NORTHWEST & ALASKA FISHERIES CENTER PROCESSED REPORT

ICHTHYOPLANKTON OF THE EASTERN BERING SEA

11 FEBRUARY TO 16 MARCH 1978

by
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ABSTRACT

An ichthyoplankton survey was conducted during February and March, 1978 to define the time at which walleye pollock (Theragra chalcogramma) begin to spawn in the eastern Bering Sea. Between 11 February - 16 March 1978 plankton was collected at 32 stations between latitude 54°-60°N and longitude 164°-177°W with neuston and bongo nets. Bongo samples contained 97% of all eggs and neuston samples 93% of all larvae. Pollock eggs in stages of development ranging from early to late were collected at 16 stations with a catch of 2,259 pollock eggs, or 99.6% of the total egg catch. A sample from one station at latitude 54°49.7'N, longitude 167°50.2'W contained over 83% of all pollock eggs. About 96% of the larval fish caught were sculpins (Hemilepidotus sp.), greenling (Hexagrammos sp.), and Atka mackerel (Pleurogrammus monopterygius). Results of the survey indicate that pollock began spawning by the first of March but spawning activity was not wide-spread as of the middle of March when the survey was completed.

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ICHTHYOPLANKTON OF THE EASTERN BERING SEA

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I. INTRODUCTION

Studies of ichthyoplankton from the eastern Bering Sea have been conducted by Soviet, Japanese, and U.S. scientists during the past 25 years. A major objective of these surveys has been to define the times and areas in which eggs and larvae of commercially valuable fish are present. Walleye pollock (Theragra chalcogramma), usually referred to as pollock, has contributed a major part of the catch of the Soviet and Japanese fishing fleets during the past decade, and because of its abundance is important in the total ecology of the eastern Bering Sea.

Serobaba (1968) reported that pollock spawn during late winter and spring with an apparent peak of spawning activity during late April and early May. During a survey conducted by Soviet scientists in 1965, pollock eggs were found as early as February 27 and other isolated eggs on the 9th and 12th of March, but eggs were not abundant until late March (Serobaba 1968). Other surveys for which there are published reports did not include sampling in February or early March. Waldron and Favorite (1977) and Waldron and Vinter (1978) reporting on surveys made in the southeastern Bering Sea during late April and May of 1976 and 1977, indicated that pollock eggs were more abundant in late April than in mid-April or early May. In mid-April 1977 the larvae of pollock were abundant with catches of $200/m^2$ to over $500/m^2$. With observed surface water temperatures of 2-4°C incubation time would be about 3 weeks, indicating that there had been extensive spawning activity prior to the 1st of April and probably as early as mid-March.

It was not possible to schedule an extensive ichthyoplankton survey during the winter of 1978, but there was an opportunity to carry out plankton sampling as a secondary objective during an adult fish survey in the Bering Sea. It was hoped that this sampling would more closely define the beginning of pollock spawning in the eastern Bering Sea.

II. AREA AND METHODS

A. Station pattern

Plankton was collected during Legs I, II, and III of cruise MF 78-1 of the National Oceanic and Atmospheric Administration (NOAA) vessel *Miller Freeman*. The primary mission durings Legs I and II was a survey of herring resources of the Bering Sea, with plankton collection as a secondary mission carried out on an opportunistic basis, while Leg III consisted of 6 days during which plankton sampling was the primary mission.

Durings Legs I and II, from 11 February - 9 March, samples were collected at one station south and 10 stations north of the Pribilof Islands at widely scattered locations; and during Leg III, from 10-18 March, samples were collected at 21 stations in a regular grid south of the Pribilof Islands (Figure 1, Table 1). Stations 1 and 23, which were separated by less than a kilometer, are the only stations which can be compared on a time basis.

B. Methods

Two types of samples were collected during the survey, (a) an integrated sample from the surface to near bottom or to a nominal depth of 200 meters in deep water collected with bongo nets, and (b) a surface sample nominally from the upper 0.15 meters collected with a neuston net. Field and laboratory equipment, methods and procedures were the same as those described by Waldron and Vinter (1978) except as noted below.

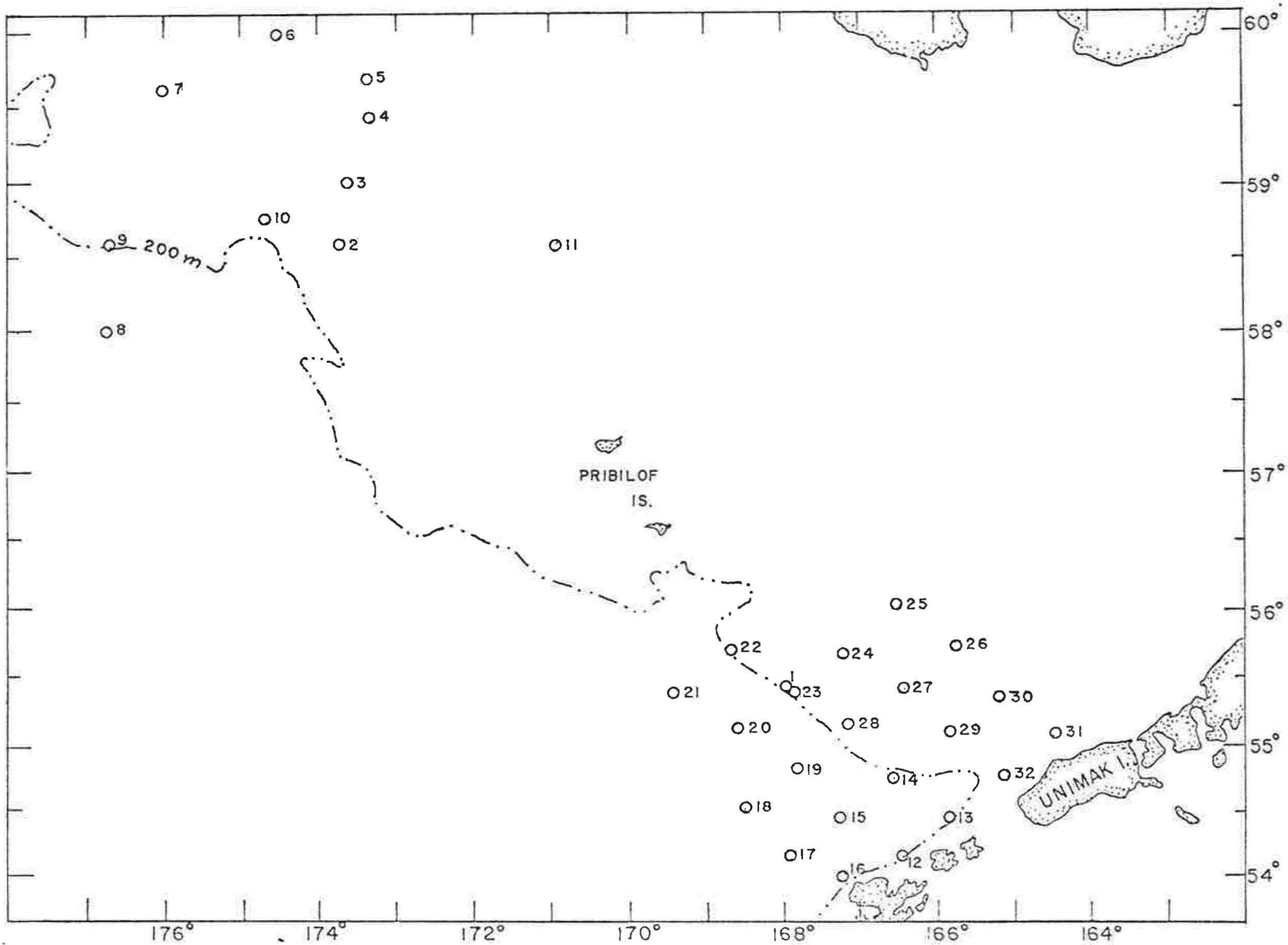

Figure 1.--Station locations in the eastern Bering Sea for Miller Freeman cruise MF 78-1, Legs I-III, 11 February-16 March 1978.

Table 1.--Station data from cruise MF 78-1 Legs I - III, Miller Freeman
11 February -16 March 1978

Sta. No.	Position Lat. N. °	'	Long. W. °	'	Date/ time	Nets used 1/	Standard haul factors 2/ Bongo A	Bongo B	Neuston A	Neuston B
					February					
1	55	25.7	167	56.1	11/2145	N B	6.465	4.14	.029	19.06
2	58	35.7	173	40.9	13/1020	N B	5.767	4.47	.038	25.31
3	59	00.3	173	36.2	14/2045	N B	8.476	7.50	.027	18.30
4	59	26.5	173	17.1	15/1825	N B	6.057	6.31	.028	18.49
5	59	43.0	173	24.0	16/1227	N B	5.606	5.84	.035	23.24
6	59	58.0	174	33.0	17/0234	N B	6.120	5.72	.029	19.00
7	59	37.9	175	28.6	17/2142	N B	5.727	4.27	.030	19.85
8	57	59.2	176	43.8	27/0752	N -	-	-	.023	15.48
9	58	35.8	176	38.8	28/0506	N -	-	-	.022	14.53
10	58	44.3	174	38.8	28/1803	N -	-	-	.026	17.24
					March					
11	58	33.2	170	58.4	3/0655	N B	6.034	8.27	.037	24.59
12	54	10.3	166	27.2	11/0822	N B	6.377	2.95	.018	11.99
13	54	27.0	165	48.4	11/1225	N B	4.506	2.35	.020	13.26
14	54	45.7	166	34.7	11/2302	N B	6.064	2.76	.020	13.34
15	54	27.3	167	16.3	12/0255	N B	6.038	2.85	.016	10.79
16	54	00.0	167	14.6	14/0026	N B	4.252	2.34	.017	11.30
17	54	08.3	167	52.8	14/0412	N B	5.379	2.57	.016	10.41
18	54	32.0	168	29.2	14/0946	- B	5.980	2.73	-	-
19	54	49.7	167	50.2	14/1727	N B	5.158	2.47	.020	13.56
20	55	07.1	168	34.8	14/2256	- B	6.340	2.92	-	-
21	55	25.0	169	25.3	15/0336	N B	5.450	2.65	.018	11.68
22	55	43.3	168	39.8	15/0737	N B	5.494	4.26	.017	11.51
23	55	24.7	167	50.2	15/1121	N B	4.876	3.17	.021	13.85
24	55	42.7	167	12.5	15/1449	N B	5.181	3.99	.021	13.90
25	56	01.0	166	31.2	15/1826	N B	6.075	5.06	.014	9.61
26	55	44.6	165	45.5	15/2143	N B	6.151	5.35	.018	11.76
27	55	25.4	166	26.0	16/0053	N B	6.176	4.68	.017	11.57
28	55	08.7	167	08.6	16/0421	N B	5.791	4.05	.015	10.11
29	55	06.4	165	50.1	16/0906	N B	5.817	4.77	.016	10.86
30	55	22.2	165	12.2	16/1222	N B	5.563	5.25	.018	12.14
31	55	05.3	164	27.7	16/1555	N B	4.757	9.71	.018	11.67
32	54	47.3	165	08.2	16/1929	N B	5.147	5.59	.018	11.67

1/ N designates neuston net; B designates bongo net.
2/ Standard haul factor A converts observed catch to catch per 10 m^2.
Standard haul factor B converts observed catch to catch per 1,000 m^3.

The neuston net differed in dimensions, and hence mouth area, from the Sameoto sampler (Sameoto and Jaroszynski 1969) used in 1977, being 0.50 m wide by 0.30 m high with an effective mouth area of 0.075 m^2 when the mouth was submerged to half its height. A further difference was that the neuston net was equipped with a flowmeter of the same type as that used in the bongo nets mounted inside and on the bottom of the sampler frame.

Processing of the samples and removal of fish eggs and larvae from the samples was done at the Seattle Laboratory of the Northwest and Alaska Fisheries Center rather than by contract as was done for samples collected during the spring of 1977.

The following definitions were added to those appearing in Waldron and Vinter (1978, p. 17):

—"Early" indicates an egg stage from fertilization to closure of the blastopore.

—"Middle" indicates an egg stage from closure of the blastopore to lateral flexion of the tail from the mid-line of the body.

—"Late" indicates an egg stage from lateral flexion of the tail to hatching.

As in Waldron and Vinter (1978), common and scientific names of fish mentioned in this report are those recommended by the American Fisheries Society (Bailey et al. 1970) and are listed in Table 2.

III. RESULTS

A. Eggs

The combined catch of the 30 neuston and 29 505-bongo net samples amounted to 2,267 fish eggs of which 2,206 (97%) were caught with the bongo net. Fish eggs were present in 14 (48%) of the 505-bongo and in 10 (33%) of the neuston samples.

Table 2.--List of scientific and common names of fishes.

Scientific name	Common name
OSMERIDAE	Smelts
Mallotus villosus	Capelin
BATHYLAGIDAE	Deepsea smelts
Bathylagus pacificus	Slender blacksmelt
Bathylagus schmidti	Northern smoothtongue
MYCTOPHIDAE	Lanternfishes
Protomyctophum thompsoni	Bigeye lanternfish[1/]
Stenobrachius leucopsarus	Lampfish
GADIDAE	Codfishes
Theragra chalcogramma	Walleye pollock or pollock
ZOARCIDAE	Eelpouts
HEXAGRAMMIDAE	Greenlings
Hexagrammos sp.	Greenlings
Pleurogrammus monopterygius	Atka mackerel
COTTIDAE	Sculpins
Hemilepidotus sp.	Irish lords
BATHYMASTERIDAE	Ronquils and searchers
STICHAEIDAE	Pricklebacks
Chirolophis polyactocephalus	Decorated warbonnet
CRYPTACANTHODIDAE	Wrymouths
Lyconectes aleutensis	Dwarf wrymouth
AMMODYTIDAE	Sand lances
Ammodytes hexapterus	Pacific sand lance

1/ Species not listed in Bailey et al. (1970). Common name from Hart (1973).

In the total catch of eggs 2,259 (99.6%) were identified as those of pollock and the remaining 8 (0.4%) could not be identified. Pollock eggs were collected at 16 of the 32 stations: 1,887 (83%) of the pollock eggs were caught at Station 19, and at only 2 other stations, Stations 16 and 20, were more than 100 eggs caught. The distribution of pollock eggs as defined by bongo samples is shown in Figure 2 and by neuston samples in Figure 3.

All pollock eggs were classified as being in an early, middle, or late stage of development, and the distribution of these stages south of the Pribilof Islands in the bongo samples is shown in Figure 4 and listed in Table 3. Of the 2,198 pollock eggs in the bongo samples, 860 (39%) were in an early, 1,027 (47%) in a middle, and 311 (14%) in a late stage of development; of the 59 pollock eggs in the neuston samples, 52 (88%) were in an early, 6 (10%) in a middle, and 1 (2%) in a late stage of development.

B. Larvae

Fish larvae were present in 21 (72%) of the 505-bongo and in 27 (90%) of the neuston samples, but 93% of the larvae were caught in the neuston net. Although most of the larvae were caught with the neuston net, the bongo net catches included more species. Table 4 shows the observed or actual catch, standardized catch, and numbers of positive stations for the taxa identified in the catches of the 505-bongo and the neuston nets.

Only 11 familes were represented in the larvae catch with 5 present in the neuston, 9 in the bongo, and 4 in both nets. Specimens within these families could be assigned to 11 genera or species, while two taxa, each represented by a single specimen, were identified only to family. In the 505-bongo catches, three taxa made up 75% of the catch and these were cottids of the genus *Hemilepidotus*, greenlings of the genus *Hexagrammos*, and the northern smoothtongue

Table 4 .-- Ichthyoplankton of the eastern Bering Sea, 11 February-16 March 1978. Catch by taxa.

Taxa	505-bongo net					Neuston net					
	Obs. no. 1/	No./10 m²	% 2/	No. pos. samp. 3/	% pos. samp. 4/	Obs. no.	No./10 m²	No./1,000 m³	% 5/	No. pos. samp.	% pos. samp.
OSMERIDAE (7)											
Mallotus villosus	-	-	-	-	-	7	0.1	82	0.7	1	3.3
BATHYLAGIDAE (21)											
Bathylagus schmidti	19	113	28.0	9	31.0	-	-	-	-	-	-
MYCTOPHIDAE (5)											
Protomyctophum thompsoni	1	5	1.2	1	3.4	-	-	-	-	-	-
Stenobrachius leucopsarus	4	26	6.4	1	3.4	-	-	-	-	-	-
GADIDAE (1)											
Theragra chalcogramma	1	6	1.5	1	3.4	-	-	-	-	-	-
ZOARCIDAE (1)	1	6	1.5	1	3.4	-	-	-	-	-	-
HEXAGRAMMIDAE (409)											
Hexagrammos sp.	10	52	12.9	7	24.1	326	6.2	4,084	32.7	26	86.7
Pleurogrammus monopterygius	1	6	1.5	1	3.4	72	1.4	908	7.3	16	53.3
COTTIDAE (642)											
Hemilepidotus sp.	26	138	34.2	10	34.5	616	11.1	7.385	59.1	16	53.3
BATHYMASTERIDAE (1)	-	-	-	-	-	1	0.1	14	0.1	1	3.3
STICHAEIDAE (2)											
Chirolophis polyactocephalus	2	9	2.2	2	6.9	-	-	-	-	-	-
CRYPTACANTHODIDAE (1)											
Lyconectes aleutensis	1	6	1.5	1	3.4	-	-	-	-	-	-
AMMODYTIDAE (7)											
Ammodytes hexapterus	7	37	9.2	4	13.8	-	-	-	-	-	-
TOTAL FISH LARVAE (1,096)	73	404		21	72.4	1,023	18.9	12,496		27	90.0
FISH EGGS											
GADIDAE (2,259)											
Theragra chalcogramma	2,198	11,323	99.6	13	44.8	61	1.2	794	100.0	10	33.3
UNIDENTIFIED FISH EGGS (8)	8	44	0.2	2	6.9	-	-	-	-	-	-
TOTAL FISH EGGS (2,267)	2,206	11,367		13	48.3	61	1.2	794		10	33.3

1/ Obs. no. = Observed number. This is the actual number caught in the nets.
2/ % = Percentage of the total for the bongo net calculated from standardized No./10 m².
3/ No. pos. samp. = Number of positive samples. This is the number of samples which contain specimens for a taxa.
4/ % pos. samp. = Percentage of positive samples. Total samples for bongo was 29 and for neuston 30.
5/ % = Percentage of total for neuston net calculated from standardized No./1,000 m³.

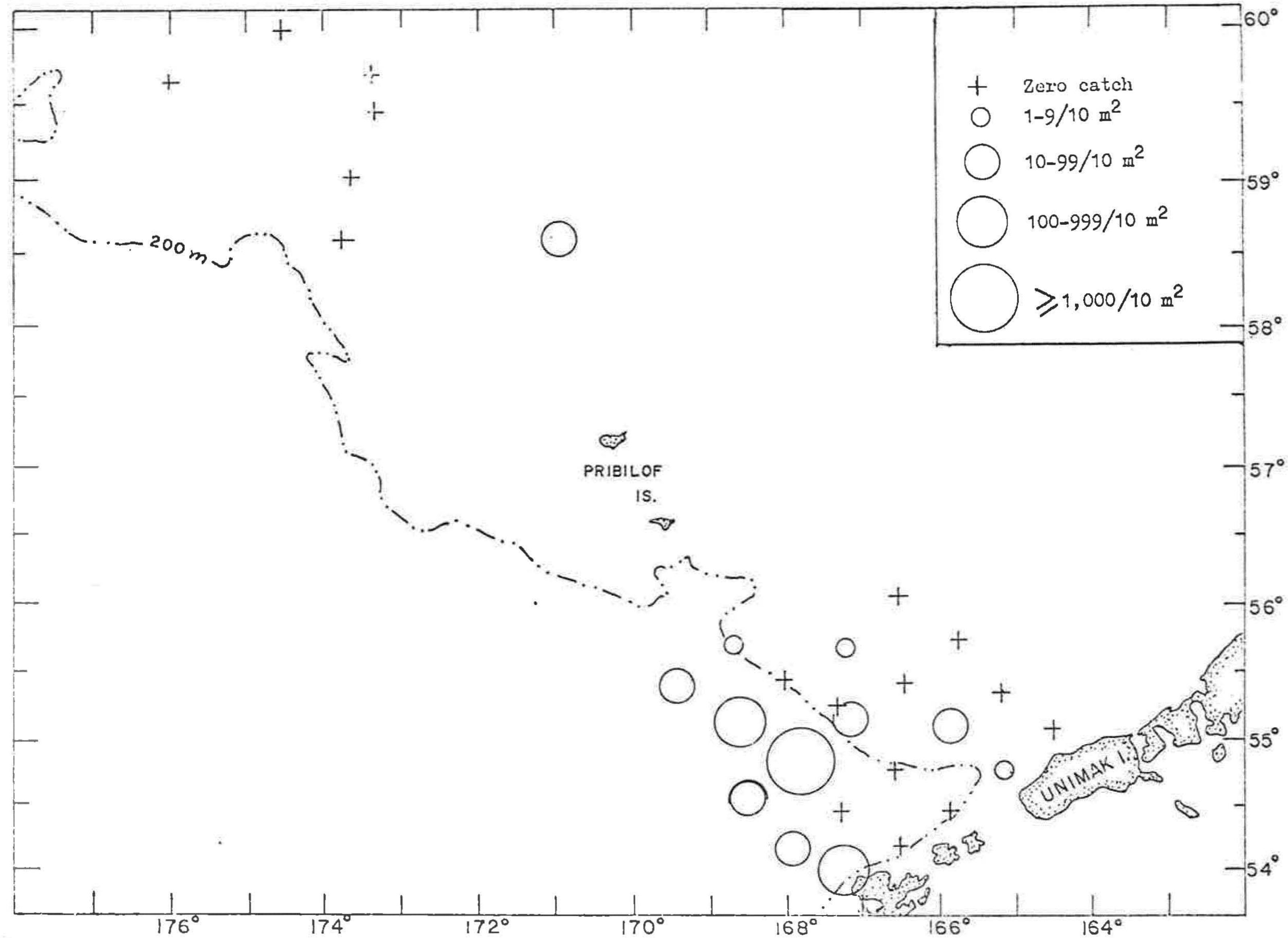

Figure 2.--Distribution and relative abundance of eggs of walleye pollock in the eastern Bering Sea, 11 February-16 March 1978. Collections made with bongo nets.

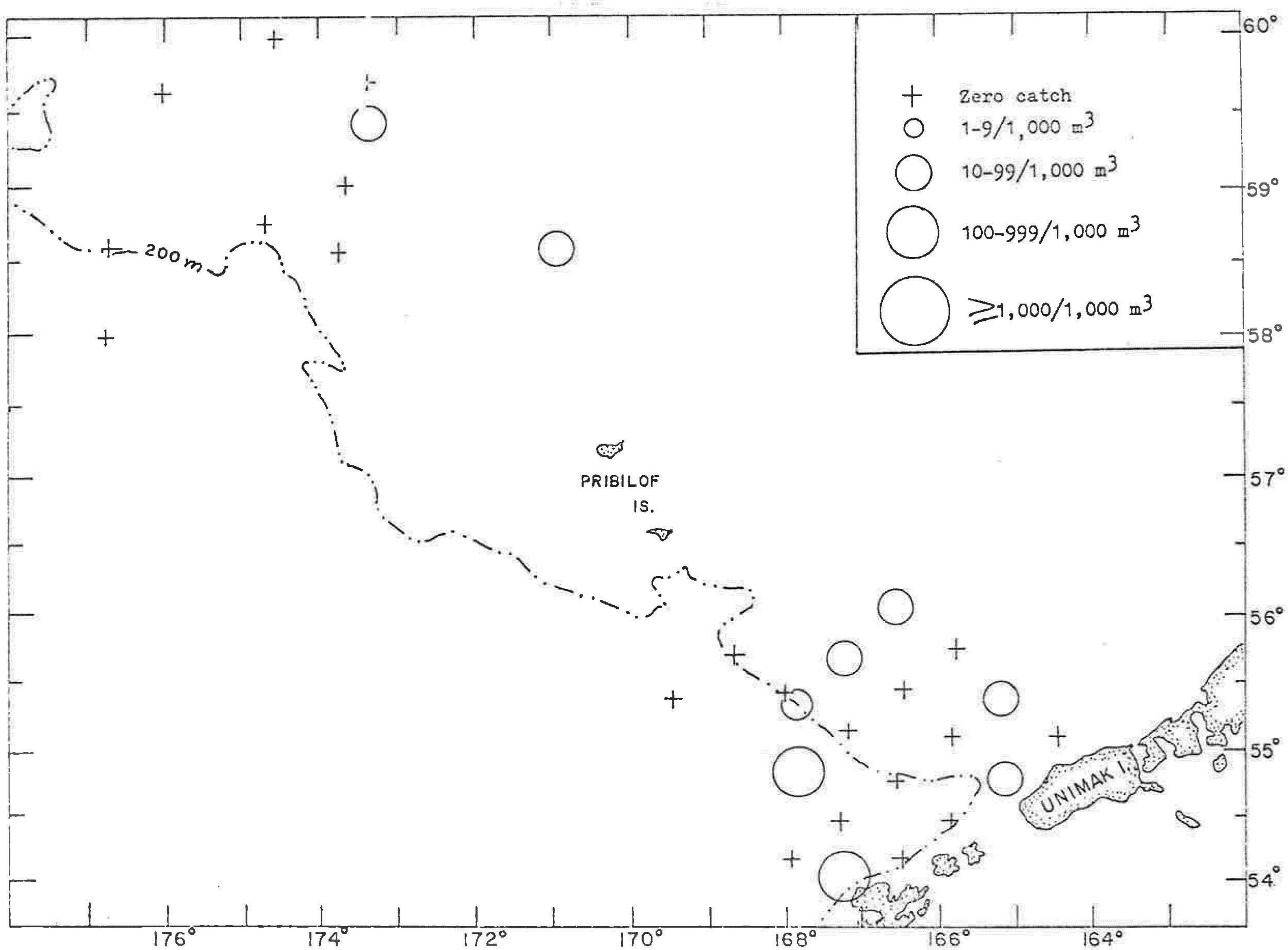

Figure 3.--Distribution and relative abundance of eggs of walleye pollock in the eastern Bering Sea, 11 February-16 March 1978. Collections made with neuston nets.

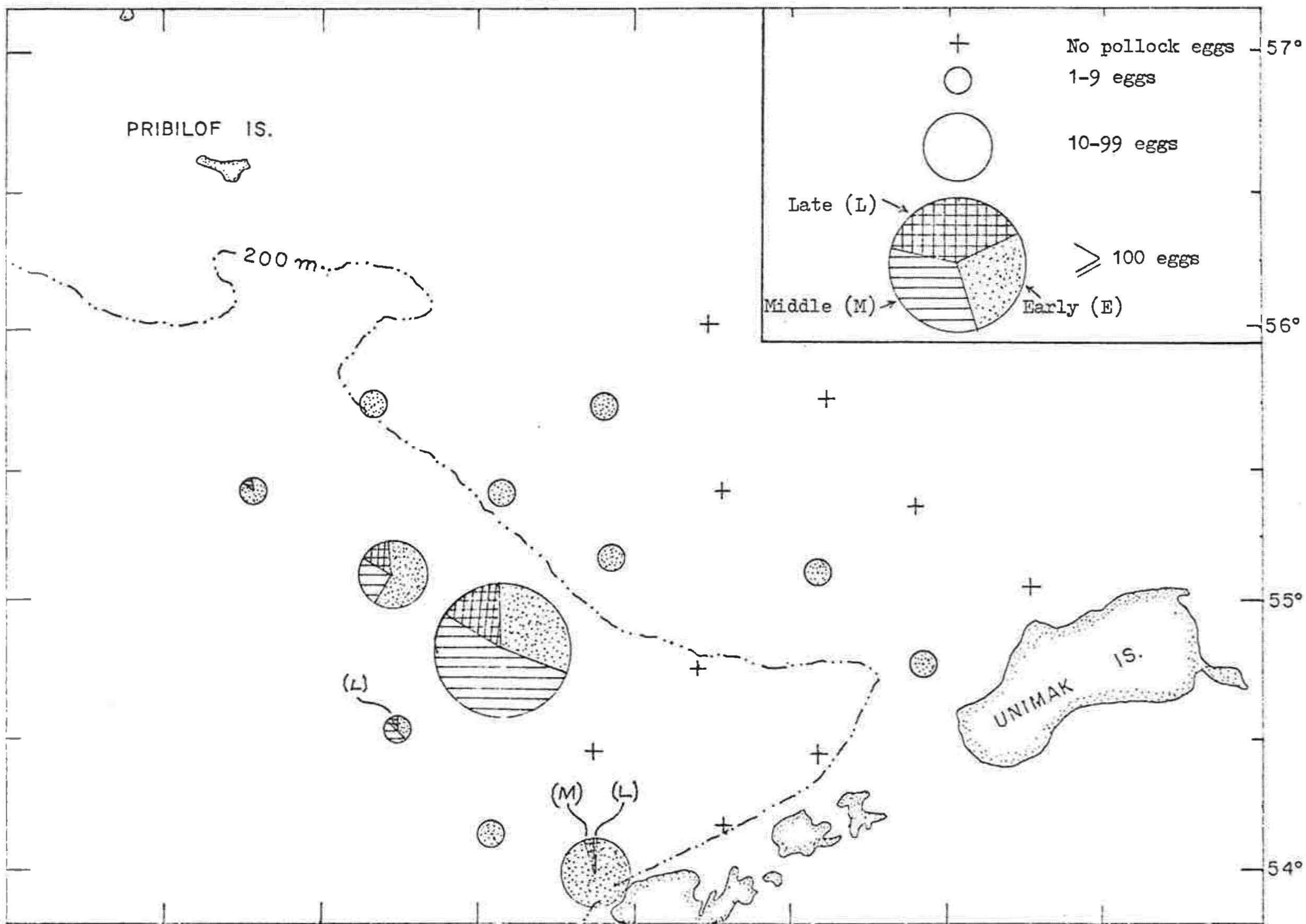

Figure 4.--Distribution and relative abundance of eggs of walleye pollock in the eastern Bering Sea, 10-16 March 1978, showing relative abundance of different embryonic stages. Collections made with bongo nets.

Table 3.--Observed number and percentage of pollock eggs in three stages of embryonic development for 10 - 16 March 1978, eastern Bering Sea.

Station no.	Total no. staged	Embryonic stages: Early No.	Early %	Middle No.	Middle %	Late No.	Late %
11	3	1	33	1	33	1	33
16	203	200	98	1	1	2	1
17	5	5	100	-	-	-	-
18	11	4	36	6	55	1	9
19	1,858	575	31	991	53	292	16
20	100	58	58	27	27	15	15
21	6	5	83	1	17	-	-
22	1	1	100	-	-	-	-
23	4	4	100	-	-	-	-
24	1	1	100	-	-	-	-
28	2	2	100	-	-	-	-
29	3	3	100	-	-	-	-
32	1	1	100	-	-	-	-
Total	2,198	860	39	1,027	47	311	14

(Bathylagus schmidti, which is given as Leuroglossus schmidti by some authors). In the neuston samples three taxa made up 99% of the catch, Hemilepidotus, Hexagrammos, and Atka mackerel (Pleurogrammus monopterygius). Only one pollock larva was found in the bongo and none in the neuston samples.

C. Pumice

In addition to fish eggs, fish larvae, and invertebrate zooplankton, considerable quantities of pumice or volcanic ash were collected by the neuston nets. Measurable quantities were found in 16 neuston samples and the largest amount collected was 31.8 grams (air-dried weight) at Station 22.

D. Environment

During cruise SU 78-A1 of the NOAA ship Surveyor, 20-27 February 1978, oceanographers measured temperature and salinity over a pattern which included part of the plankton grid sampled during cruise MF 78-1, Leg III (Figure 5). Surface water temperatures were highest just west of or along the continental slope with lower temperatures of less than 3°C to the east and west. The warmer temperatures in this area extended to the bottom along the slope and were in fact higher at the 100 m level than at the surface. Vertical profiles show that a temperature maximum of about 4°C occurred at about 100 m depth.

IV. DISCUSSION

A. Pollock eggs: March 1978 vs April-May 1977

A major objective of the 1978 survey was to determine the extent of spawning by pollock during late February and early March in the eastern Bering Sea. Results show that north of the Pribilof Islands pollock eggs were captured at only 2 locations, 1 egg in a neuston sample from Station 4 on 15 February and 3 eggs in a bongo sample from Station 11 on 3 March. South of the Pribilof Islands Station 1 was sampled on 11 February but no pollock eggs were caught.

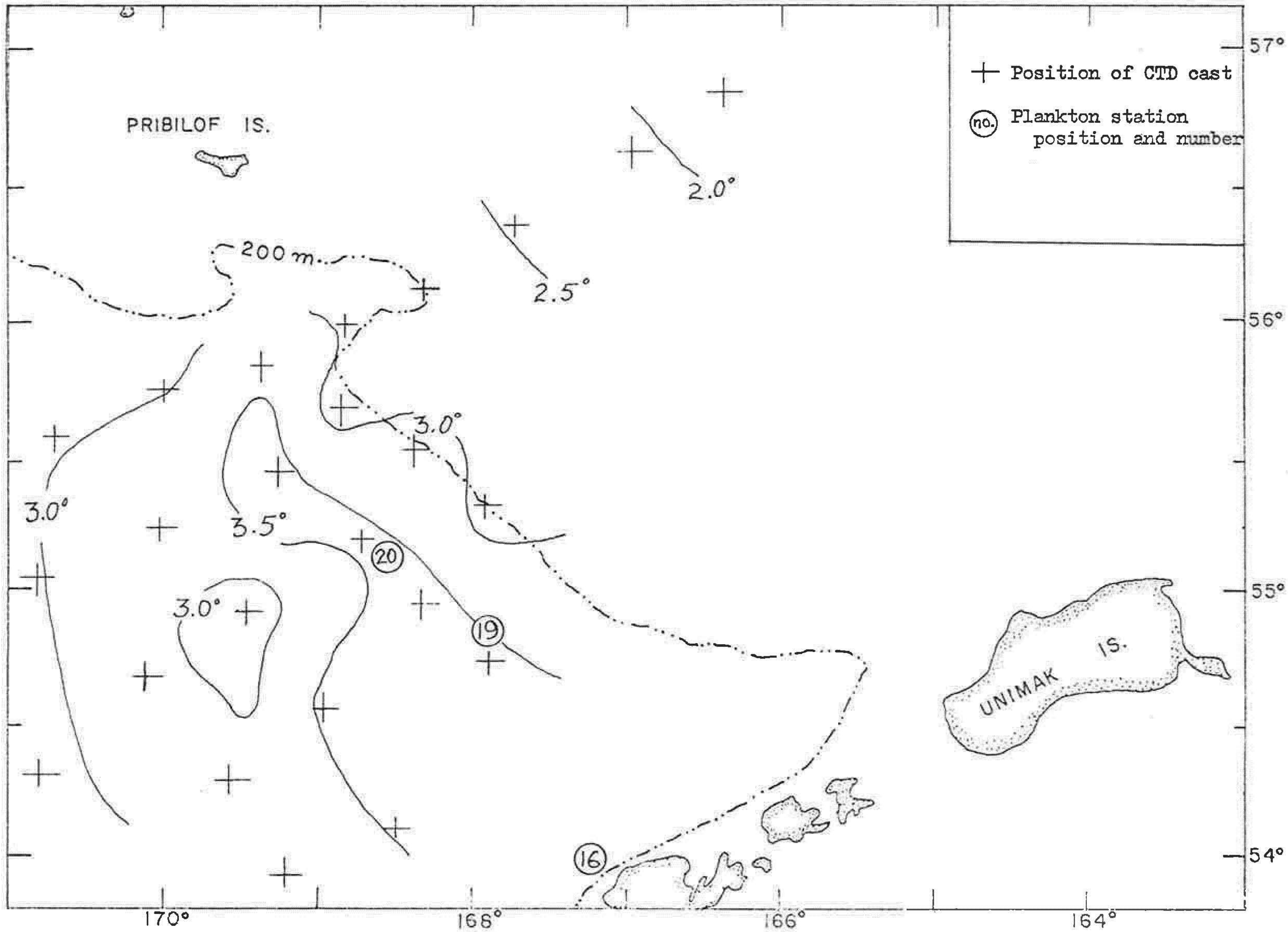

Figure 5.--Surface water temperature (°C.) during 20-23 February 1978, Surveyor cruise SU-78-A1.

Between 10-16 March, 21 stations were sampled and pollock eggs were caught at 12 stations including Station 23 immediately adjacent to Station 1 (see Figure 1). However, at only 3 stations, Stations 16, 9, and 20, did egg concentration exceed 100/10 m^2, and at only Station 19 did the concentration exceed 1,000/m^2.

On this basis it appears that pollock spawning may have commenced as early as mid-February, but there was no evidence it was widespread even at the end of the survey in mid-March.

Another method of evaluating pollock spawning during early March is to compare the total number of eggs present in the area surveyed during 10-16 March 1978 with total number of eggs present in the same area, as indicated by repetitive sampling, during the previous year (16-19 April, 23-26 April, and 4-10 May 1977). The area chosen for comparison consists generally of the area represented by Stations 1-24 of the 1977 survey (Waldron and Vinter 1978) and Stations 12-32 (except Stations 17, 21, and 22) of the 1978 survey. Total eggs present for different time periods for the area were calculated following the method described by Houde (1977) and the results are tabulated in Table 5. Spawning in March 1978 appears to have exceeded that for the highest period in 1977 (23-26 April) by 3.962×10^{11} eggs, and was over five times that for the period 16-19 April 1977. However, the calculated eggs for a single area, that represented by Station 19 in the 1978 survey, accounted for over 98% of the entire number of eggs for that year. During 1978, samples from half of the stations included in the foregoing comparison did not contain eggs; whereas during 1977, eggs were absent from relatively few stations and this is reflected in the standard deviations shown in Table 5.

Table 5.--Estimates of total walleye pollock eggs in an area of the eastern Bering Sea during 10-16 March 1978 and 16 April-10 May 1977.

Dates of sampling	No. of pollock eggs in common area 1/	Mean no. of eggs per sample area	Standard deviation of sample areas	No. of areas
1977				
16-19 April	0.455×10^{12}	1.897×10^{10}	0.287×10^{11}	24
23-26 April	2.145×10^{12}	8.935×10^{10}	1.813×10^{11}	24
4-10 May	1.092×10^{12}	4.551×10^{10}	1.029×10^{11}	24
1978				
10-16 March	2.541×10^{12}	14.120×10^{10}	5.879×10^{11}	18
10-16 March 2/	0.044×10^{12}	0.259×10^{10}	0.065×10^{11}	17

1/ Total area common to 1977 and 1978 in this comparison = 3.965×10^{10} m^2.

2/ The second estimate for March 1978 was made with sample area 19 deleted.

The distribution of pollock eggs during March 1978 was quite different from that found in repetitive sampling during mid-April to mid-May 1977. During the 1978 survey the greatest egg concentration was found over the continental slope, while in the 1977 surveys pollock eggs were more abundant over the continental shelf well to the eastward even though the 1978 survey of 10-16 March did not include the locations of stations with the greatest egg concentrations in 1977.

Stations 25 and 26 of the 1977 survey (see Figure 1 in Waldron and Vinter 1977) immediately northeast of the area common to 1977 and 1978, contained over 7 times the number of pollock eggs in the common area during 16-19 April 1977 and 1.3 times the number in the common area during 10-16 March 1978.

B. Time of pollock spawning deduced from staging of eggs

Results of staging pollock eggs (see Figure 2 and Table 3) show that spawning south of the Pribilof Islands probably began in late February 1978 and continued through the time of the survey. Embryonic development of pollock is temperature dependent, with incubation time from fertilization to 50% hatching of 24.5-27.4 days at 2°C, 13.8-14.4 days at 6°C, and 10 days at 10°C (Hamai et al. 1971-1972). On this basis, the age of eggs staged from samples collected in March 1978 would be as shown in Table 6. With such a time table and temperatures in late February of 3-4°C (Figure 5), the eggs from Station 19, sampled on 14 March, could have been spawned from about 26 February to a few days before the collection was made. Although there were a few eggs in a very late stage of development, it appears that hatching had not begun or had just barely started because only 1 pollock larva was caught during the entire 1978 survey. Since no eggs were caught at Station 1 on 11 February and only the one

Table 6.--Duration of stages of embryonic development of walleye pollock based on data from Hamai et al. (1971).

	Water temperature (°C)		
Stage	2	4	6
	- - - - - Whole days - - - - - -		
Early	0 - 8	0 - 7	0 - 4
Middle	8 - 17	7 - 13	4 - 9
Late	17 - 26	13 - 20	9 - 14

larva was caught, it seems that pollock spawning started during the last week of February in the area south of the Pribilof Islands. If spawning had commenced earlier there should have been pollock larvae present in many of the samples, and if spawning had commenced much later, say during the first week of March, it is likely that only eggs in an early stage of development would have been found in the samples.

Considering the foregoing points (number of stations at which pollock eggs were absent, stages of embryonic development of the eggs, and lack of pollock larvae) it may be concluded that, although pollock began spawning as early as late February, spawning activity was sporadic, although intense in localized areas, prior to mid-March 1978 when the survey was completed. In spite of the rather restricted area in which pollock eggs were present, the total number of eggs estimated as present in the common area during 10-16 March 1978 exceeded the number estimated for any one of three surveys made during 16 April - 10 May 1977.

C. Spawning location

Presence of large number of pollock eggs in stages of development ranging from early to late at Station 19 poses the interesting question of where spawning occurred. Appreciable numbers of late stage eggs were found only at Stations 19 and 20 with a few at Stations 16 and 18 (see Figure 2). At the remaining stations only early stage eggs were found, except for 1 middle stage egg at Station 21, and pollock eggs were absent at 9 stations, including Stations 14 and 15 adjacent to Station 19. All of the stations at which late stage eggs were caught, as well as the stations at which eggs were present in large numbers, were in water located where water depth was greater than 200 m along the continental slope.

If it is assumed there is no flow of water through the survey area, then the observed distribution of pollock eggs could result from a spawning population that remained in one location, centered around Station 19, for about 20 days. The presence of a few early stage eggs at adjacent stations could indicate an expansion of the spawning population during or immediately prior to the survey. If there was a northerly flow of water through the area, a more reasonable assumption, then the observed distribution could result from a spawning population moving in the same direction and rate as the water in which spawning first occurred. The presence of eggs in different stages of development could be attributed to a continuation of spawning as the population moved with the water. The absence of pollock eggs at Stations 12-15 and the presence of large numbers of eggs at Station 16 suggests that spawning did not take place to the southeast of Station 19, but rather between Stations 16 and 19. Further, all but 3 of the eggs collected at Station 16 were in an early stage of development indicating that a second group of pollock had started to spawn in that vicinity.

D. Fish larvae composition

Sculpins (family Cottidae) represented by Irish lords (Hemilepidotus sp), were the most abundant group of larvae caught during the February-March 1978 survey. In the combined neuston and bongo catch, they contributed 642 specimens or 55% of the total larval catch. Of these, 616 (96%) were in the neuston samples and 26 (4%) in the bongo samples. Irish lord larvae were present in 16 (53%) of the neuston samples and 10 (35%) of the bongo samples, and were collected both north and south of the Pribilof Islands (Figures 6 and 7), although they were absent at the 5 most northerly stations. Range in standard length

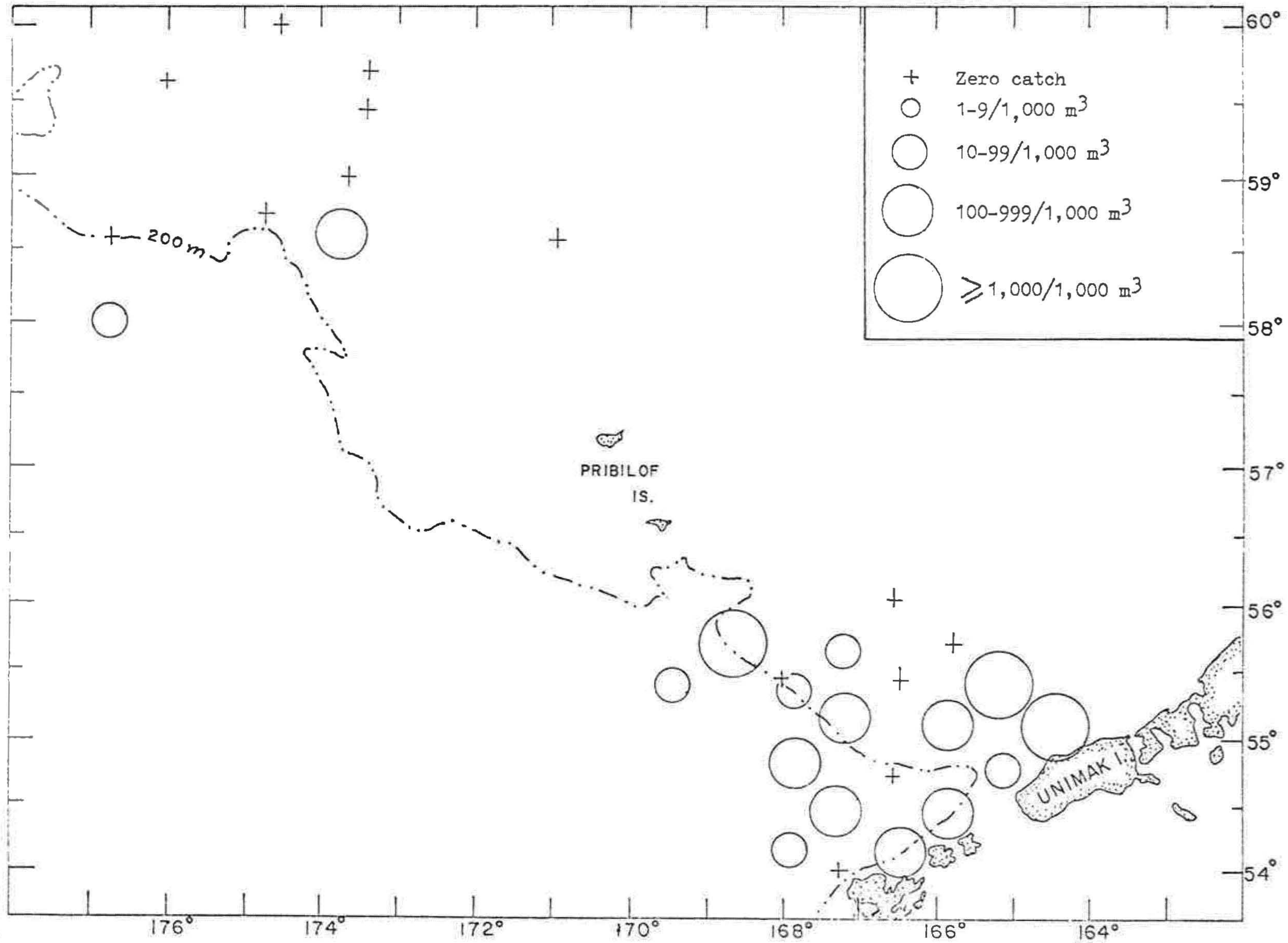

Figure 6.--Distribution and relative abundance of larval sculpins (*Hemilepidotus* sp.) in the eastern Bering Sea, 11 February-16 March 1978. Collections made with neuston nets.

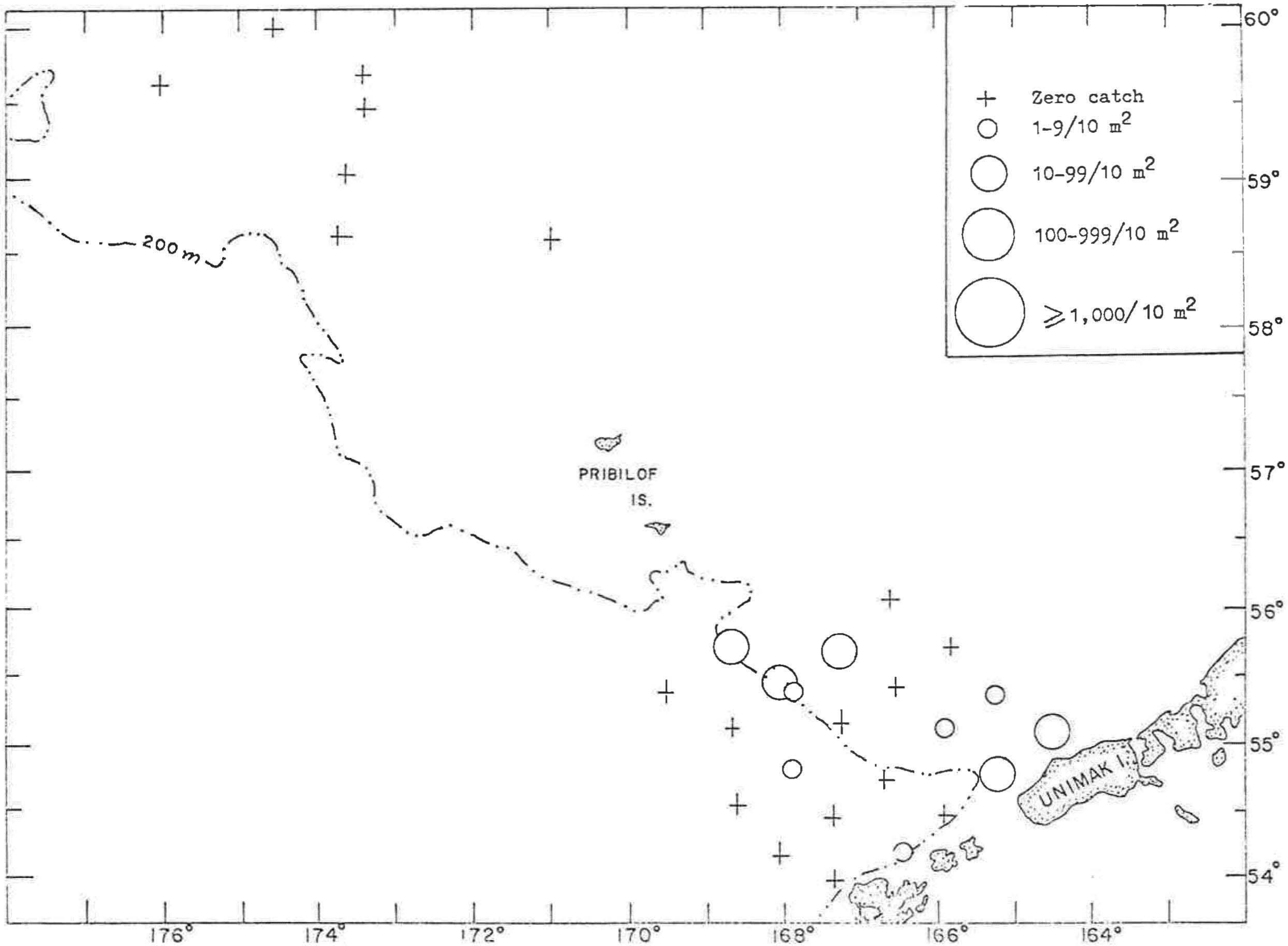

Figure 7.--Distribution and relative abundance of larval sculpins (*Hemilepidotus* sp.) in the eastern Bering Sea, 11 February-16 March 1978. Collections made with bongo nets.

of Irish lords collected during 1978 was 7-15 mm, with most of the specimens between 8-12 mm. This size is considerably smaller than for the Irish lords collected during 1977 when standard length ranged from 8-26 mm with many in the 15-20 mm range.

Greenlings (family Hexagrammidae) were the second most abundant larvae, with an observed catch of 409 specimens, 398 (97%) in the neuston and 11 (3%) in the bongo samples. Most of the specimens, 336 (82%), were greenlings of the genus Hexagrammos and the remaining 73 (18%) were Atka mackerel. Greenling larvae were found in 26 (87%) of the neuston samples collected both north and south of the Pribilof Islands and in 7 (24%) of the bongo samples, all of which were south of the Pribilof Islands and over or near the edge of the continental shelf (Figure 8). There were no marked centers of abundance and the highest catch of the neuston net was at Station 31 near Unimak Island, with generally lower catches over deep water west of the continental slope. Standard length of greenling larvae ranged from 9-33 mm, with most specimens between 12-25 mm, about the same size as those caught during the April-May 1977 survey.

Atka mackerel were much less numerous than greenlings and with one exception were caught with the neuston net. They were found in 16 (53%) of the neuston samples, 2 from north and 14 from south of the Pribilof Islands (Figure 9). There did not appear to be any center of abundance and the largest catch was at Station 8 northwesterly of the Pribilof Islands. Large catches tended to be made over deeper water than was the case with larvae of Hexagrammos. Standard length of Atka mackerel larvae ranged from 12-22 mm, slightly smaller than those collected during April-May 1977.

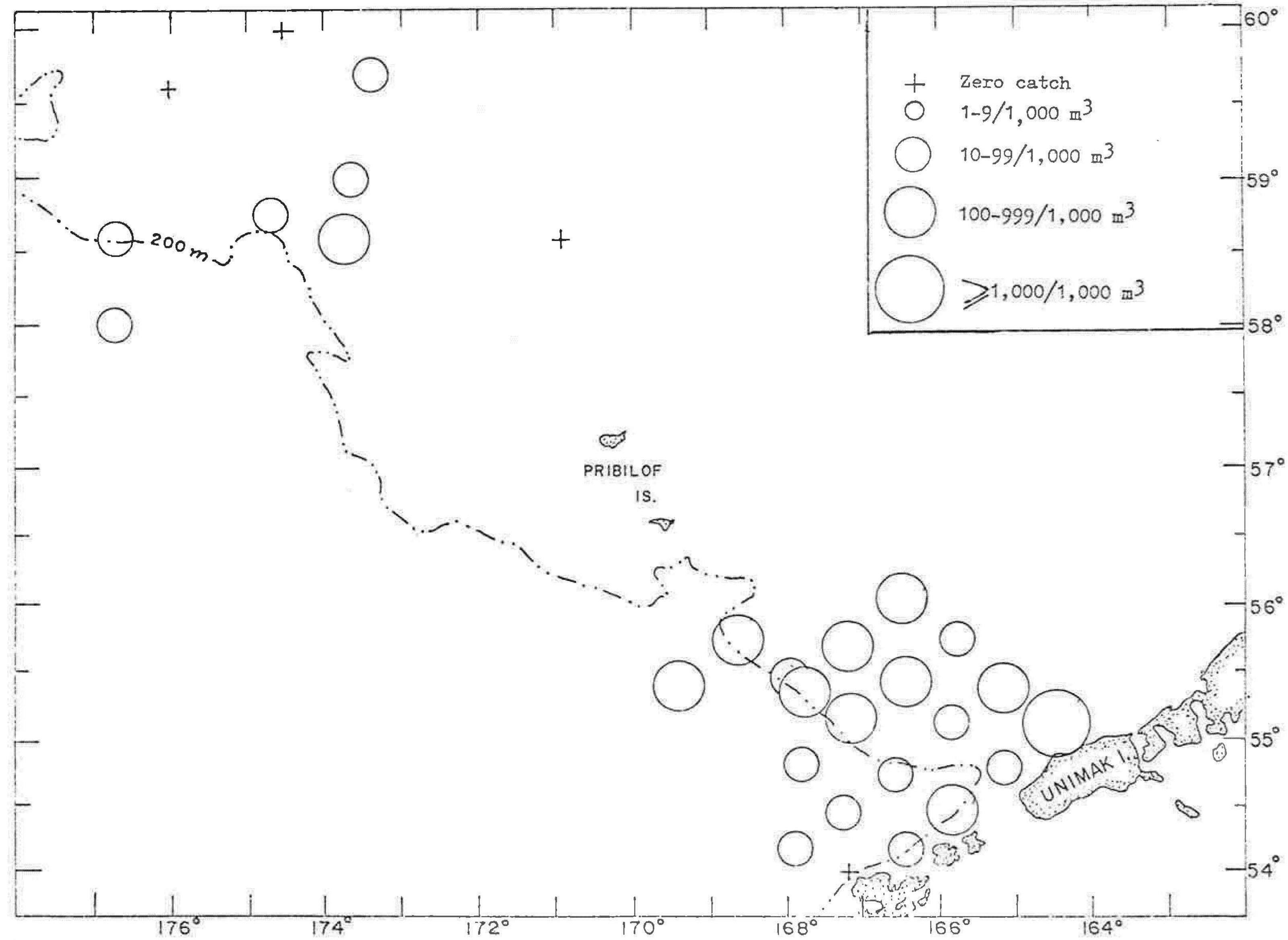

Figure 8.--Distribution and relative abundance of greenlings (Hexagrammos sp.) in the eastern Bering Sea 11 February-16 March 1978. Collections made with neuston nets.

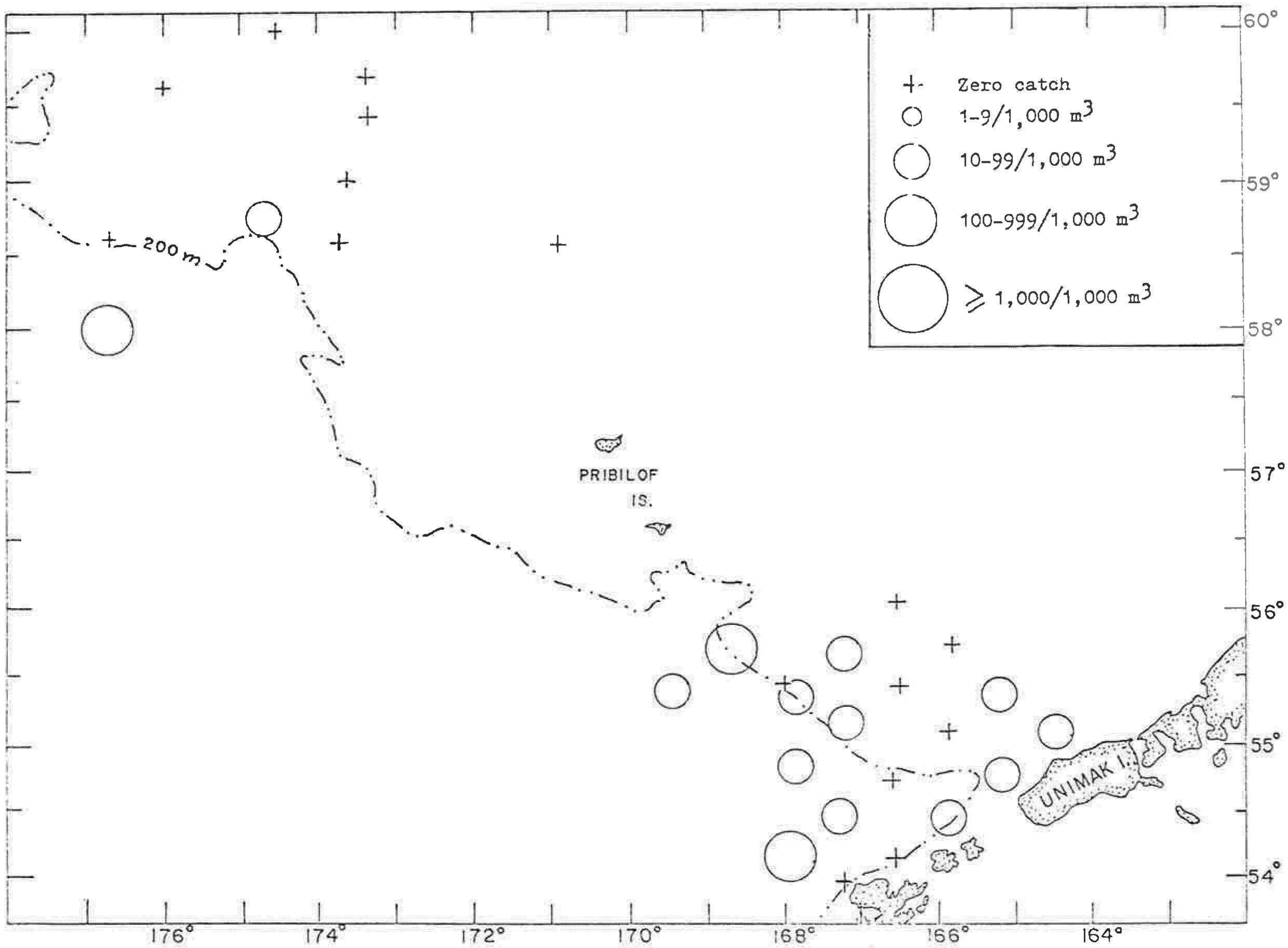

Figure 9.--Distribution and relative abundance of larvae of Atka mackerel in the eastern Bering Sea, 11 February-16 March 1978. Collections made with neuston nets.

Larvae and juveniles of the northern smoothtongue (family Bathylagidae) were the third most abundant family but, with only 21 specimens, were far less numerous than Cottidae and Hexagrammidae. Bongo samples contained 20 (95%) and neuston samples 1 (5%) of northern smoothtongue. All specimens in the bongo samples were caught south of the Pribilof Islands with 17 (85%) collected at stations over deep water west of the continental shelf and only 3 (15%) collected at shallow water stations over the continental shelf (Figure 10). Standard lengths of northern smoothtongue ranged from 8-64 mm, with two or three size groups present. Most specimens, 13, were 8-11 mm larvae, 2 were 28 mm larvae, and the remaining 6, including the single neuston-caught specimen, were juveniles 54-64 mm standard length. All of the bongo-caught juveniles were collected at stations over shallower water and closer to shore than were the smaller larvae. Total size range for specimens from the April-May 1977 survey was somewhat larger, extending to 80 mm standard length.

The remaining 25 larvae in the combined bongo and neuston samples were divided among 8 families, none of which was represented by more than seven individuals, and their distribution varied (Figure 11).

Capelin, Mallotus villosus (family Osmeridae), were present only in neuston samples collected at Station 31 and only 7 specimens were captured. Capelin were relatively large, ranging from 45-50 mm standard length, approximately the same size as those collected during April-May 1977.

Pacific sand lance, Ammodytes hexapterus (family Ammodytidae), were present only in 4 bongo samples collected at Stations 26, 30, 31, and 32 with a total catch of 7 larvae. All of the Pacific sand lance were small with a range of 6-10 mm standard length, much smaller than those collected during April-May 1977.

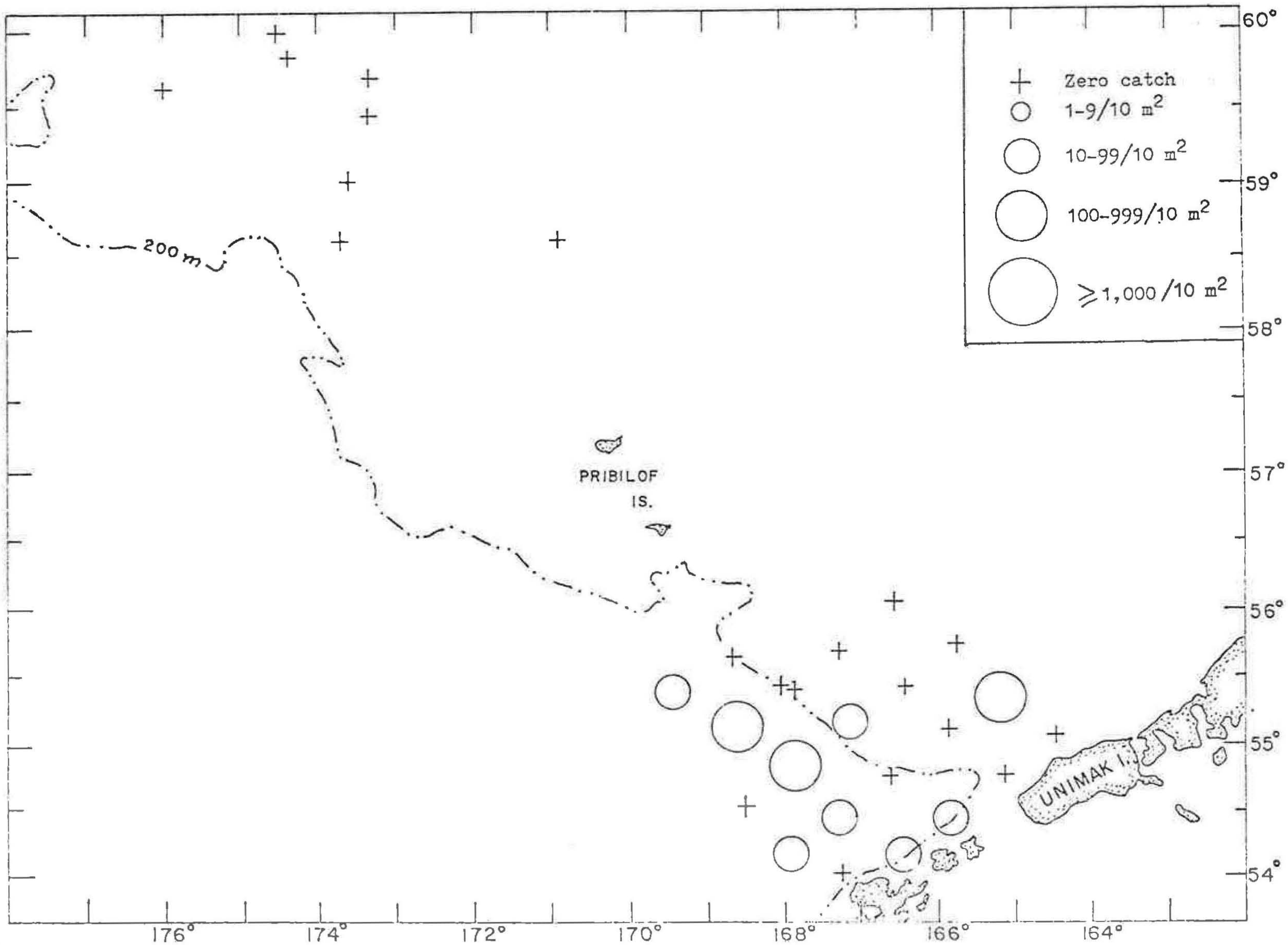

Figure 10.--Distribution and relative abundance of larvae of the northern smoothtongue in the eastern Bering Sea, 11 February-16 March 1978. Collections made with bongo nets.

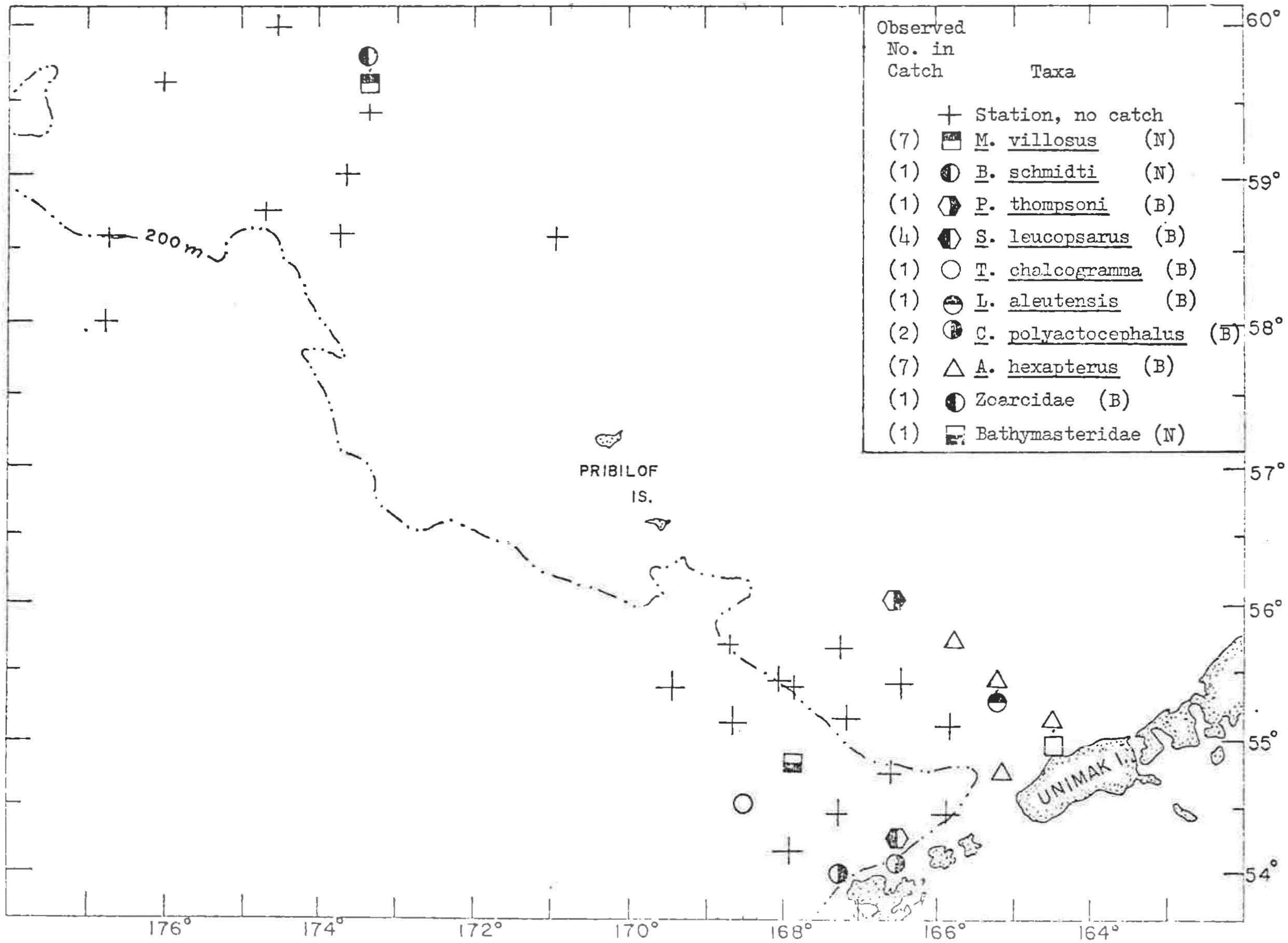

Figure 11.--Location of capture of larvae of various fish in the eastern Bering Sea, 11 February-16 March 1978, with number of specimens in observed catch and net in which they occurred. (N) = Neuston net, (B) = Bongo net.

Lanternfish (family Myctophidae) were represented by 5 specimens collected at 2 stations with bongo nets. A single bigeye lanternfish (Protomyctophum thompsoni), 16 mm standard length, was caught at Station 24. At Station 12 the catch of lanternfish consisted of 4 lampfish (Stenobrachius leucopsarus), 2 juveniles of about 23 mm standard length and 2 adults of about 70 mm standard length.

Pricklebacks (family Stichaeidae) were represented by 2 decorated warbonnets (Chirolophis polyactocephalus), one each from bongo net samples at Stations 13 and 16. Standard length of the specimens was about 15 mm.

Wrymouths (family Cryptacanthodidae) were represented by one larval dwarf wrymouth (Lyconectes aleutensis), 27 mm standard length collected with a bongo net at Station 30.

An unidentified eelpout (family Zoarcidae), 29 mm standard length, was collected with the bongo net at Station 5, one of the more northerly stations sampled during the survey.

The single walleye pollock larvae caught during the survey was collected with a bongo net at Station 18 on the western edge of the survey area. Samples from Station 18, as well as those from adjacent Stations 19 and 20, contained pollock eggs in late stages of embryonic development, and this 4.5 mm pollock larva may represent the initial hatch of pollock for the eastern Bering Sea in 1978.

A single searcher (family Bathymasteridae), 33 mm standard length, was caught with a neuston net at Station 19.

V. SUMMARY

Ichthyoplankton was collected between 11 February and 16 March 1978 on Legs I-III of Miller Freeman cruise MF 78-1 to help define the time when pollock commence spawning in the eastern Bering Sea. Neuston and bongo nets were used to collect samples at 32 stations located from the western end of the Alaska Peninsula northward near the continental slope or outer shelf to latitude 60°N.

Presence of pollock eggs (99.6% of all eggs) in half the samples indicated that pollock had started to spawn especially in the area south of the Pribilof Islands, although eggs were abundant at only one station. Eggs in early, middle, and late stages of development were collected at a few stations situated over deep water, including the one station at which eggs were abundant, but the few eggs collected over the continental shelf were all in an early stage of development. The location in which eggs were abundant and in which eggs in an advanced stage of development were found was characterized by water that in late February was about 3.5°C, nearly 1°C higher than the surrounding area.

Only one pollock larva was collected during the survey and that was at a station near the southwestern edge of the survey area.

Presence of pollock eggs in various developmental stages, combined with the presence of only one larva, indicates that spawning started during the last week of February 1978 and continued through the time of the survey. Absence of pollock eggs at many stations indicated that spawning was not yet widespread by mid-March.

The restricted area in which pollock eggs in all stages of development were found and the paucity of eggs in surrounding area, gives some indication of where the eggs were spawned. If there was no net flow of water through the area, spawning probably began and continued in the vicinity of Station 19. If there was a net flow of water through the area, then spawning may have begun between Stations 16 and 19 and the population of pollock continued to spawn as it moved in a northerly direction with the body of water in which initial spawning occurred.

The majority of fish larvae collected during the cruise (about 93%) were caught with neuston nets. Although the bongo samples contained fewer larvae, they included a greater variety, 11 taxa, than did the neuston samples, 5 taxa. Fewer taxa of fish were collected than during previous years and in the combined bongo and neuston samples 96% of the larvae were sculpins of a single genus, *Hemilepidotus*, greenlings of the genus *Hexagrammos*, and Atka mackerel. Length of larvae in most taxa was smaller in the March 1978 samples than in the same taxa collected during April and May 1977.

An interesting component of the neuston samples was a pumice-like material, with measurable quantities of up to 31.8 g air-dried weight, present in 16 samples collected south of the Pribilof Islands. This material was not a noticeable item in samples collected during 1976 and 1977.

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