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DISTRIBUTION AND ABUNDANCE OF LARVAL HERRING, CLUPEA HARENGUS HARENGUS LINNAEUS, OVER EGG BEDS ON GEORGES BANK

by

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INTRODUCTION

This is a preliminary report of a cooperative cruise (U.S., Canada and the U.S.S.R.) to survey the distribution of herring eggs on Georges Bank (Sept. 24 - Oct. 6, 1970).1/ During the cooperative survey, each country contributed an important component of the operation. The U.S.S.R. located and mapped the distribution of two adjoining egg beds on the northeastern part of Georges Bank and placed a buoy on them prior to the operations. The Canadians provided a submersible, Pisces I, for observations of the egg bed. The U.S. provided a mother-ship for the Canadian submersible, confirmed the location of the egg beds, positioned the submersible for its dives, and conducted a survey of larval herring hatched from the egg bed. Representatives from each nation made dives aboard the submersible.

Soviet scientists will report on the egg beds surveyed with conventional gear and the Canadians will report on the results with their submersible. This paper is concerned with larval herring captured during the cruise and their association with the egg beds.

MATERIALS AND METHODS

Samples of eggs were obtained from the bottom with a Naturalist Dredge and a Smith-McIntyre grab sampler. The grab sampled an area of 0.5 $m.^2$. The dredge was fished in waters approximately 26 fms. for five minutes by permitting the drift of the vessel to drag the dredge over the bottom. When eggs were obtained in the dredge, the grab was lowered over the side and the bottom sampled further. The dredge was towed 21 times and the grab was lowered 9 times. The quantity of eggs in the sample was expressed relatively as light, medium and heavy. A light catch referred to eggs scattered within the gravel or cobble; a medium catch contained small clumps (about 1 $cm.^2$ or less); and a heavy catch contained larger clumps. Eggs were preserved in 3% buffered formalin for examination in the laboratory.

1/ We wish to thank the Canadian and Soviet scientists for their cooperation and consideration during the cruise.

Two pairs of Bongo sampling nets[2] were used to capture larval herring. A large pair of Bongo samplers was mounted on the towing wire above a depressor and a smaller pair was mounted 28 inches (71 cm.) below it. The nets of the small Bongos had a mouth diameter of 8 inches (20 cm.) and those of the larger Bongos had a mouth diameter of 24 inches (61 cm.). The smaller pair had mesh openings of .253 mm. and .366 mm. in diameter and the larger pair had mesh openings of .333 mm. and .505 mm. in diameter. A single meter was installed in one net to determine the distance towed in meters and the volume of water strained was calculated by multiplying this distance by the cross sectional area of the mouth of a given net to obtain cubic meters of water strained during a tow. The catch was expressed as the number of larvae captured per 100 cubic meters of water strained during a given tow. The gear was towed at 5 knots for 15 minutes in a staggered oblique sequence with 5 minutes each at depths of 30, 20 meters and the surface. These depths were changed to 20, 10 meters and the surface when the scientist on watch believed the nets might contact the bottom. Towing stations varied from 17 to 144 fms. in depth. Seventy plankton stations were occupied, most during darkness. To facilitate counting, 10 samples were split in half, 5 into fourths and 1 into an eighth; the total number of larvae in a given sample was estimated from the split portions. For the purposes of this report, only larvae from the catch of one small mouthed net with a mesh opening of .366 mm. have been examined.

RESULTS

Bottom Sampling

Although samples obtained with the dredge and grab sampler were sufficient to place the submersible on the egg beds, only 5 of the 30 samples collected contained eggs. Two samples had light amounts of eggs on September 26 and one had medium and two had heavy amounts of eggs on September 27. No eggs were found in samples taken during September 29 and October 1 and 2. The largest clump of eggs was 15 $cm.^2$ and 5.2 cm. thick.

Hatching

Hatching from the egg beds apparently began before the U.S. vessel M/V *Albatross* arrived on September 26. The sparsity of eggs collected from the bottom suggested that there were fewer eggs on the beds than there were during the prior Russian survey. Hatching was completed before October 6 when dives by the submersible, *Pisces I*, found the egg beds to be in a decayed condition. At this time samples brought to the surface by the submersible contained only a few eggs and these and the residual material were putrified.

The number of yolk sac larvae in the samples also suggested a decline in hatching. Eggs obtained from the bottom on September 27 began to hatch when placed in seawater aboard the *Albatross*. The following day the largest percentage (10.4%) of yolk sac larvae were obtained in a plankton sample from the vicinity of the beds (Fig. 1). On September 30 the largest percentage was 8.8%, by October 1 it was 4.7% and decreased to 0.7% on October 2. The vicinity of the beds was again sampled on October 5 and at that time no yolk sac larvae were obtained.

Larval Catch

During the cruise 52,333 larval herring were captured. These fell into two size groups, one of small larvae with a mode at 7 mm. and the other with a mode at 13 mm. (Fig. 2). Of the total larvae taken there were 49,996 in the small mode and 2,737 in the large mode. The two groups were well separated with only a few larvae in the 10 mm. length between them. The catch rate of the smaller larvae averaged 131 per 100 $m.^3$ and ranged from 0 to 1,167 per 100 $m.^3$. For the larger larvae the average catch was 42 per 100 $m.^3$ with a range of 0 to 96 per 100 $m.^3$.

2/ Posgay, J. A., R. R. Marak, and R. C. Hennemuth. 1968. Development and test of new zooplankton samplers. Int. Comm. Northwest Atl. Fish. Res. Doc. 68-34, 7 pp.

Larval Distribution

The distribution of the two size groups was similar in that the larvae were very abundant near the location of the egg beds and extended southerly from them (Fig. 1). However, the distribution of the larger larvae was directed more to the southeast than the smaller larvae. The location of the two catches of larger larvae in the northwest area of the grid suggests either a discontinuity in their distribution or another group of larvae to the west of our sampling area.

Environment

The egg beds were located in an area of complex temperature and salinity distribution (Fig. 3). At the surface, a tongue of colder (14°C.) and more saline (32.15 o/oo) water extended westward into the survey area. At middepth and at the bottom, a body of warm water was especially evident in the southwestern portion of the survey area. Bottom temperatures in the vicinity of the egg beds at about 27 fathoms (48 m.) varied from 13 to 15°C.

DISCUSSION

Source

The presence of yolk sac larvae in the vicinity of the egg beds and the decline in hatching suggests that the larvae with a mode at 7 mm. length originated from these beds. There is some doubt as to the origin of the larger size group. This group, with a modal length of 13 mm., might also have originated from the same egg beds because there is a resemblance between their distribution in the survey area and that of the small size group. However, such similarity might be related to the distribution of currents in the area rather than to the location of particular egg beds.

Growth

Sampling was not sufficiently repetitive to obtain a measure of growth for larvae from the entire survey area, but a measure of short term growth was obtained from larvae captured in the vicinity of the egg beds on October 1 and 5. The size frequencies of larvae from these samples showed an increase in larval length averaging 4 mm. in 4 days. The shift in length frequency was probably retarded little by the addition of newly hatched larvae. The average percentage of larvae bearing yolk sacs was only 2.1 and was less the following day. However, the increase in growth should be considered minimal because those larvae that were larger and older were exposed longer to the severities of the environment. Thus, some selection of these larger larvae through mortality might have reduced the frequencies at the larger sizes (8 and 9 mm.) recorded on October 5.

Mortality

Because the source of the larvae was known for the small size group, an estimate of mortality was made using data obtained on October 1 and 5 within the vicinity of the egg beds. Catch rates were determined for each larval length (Table 2). For October 1 the rates for larvae of 5 through 7 mm. length were summed (344.83 per 100 $m.^3$); and also for October 5 for larvae of 7 through 9 mm. length (64.66 per 100 $m.^3$). We calculated an instantaneous mortality rate as $N_t/N_o = e^{it}$ where N_o is the catch per unit effort in numbers per 100 $m.^3$ of water strained in a given time period and N_t is the catch per unit effort in numbers per unit effort t time periods later[3/]. Thus, the estimated mortality was the natural logarithm of the ratio of the summed rates for October 5 and 1, or 64.66/344.83 = 0.68 for the 4 days. We assumed that during the 4 days the effect of dispersion of larvae from the egg beds would not have a significant effect. On a given day 17% of the larval population were estimated to have died.

3/ Ricker, W. E. 1958. Handbook of computations for biological statistics of fish populations. Bull. Fish. Res. Bd. Can., 119: 300 pp.

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Table 1. Length frequencies of larval herring captured October 1 and 5.

Size mm.	October 1 %	October 5 %
5	1.0	0.2
6	8.8	3.1
7	66.6	49.9
8	22.8	44.1
9	0.8	2.7
No.	479	517

Table 2. Catch rates for length frequencies of larval herring captured on October 1 and 5.

Size mm.	October 1 No./100m.^{3}	October 5 No./100m.^{3}
5	3.53	0.13
6	36.66	2.28
7	304.64	34.78
8	70.31	28.05
9	1.19	1.83
No.	11,912	2,802

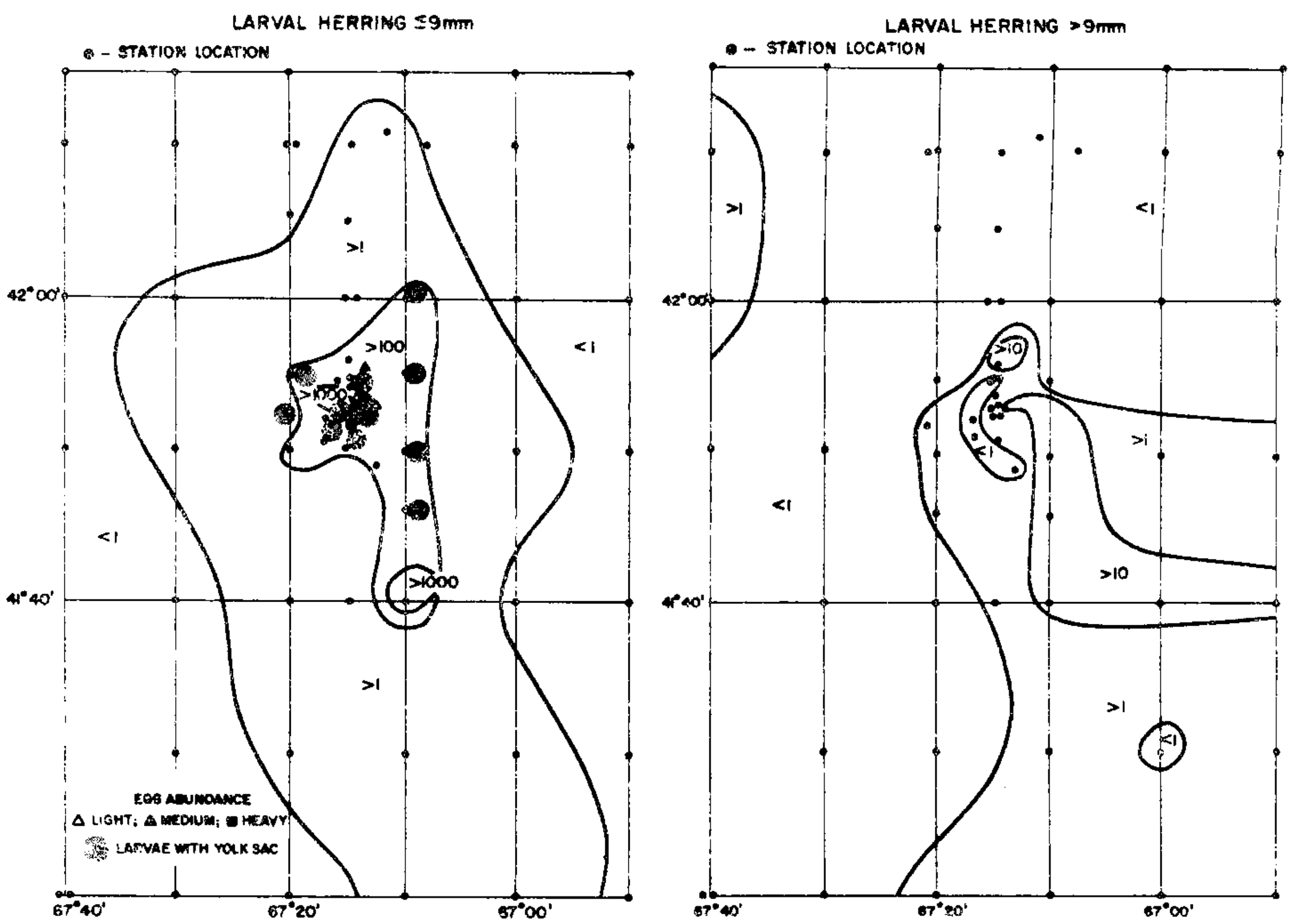

Figure 1. Catch distributions of the two size groups of larval herring (≤9 mm. and >9 mm.) during the survey.

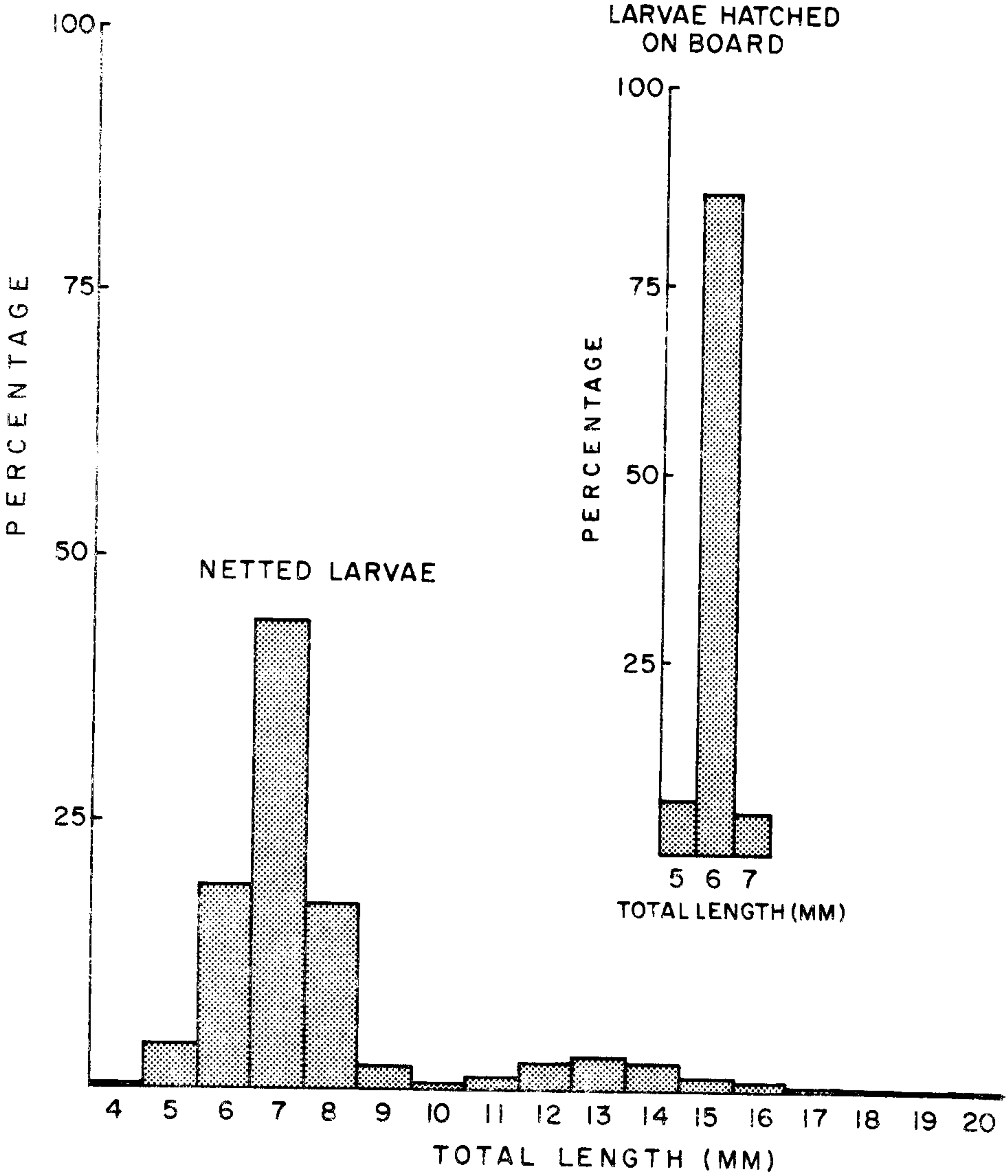

Figure 2. Length frequency distributions of larval herring captured in plankton nets and hatched aboard the Albatross (insert).

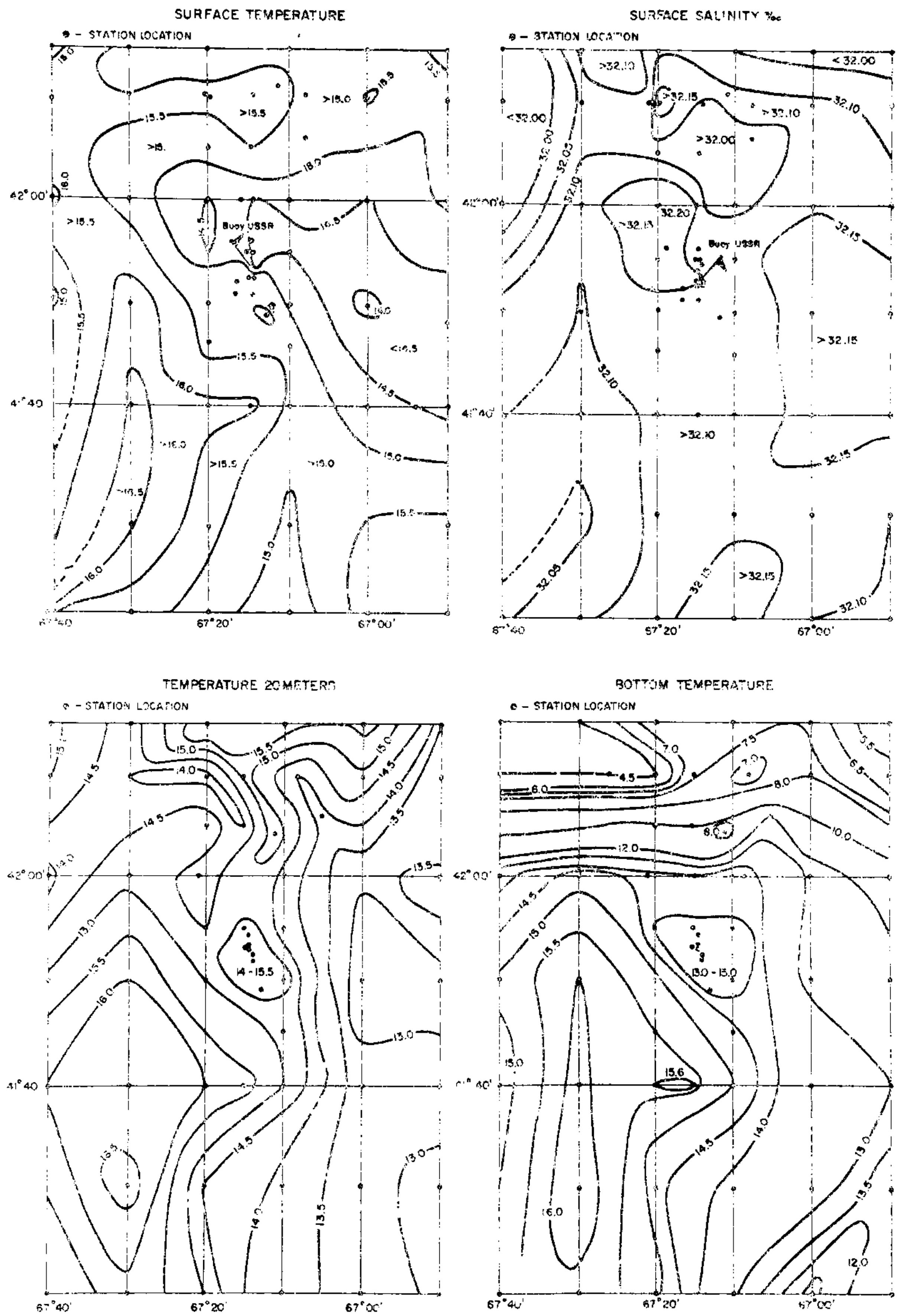

Figure 3. Distributions of temperatures (°C) at the surface, 20 meters, and the bottom, and salinity o/oo at the surface, during the larval herring survey.