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DISTRIBUTION OF MEROPLANKTON IN RELATION TO THE THERMOCLINE IN THE WESTERN INDIAN OCEAN DURING DAY AND NIGHT*

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ABSTRACT

Based on 35 night and 27 day zooplankton collections made from a depth of 200 m to surface and the thermocline layer to surface, the distribution of meroplankton in relation to the thermocline was studied in the western Indian Ocean. The abundance of fish larvae both below and above the thermocline indicated that the thermocline is not a barrier for the distribution of larvae. Fish larvae showed nocturnal abundance. Their diurnal migration indicate that the major factor controlling the vertical migration is light rather than temperature. Fish eggs were found in large numbers in certain areas probably due to congregation of spawners. Larvae of bivalves and Anthozoa indicated nocturnal abundance influenced more by light than temperature. Larvae of sipunculoids and cirripeds mainly present below thermocline and Tornaria above thermocline showed nocturnal abundance. Actinotrocha and phyllosoma larvae were rare. A swarm of stomatopod larvae occurred in one collection. Cephalopod larvae indicating nocturnal abundance preferred the layer below thermocline. In general vertical migration of larvae were more influenced by light than temperature.

INTRODUCTION

THE WESTERN half of the Indian Ocean is an area where the changes brought about by the monsoon (time) is found to be outweighing the changes brought about by space in the primary and secondary production. The depth of the thermocline was found varying from shallow to deep, being subjected to the influence of monsoons. So this study was undertaken in order to find out the nature of relation, if any, existing between the thermocline and the vertical distribution of the meroplankton.

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MATERIAL AND METHODS

As part of the International Indian Ocean Expedition (1960-65), R.R.S. *Discovery* collected zooplankton samples from 62 stations in the western half of the Indian Ocean. Of these, 35 samples were collected during night and 27 samples during day. At each station two separate hauls were made, one from 200 m to surface and another from the thermocline to the surface; using Indian Ocean Standard net. The depth of the thermocline varied between 30 and 120 m. The entire observation lasted from March 1964 to August 1964. The station number with positions are depicted in Fig. 1. As a matter of convenience to explain all the 62 stations were grouped under 6 cruise tracks following mainly the time of cruise.

The numerical data of certain meroplankton taxa collected from each station in relation to the thermocline is presented in the form of graphs in Figs. 2 to 5. In presenting the data the unit standard haul system is found more meaningful than the number per m³ since the initial assumption that the number of organisms is greater when the volume of water filtered is greater is not applicable for long vertical hauls, especially in relation to the non-random distribution of the organisms. But in fact the number of organisms are really more in the long haul (200-0 m) than in the short haul (thermocline to surface). Also the regression analysis showed the relationship between the two hauls, 200-0 m and the thermocline to 0 m (No./m³) to be highly significant (99% level).

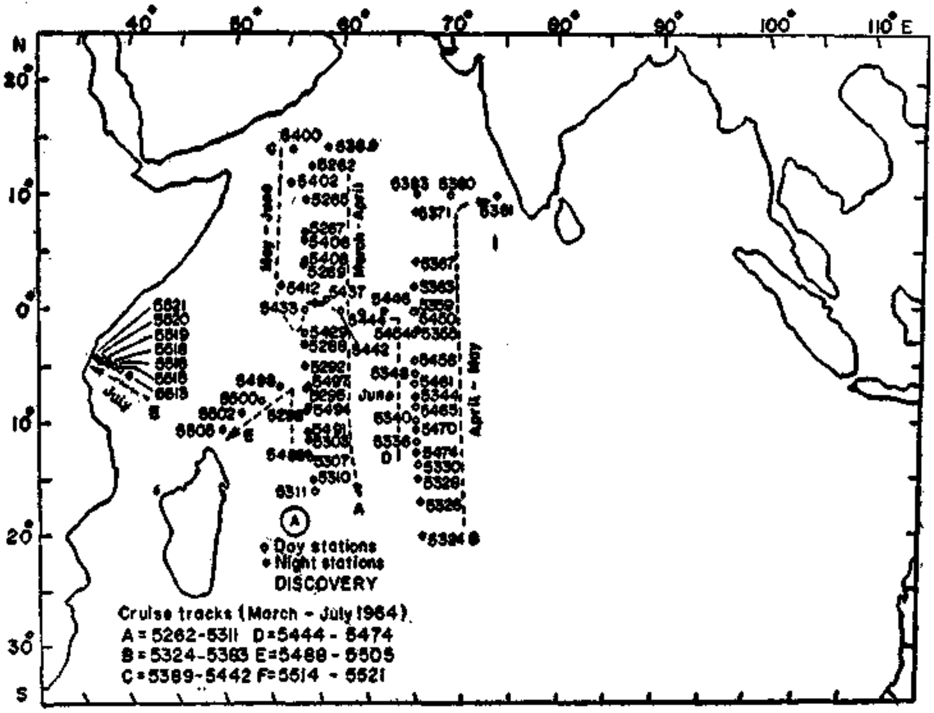

Fig. 1. Stations with positions from where the observations made.

Results and Discussion

The distribution of fish larvae in relation to the thermocline is shown in Fig. 2. Fish larvae showed nocturnal abundance having 25 larvae per haul above the thermocline and 33 larvae per haul below the thermocline, whereas they are sparsely populated above (7/haul) and below (17/haul) the thermocline in the day hauls, in the 200 m water column. Fish larval abundance below the thermocline in the day time indicates the vertical migration undergone by fish larvae to avoid surface light. The mean day level may vary according to the penetration and intensity of light in different stations.

The area explored being under the influence of monsoon and having thermocline in shallow depths due to mixing of bottom and surface waters, light penetration is low. And so fish larvae occur in most day stations, but in lesser numbers. The occurrence of fish larvae above and below the thermocline indicates that the thermocline is not a barrier for the distribution of fish larvae. However, George (1979) found fish larvae of *Rastrelliger*, sardine and tuna being abundant at specific temperature ranges.

Ahlstrom (1959) found no consistant difference in the day and night catches of larvae of *Trachurus symmetricus* off California. While Richards *et al.* (1971) found no difference in catches of *Auxis* larvae between day and night, (1974) and Peter (1977) recorded increased catches of fish larvae at night in the Indian Ocean, while Boonprakob and Debtaranon (1974) found positive phototaxis reaction in the larvae of *Rastrelliger neglectus*, large

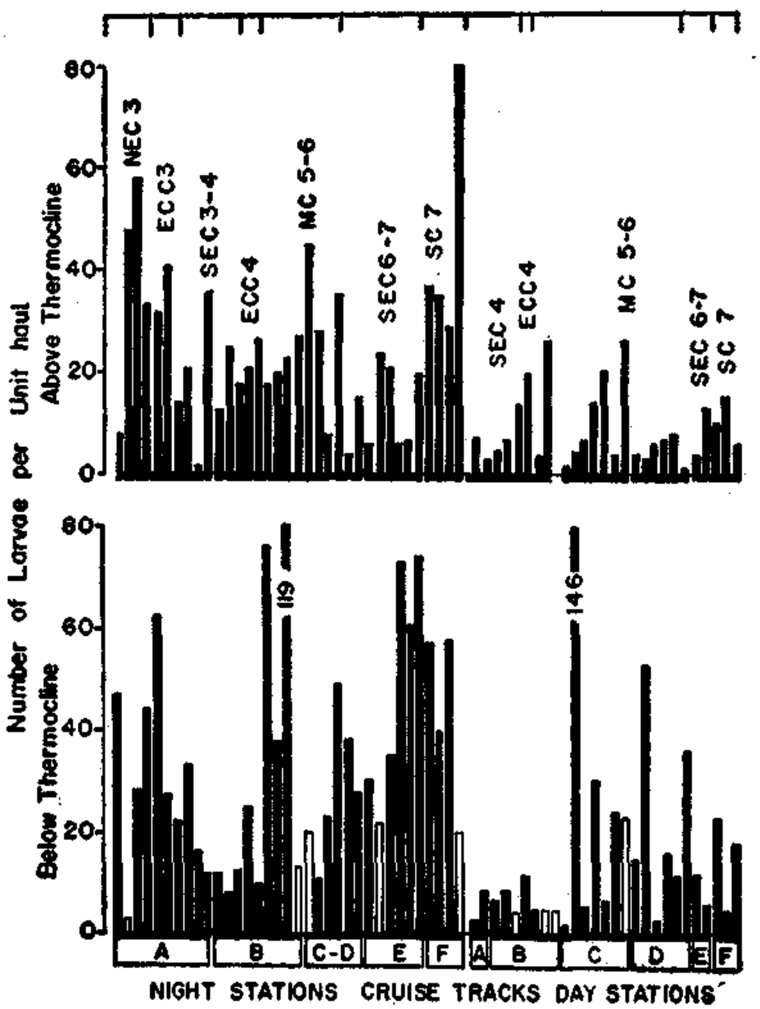

Fig. 2. Distribution of fish larvae (in terms of unit haul). Blank columns represent negative values. NEC 3—North Equatorial Current during March, ECC 3—Equatorial Counter Current during March, SEC 3, 4—South Equatorial Current during March and April, ECC 4—Equatorial Counter Current during April, MC 5, 6—Monsoon Current during May and June, SEC 6,7—South Equatorial Current during June and July and SC 7—Somali Current during July.

Klawe (1963) had noted lesser catches of *Auxis* larvae at night. Ali Khan (1972), Silas number of the larvae congregating at 5 to 10 m during day time and sinking to greater depths from dusk through night. George (1979) studying day and night larval catches showed in most cases a marginal increase in number of larvae caught at night than in the day. The larvae of *Vinciguerria* showed 100 per cent increase in the night catch, while *Sardinella* spp.

Thus the diurnal variation seen in the above studies indicates that the major factor in controlling the vertical migration of fish larvae in the region under study is light rather than temperature. Of the 6 cruise tracks, Tracks A, E and F show relatively high abundance

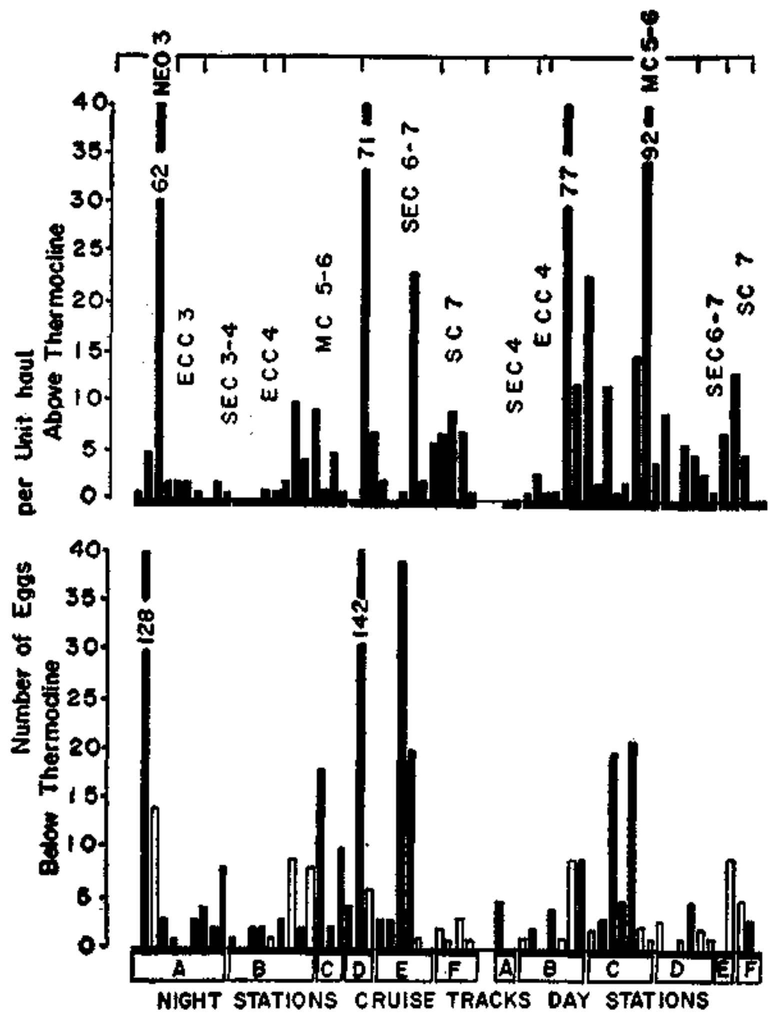

Fig. 3. Distribution of fish eggs (in terms of unit haul). Blank columns represent negative values (For abbreviations, please see Fig. 2).

and *Euthynnus affinis* showed a 50 per cent increase and all the other tuna larvae and larvae of *Rastrelliger kanagurta* showed only a marginal increase in night collections.

of fish larvae (50, 49 and 59 per haul respectively) which perhaps might be due to the influence of the SW Monsoon during June and July. In March-April (Track A) fish larvae are comparatively less in the South Equatorial Current (SEC) than the North Equatorial Current (NEC) and Equatorial Counter Current (ECC). In April-June (Tracks B, C and D) stations of monsoon current show less abundance than SEC and ECC. Track E falling in the area of divergence in July near northeast Madagascar and the Track F in July under the present. This can be due to the non-random distribution of the organisms or due to an artefact of the method used.

The distribution of fish eggs (Fig. 3) indicates only narrow nocturnal abundance (18 per haul) compared to the day hauls (13 per haul). Of the 35 night hauls, while on an average 7 eggs

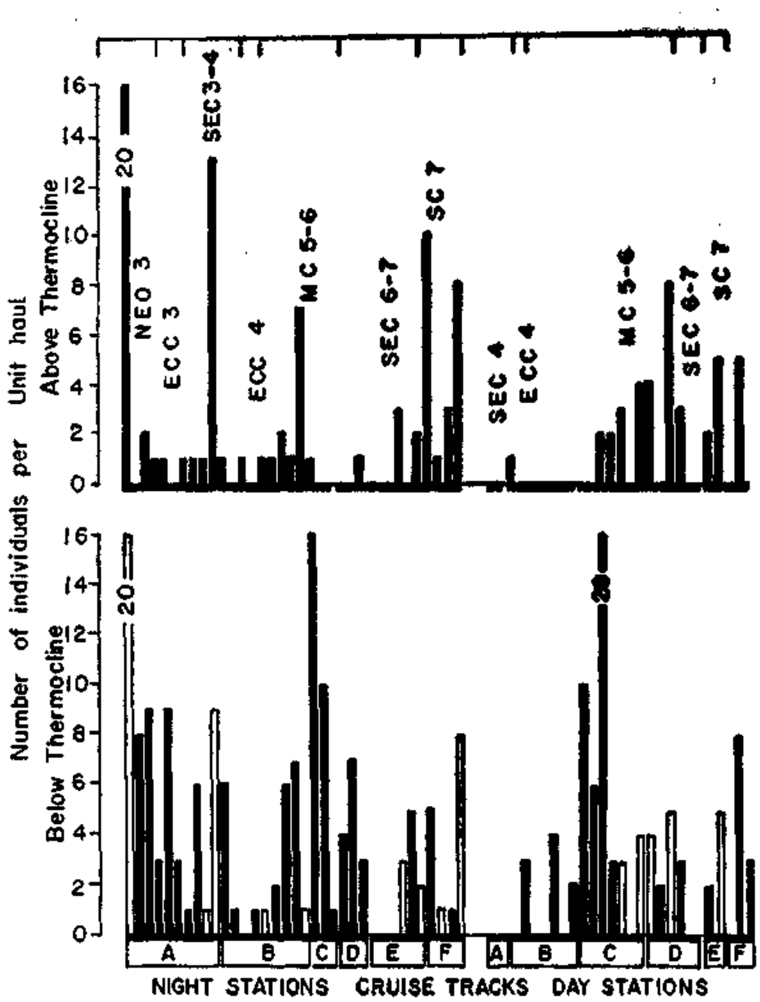

Fig. 4. Distribution of bivalve larvae (in terms of unit haul). Blank columns represent negative values. (For abbreviations, please sea Fig. 2).

influence of Somali Current show significant increase in the number of fish larvae. Nine stations showed negative values below thermocline, giving the impression that no larvae were were obtained from hauls above thermocline. hauls below thermocline had 11 eggs per haul. Similarly of the 27 day hauls made, collections above thermocline contained 11 eggs per haul while the collections below thermocline contained only 3 per haul. On a track-wise, Tracks C and D sampled during April-June from the area of monsoon current showed more abundance revealing highest spawning activity. The presence of large number of eggs in certain areas can be taken as proof of congregation of spawners and of spawning ground there. Above results indicate absence of light or temperature effect on the distribution of fish eggs.

Bivalve larvae (Fig. 4) were present in 32 out of 35 night stations, on an average of 3.2 larvae per haul and in only 18 out of 27 day stations with an average of 1.6 larvae per haul. This indicates nocturnal abundance of bivalve larvae in all the collections. While the night hauls made above thermocline had 2.4 larvae per haul, those collections below thermocline had 3.3 larvae per haul. In the day stations, collections above the thermocline had an average of 1.3 larvae per haul and collections

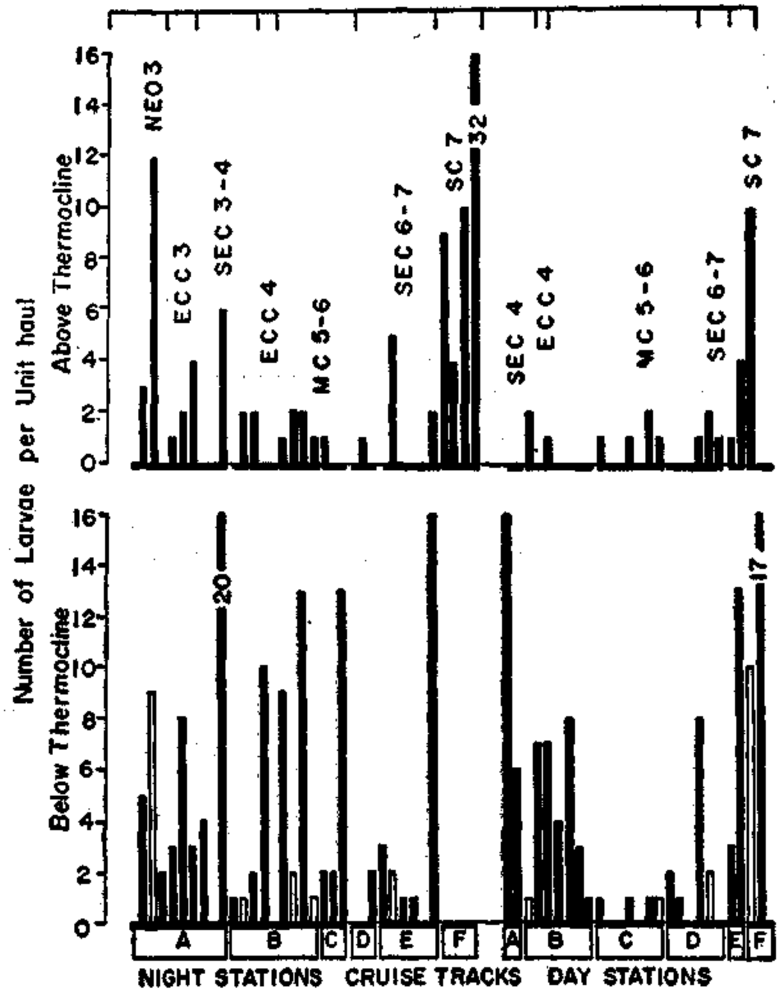

Fig. 5. Distribution of Anthozoan larvae (in terms of unit haul). Blank columns represent negative values (For abbreviations, please see Fig. 2).

below the thermocline had an average of 2.4 larvae per haul. Half of the collections made below the thermocline showed negative values.

Similar to fish larvae, bivalve larvae were also influenced more by light than the temperature during vertical migration. Of the 6 Tracks sampled, the order of abundance was C, A, F, D, B and E. Track C with maximum abundance was under monsoon currents.

Anthozoan larvae (Fig. 5) are present in 24 out of 35 night stations and 22 out of 27 day stations. Frequency of occurrence are same (20 out of 35) in samples above and below thermocline in the night collections and less (12 out of 27) above thermocline than below thermocline (17 out of 27) in the day collections. Larvae are more abundant (about 4 per haul) below thermocline than above thermocline (about 2 per haul) in both the day and night stations. However, 5 night stations and 4 day stations below thermocline showed negative values. The above results indicate that more than the temperature, the light factor acts as a control in the vertical distribution of anthozoan larvae as noted for fish larvae and bivalve larvae. Of the six tracks sampled, the stations of track F which was covered in July falling under the area of the Somali Current had the maximum abundance of 12 larvae per haul. Next to it was the Track A stations covered in March and April under the influence of major Equatorial Currents. The stations in Tracks C and D under the influence of the Monsoon Current and the South Equatorial Current had very poor larval occurrence (2 per haul).

Sipunculoidea larvae are present in 13 out of 62 stations sampled. They are mainly collected from stations in Tracks A and E during March and April period. They are mainly present in the night samples especially below thermocline.

Actinotrocha larvae are present in only 2 out of 62 stations. One day station in Track B under the influence of South Equatorial Current had 37 larvae below thermocline and only one larva above the thermocline. Another day station also in Track D influenced by the Monsoon Current had 4 larvae below the thermocline.

Tornaria larvae are present in 25 out of 62 stations. sixteen night stations had an average number of 7 larvae per haul, whereas 9 day stations had an average number of 6 larvae per haul. This indicates nocturnal abundance. Tornaria are found abundant above the thermocline in contrast to other larval forms. Tornaria are absent below the thermocline in the day stations. Maximum larvae are collected during July from the Somali Current area.

Cirripede larvae are present in 17 out of 62 stations. Of these 10 night stations had 9 larvae in each and 7 day stations had 4 larvae in each. This indicates nocturnal abundance. While the collections above thermocline had an average of one larva per haul, that of below the thermocline had an average of 6 larvae per haul.

Of the 62 stations only one day station above the thermocline in the Track C had one phyllosoma larva. Similarly four brachiopoda larvae are present in a night station above the thermocline in Track E.

Stomatopoda larvae are present in 20 out of 62 collections made. But for the 54 larvae obtained from a night station above the thermocline they are present in very few numbers in the day and night hauls and above and below the thermocline.

Cephalopod juveniles are present in 24 stations out of 62 stations sampled. 13 night stations had an average of 8 larvae per haul whereas 11 day stations had an average of 3 larvae per haul. On an average more cephalopod juveniles are present below the thermocline. Of the 6 tracks sampled tracks E and F covered during June and July had maximum number of juveniles.

References

AHLSTROM, E. H. 1959. Vertical distribution of pelagic fish eggs and larvae off California and Baja California. *U.S. Fish. Bull.*, **161**, 60 : 107-143.

ALI KHAN, J. 1972. Distribution and abundance of fish larvae in the Gulf of Aden and in the Waters off the coast of W. Pakistan in relation to the environment. *Diss. Kiel*, **191**.

BOON PRAKOB, V. AND Y. DEBTARANON 1974. Diurnal vertical distribution of the larvae of the Indo-Pacific mackerel *Rastrelliger neglectus* (Var Kampen) *Proc. IPFC 15th Sess.*, 1972 : 131-143.

GEORGE, K. C. 1979. Studies on the distribution and abundance of fish eggs and larvae off the southwest coast of India with special reference to Scombroids. *Ph. D. Thesis, Univ. of Cochin* 197 pp.

KLAWE, W. L. 1963. Observations on the spawning of four species of tuna in the eastern Pacific Ocean based on the distribution of their larvae and juveniles. *Bull. Inter-Am. Trop. Tuna Comm.*, **6** (9) : 449-514.

PETER, K. J. 1977. Distribution of tuna larvae in the Arabian Sea. *Proc. Symp. Warm Water Zoopl., Spl.Publ., UNESCO/NIO, Goa.* pp. 36-40.

RICHARDS, W. J. AND C. DAVID SIMMONS 1971. Distribution of tuna larvae (Pisces, Scombroidae) in the northwestern Gulf of Guinea and off Sierra Leone. *U.S. Fish. Bull.*, **69** (3) : 555-568.

SILAS, E. G. 1974. Larvae of the Indian Mackerel *Rastrelliger kanagurta* from the west coast of India. *Indian J. Fish.*, **21** (1) : 233-253.