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Results of Distribution and Abundance Survey of Herring Larvae
in The Georges Bank Area in September-October, 1975

by

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I. Introduction

Two ichthyoplankton surveys of herring larvae abundance - the first one (75-2) from September 25 to October 9 at 88 standard stations (fig. 1), the second one (75-3) from October 17 to October 30 at 93 standard stations (fig. 2) - were carried out in 1975 by RTM "Belogorsk" in the Georges Bank area according to the ICNAF program.

The following observations were made during the surveys: measurements of water temperature and salinity, sampling of ichthyoplankton, zooplankton, phytoplankton and water for nutrient determinations.

In the present paper ichthyoplankton and zooplankton sampling methods are described and the main results are given.

II. Material and Methods

Ichthyoplankton sampling was made by means of oblique hauling with the large Bongo plankton sampler (the opening diameter 61 m), and zooplankton sampling was made with the small Bongo plankton sampler (the opening diameter 20.5 cm).

The ship speed was constant and constituted 3.5 knots. The hauling was started from the depth of 100 meters. In shallow water regions (less than 100 m) the sampler passed at about 10 m from the bottom. The sinking speed of the sampler was 50

m/min, while the lifting speed was 10 m/min. The flowmeters calibrated before and after each survey, were used for the measurement of the water, filtered by the net. Nets with mesh-size of 505 and 333 μ were used for ichthyoplankton sampling and those with 105 μ mesh-size for zooplankton sampling. Ichthyoplankton sampled with the net of 505 μ mesh-size was sorted and treated, while that sampled with the net of 333 μ mesh-size was sent to the Sample Sorting Centre in Szczecin.

Fish larvae were selected from the plankton samples under binocular. Small samples up to 0.5 l by volume were sorted completely. Large samples (over 0.5 l) were divided with Folsom divider into 4 subsamples.

Depending on the sample size 1 part was sorted and the resulting larva number was recalculated for the total sample volume. 100 larvae were measured. In samples including less number of larvae all specimens were measured. Herring larvae were measured from the end of mandible to the end of caudal peduncle to the nearest 1 mm.

Depending on the body length the larvae were divided into 3 length groups: below 10 mm, 10-15 mm, and 15-20 mm. The number of the larvae determined by length groups was outlined on the drafts and the resulting data were interpolated. The total larvae abundance was determined with the help of planimeter.

III. Survey results

During the first ichthyoplankton survey (75-2), carried out from September 9, 1975, a total of 506 herring larvae was caught. The bulk of the larvae was mainly located along the northern slopes of Georges Bank (fig. 3). Maximum number of larvae was discovered on the northern Georges Bank (Station No. 85), where their density constituted 17 specimens under 10 m² at the average length of 6.5 mm. In the south-eastern, southern and western parts of Georges Bank the larvae occurred

individually with the average length of 15.3 mm (fig. 4, 5, 6). Generally in the Georges Bank area the average larvae length varied from 5 to 18 mm at $M = 6.5$ (fig. 7,a). Probably the increase of larvae length at some stations confirms the clockwise direction of larvae migration caused by the currents, dominating on Georges Bank.

On the Nantucket Shoals the larvae were seen only at station No. 27, their density was 166 specimens under 10 m^2 at the body length of 5-7 mm. The availability of small, newly hatched larvae both on the Nantucket Shoals and on the northern slope of the Bank indicated that the spawning of herring occurred in the above regions.

During the second survey (75-3) which lasted from 17 to 30 October a total of 25369 larvae was caught. The largest larvae aggregations were observed on the Nantucket Shoals and in the northern Georges Bank area (fig. 8). The larvae body length varied from 5 to 19 mm in the survey area. The dominating length groups constituted:

- 1) for Georges Bank 10-12 mm at $M = 10.5$ mm (fig. 7,b)
- 2) for the Nantucket Shoals 6-9 mm at $M = 8.5$ mm (fig.7,c).

Assuming that the larvae growth rate was about 5-7 mm a month, it can be suggested that the spawning of herring on the Nantucket Shoals had occurred 10 days earlier, than in the Georges Bank area.

The analysis of the larvae quantitative distribution by length groups showed a slight south-westward drift of herring larvae from the spawning ground on the northern slopes of Georges Bank, and a north-eastward drift from the spawning ground around the Nantucket Island (fig. 9, 10, 11). Such pattern of larvae distribution can be explained by the influence of anticyclonic currents, developed on Georges Bank during the summer-autumn period. Resulting from such water circulation large larvae (body length of 15-20 mm) appeared in the centre of the eddy (fig. 11).

Determination of total herring larvae abundance in October 1975 revealed its increase in the Nantucket Shoals area approximately 1.5 times as compared with the Georges Bank area (total abundance on the Nantucket Shoals constituted 1.02×10^{12} specimens, and on Georges Bank 0.66×10^{12} specimens).

Zooplankton biomass

The areas of large aggregations of herring larvae (Nantucket Shoals and northern Georges Bank) coincided with the areas of largest seston concentrations, as is evident from fig. 12. Seston biomass over the most part of the area surveyed constituted from 50 to 100 g under 1 m^2 , but in the centre of larva aggregation on the northern Georges Bank (station No. 83) it was 162 g under 1 m^2 .

The bulk of zooplankton consisted of the following species: *Calanus finmarchicus*, *Paracalanus parvus*, Ova and Nauplii Copepoda, *Oithona similis*. The largest concentrations of *Calanus finmarchicus* with the abundance of 1-10 thous. specimens under 1 m^2 were seen eastward of Cape Cod in the herring spawning grounds, but this species was not found in the central part of Georges Bank (fig. 13). Large concentrations of *Paracalanus parvus* (100 thous. specimens under 1 m^2) were observed in the central part of Georges Bank and on the Nantucket Shoals (fig. 14). The distribution of the species coincided with the direction of herring larva drift. Most considerable aggregations of *Centropages* Spp. were located in the central and northern parts of Georges Bank (850 thous. specimens at St. No. 64) as well as southward of the Nantucket Island (fig. 15). Maximum numbers of *Oithona similis* (over 300 thous. sp. under 1 m^2) were observed around the Cape Cod peninsula (fig. 16). Ova and Nauplii of Copepoda were distributed comparatively evenly over the whole Georges Bank area. The larva and egg concentrations of Copepoda numbering over 500 thous. sp. under 1 m^2 were located within the 100-meter isobath and coincided with the herring larva aggregations (fig. 17).

Thus, the location of herring larva maximum concentrations in October 1975 coincided with the seston biomass, where the main food objects for the larvae dominated. In the areas of low zooplankton concentrations no herring larvae were observed, therefore, during the studied period the herring larvae found more or less favourable trophic conditions for further development.

The main zooplankton concentrations, as well as those of herring larvae were developing under the influence of anti-cyclonic currents.

Conclusions

1. Herring larva distribution in the Georges Bank area in general was similar to that in the previous years.
2. Unlike the previous years, in October 1975 the 1.5 fold increase of the total larva abundance was observed on the Nantucket Shoals as compared with Georges Bank.
3. In October 1975 maximum aggregations of herring larvae coincided with the areas of the largest seston and Copepoda Nauplii biomass, which are the main food for herring larvae.

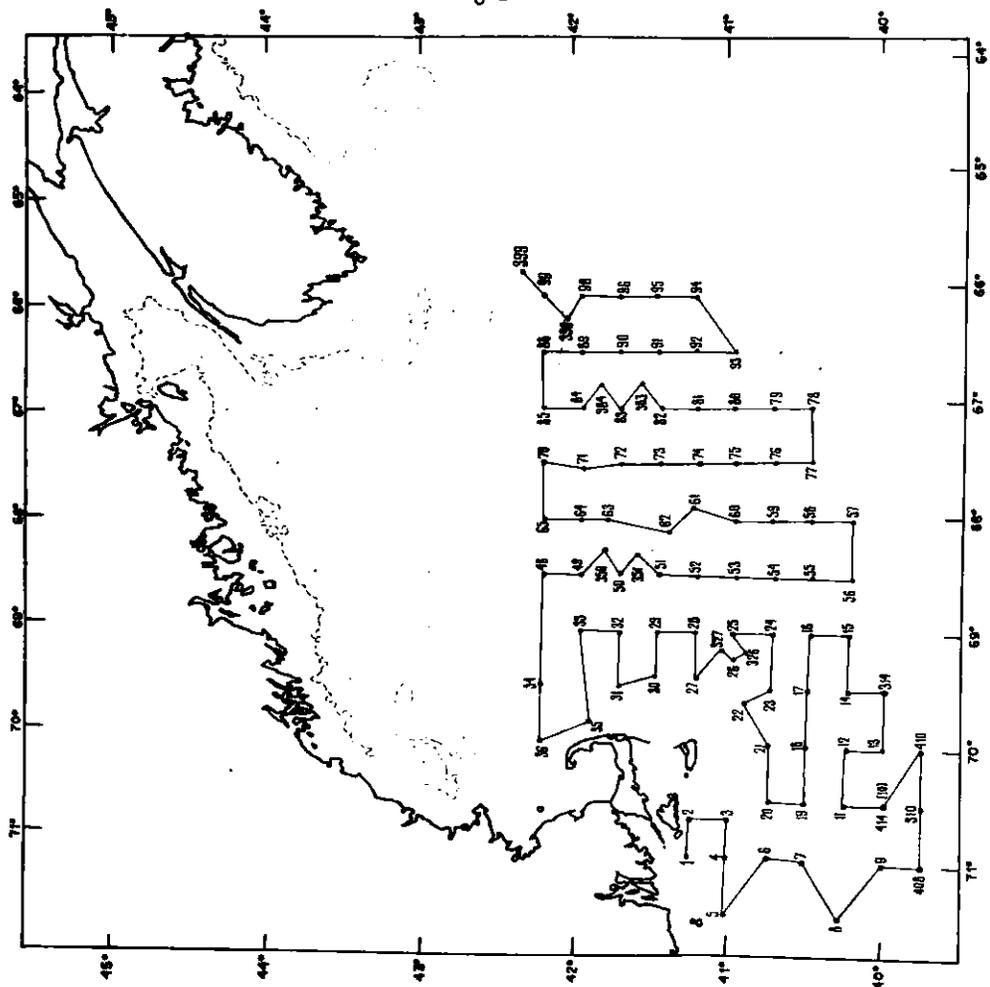


Fig. 2. Grid of stations for herring larva survey, cruise 75-3.

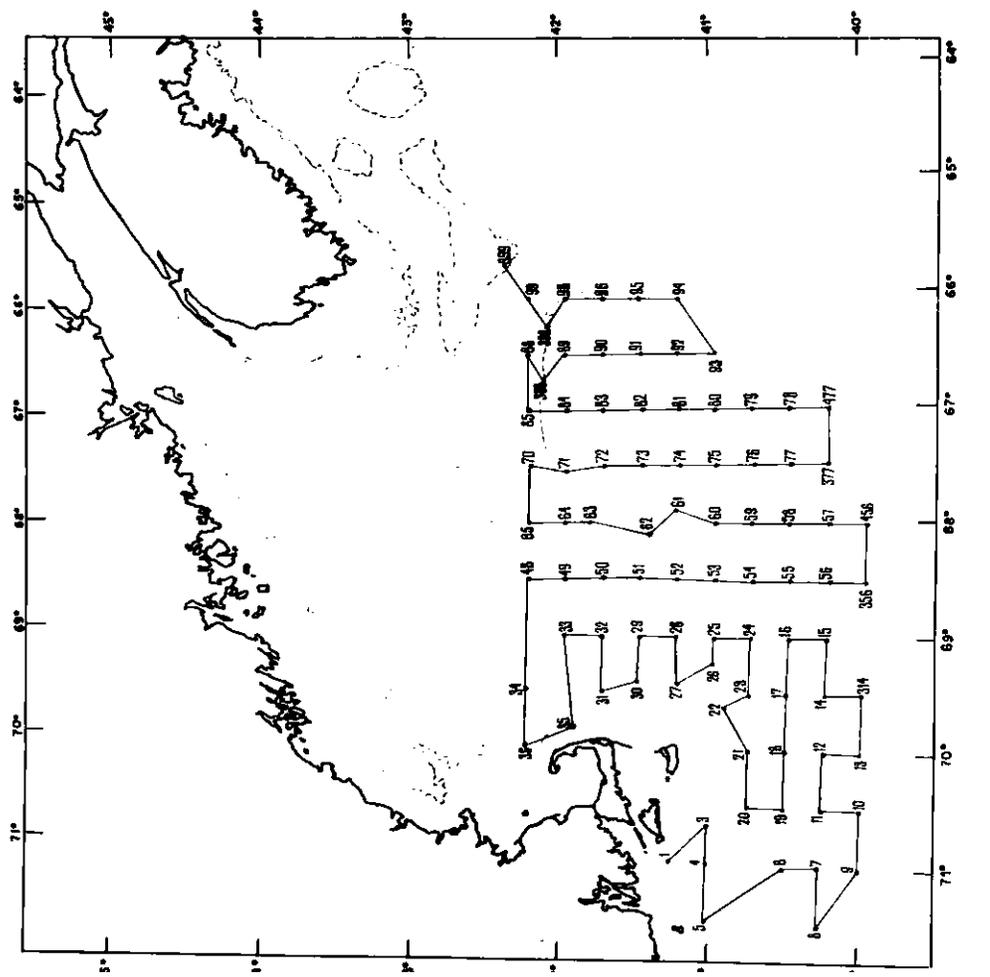


Fig. 1. Grid of stations for herring larva survey, cruise 75-2.

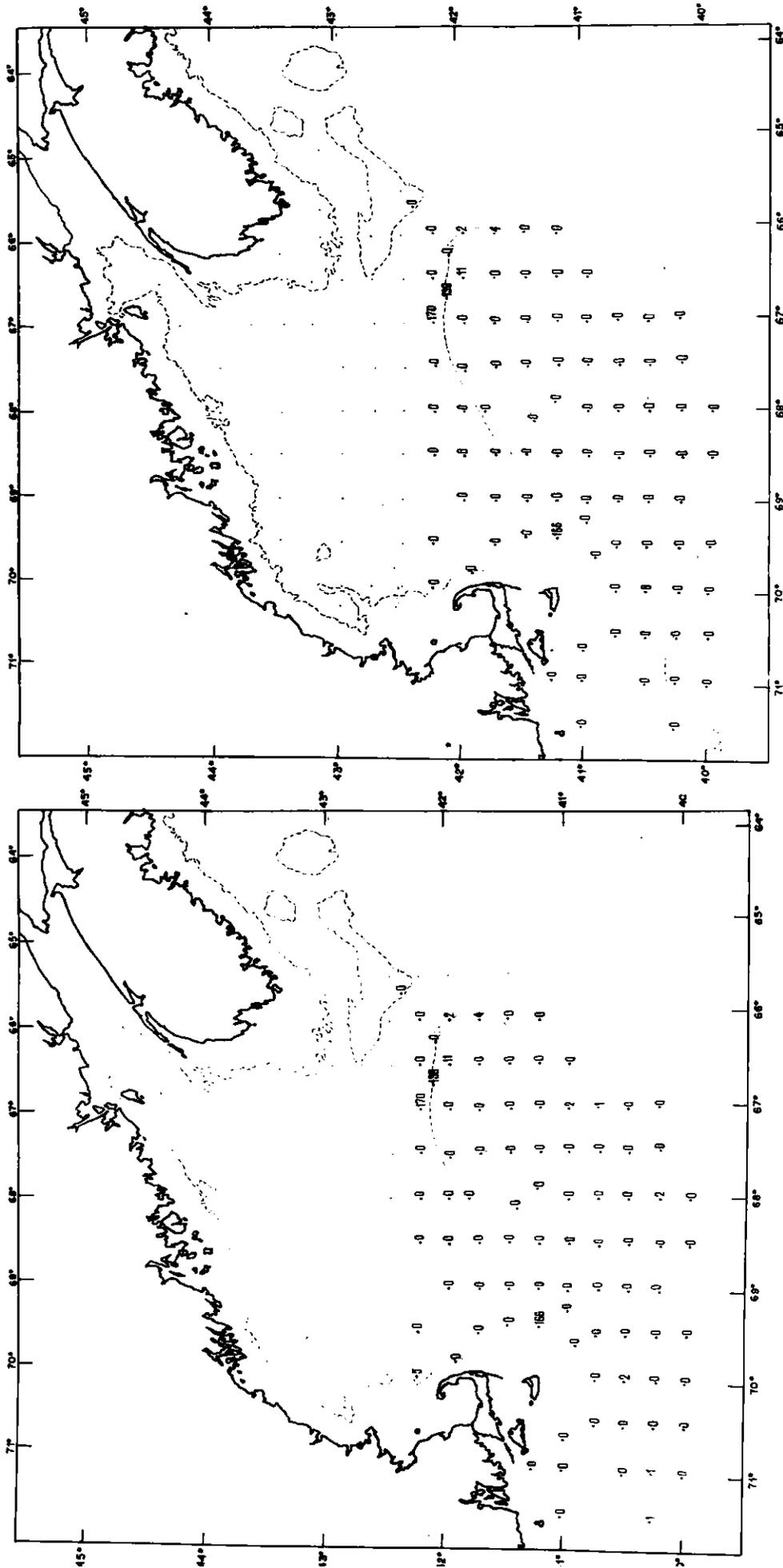


Fig. 3. Distribution and abundance of herring larvae in September-October 1975.

Fig. 4. Distribution and abundance of herring larvae below 10 mm in September-October 1975.

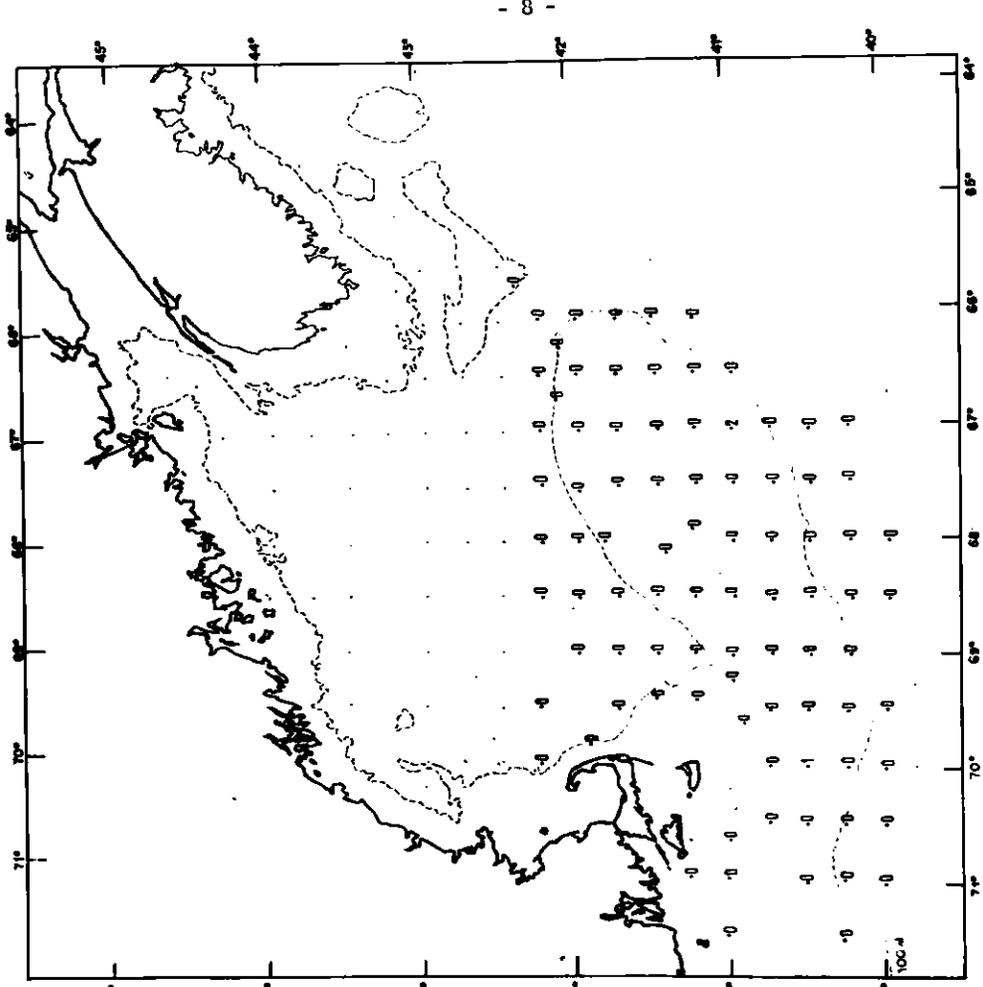


Fig. 6. Distribution and abundance of herring larvae from 15 to 20 mm in September-October 1975.

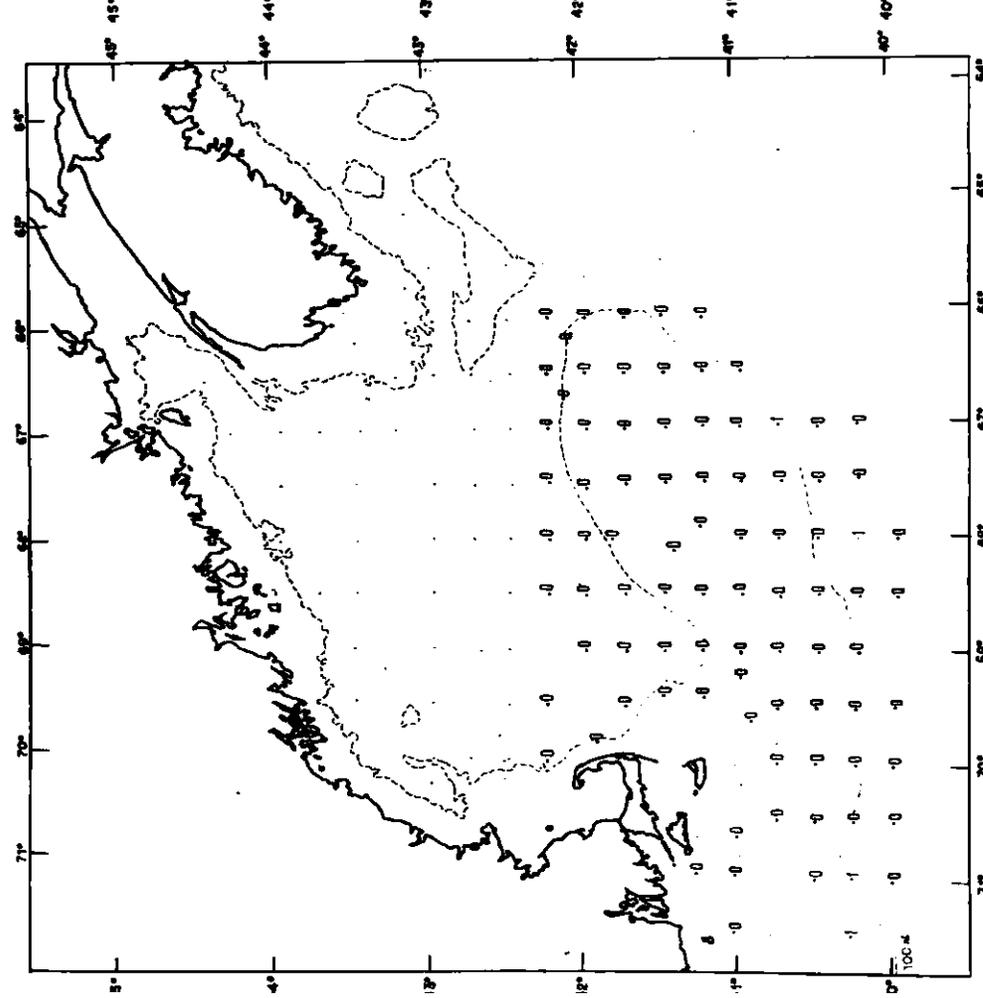


Fig. 5. Distribution and abundance of herring larvae from 10 to 15 mm in September-October 1975.

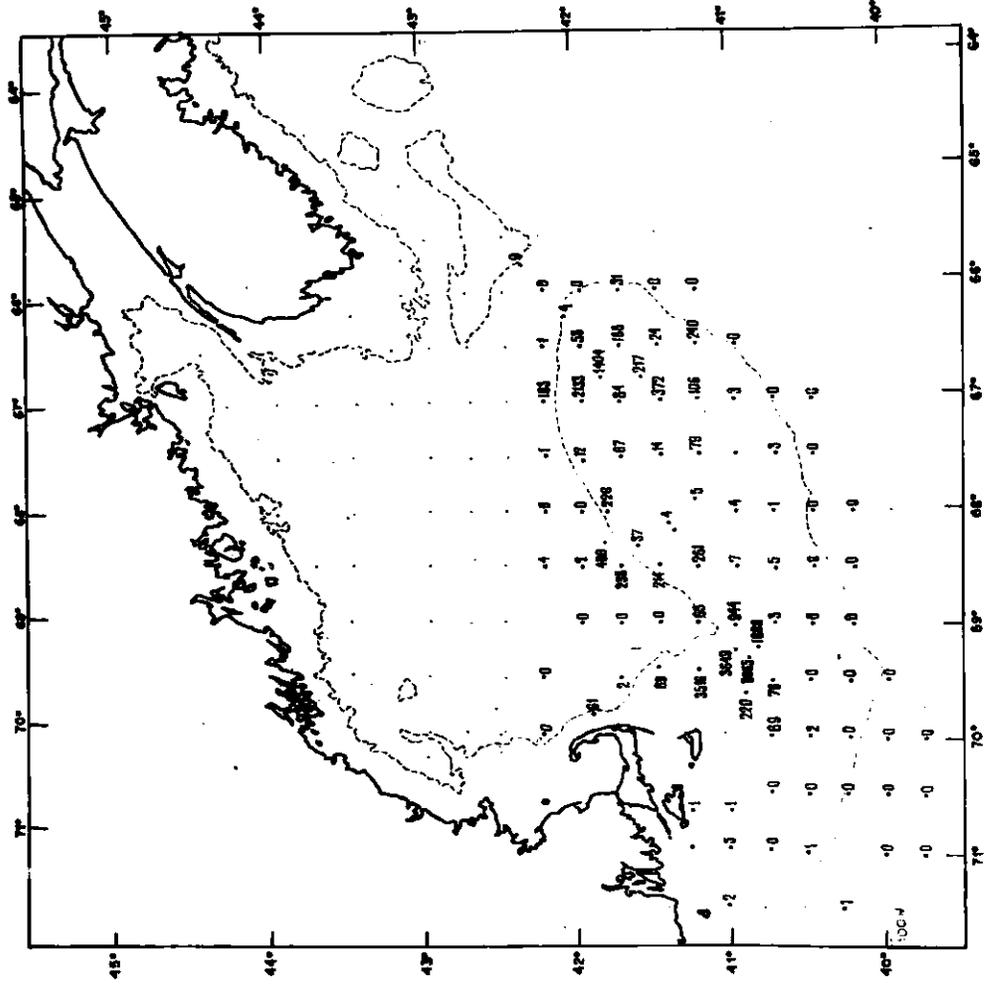


Fig. 8. Distribution and abundance of herring larvae in October 1975.

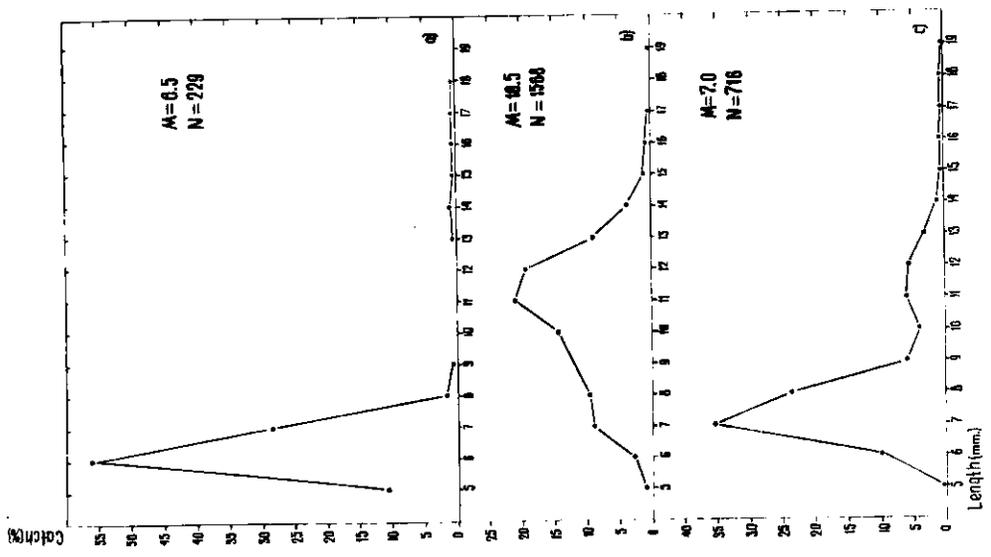


Fig. 7. Size composition of herring larvae.
 a) on Georges Bank in September-October 1975.
 b) on Georges Bank in October 1975.
 c) on the Nantucket Shoals in October 1975.

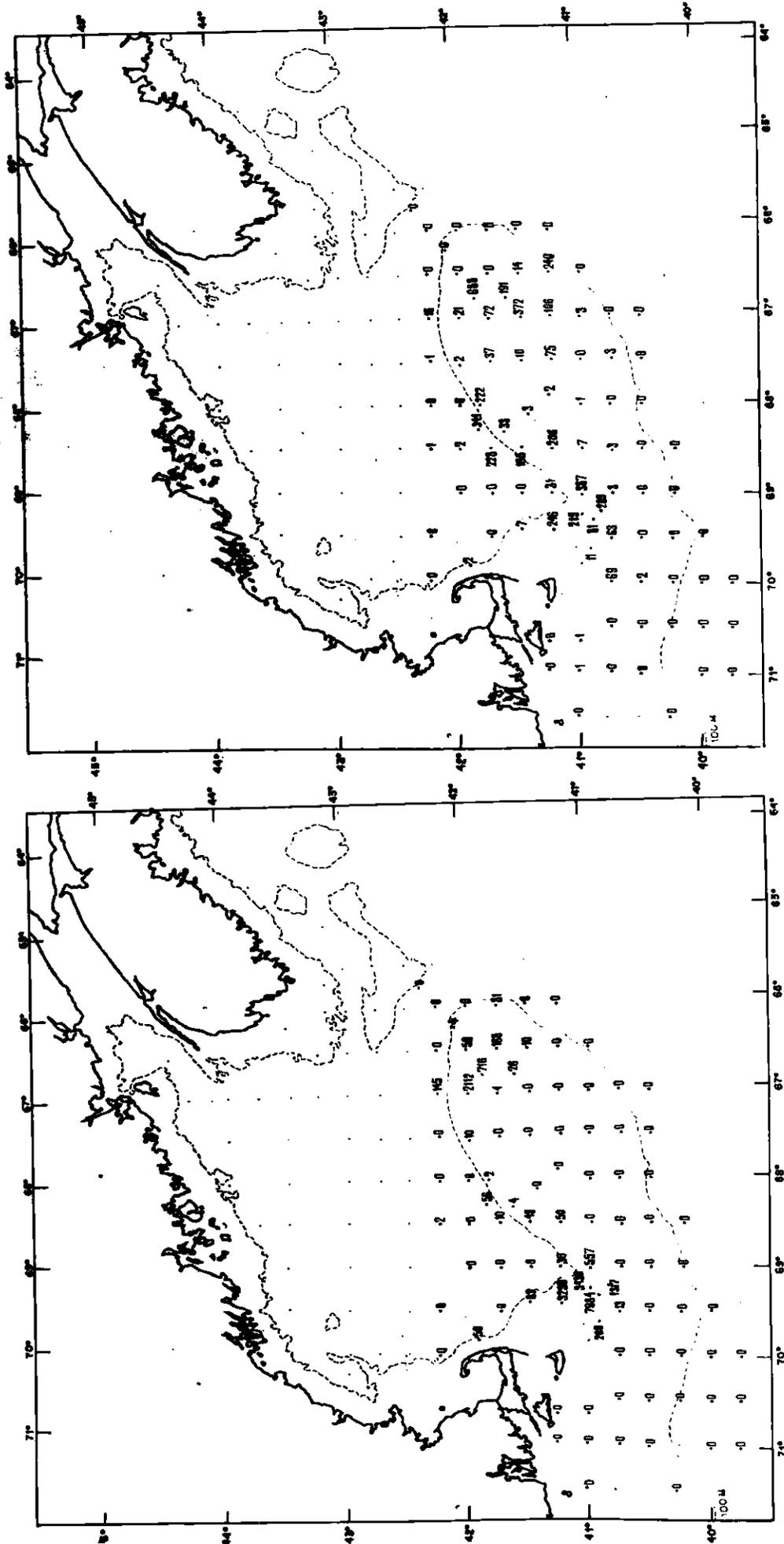


Fig. 9. Distribution and abundance of herring larvae below 10 mm in October 1975.

Fig. 10. Distribution and abundance of herring larvae from 10 to 15 mm in October 1975.

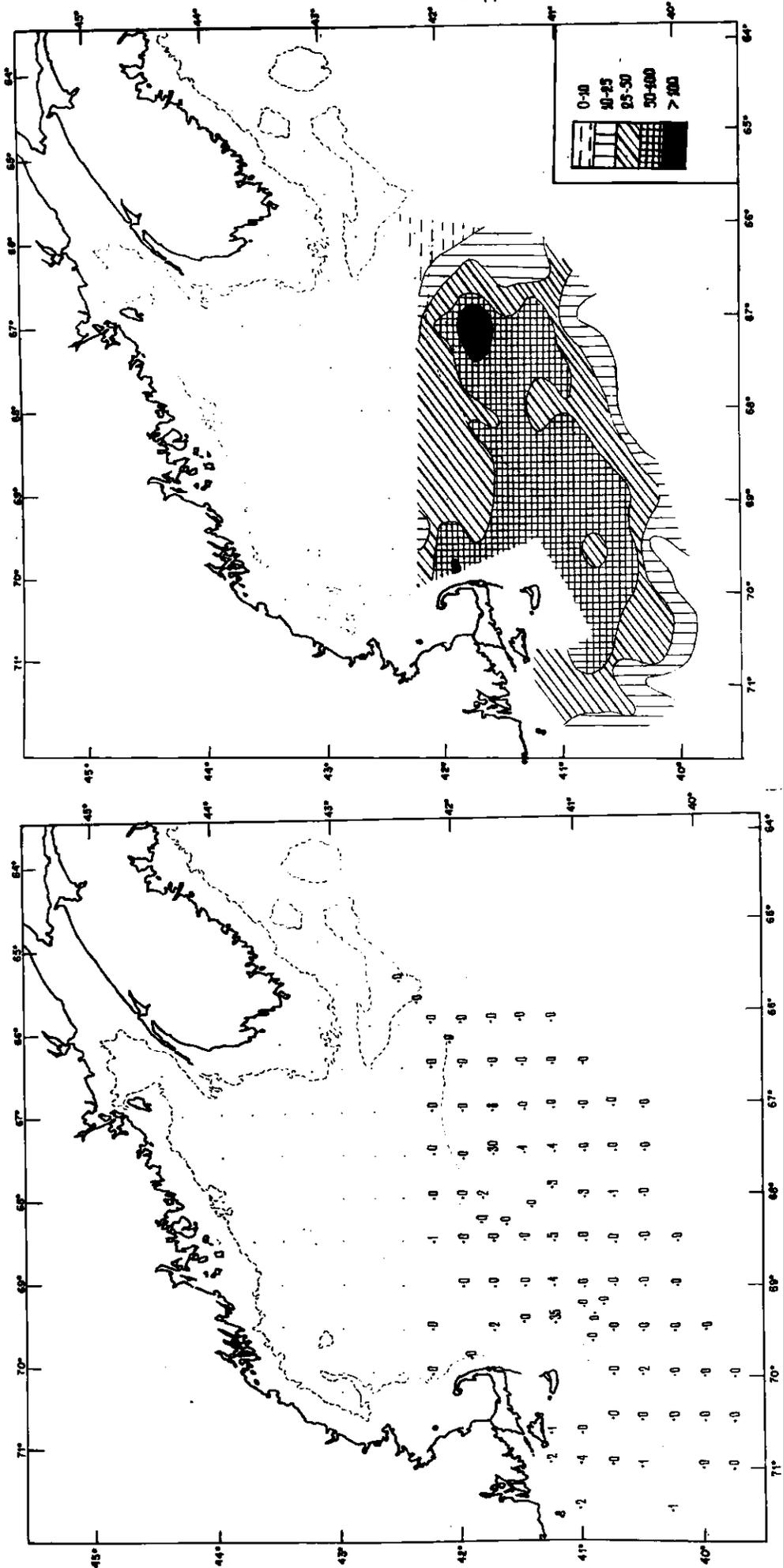


Fig. 11. Distribution and abundance of herring larvae from 15 to 20 mm in October 1975.

Fig. 12. Distribution and abundance of seston in October 1975.

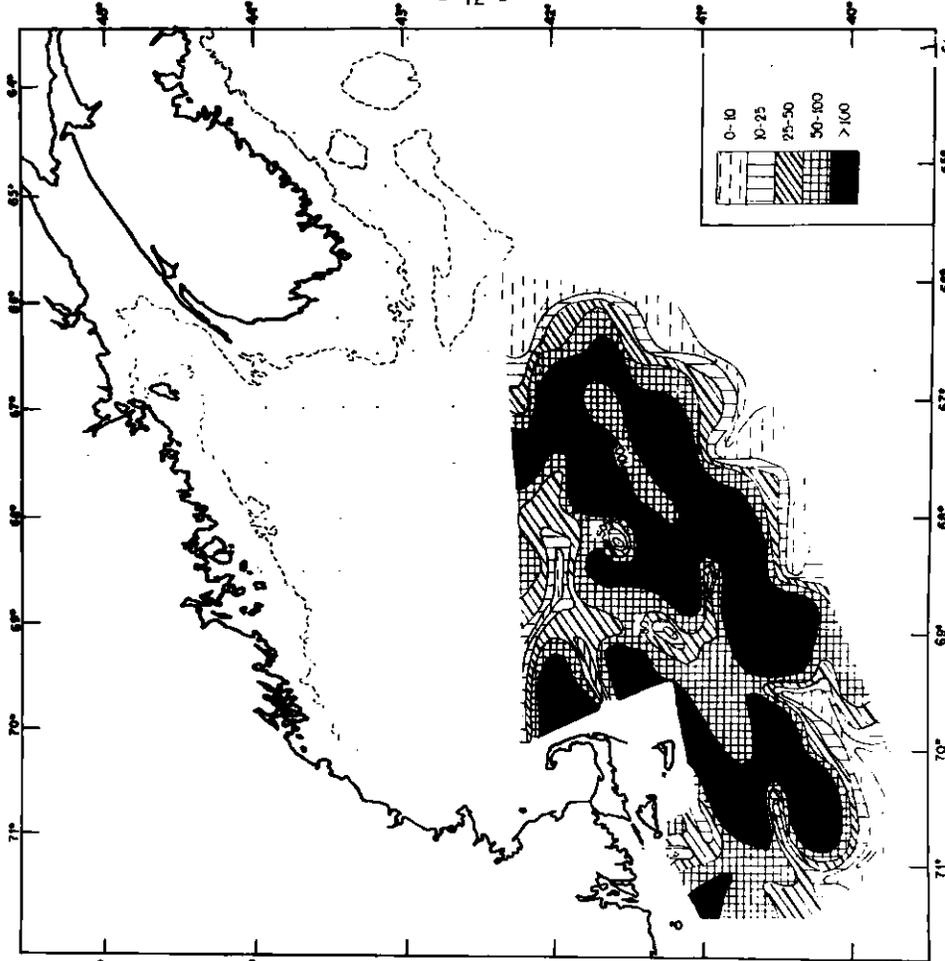


Fig. 14. Distribution and abundance of *Panacalanus parvus* in October 1975.

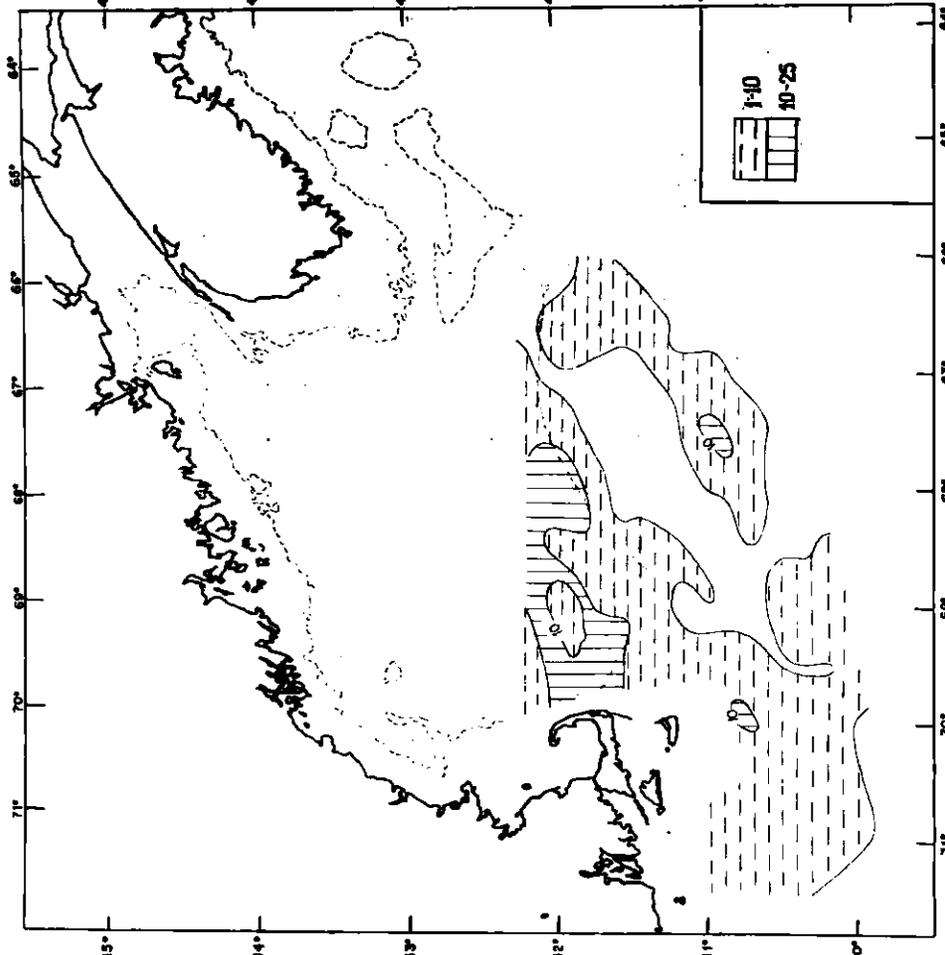


Fig. 13. Distribution and abundance of *Calanus finmarchicus* in October 1975.

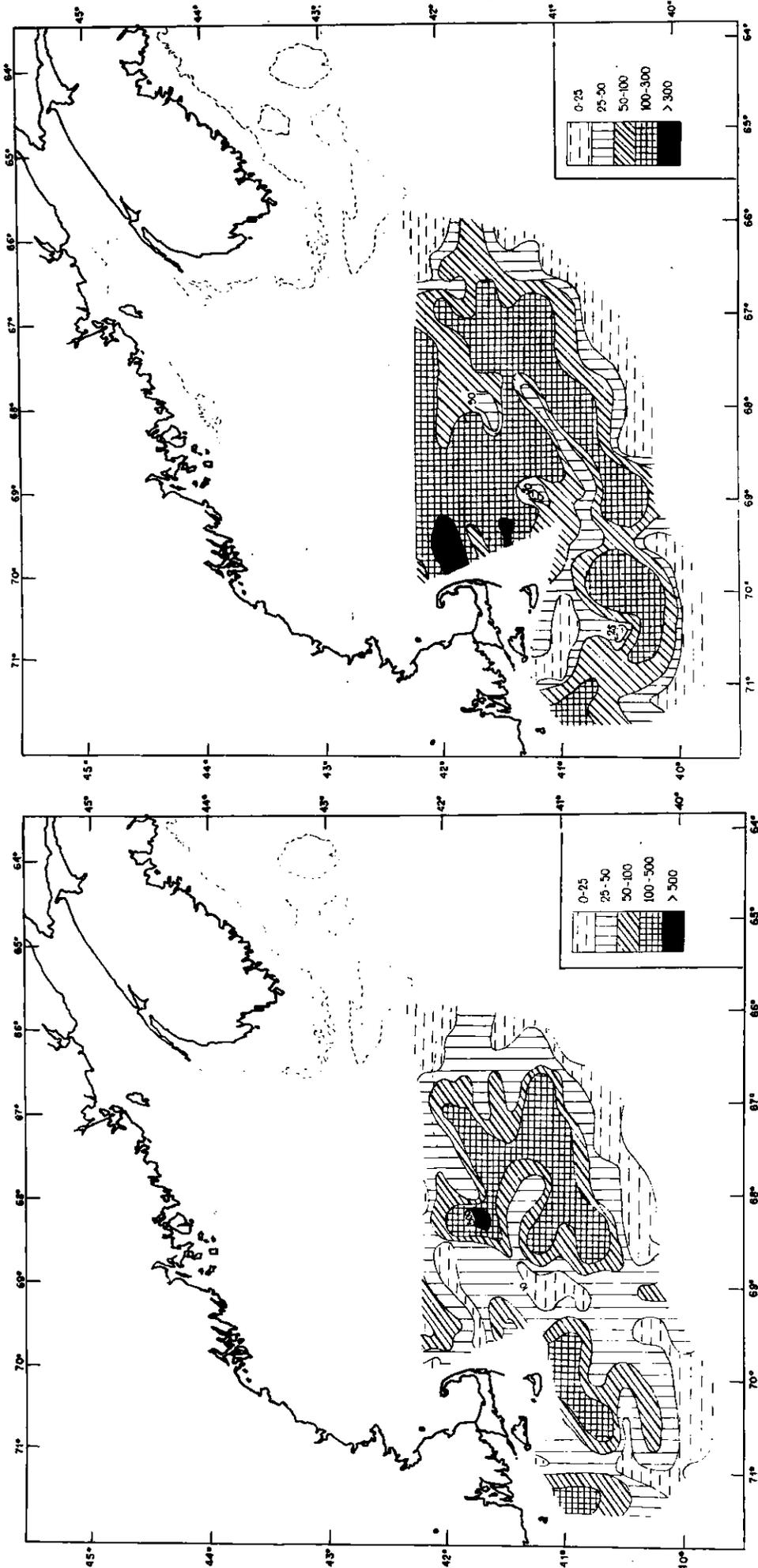


Fig. 15. Distribution and abundance of *Centropages* spp. in October 1975.

Fig. 16. Distribution and abundance of *Oithona similis* in October 1975.

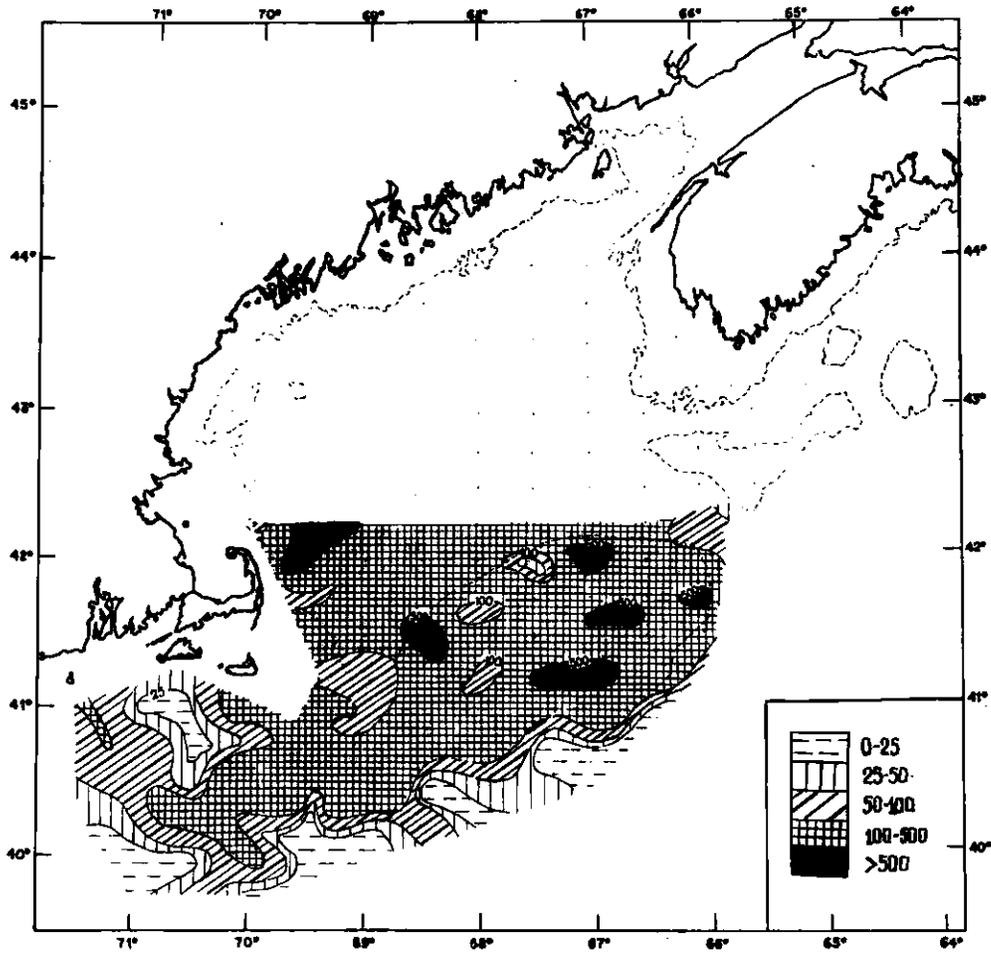


Fig. 17. Distribution and abundance of *Ova* and *Nauplii Copepoda* in October 1975.