# VERTICAL DISTRIBUTION OF SIPHONOPHORA IN RELATION TO THERMOCLINE IN THE ARABIAN SEA AND SOUTHWEST INDIAN OCEAN

R. DANIEL
*Women's Christian College, Madras - 600 006, India*

The influence of thermocline on Siphonophora was studied and the results are presented in this account. The density of Siphonophora did not show any marked difference above and below the thermocline at 10 stations while at other stations (51 stns.) it appeared to be influenced by the thermocline. It was observed that of the 46 species encountered, 6 species, *Athorybia rosacea, Vogtia pentacantha, V. glabra, Dimophyes arctica, Lensia multicristata and L. fowleri* were never recorded above the thermocline which acted as a barrier in their upward migration. 12 species, *Agalma okeni, Diphyes dispar, D. bojani, Sulculeoraria chuni, Lensia hotspur, Eudoxoides mitra, E. spiralis, Chelophyes appendiculata, C. contorta, Abylopsis tetragona, A. eschscholtzi* and *Bassia bassensis* were not influenced by the thermocline and formed the bulk of the siphonophore constituent in all stations. Further it is of interest to note that the deep water 'indicator species' *Dimophyes arctica* is brought upto the lower boundary of the thermocline during the upwelling of the deep water masses.

## INTRODUCTION

Siphonophores are extremely abundant in the sea and constitute an important part of the marine plankton. A good deal of published information is available on this group from the Atlantic and Pacific Oceans. Except for the work on the Siphonophora from Seychelles, Mauritius and Chagos Archipelago (Browne, 1926), from the Red Sea and Gulf of Aden (Totton, 1954), from the Madras Coast (Daniel and Daniel, 1963), from Madagascar (Patriti, 1970), from the west coast of India and the Laccadive Sea (Rengarajan, 1973, 1974), from the tropico-equatorial region (Alvarino, 1974) and from the Indian Ocean (Daniel, 1974) not much is known on this group from the Indian Ocean. There is a definite paucity of knowledge on the distribution, abundance and seasonal fluctuations, especially on their vertical distribution in Indian Ocean. Siphonophores have been shown to be an important constituent of the Sonic Scattering Layer (Barham, 1963; Totton, 1954, 1965). It has been further shown how thermocline influences the formation of the Sonic Scattering Layer and the vertical distribution of the zooplankton in general (Raymont, 1963; Banse, 1964; Daniel and Premkumar, 1965; Daniel *et al.*, 1967). Therefore, a preliminary study of the vertical distribution of the Siphonophora in relation to the thermocline was undertaken and the observations are presented in this paper.

## MATERIAL AND METHODS

During the International Indian Ocean Expedition (1962-1965), in the third cruise of the R. R. S. DISCOVERY hauls were made from thermocline to surface,

in addition to standard hauls (200-O m) at 61 stations established between 15°N —25°S and 40°E—75°E. Of these 61 stations, 27 were established during day and 34 during night. The siphonophores present in these hauls were sorted out and identified. The vertical distribution of siphonophore abundance above and below the thermocline are presented in Fig. 1 and 2.

## OBSERVATIONS AND CONCLUSION

Fig. 1 and 2 show that the thermocline varied from 35 m to 100 m in the day stations and 30 m - 120 m in the night stations. The density of Siphonophora did not show any marked difference above and below the thermocline at 10 stations (2 day stations - Fig. 1, a and b and 8 night stations - Fig. 1, c - j). In the remaining 51 stations the depth distribution appears to be influenced by the thermocline. The siphonophore abundance is relatively higher above the thermocline at 32 stations. Of these, 13 are day stations (Fig. 1, k - w) and 19 are night stations (Fig. 1, x - z, $a_1$ - $d_1$ and Fig. 2, a - 1). Lesser densities of siphonophores occur above the thermocline at 19 stations of which 12 are day stations (Fig. 2, m - x) and 7 are night stations (Fig. 2, y, z & $a_1$-e ).

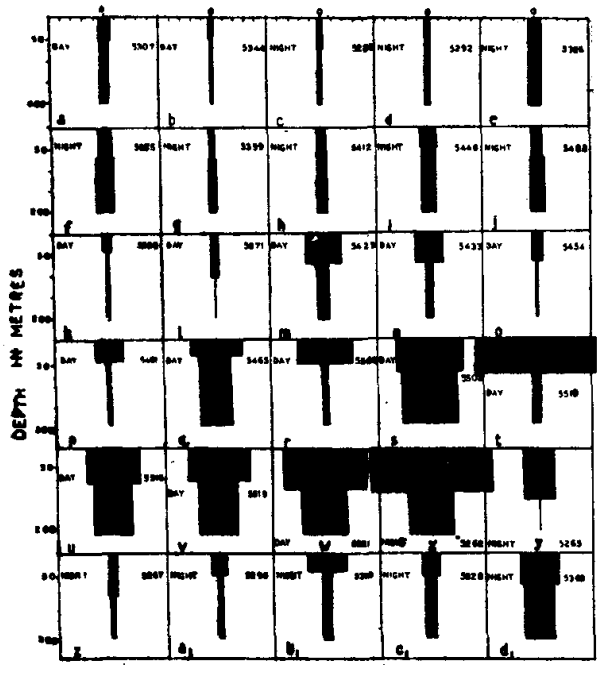


Fig. 1

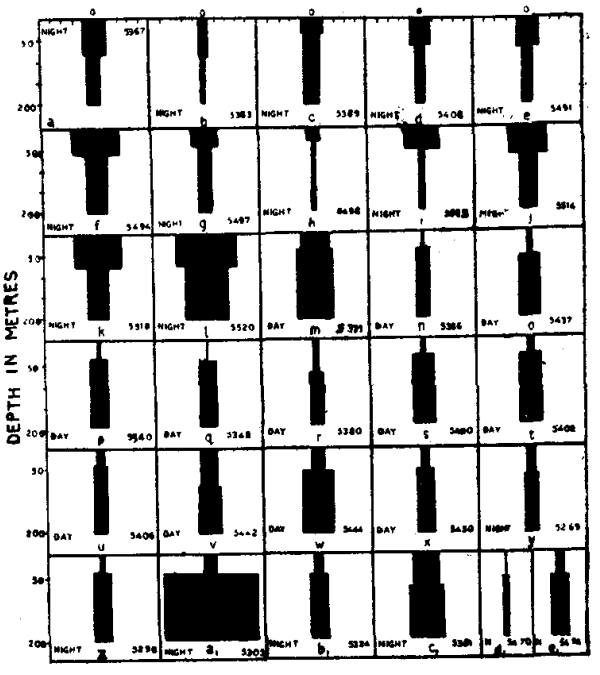


Fig. 2

Fig. 1 and 2. Vertical distribution of Siphonophora at two stratified depths. Scale: one Division=100 nos. of siphonophores

The thermocline seems to act as a barrier which impedes the vertical migration of several species of Siphonophora. However, some species of Siphonophora are recorded in both the vertical zones indicating that their vertical migration is not impeded by the thermocline barrier.

Forty-six species of Siphonophora were encountered in the two vertical zones. These are arranged into the following groups:

*Group I*: Species whose distribution is restricted from below the thermocline to 200 m depth( *i. e.*, never recorded above the thermocline in the present study):

*A. rosacea, V. pentacantha, V. glabra, D. arctica, L. multicristata* and *L. fowleri.* *Group II*: Species distributed in both the vertical zones (*i. e.*, not restricted by the thermocline): *A. okeni, D. dispar, D. bojani, S. chuni, L. hotspur, E. mitra, E. spiralis, C. appendiculata, C. contorta, A. tetragona, A. eschscholtzi* and *B. bassensis.*

*Group III*: Species whose distribution is restricted by the thermocline at particular stations (*i. e.*, recorded either below or above the thermocline): *Rhizophysa* sp; *Forskalia* sp; *P. hydrostatica, A. elegans, H. rubra, N. bijuga, A. acaule, R. cymbiformis, H. hippopus, D. chamissonis, L. subtilis, L. campanella, L. cossack, L. meteori, L. leloupi, L. subtiloides, S. quadrivalvis, S. monoica, S. biloba, S. angusta, S. turgida, S. bigelowi, E. macra, C. leuckarti, C. sagittata, A. schmidti, A. hackeli* and *E. hyalinum.*

From an analysis of the data on the depth distribution of the species constituent of the Siphonophora in relation to the thermocline it appears that only twelve (group II) of the 46 species occurring in the 61 stations, were able to cross the thermocline barrier at all the stations and continue their vertical diurnal migration. These twelve species are actively swimming forms and contribute to the bulk of the siphonophore constituent of the zooplankton in the Indian Ocean. Several species which are restricted in their distribution due to the thermocline barrier at particular stations (group III) are probably prevented from crossing the thermocline barrier due to the influence of several factors such as changes in pH, oxygen tension, salinity, pressure, water mass movement, presence of phytoplankton and the physiological state of the species (Raymont, 1963; Banse, 1964; Daniel and Premkumar, 1965).

Six species (group I) are prevented from crossing the thermocline barrier at all stations suggesting that their vertical migratory movements are prevented by the discontinuity layer as a result of the sharp temperature - salinity changes in the waters (thermohaline stratification). It is probable that these species of siphonophores contribute to the chief constituents of the Sonic Scattering Layers. Further it is of interest to note that *Dimophyes arctica* which inhabits the deep colder waters is brought up to the lower boundary of the thermocline due to the upwelling of the deep water masses.

A number of previous workers have underlined the controversial nature of the problems relationg to the zoological constituents of the Sonic Scattering Layer and it is obvious that much work in this field remains to be done.

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