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# ZOOPLANKTON FROM SOUTHERN BRAZIL-2. ITS COMPOSITION, DISTRIBUTION AND DENSITY IN SPACE AND TIME*

**João Oldair Menegheti****

### SUMMARY

Densities, time and space distribution in continental shelf of southern Brazil (nearly 29°21' S to 33° 44' S) of the following groups were studied: Copepoda, Chaetognatha, medusae, Siphonophora, Thaliacea, Pteropoda, Amphipoda and other crustaceans.

These groups were the most abundant in the samples.

The samples were collected in six oceanographic cruises of the "Programa RGS" carried out by the "Instituto Oceanográfico da Universidade de São Paulo" and "Grupo Executivo do Desenvolvimento da Indústria da Pesca" (GEDIP).

### RESUMO

Estudaram-se as densidades e as distribuições no tempo e espaço dos seguintes grupos de zooplâncton da plataforma continental do Rio Grande do Sul: Copepoda, Chaetognatha, medusas, Siphonophora, Thaliacea (Salpidae e Doliolidae), Pteropoda, Amphipoda e outros crustáceos.

Estes grupos zoológicos foram os mais abundantes nas amostras coletadas durante os seis cruzeiros oceanográficos do Programa RGS. Copépodos e quetognatos foram grupos anuais porque ocorreram todo o ano. Anfípodos foi o grupo invernal já que ocorreram em maiores densidades durante o inverno. Sifonóforos, taliáceos e pterópodos foram os grupos estivais. Os anfípodos serviram como indicadores biológicos da maior influência de águas frias enquanto que os pterópodos, taliáceos e sifonóforos da maior influência de águas quentes. Todos os grupos importantes pela sua abundância foram holoplanctônicos. O meroplâncton foi menos numeroso, apesar de se ter trabalhado com zooplâncton nerítico. A variação estacional foi provavelmente devida a maior ou menor intensidade de reprodução dos grupos estudados e a invasão de organismos de outras águas sobre a plataforma. O provável fator que determina a reprodução estacional das espécies é a temperatura. Altas densidades de taliáceos excluíram outros grupos de zooplâncton.

## INTRODUCTION

The area studied is limited by the Torres and the Chui latitudes (nearly 29°21' S to 33°44' S), from 7 nautic miles out to about the

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limits of the continental shelf (see figure 1 — MENEGHETTI, 1973, p. 66) The cruise always followed the track of figure 1 excepting the 6th cruise to which some stations were added. In this region no survey of the type here published was made before. It consisted in determining the standing stock of the total zooplankton and its variation in space and time with samples collected in fulfilment of the Rio Grande do Sul Program (carried out by Oceanographic Institute of São Paulo and Grupo Executivo do Desenvolvimento da Indústria da Pesca). The present work deals with the general composition of the zooplankton, taking into consideration the most numerous and the time during which the oceanographic cruises were made. Only a few species were identified. The following groups were studied: Copepoda, Chaetognatha, Medusa, Siphonophora, Thaliacea (Salpidea and Doliolidae), Pteroponda and other crustaceans.

## MATERIAL AND METHODS

The cruises took place at the following dates:

| | | | |
|---|---|---|---|
| April, 24 to 28, 1968 (Autumn) | 1st | Oceanographic | Cruise |
| June, 21 to 30, 1968 (Winter) | 2nd | " | " |
| August, 16 to 27, 1968 (Winter) | 3rd | " | " |
| October, 25 to November, 6, 1968 (Spring) | 4th | " | " |
| December, 4 to 14, 1968 (end of Spring) | 5th | " | " |
| March, 5 to 26, 1969 (end of Summer) | 6th | " | " |

A Hensen net was used with a 290μ wide mesh, a 0,75m mouth diameter and an approximate length of 2,50m. A flow-meter was employed. The sampling was vertical. The maximum depth was 150m. The haul was always made from a greater depth than the scattering-layer. The depth of the haul should correspond at least to 70% of the local depth. As the track of the 6 cruises was the same, the stations were always at about the same distance from the coast. Thus the stations more or less equidistant from the coast can be grouped into four zones parallel to the coast. The first zone is the area in which the stations nearest to the coast are situated and the fourth is the one which includes those most distantly situated. In longitude the stations in the first ozne are about 7 n.m. distant from the coast; those of the second zone are 34 n.m. distant; those of the third zone are 61 n.m. away; and those of the fourth zone are 88 n.m. far from the coast. In latitude the stations of the first zone lie at about 31 n.m. distance from each to another. The density of each group was determined by the number of specimens per cubic meter, excepting amphipods and euphausids. The fragility of siphonophores is known. They are easily damaged by rubbing against the net and against other specimens. Therefore only the central parts of the colonies were counted as units. The low values obtained must be considered with care, because in reality a colony with several predator specimens was counted as an individual.

## RESULTS

a) *Dominant groups of the zooplankton:*

There are two groups of the zooplankton which dominated during the year of sampling: copepods and chaetognaths. They are widely distributed in space and time. Other groups occurred in large numbers such as medusae, siphonophores, salps, doliolids and pteropods.

Other groups also occurred abundantly, but their densities were not determined because this was not the scope of this work. For these the apparent volume was measured. Other crustaceans and amphipods were among the three groups which had the largest volume.

*Copepoda* (Fig. 2, 3, 4)

They were found during the whole year in considerable densities. But, during the predominance of chaetognaths, medusae, siphonophores, salps and doliolids, their densities were very low. Thus, during the cruise of April, June and August, the copepods were dominant over all the other groups in nearly all the stations. From the October cruise onwards, their density diminished considerably, and was accentuated in the December cruise. During the March cruise it was again larger. Their spatial distribution was ample, both in longitude and in latitude, but the greatest values occurred in the first zone and there the greatest densities were more frequent.

*Chaetognatha* (Fig. 5, 6, 7, 8, 9)

They were widely distributed in latitude and longitude. They were the most abundant in the 3rd cruise, then in the 6th and in the 4th, and the smallest in cruises 2nd and 5th. The highest values occurred in the stations of the first zone, excepting in one station during the 3rd cruise, in the second zone. Larger densities occurred with greater frequency at south of Rio Grande. The amplitude of salinity and temperature in which they were found more abundantly is very large.

*Medusae* (Fig. 10, 11, 12)

The medusae occurred in greater abundance during the cruises of the warmest time of the year: (Spring, end of Spring and end of

Summer). In these cruises, they occurred preferentially in the stations of the first zone. They were found in high salinities in intermediate and high temperatures. The latitudes during the cruises where the greatest concentrations of medusae were found, varied. *Liriope tetraphyla* was the dominating medusa among the collected species and *Proboscidactyla ornata* came in second place.

*Siphonophora* (Fig. 13, 14, 15)

The densities are low relatively to other groups. The highest density occurred in the 4th cruise, at a station in the first zone, in the first radial. In the 6th cruise higher densities occurred, and in the 4th and 5th there were lower densities. Very low densities were observed especially in the 2nd cruise and also in the 3rd. There were no characteristic distributions of siphonophores in latitude or in longitude.

*Pteropoda* (Fig. 16, 17)

They practically did not occur in the 2nd and 3rd cruises but when they were present, the densities were low. The highest densities occurred in the 5th and 6th cruises. In the 5th they were especially dense in the 2nd and 6th radial. In the 6th cruise high density was present in the second radial, second zone. The greatest concentrations were observed at stations in which the temperature and the salinity were high, especially South of Conceição.

*Thaliacea* (Fig. 18, 19, 20)

They practically did not occur in the 2nd and 3rd cruises. Their densities rise from the 4th cruise, and are higher in the 5th and 6th cruises. In the 5th cruise they were present in very high densities in 4 stations of the first, second and third zones. In the 6th cruise they occurred in 3 stations of the same zones. During this cruise the largest frequency of high numbers was found in the first zone. They were collected in high salinities and temperatures. When the salps and doliolids appeared in great densities the remaining groups of the zooplankton disappeared.

*Amphipoda*

Large enough volumes occurred especially in the August and October cruises and in one April and in two June stations. They were caugh in media temperatures and in relatively low salinities, and always in stations within the second and third zones, especially in the last mentioned. This may means that these animals are benefitted by the stronger mixture between coastal and oceanic waters which occurs in this area. The most abundant species was *Parathemisto* sp. They were distributed in a zone where there is possibly influence of water which comes from the south, and of which the species is an indicator. From the 14 stations, where the volumes were large, 12 are at the south of Rio Grande and only 2 from the June cruise are situated at north of the same.

*Other Crustaceans*

They occurred with large volumes in the hauls made during the cold months, June especially, and then in August and October. The amplitude of temperature and salinity in which they occurred was wide (13° to 25° C and 32,4‰ to 36,3‰ respectively). They were present both in the north and in the south of the area. They seem to follow a diurnal rythm of concentration because they were only caught at night in large enough volumes.

## DISCUSSION

All the abundant zooplankton groups were holoplanktonic, although the catches were in the neritic zone. The meroplankton was not very abundant. Thus, the variation in seasonal abundance was not caused by the meroplankton, but by the variation in the epoch of the maxima reproduction of the groups studied, plus the invasion of organisms from other waters, which altered the biocoenosis present in the area and caused a readjustment of the equilibrium among its components. An example is the invasion of the salps into the coastal region. Temperature is a possible factor, responsible for the seasonal reproduction of the species and for the fluctuation of the zooplankton.

From the data it may be noticed that there are several organisms characteristics of coastal and shelf waters, such as several species of copepods, chaetognaths and other crustaceans. There are others such as salps, doliolids, peteropods and siphonophores which penetrate at other times, the areas ocupied by the just mentioned waters, in infiltrating waters of more oceanic influence. Unexpectedly the physico-chemical conditions of the column of water in the stations nearest to the coast were extremely homogeneous during the cruises. Thus, the salps, doliolids, and pteropods which came into this region found better conditions, probably in a less mature environment than the oceanic and multiplied exceedingly.

There are groups which can be used as biological indicators to give an idea of the gross hydrography of the region. Even without identifying the species of pteropods, thaliacea and siphonophores, but verifying the environment's parameters it can be supposed that the species which occur in great densities and are the majority of these groups characterize warm waters (RAYMONT, 1963; HYMAN, 1968; FURNESTIN, 1966; RUSSEL, 1939). Thus, they can be used as indicators of the infiltration into the continental shelf of water with oceanic origin.

Care must be taken to consider only species with high densities because of the question raised by EKMAN (1953) that an animal only lives in high densities in environments with its preferred parameters, since it may be carried alive during many miles away from its normal habitat. In this case it cannot reproduce. It is in an expatriation area (MARGALEF, 1967).

The distribuitions of greater densities of salps and doliolids show an increase in the penetration of waters of higher salinities and temperatures nearer to the coast at the south from the 5th to the 6th cruise. The same was observed for the pteropods. In the 5th cruise it seems that the invasion of waters of oceanic origin over the continental shelf was in the form of two tongues at south of Conceição. In the 6th this penetration was compact, reaching the stations of the first zone from the south of Rio Grande to the south of Albardão.

*Parathemisto* contained the most abundant species amphipods in our samples. It is an indicator of cold waters (MACKINTOSH, 1934 and RAYMONT, 1963).

It can be observed that there were anual groups of zooplankton, present all year round; others, which could be called winter forms, which were most numerous in the cruises during the colder months of the year; and the summer forms which occurred mainly in the warmer time of the year. The anual forms was composed of copepods and chaetognaths; the winter forms was represented by amphipods; the summer forms were the siphonophores, the salps, the doliolids and the pteropods. As we can notice there was a succession of the predominant groups of zooplankton.

When high densities of salps and doliolids occurred, the remaining groups, of the zooplankton were present only in small densities or disappeared. Three could be the causes, which summed up, might determine this phenomenon:

1 — with the invasion of the waters of oceanic origin over the continental shelf, there would be an impoverishment of the area;

2 — *salps and doliolids* would consume the phytoplankton to such an extent that its standing stock would be lowered. So the remaining organisms of the zooplankton would have nothing to eat directly (herbivorous) or indirectly (carnivorous animals);

3 — the large concentrations of salps and doliolids could act as physical repellents (FRASER, 1961).

Though the two first causes may influence the phenomenon, it is more probable that this last one is the most important, as can be verified in the distributions of the various groups during different times of the year.

## ACKNOWLEDGEMENTS

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DISTRIBUTION IN LATITUDE AND LONGITUDE OF THE DENSITIES OF Copepoda
1st OCEANOGRAPHIC CRUISE

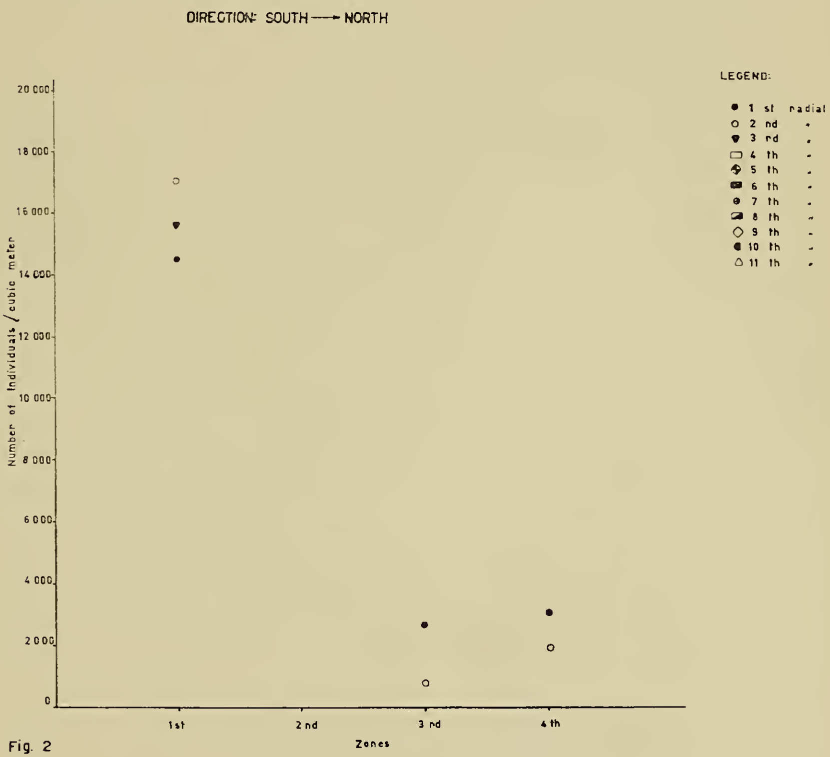


Fig. 2

DISTRIBUTION IN LATITUDE AND LONGITUDE OF THE DENSITIES OF Copepoda

2 nd OCEANOGRAPHIC CRUISE DIRECTION: SOUTH → NORTH

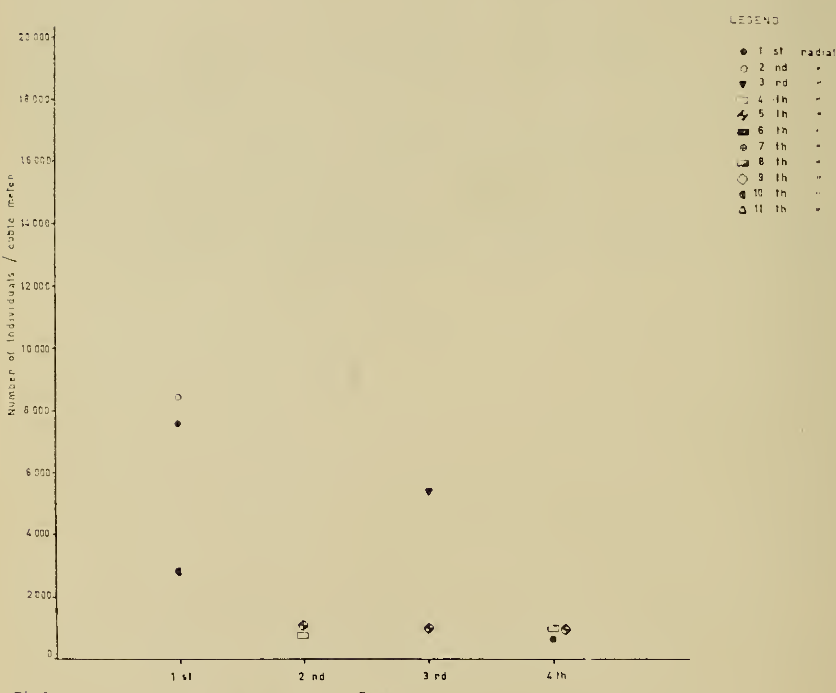


Fig 3

DISTRIBUTION IN LATITUDE AND LONGITUDE OF THE DENSITIES OF Copepoda

3 rd OCEANOGRAPHIC CRUISE DIRECTION: SOUTH NORTH

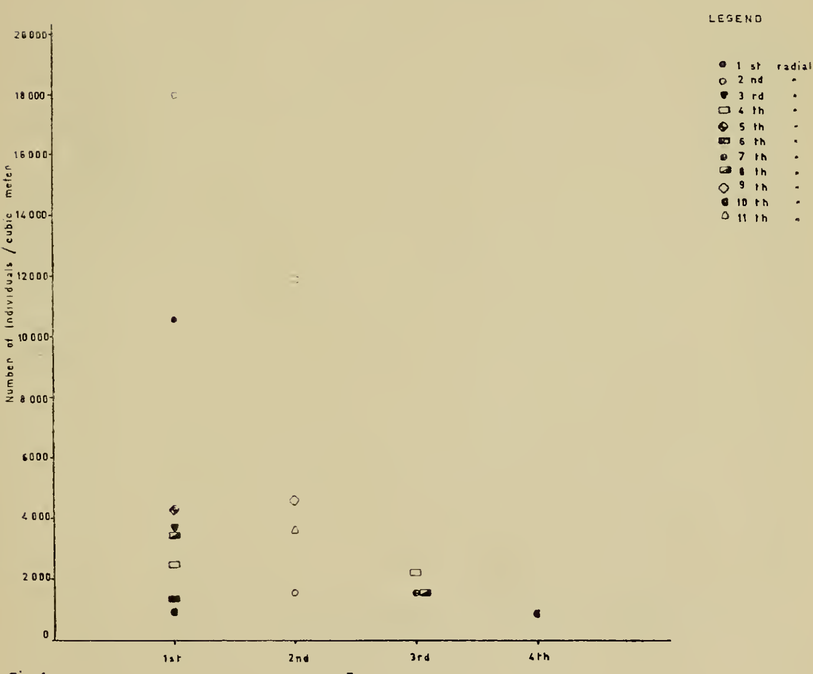


Fig. 4

DISTRIBUTION IN LATITUDE AND LONGITUDE OF THE DENSITIES OF Chaetognatha

2 nd OCEANOGRAPHIC CRUISE DIRECTION: SOUTH → NORTH

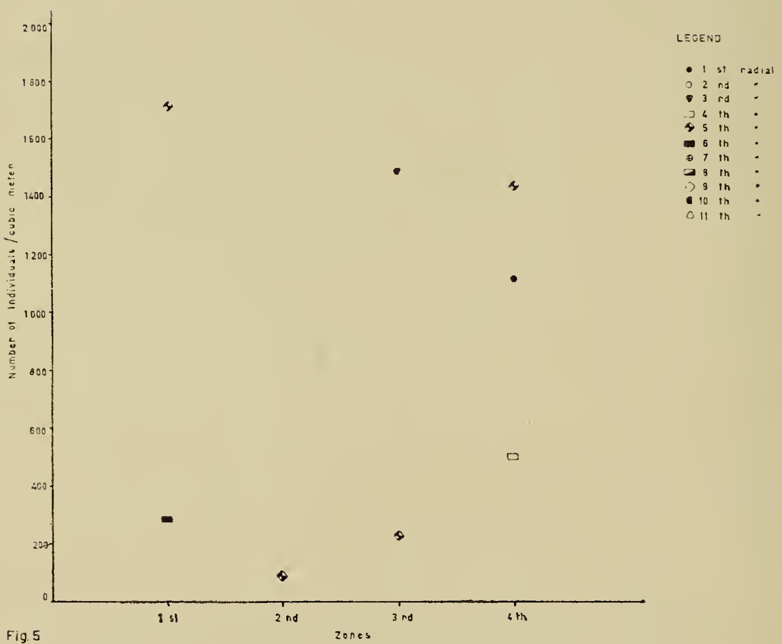


Fig. 5

DISTRIBUTION IN LATITUDE AND LONGITUDE OF THE DENSITIES OF Chaetognatha

3 rd OCEANOGRAPHIC CRUISE DIRECTION: SOUTH → NORTH

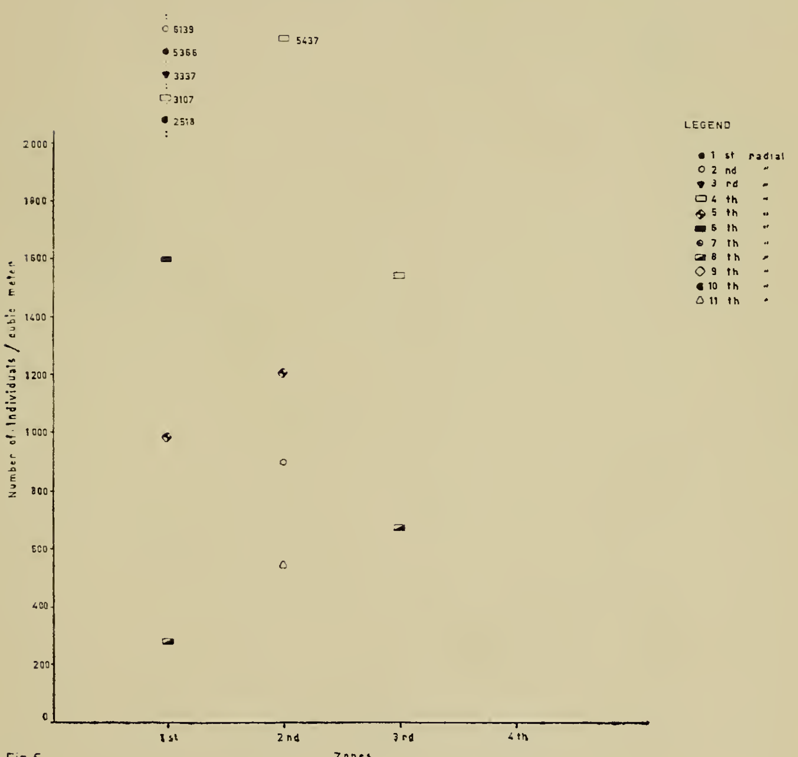


Fig. 6

DISTRIBUTION IN LATITUDE AND LONGITUDE OF THE DENSITIES OF Chaetognatha

4 th OCEANOGRAPHIC CRUISE DIRECTION: SOUTH ⟶ NORTH

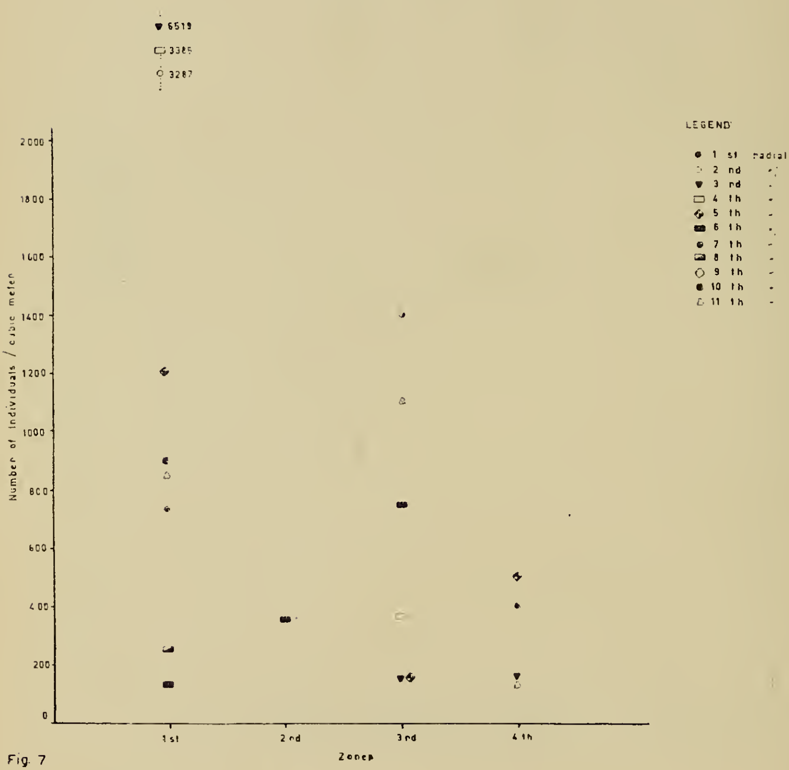


Fig. 7

DISTRIBUTION IN LATITUDE AND LONGITUDE OF THE DENSITIES OF Chaetognatha

5 th OCEANOGRAPHIC CRUISE DIRECTION: SOUTH ——> NORTH

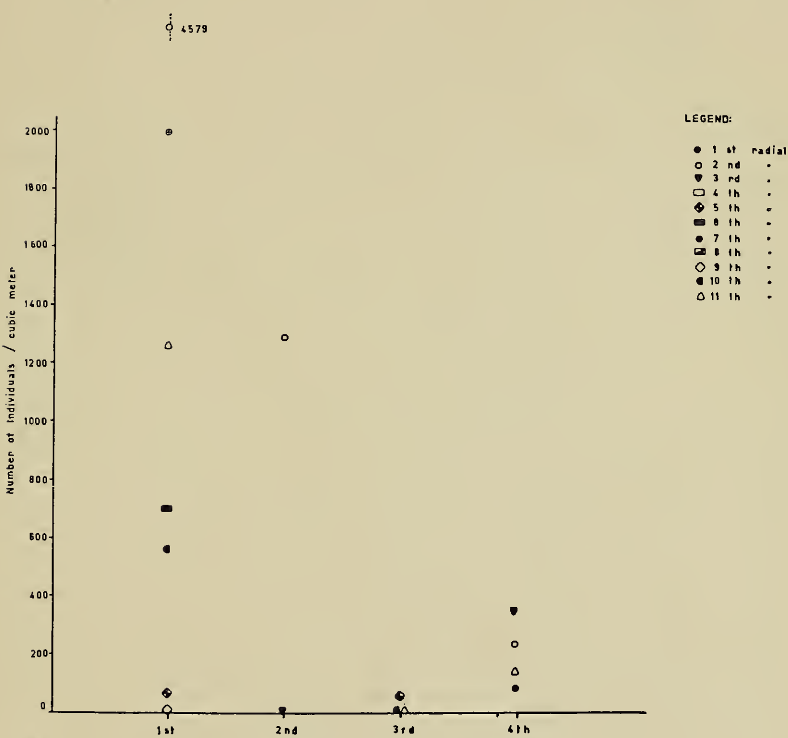


Fig. 8

DISTRIBUTION IN LATITUDE AND LONGITUDE OF THE DENSITIES OF Chaetognatha

6 th OCEANOGRAPHIC CRUISE DIRECTION: SOUTH ——→ NORTH

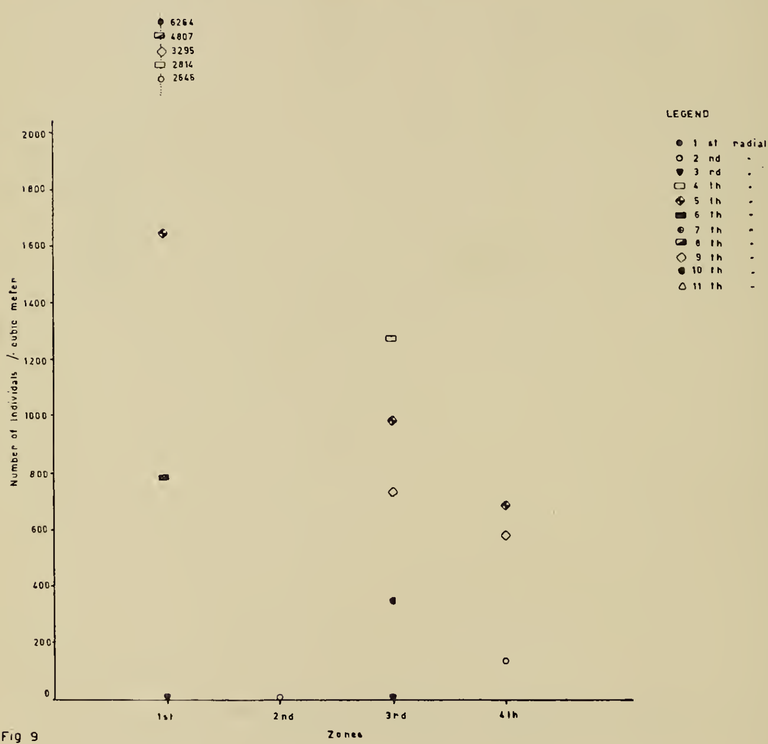


Fig 9

DISTRIBUTION IN LATITUDE AND LONGITUDE OF THE DENSITIES OF Medusae

4 th OCEANOGRAPHIC CRUISE DIRECTION: SOUTH → NORTH

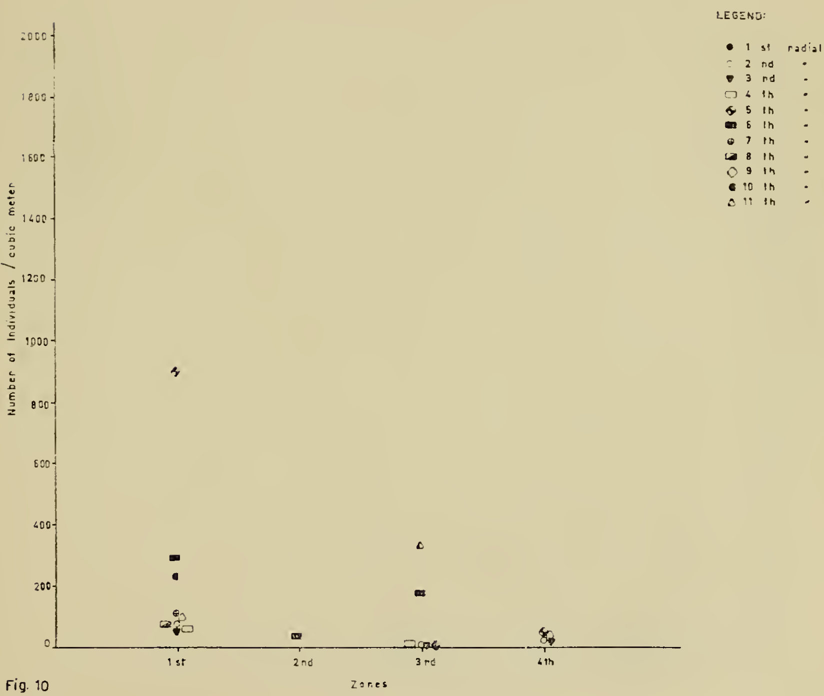


Fig. 10

DISTRIBUTION IN LATITUDE AND LONGITUDE OF THE DENSITIES OF Medusae

5 th OCEANOGRAPHIC CRUISE DIRECTION: SOUTH → NORTH

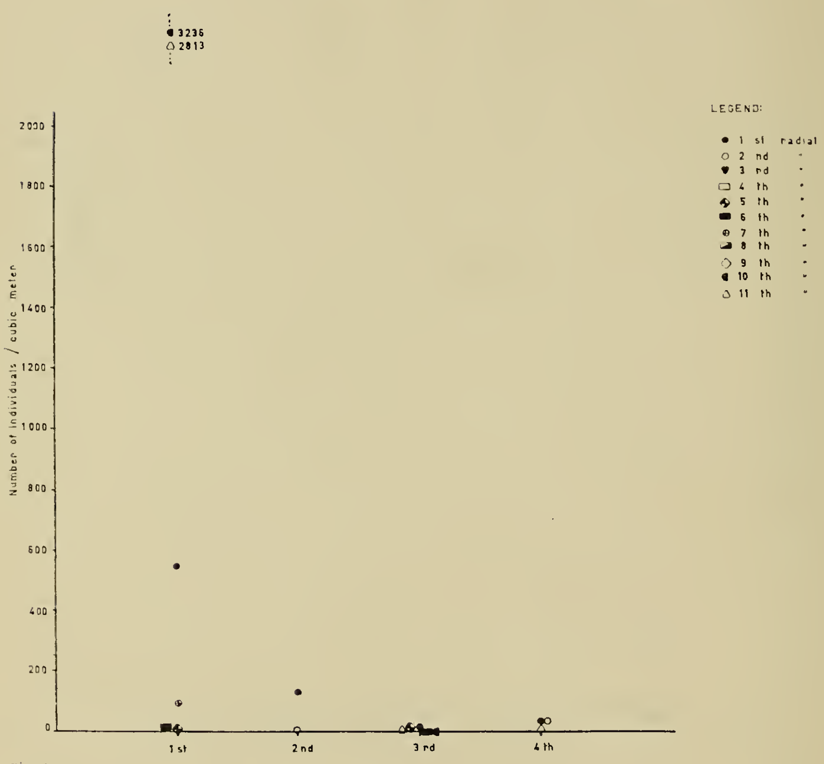


Fig 11

DISTRIBUTION IN LATITUDE AND LONGITUDE OF THE DENSITIES OF Medusae

6 th OCEANOGRAPHIC CRUISE DIRECTION: SOUTH ---→ NORTH

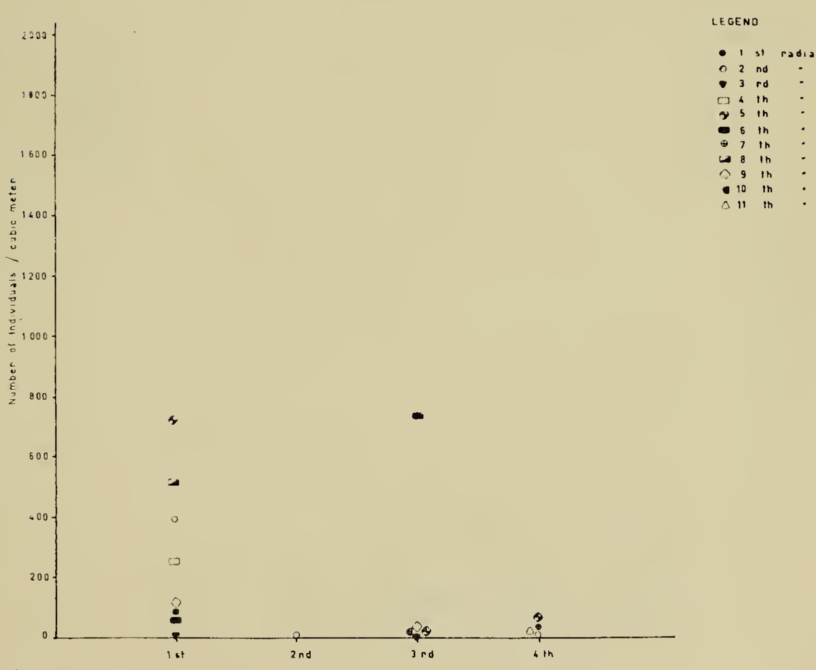


Fig. 12

DISTRIBUTION IN LATITUDE AND LONGITUDE OF THE DENSITIES OF Siphonophora

4 th OCEANOGRAPHIC CRUISE DIRECTION: SOUTH——NORTH

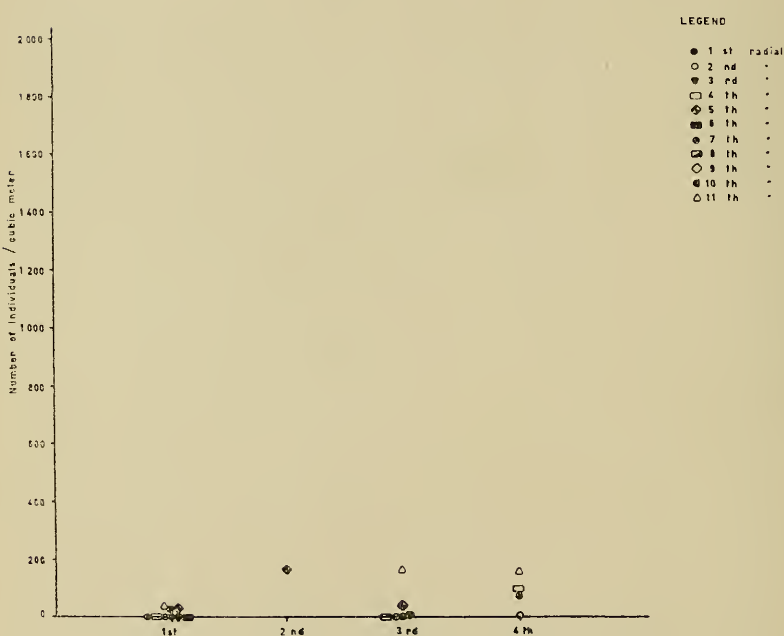


Fig. 13

DISTRIBUTION IN LATITUDE AND LONGITUDE OF THE DENSITIES OF Siphonophora

5 th OCEANOGRAPHIC CRUISE DIRECTION: SOUTH ——→ NORTH

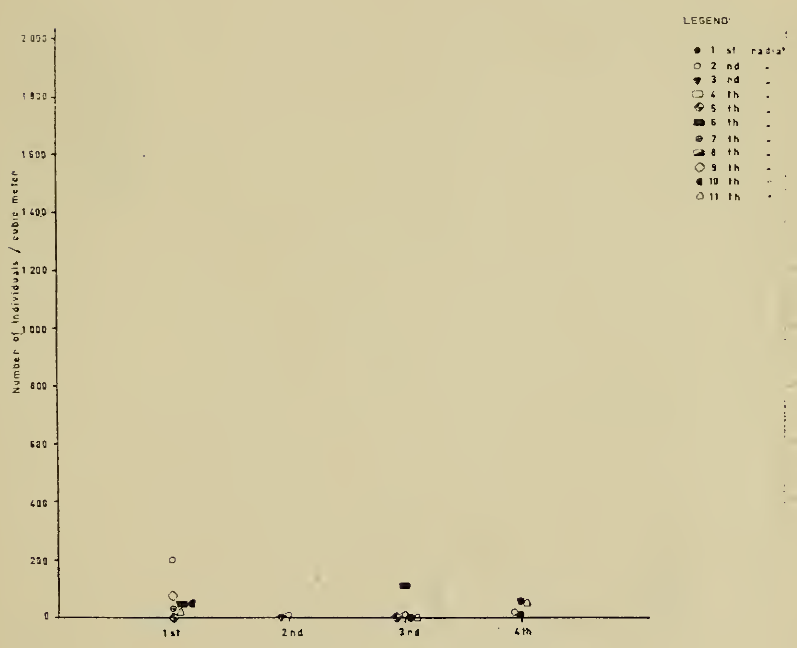


Fig. 14

DISTRIBUTION IN LATITUDE AND LONGITUDE OF THE DENSITIES OF Siphonophora

6 th OCEANOGRAPHIC CRUISE DIRECTION: SOUTH ——→ NORTH

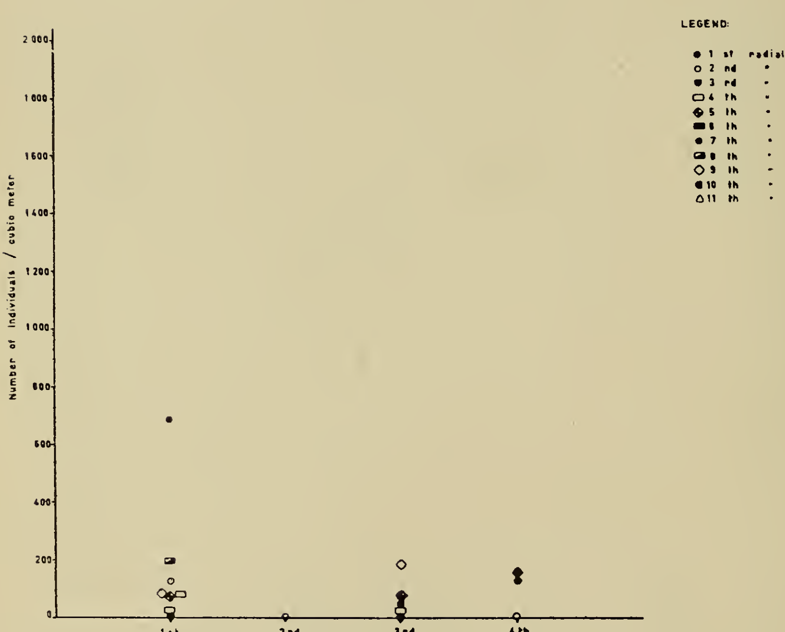


Fig. 15

DISTRIBUTION IN LATITUDE AND LONGITUDE OF THE DENSITIES OF Pteropoda

5 th OCEANOGRAPHIC CRUISE DIRECTION: SOUTH → NORTH

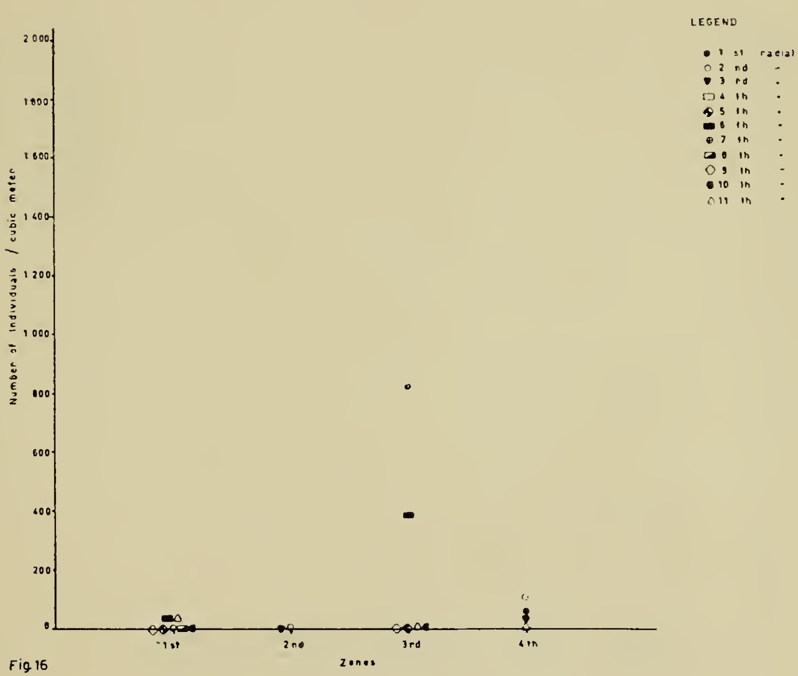


Fig. 16

DISTRIBUTION IN LATITUDE AND LONGITUDE OF THE DENSITIES OF Pteropoda

6 th OCEANOGRAPHIC CRUISE DIRECTION: SOUTH ⟶ NORTH

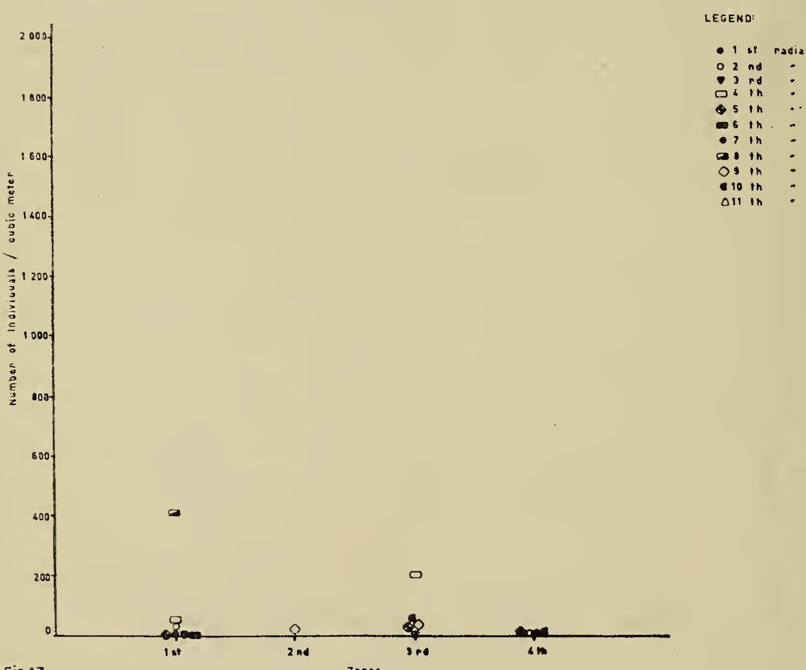


Fig. 17

DISTRIBUTION IN LATITUDE AND LONGITUDE OF THE DENSITIES OF Thaliacea

4 th OCEANOGRAPHIC CRUISE DIRECTION: SOUTH → NORTH

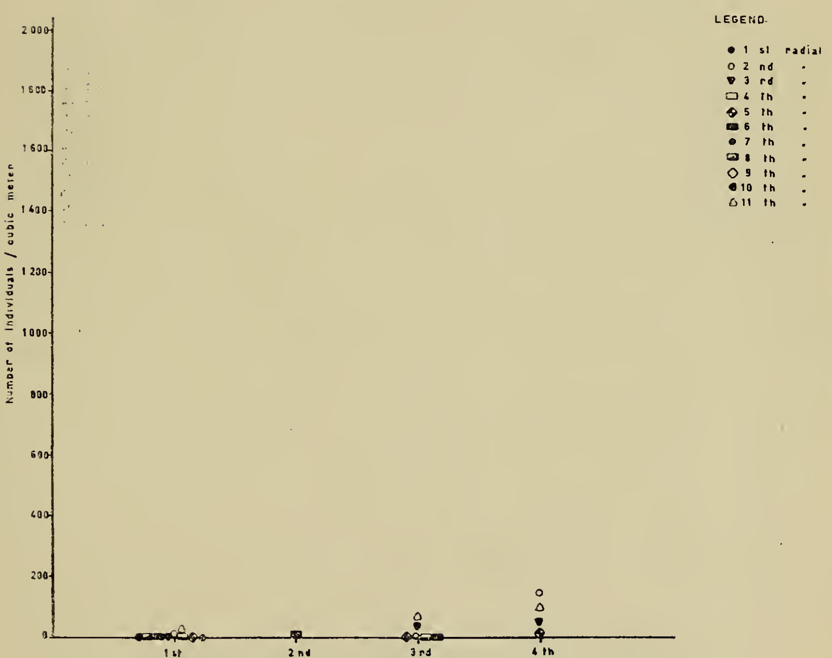


Fig. 18

DISTRIBUTION IN LATITUDE AND LONGITUDE OF THE DENSITIES OF Thaliacea

5 th OCEANOGRAPHIC CRUISE DIRECTION: SOUTH ⟶ NORTH

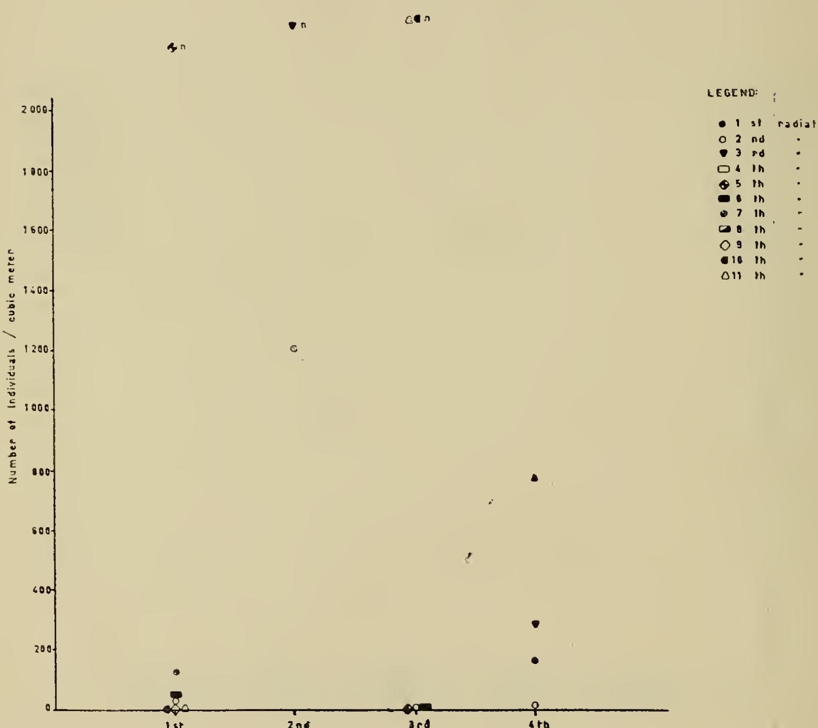


Fig. 19

DISTRIBUTION IN LATITUDE AND LONGITUDE OF THE DENSITIES OF Thaliacea

6 th OCEANOGRAPHIC CRUISE DIRECTION: SOUTH → NORTH

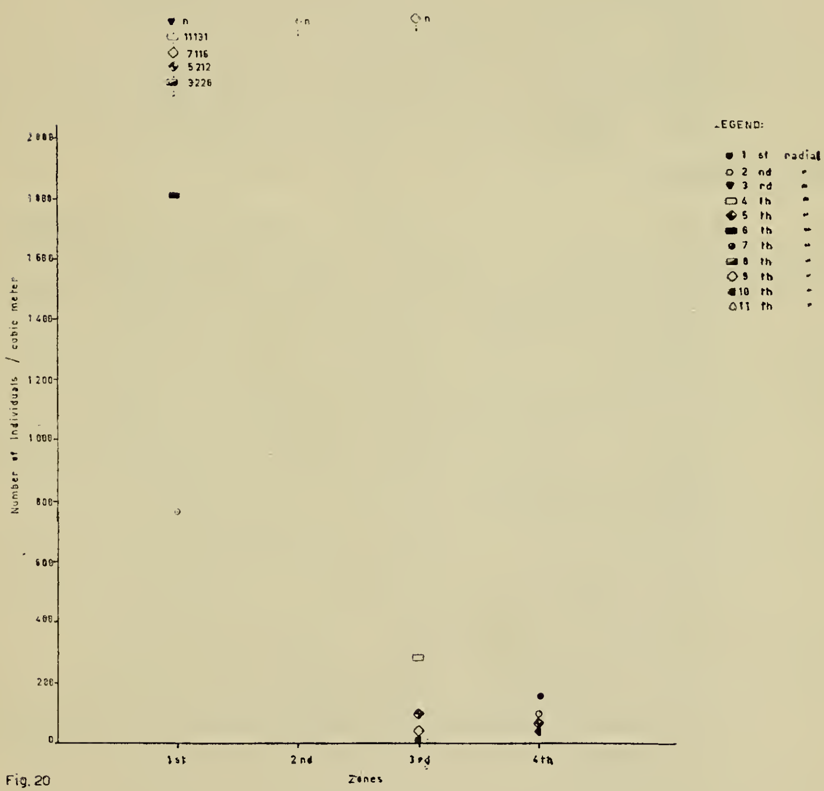


Fig. 20