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Quantitative Distribution And The Seasonal Population Dynamics Of Zooplankton In The Newfoundland Area

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The area of Newfoundland shallow waters represents one of the most important areas of the world fishery. Our task was to study the composition, distribution and seasonal fluctuations of zooplankton - supplying food for a number of commercial fish species.

Plankton samplings taken during the International Geophysical Year and the Year of the International Geophysical collaboration from the R/V "M. Lomonosov" (cruises II, IV, VII and XI) and the E/V "Sevastopol" (cruise XIV) gave the material for the information (Fig. I). Plankton was sampled with a No. 38 (38 threads per cm) little Juday net (made of silk gas) from standard horizontal layers starting from the depths of 500 or 1000 m upward. The quantitative treatment of zooplankton was carried out according to the standard methodics. The work was started under the guidance of A. P. Kusmorskaya who had published a part of material of Cruise II (2, 3, 4, 6, 7, 8).

The area under investigation is rather heterogeneous with regard to its hydrologic regime. Subarctic water masses extend to north and north- east of the Great Newfoundland Bank. The Labrador waters with a high content of biogen elements discharge from the north- west. The southern part of the area is occupied with warm waters of the North- Atlantic current. The area of horizontal transformation (4, 5) is situated between the Labrador and subarctic water masses on one side and the North- Atlantic water mass on the other.

A complicated system of currents forming water masses of this area provides favourable conditions for creating a chemical base of primary productivity. Early in spring (March to April) the mass development of phytoplankton and then zooplankton starts in the southern part of the Great Newfoundland Bank (I). Somewhat later the mass development of plankton is observed along the northern slopes of the Bank and in August this process is seen near the Labrador coast (Fig. 2).

The qualitative composition of zooplankton off Newfoundland is rather diverse. Boreal species characteristic of the Subarctic water mass are predominant in the plankton population on the Great Newfoundland Bank and the Flemish-Cap Bank. Food zooplankton of the boreal fauna is chiefly represented by Calanus finmarchicus (Gunner); besides that the most abundant species are Pseudocalanus minutus gracilis G.O. Sars, Pareuchaetra norvegica (Boeck), Metridia lucens Boeck, Thisanoessa longicaudata (Kroyer), Pleuromamma robusta Dahl, Tomopteris sp., Limacina retroversa Flemming.

Hydromedusae (mainly Aglantha digitale) and Ctenophora are the most frequent of the nonfood species. A few arctic species such as Calanus hyperboreus Kroyer, Calanus glacialis Jaschnov, Limacina helicina, Clione limacina phipps, Oicopleura labradoriensis Lohman are supplemented to the boreal varieties on the Banks and their slopes being carried here with Labrador waters.

Warm- water species are brought and distributed by the North- Atlantic Current. No any particular species prevails within the area of this current ; although a great diversity of species is observed none of them reaches such mass development like some of the boreal varieties. Warm water species such as Calanus Helgolandicus (Claus), Neocalanus gracilis (Dana), Nannocalanus minor (Claus), Mecynocera clausi Thompson and various species of families Calocalanus Spinocalanus, Pluromamma,

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Heterorhabdus, Euchaeta are most frequent above extensive depths in the area of the North- Atlantic Current.

Of non - food species Doliolidae and Salpae (mainly Salpae fusiformis which occurs in spring in the number of nearly 700 specimens per haul with a Juday net) are found in large quantity in waters of the North- Atlantic Current. The limits of penetration of arctic and warm- water species are shown on zooplankton biomass charts (Fig. 3 and 4).

The zone of horizontal transformation represents a zone of intermingling where representatives of boreal and warm-water faunas are found together. The +10° C surface isotherm in this zone may be taken as the southern border of mass distribution of boreal species.

It should be noted that in shallow waters of the Great Newfoundland Bank oceanic organisms are replaced by neritic forms, such as : Temora longicornis (Muller), Pseudocalanus minutus elongatus (Boeck), Centropages hamatus (Lilljeborg) and by various species of Evadne and Pordon families. In addition to the above species the considerable amount of benthic larvae is found in the shallow waters.

The distribution of plankton biomass within the area in question is extremely unequal. The volume of food zooplankton biomass varies from some tens to hundreds mg per one cubic meter of water. The largest volume of biomass is characteristic of the Labrador and subarctic water masses. The maximum quantity of food zooplankton is observed in the central shallow area of the Great Newfoundland Bank up to its northern slopes. Waters of the North-Atlantic Current area considerably poor than those of the subarctic area and the zone of horizontal trasformation is the poorest one.

A diagram of the distribution of food zooplankton in respect of two seasons - spring and autumn is attached herewith.

The average volume of food zooplankton biomass in the boreal zone in the 100-0 m layer fluctuates from 130 mg/m^3 up to 350 mg/m^3; the maximum biomass volume for the 200-0 m layer is 520 mg/m^3 and the volume of particular samples is 900 mg/m^3. In the zone of habitat of warm water species zooplankton biomass was only 30-50 mg/m^3, scarcely 90 mg/m^3. The biomass of Calanus finmarchicus represents the base of the total biomass of food zooplankton in the boreal zone, the sizable share of the biomass in the central part of the Great Newfoundland Bank shallow waters is represented by neritic forms and larvae of benthic forms.

In summer the biomass zooplankton is considerably higher than that in spring in a number of areas it sometimes exceeds 1000 mg/m^3.

The distribution of zooplankton in autumn reproduces in general features its spring distribution, however the ratio between arctic, boreal and warm-water species considerably changes at a number of stations.

In autumn both the habitat area of arctic species and the share of the arctic species biomass in the total amount of food zooplankton greatly decreases (from 20% to 4%). The habitat area of boreal species remains unchanged in autumn, but at some stations their share in the total biomass increases due to the presence of arctic species. At other stations however the amount of boreal forms decreases because of growing portion of warm-water species.

In autumn warm-water species penetrate more northward and at some stations their biomass is considerably higher than that in spring.

The total biomass of food zooplankton substantially decreases in autumn. And the only place where biomass remains higher than 300 mg/m^3 is a small part of shallow water on the Great Newfoundland Bank. This may be explained by the presence of neritic forms. On a great part of the aquatic area the biomass slightly exceeds 100 mg/m^3, and south-west of the Great Newfoundland Bank the maximum biomass sharply decreases in autumn up to 10-20 mg/m^3. The vertical distribution of zooplankton biomass and ensuing food supply of particular layers of water are extremely heterogeneous.

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In the boreal zone because of existence of day and night vertical migration sizable part of zooplankton leaves the upper layers in the day time. In winter the bulk of Calanus finmarchicus passes to hibernation, stops migrating and in the deep - water areas keeps below 200 m. This fact sharply impoverishes food supply of the upper water layers. In a shallow water area zooplankton densely inhabits the whole column of water from the bottom to the surface. Neritic species inhabiting here do not perform day and night mass migrations and food supply therefore varies slightly during 24 hours. Figure 5 shows the vertical distribution of food zooplankton biomass along the section " ab " which goes across the Great Newfoundland Bank and the Flemish Cap Bank. In the Flemish Cap area (station 941) the bulk of calanus settled down in bottom layers, and biomass food zooplankton reached here 410 mg/m^3.

In shallow waters of the Great Newfoundland Bank (st. 944-947) Calanus finmarchicus occurs in the layer 50-0 m above the bottom layers of water having temperature below 0°C. The day-and-night vertical migration is not clearly distinguished in the zone inhabited by warm-water species. The upper layer from 0 to 50 m is the most abundant with food organisms.

There is some difference in the ratio of Calanus finmarchicus stages of development in various seasons of a year. In spring the population was chiefly represented by the Ist and the VI th copepoid stages (30 % for each stage); in summer the I st and the II nd copepoid stages in the Great Newfoundland Bank area made up 97%, and 80% of Calanus finmarchicus in the Flemish Cap area were represented by the IV th and the Vth stages. In autumn no one stage predominated in the 200-0 m layer, the presence of great amount of youngs was found in the population. The IV th and the V th copepoid stages of Calanus finmarchicus mainly occurred in the 1000-200 m layer appeared an indication of its pass to hibernation.

The distribution of Calanus finmarchicus biomass reproduces in general features the distribution of food zooplankton biomass inhabiting the boreal zone. In spring the biomass of Calanus finmarchicus constituted 40-70% of the total food zooplankton biomass in the 200-0 m layer, in summer - 50% in the 500-0 m layer (in a number of samples taken in 500-0 and 200-0 m layers the percent of the biomass was 85-90); in autumn the biomass of Calanus finmarchicus reached 60-90% in the 100-0 m layer and 40-84% in the 1000-0 m layer.

Thus the boreal fauna species and Calanus finmarchicus as the main species represent the base of food zooplankton in the area in question. The development and the distribution of Calanus finmarchicus condition the natural resources of this area.

REFERENCES

1. E. V. Vladimirskaya "Distribution and seasonal fluctuations in the Newfoundland area", Trudy VNIRO, vol. 46, Moscow, 1962.

2. A. P. Kusmorskaya "Zooplankton of the frontal zone of the North Atlantic in spring 1958". Soviet Fishery Surveys in the Seas of the European North, Moscow, 1960.

3. A. P. Kusmorskaya, I. P. Kanaeva and E. V. Vladimirskaya "Soviet Surveys on the Distribution of zooplankton in the Atlantic in 1958-1960". The Report at 49 Meeting of ICES, Moscow, 1960.

4. O. I. Mamaev "On water masses of the north Atlantic and their Interaction". Trudy MGI AN USSR, vol. XIX, Moscow, 1960.

5. JU. V. Istoshin, A. B. Zaklinsky and D. A. Aksenov. "On seasonal temperature variations of the north Atlantic waters". Trudy MGI AN USSR, vol. XIX, Moscow, 1960.

...../4

6. A. P. Kusmorskaya "Distribution of Plankton in the North Atlantic in spring and autumn 1958." Rapp. ez Proc.-Verb. vol. 149, Cons. Intern, Explor. de la Mer. 1961.

7. A. P. Kusmorskaya "Distribution of Plankton in the North Atlantic in Spring 1958". Washington, 1959.

CAPTIONS

Figure 1. Diagram of Cruises.

1. R/V "M. Lomonosov", cruise 2, 6.IV-2.V. 1958.
2. R/V "M. Lomonosov", cruise 4, 4.XI-2.XII. 1958.
3. R/V "M. Lomonosov", cruise 7, 17.III.-30. III. 1960
4. R/V "M. Lomonosov", cruise XI, 25.IX-7.X. 1961.
5. RT "Sevastopol", cruise XIV, 7.VII-11.VIII. 1959.

Figure 2 Seasonal Displacement of "flowering" areas.

1. March 1960. 2. April 1958. 3. August 1959.

Figure 3. Quantitative Distribution of Food Zooplankton in the Newfound area in mg per cubic meter in the 100-0 m layer. Spring.

1. >300, 2.300-200, 3.200-100,4. 100-50,5.<50,
6. The north-western border of warm water species distribution,
7. The south-eastern border of arctic organisms distribution,
8. Locating the surface isotherm + 10°C

Figure 4. Quantitative Distribution of Food Zooplankton in the Newfoundland area in mg per cubic meter in the layer 100-0 m. Autumn.

1. >300,2. 300-200,3.200-100,4.100-50,5.<50,
6. The north-western border of warm water species distribution.
7. The south-eastern border of arctic organisms distribution.
8. Locating of the surface isotherm +10°C

Figure 5. Vertical Distribution of Food Zooplankton in the Newfoundland area in mg per cubic meter. September, 1961.

1. 500-200, 2.200-100, 3.100-50, 4.<50.

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Fig. I Diagram of Cruises.

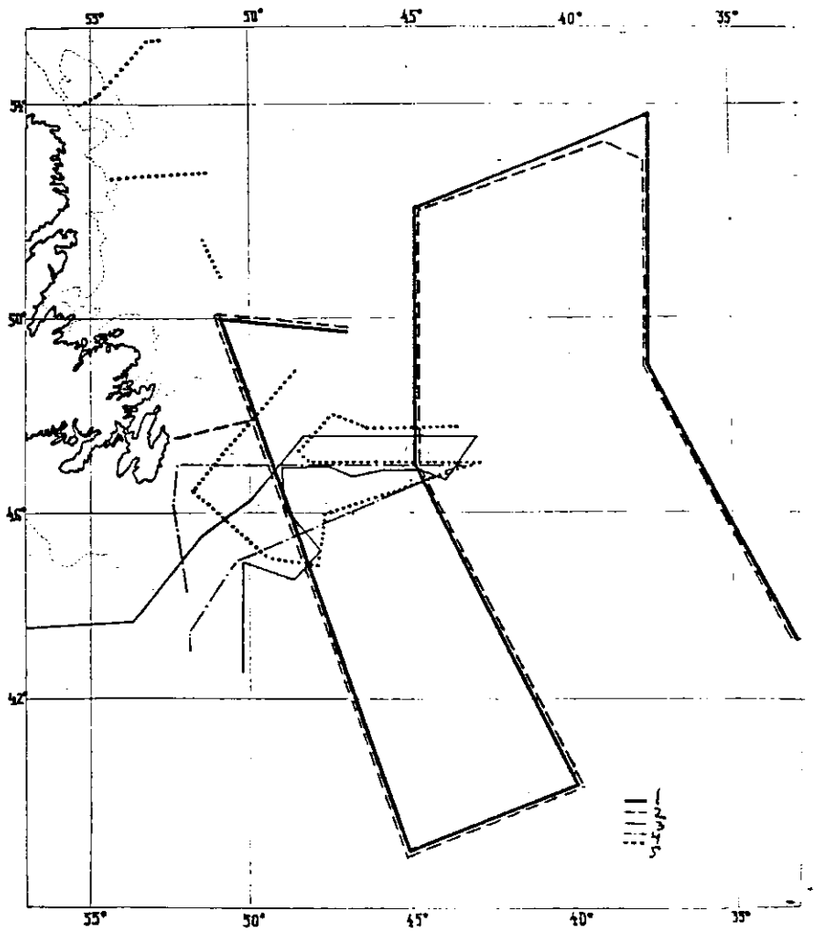

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Fig.2 Seasonal Displacement of "flowering" areas.

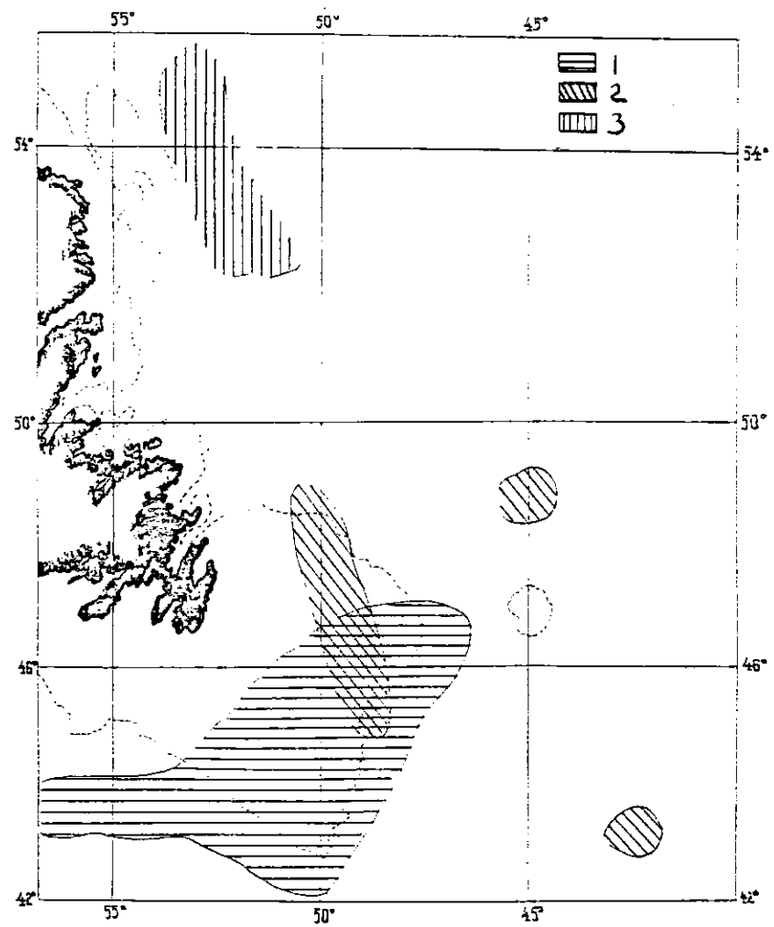

Figure 2. Seasonal Displacement of "flowering" areas.
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Fig.3 Quantitative Distribution of Food Zooplankton in the Newfoundland area in mg per cubic meter in the 100-0 m layer. Spring.

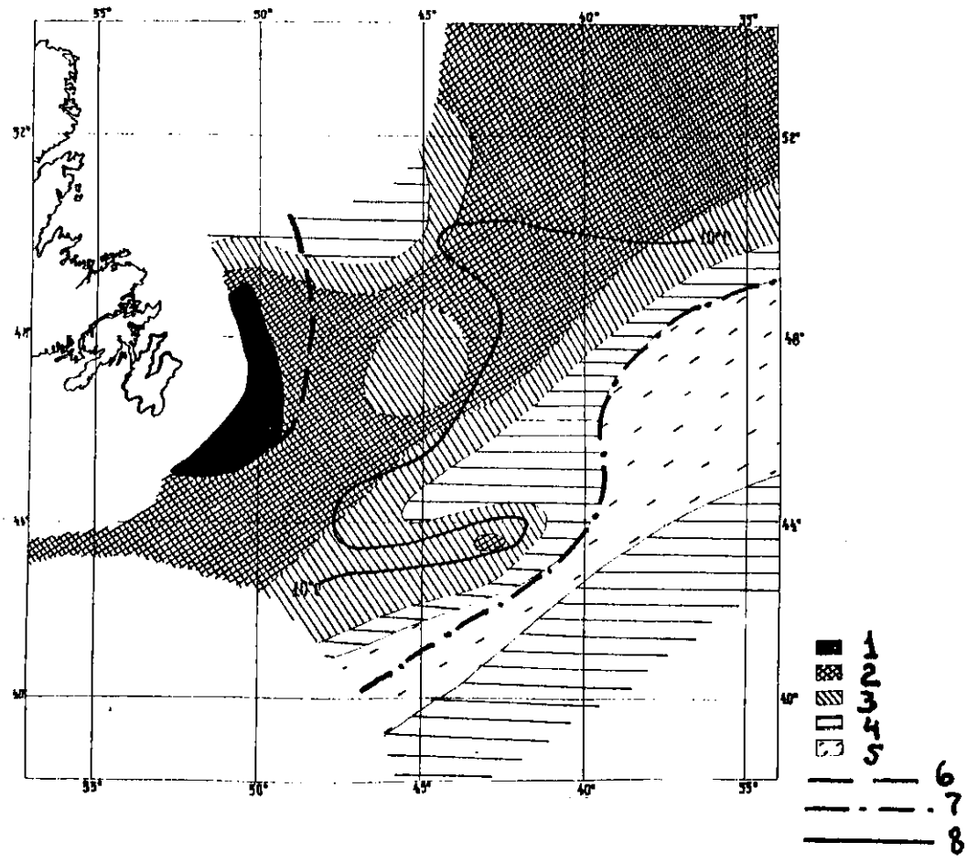

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Fig. 4 Quantitative Distribution of Food Zooplankton in the Newfoundland area in mg per cubic meter in the layer I00–0 m. Autumn.

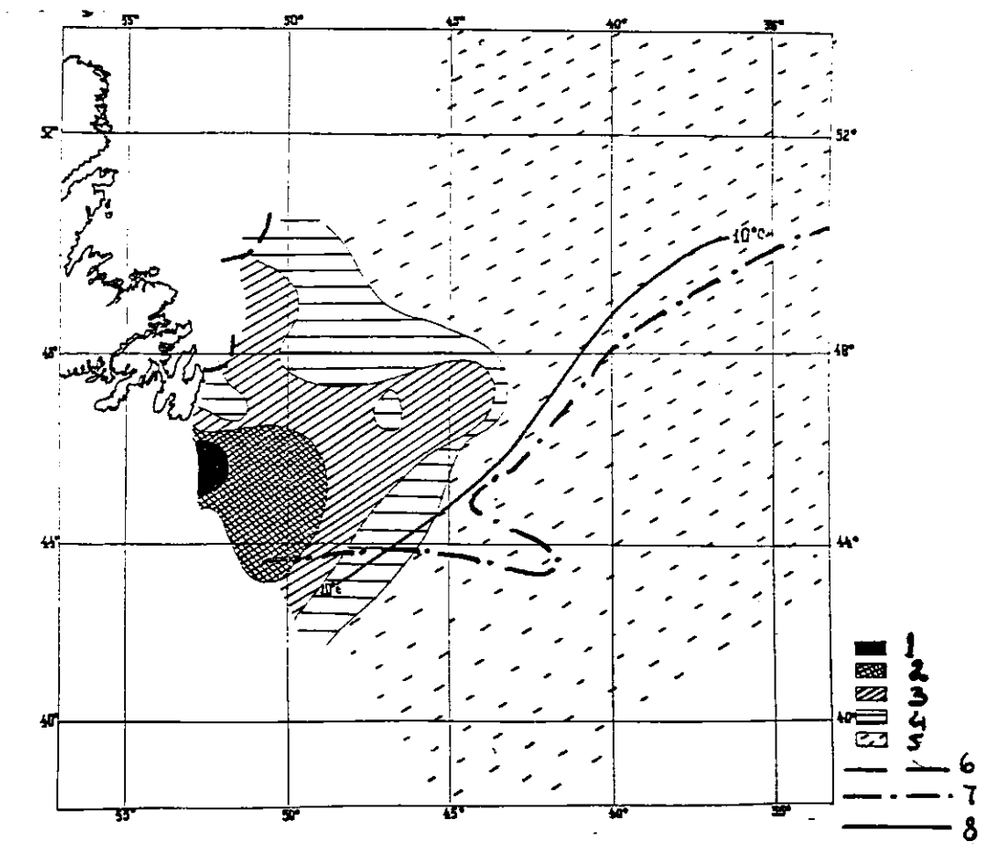

Fig.4. Quantitative Distribution of Food Zooplankton in the Newfoundland area in mg per cubic meter in the layer 100-0 m. Autumn.
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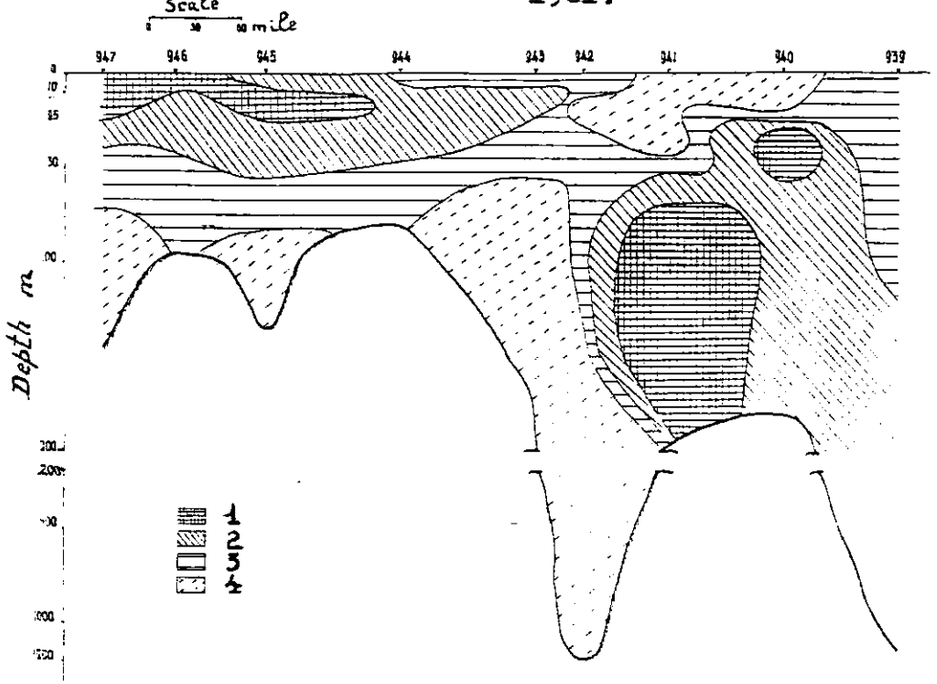
Fig.5 Vertical Distribution of Food Zooplankton in the Newfoundland area in mg per cubic meter. September, I96I.



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