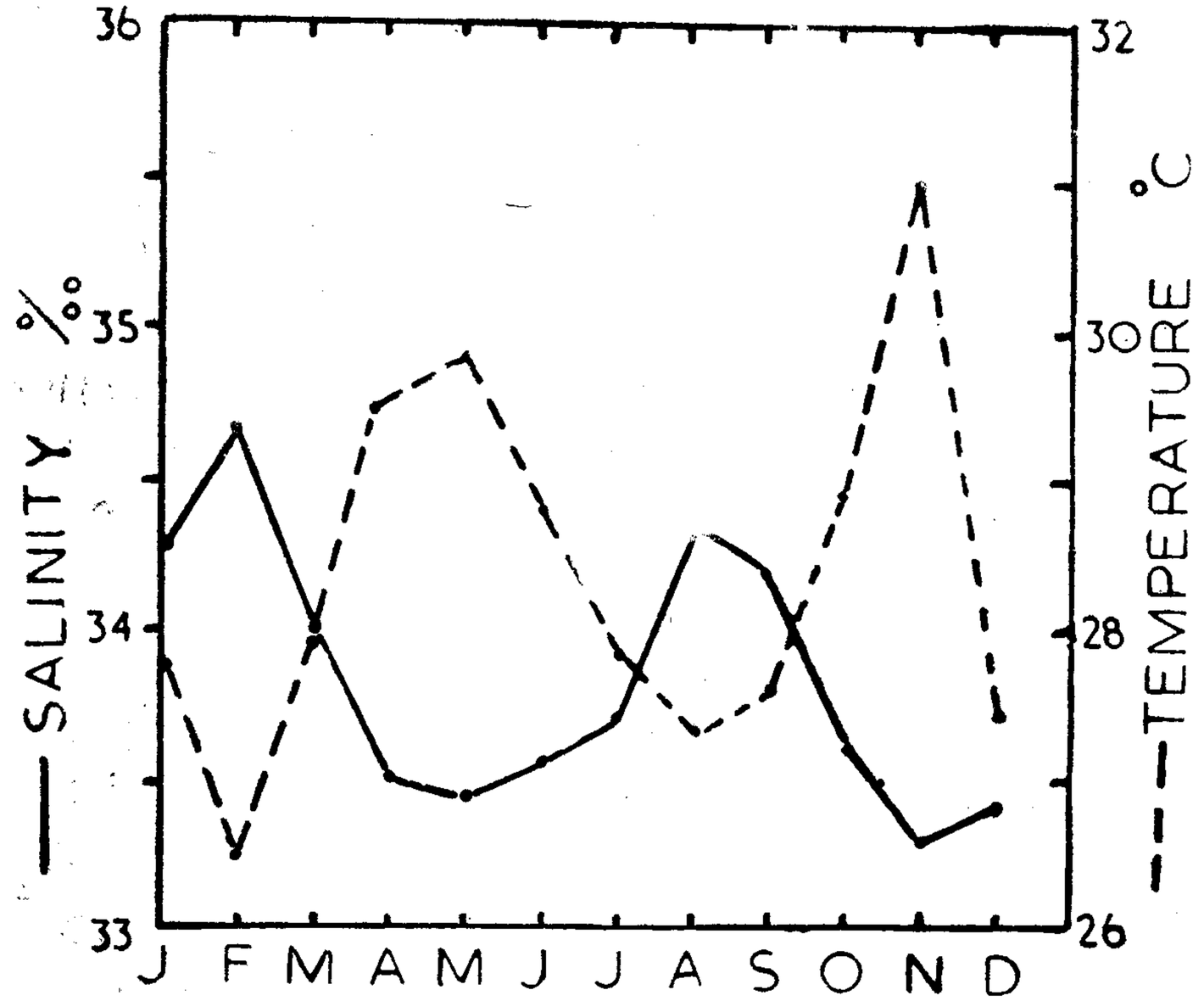


FIGURE 6 : Seasonal changes in surface temperature and salinity in the heart of fishing grounds, 1970

Turbidity and color of water.

The extinction coefficient of water as determined by the use of sacchi disc of the water showed a rapid fall off-shore (Figure 7). Seasonal variations in this coefficient were not regular except in so far that water was relatively clear during the fishing (= spawning) season and fairly turbid for most of the rest of the year (Figure 8).

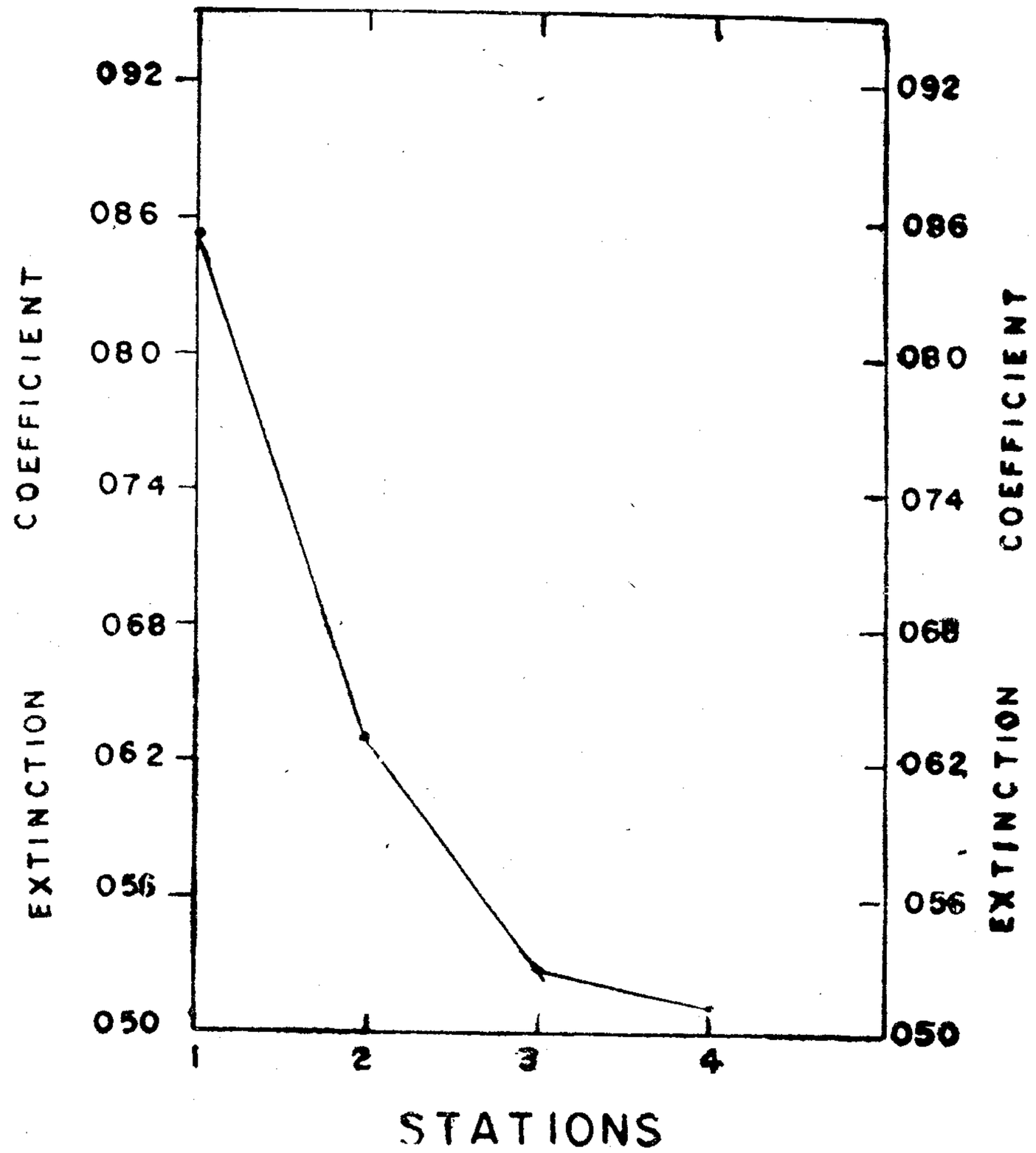


FIGURE 7: Changes in extinction coefficient with distance off-shore during the fishing season, 1969-1971.

Eye estimation of the color of water changes from greenish to light blue with distance off-shore (Table 1). On the fishing-grounds the color was paler blue during the fishing season than at any other time of the year.

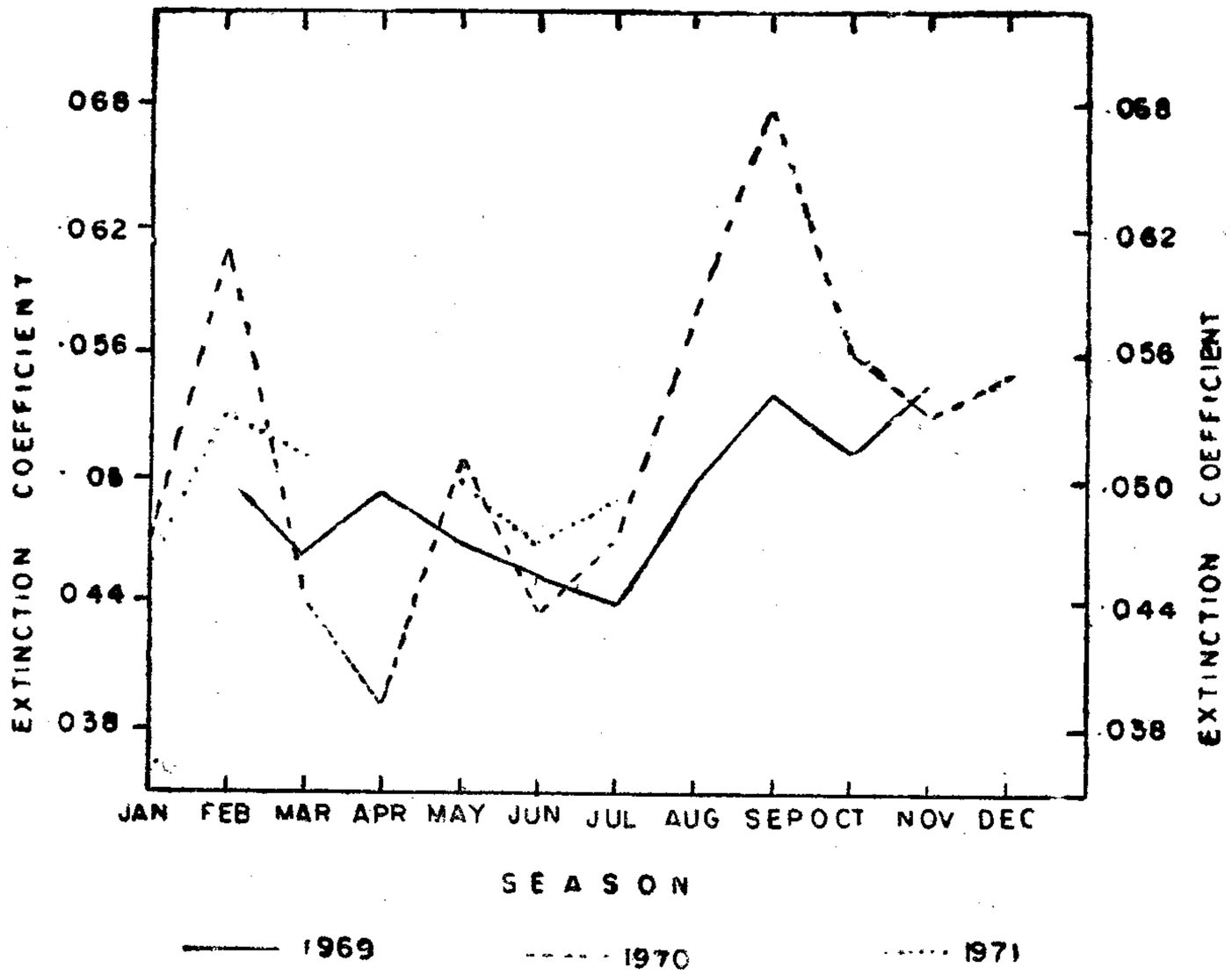


FIGURE 8 : Seasonal changes in extinction coefficient within the fishing grounds, 1969–1971. (Each month is represented by the measurement of the first week only.)

TABLE 1.

Seasonal changes in color of the water (1969 to 1971).

Season	Stations								
Months	1	2	3	4	5	6	7	8	9
	(Fishing - Grouds)								
January	Green		Dark blue				Blue		
February	Dark Green		Dark blue				Blue		
March	Green		Blue				Light blue		
April	do		Light blue				do		
May	do		do				do		
June	do		do				do		
July	do		do				do		
August	Dark blue		Dark blue				Blue		
September	Dark green		Dark blue				do		
October	do		do				do		
November	Green		Blue				do		
December	do		Dark blue				do		

Plankton

The extensive plankton collections made will be the subject of a separate report. For the present it will be suffice to note that total production varied between 0.5×10^3 and 5.0×10^3 per standard tow of 15 mnts, the period of the southwest monsoon being least productive (Figure 9).

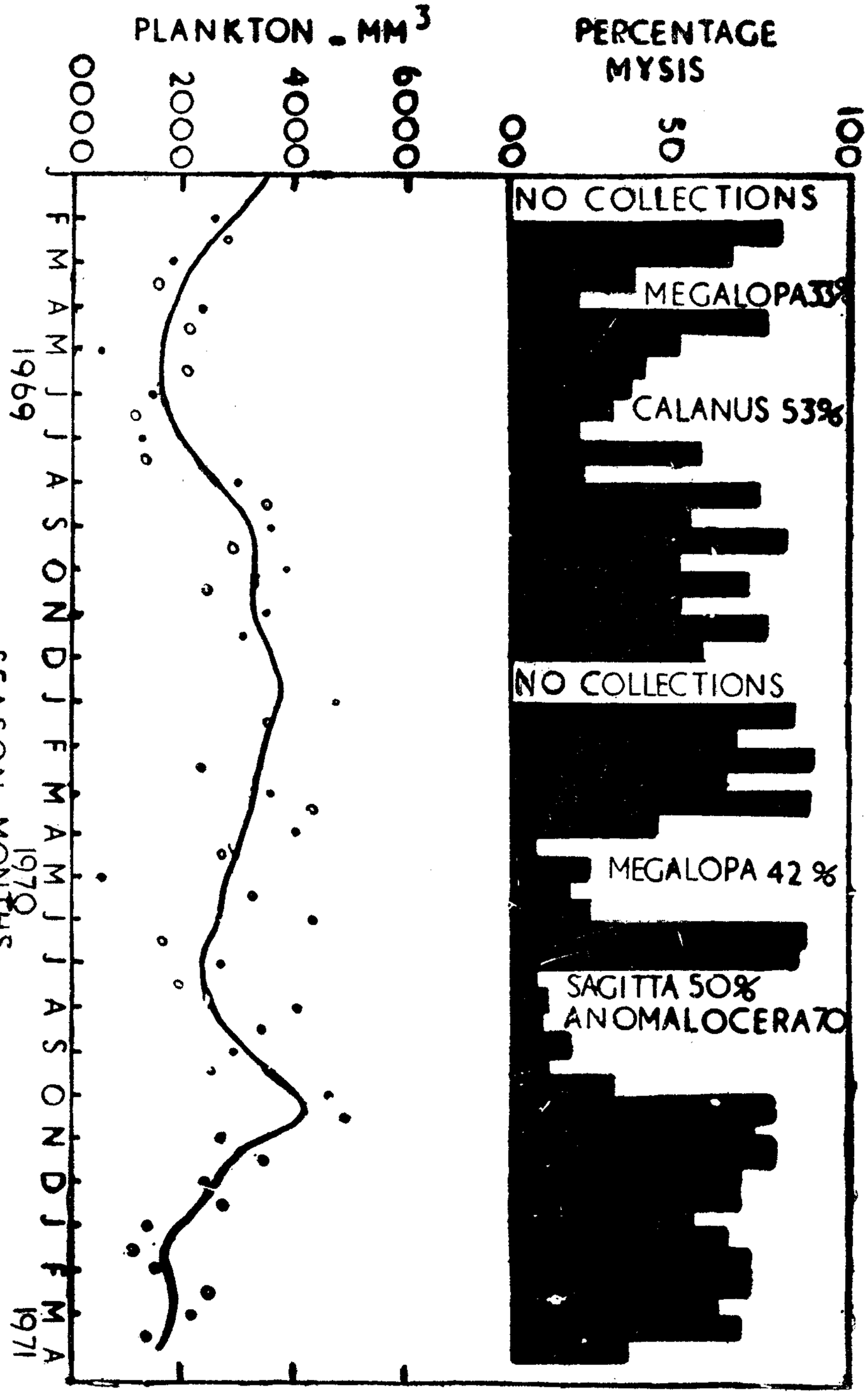


FIGURE 9: Seasonal changes in plankton production and in abundance of *Mysis* sp. Dot = First week. Circle = Third week.

Mysis. spp is most dominant member of the plankton, forming well over 50% in number of the collection throughout most of each year. *Anomalocera*. spp (August 1970), *Sagitta*. Spp (July 1970), *Calanus*. spp (June 1970) and *Megalopa* larvae (March 1969, March/April 1970) displaced it from this position in some few months of the 2 1/2 years during which plankton collections were made (Figure 9).

It might be noted in passing that *Amphioxus*. spp occured occasionally in the surface plankton at night during September and October 1970 (Table 2).

TABLE 2.

The size frequency distribution of *Amphioxus*. spp.

Size mm	Number
4	2
5	4
6	9
7	3
8	2
9	4
10	2
11	1

Conclusion.

The presence of the flying fish *H. coromandelensis* Hornell in this fishing grounds is limited to a very short period of the year. Temperature commence-to fall rapidly and salinity to rise at this time of arrival of the spawing stock (Figure 10) and during the spawning season the surface temperature ranges between 27.5°C to 29.0°C, salinity between 33.5‰ and 33.7‰. The season ends as the temperature begins to rise again and the salinity to fall beyond these ranges. Due to lack of facilities studies on the vertical distribution of temperature and salinity could not be carried out hence changes in the character of the water-mass cannot be considered now.

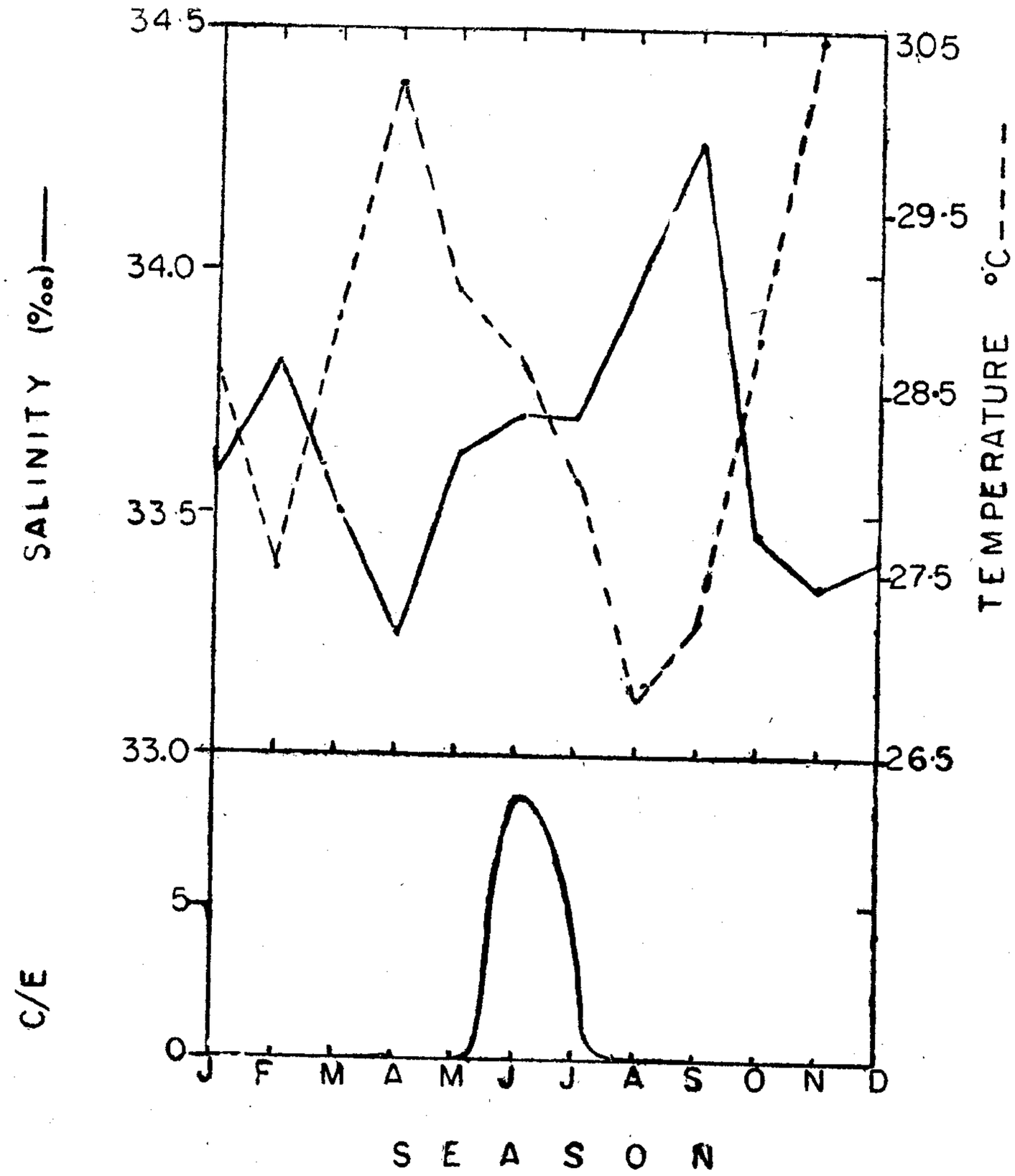


FIGURE 10: Changes in mean catch rate of the spawners, mean temperature and salinity of the surface waters in the spawning grounds,
C/E = catch per unit effort measured in number of baskets (70 lbs per basket).

However, considering surface temperature, surface salinity, plankton production, color of water, and extinction coefficient, it could be concluded that a temperature range of 27.5°C to 29.5°C, salinity of 33.5‰ to 33.7‰, very clear water with very low extinction coefficient and very low plankton production characterise the waters in which the flying fish *H.coromendelensis* Hornell spawns off Trincomalee, Sri Lanka.

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I have great pleasure of thanking Professor A.C. J. Weerakoon, Department of Biological Sciences for encouraging me to take to research in Fisheries, arranging for a supervisor for me and also for revising this manuscript for publication.

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