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Ichthyoplankton off Washington, Oregon, and Northern California, January 1987

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NOTICE

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by

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INTRODUCTION

This is the tenth report of a series describing cooperative U.S.-U.S.S.R. ichthyoplankton surveys conducted off the U.S. west coast from 48°-40°N. The cruise described here took place aboard the NOAA Ship Miller Freeman, and is designated 1MF87. Similar reports, based on cruises occurring since April-May 1980, have already been produced (Kendall and Clark 1982a, 1982b, Bates 1984, Clark 1984, 1986a, 1986b, Clark and Kendall 1985, Clark and Savage 1988, and Savage 1989). These surveys were designed to determine the seasonal and spatial distribution of ichthyoplankton as background information for more detailed studies of the early life history of fishes of the area. The initial plans were to conduct two such surveys each year, at different times of the year, so that after several years the complete annual cycle of fish egg and larval occurrence would be documented. These are the first large-scale ichthyoplankton surveys of the area to sample all seasons. Results from these surveys eventually will be compared to those of the CalCOFI program off California and Baja California to the south, and to several smaller-scale surveys conducted previously off Washington and Oregon. In the meantime, we plan to present a data report such as this for each cruise, as soon as feasible.

During this cruise, standard bongo (to 200 m) and neuston ichthyoplankton sampling was done at 98 stations, Tucker trawls to 400 m were done at 17 of the 98 original stations, and CTDs were done at 53 of the original 98 stations and at 12 additional stations. The Tucker trawls were done to sample a large volume of water and to sample deeper than the usual 200 m bongo tows to obtain sablefish (Anoplopoma fimbria) eggs and early larvae, which seem to be rare and occur only below 200 m.

METHODS AND MATERIALS

A grid of 88 stations (and 12 additional CTD stations) which was laid out off the Washington, Oregon, and northern California coasts extended from 3 miles (5.6 km) to 200 miles (370 km) from shore (Figure 1). Stations were more closely spaced nearshore than offshore. The NOAA Ship Miller Freeman, with Jay Clark serving as Chief Scientist, occupied these stations from north to south from January 7 to 28, 1987. Ten stations on two transects were re-occupied with Tucker trawls as the ship returned from the southern end of the survey grid between January 28 to 31. At 53 stations in the original grid, and at 12 additional stations near the shelf break on six transects, CTD casts to a maximum depth of 1,000 m were made. Results of these temperature and salinity measurements will be reported elsewhere. Paired neuston tows using 0.3 m high by 0.5 m wide Sameoto samplers (Sameoto and Jaroszynski 1969) with 0.505 mm mesh nets were made at 2.0 knots (1.03 m/sec) for 10 minutes

at each station. A standard MARMAP bongo tow (Smith and Richardson 1977) with 60 cm diameter frames, and 0.505 mm mesh nets with a maximum of 300 m of wire out was made at each station. A total of 27 Tucker trawls with 1 m frames, and 0.505 mm mesh nets was made on three transects (46°40'N, 43°20'N, 40°40'N). Ten Tucker trawl stations on the northern two transects were re-occupied after the main survey. Tucker trawls used the same towing scheme as the bongo tows (i.e. deployed at 50 m/min, retrieved at 20 m/min, wire angle maintained at 45°), except 600 m of wire was paid out to achieve a nominal maximum sampling depth of approximately 400 m. Flowmeters in the mouths of the nets were used to determine the volume of water filtered by each net for the bongo and neuston tows and the Tucker trawls. Only one sample from each bongo tow was retained for processing. The second samples from the paired bongo nets were quickly sorted aboard ship for the larvae of Glyptocephalus zachirus (rex sole) and Microstomus pacificus (Dover sole). These specimens were preserved in 95% ethanol at sea for otolith ageing and morphometric studies. The rest of the samples were fixed in formalin at sea, but sorted fish larvae were later transferred to 70% ethanol for storage to inhibit bone deterioration. The Tucker samples were sorted inhouse at Oregon State University where Dr. Douglas Markle retained the Microstomus pacificus larvae. The bongo and neuston samples were processed by the Polish Plankton Sorting Center in Szczecin, Poland, where displacement plankton volumes were determined (for bongo samples)

and all fish eggs and larvae were removed. The fish eggs were later identified and counted by Ann C. Matarese and Deborah Blood at NWAFC. Identifications were made to the lowest taxonomic level possible, and in some cases "types" of unidentified eggs or larvae were established in hopes that with further study their identity could be established. Deborah Blood, Bill Rugen, and David Savage at NWAFC checked larval identifications for both the bongo and neuston samples. Counts of fish eggs and larvae in the samples were converted to numbers per 10 m^2 of surface area for the bongo samples and numbers per 1,000 m^3 for the neuston samples. The logarithm of the number of eggs or larvae in the survey area is based on the Sette and Ahlstrom census as used by Richardson (1981).

RESULTS

The station pattern (Figure 1) was occupied as planned. Data associated with the 98 stations are listed in Tables 1a-1c. A summary of the catches of fish eggs, larvae, and juveniles is presented in Tables 2-7. Totals of 26 taxa of eggs and 52 taxa of larvae were found in the neuston and bongo catches. Totals of 19 taxa of eggs and 33 taxa of larvae were found in Tucker trawl catches. Figures 2-7 illustrate the rank abundances of egg and larval catches in bongo and neuston tows for the cruise using several measures of abundance. Figures 8-31 show the geographic distribution, abundance at each station and length frequencies of larvae and eggs of the more abundant taxa. Results of recurrent

group analysis (Fager 1957) of eggs and larvae from bongo and neuston samples are shown in Figures 32 and 33.

Relative Abundances

The rank order of abundance among the taxa depends on the measure of abundance examined. Four measures of abundance for each net were used: total number caught, percent occurrence, logarithm of number in survey area, mean number per 1,000 m^3 (for neuston) and mean number per 10 m^2 (for bongo).

In the bongo net, egg catches were dominated by Pleuronectidae in number per 10 m^2 and number caught (Figure 2). Bathylagidae dominated the percent occurrence and log of the number in the survey area criteria in the bongo egg catches. Bothidae ranked second overall in the bongo egg catches in the number per 10 m^2 and the number caught criteria. In the neuston net, all egg abundance criteria except for percent occurrence were dominated by Bothidae (Figure 5). Trachipterus altivelis had the highest percent occurrence in neuston egg catches. The results for both the bongo and the neuston egg catches are similar to the October-November 1981 cruise (Bates 1984).

Larval catches in the bongo net were dominated by Sebastes spp. (Figures 3a and 3b) in all abundance criteria except for number per 10 m^2, which was dominated by Parophrys vetulus. Larval catches of Stenobrachius leucopsarus in the bongo net ranked second overall. In the neuston net, larval catches were dominated by Hemilepidotus spinosus in the number caught and

logarithm of the number in the survey area criteria (Figure 6). Hexagrammos decagrammus had the highest percent occurrence of larvae caught in the neuston net. Citharichthys spp. larvae from neuston catches ranked highest in the number per 1,000 m^3 criterion. These results are similar to the April-May 1985 cruise (Savage 1989). Juvenile catches in the neuston net were led in all criteria by Tarletonbeania crenularis. In the bongo net juvenile catches were dominated by Diaphus theta.

Data analysis for percent occurrence and number caught in the Tucker trawl showed that Bathylagidae eggs were most abundant, followed by teleost type E eggs. Stenobrachius leucopsarus were the most abundant larvae, followed closely by Tarletonbeania crenularis.

Distributions

While this is not intended to be a definitive report on these data, certain outstanding features of the distribution of eggs, larvae and juveniles of the more abundant taxa will be mentioned.

Teleost type E eggs were found in the Tucker trawl in uniform abundance throughout the survey area. Teleost type E eggs were collected at 89% of the Tucker stations occupied.

Bathylagidae (Figure 8) - Blacksmelt eggs were found in bongo tows throughout the survey area. The highest concentration per 10 m^2 of eggs was found at nearshore stations south of 42°N. Blacksmelt eggs were found at 45% of the bongo stations occupied. Bathylagidae eggs from the Tucker trawl had a similar

distribution pattern to those in the bongo. Eggs were seen throughout the survey area, but had the highest abundance nearshore south of 41°N. Blacksmelt eggs were found at 89% of the Tucker trawl stations occupied.

Bathylagus ochotensis (Figure 9) - Popeye blacksmelt larvae from bongo tows were distributed in highest concentrations offshore in the southern half of the survey area, although they were found as far north as 47°30'N. Popeye blacksmelt larvae ranged from 3.2-12.4 ($\bar{x}$ = 6.7) mm SL with a percent occurrence of 36%.

Chauliodus macouni (Figure 10) - Pacific viperfish eggs from bongo tows were found in highest concentration offshore between 41°N and 46°N. Eggs occurred at 34% of the stations occupied.

Diaphus theta (Figure 11) - California headlightfish juveniles caught in bongo tows were found throughout the survey area south of the Columbia River. The juveniles ranged from 20.5-54.0 ($\bar{x}$ = 30.0) mm SL and occurred at 30.7% of the stations occupied.

Stenobrachius leucopsarus (Figure 12) - Northern lanternfish larvae sorted from bongo catches were found throughout the survey area, but were found in highest numbers south of 43°N. The larvae ranged in length from 2.5-5.2 ($\bar{x}$ = 3.9) mm SL and were found at 41% of the stations occupied. Northern lanternfish juveniles from the bongo were found throughout the survey area and ranged from 19.8-61.0 ($\bar{x}$ = 36.0) mm SL with a percent occurrence of 24% (Figure 13). Larvae caught in the Tucker trawl

were also distributed throughout the survey area with a range of 2.8-56.0 ($\bar{x}$ = 4.2) mm SL and a percent occurrence of 78%.

Tarletonbeania crenularis (Figure 15) - Blue lanternfish larvae from the bongo were abundant throughout the survey area. The larvae ranged from 2.2-13.3 ($\bar{x}$ = 7.0) mm SL and occurred at 42% of the stations occupied. Blue lanternfish larvae from the neuston were found primarily south of 44°N, although there was a high concentration (544/1,000 m^3) to the north at station 4. Larvae from the neuston ranged from 19.5-29.5 ($\bar{x}$ = 24.4) mm SL with a percent occurrence of 22% (Figure 16). Juveniles from the neuston (Figure 17) were found in high concentrations throughout the survey area and ranged in length from 21.0-67.0 ($\bar{x}$ = 31.6) mm SL with a percent occurrence of 35%. Blue lanternfish larvae from the Tucker trawl were found throughout the survey area and ranged from 2.3-14.2 ($\bar{x}$ = 6.7) mm SL with a percent occurrence of 78%.

Cololabis saira (Figure 18) - Pacific saury larvae from the neuston were found offshore in the southern half of the survey area and both offshore and nearshore in the northern half of the survey area. The larvae ranged from 7.3-57.0 ($\bar{x}$ = 24.2) mm SL and occurred at 19.3% of the stations occupied.

Trachipterus altivelis (Figure 19) - Eggs of the king-of-the-salmon sorted from neuston net catches were distributed throughout the survey area at both nearshore and offshore stations. King-of-the-salmon eggs were found at 42% of the neuston stations occupied.

Sebastes species (Figure 20) - Rockfish larvae from bongo tows were found in highest concentrations nearshore south of 46°N. The larvae ranged from 2.3-11.0 ($\bar{x}$ = 3.8) mm SL with a percent occurrence of 47%.

Anoplopoma fimbria (Figure 21) - Sablefish eggs from Tucker trawls were most abundant over the edge of the continental shelf (depth range 400-1700 m), although they occurred throughout the sampling area. There was a gap in occurrence of eggs between 125°W (near the edge of the continental shelf) and 126°30'W (195 km offshore), throughout the survey area, where no eggs were found. More eggs were found in the Tucker during the second pass over the grid in late January, especially at stations near the shelf break. Sablefish eggs were found at 41% of the Tucker stations occupied, however no sablefish larvae were found. A total of 47 sablefish eggs were found in the Tucker trawl. No sablefish eggs or larvae were collected in the bongo or neuston tows.

Hexagrammos decagrammus (Figure 22) - Kelp greenling larvae were found in neuston samples predominately in coastal regions throughout the survey area, with the highest abundances occurring at 44°N. The larvae ranged in length from 6.2-19.0 ($\bar{x}$ = 12.0) mm SL and occurred at 43% of the stations occupied.

Hexagrammos lagocephalus (Figure 23) - Rock greenling found in the neuston were distributed east of 128°W throughout the sampling area. The larvae ranged from 6.1-28.5 ($\bar{x}$ = 16.3) mm SL and occurred at 28% of the stations occupied.

Hemilepidotus spinosus (Figure 24) - Brown Irish lord larvae caught in the neuston were found in coastal regions, predominately south of the Columbia River, and were particularly abundant nearshore at 43°30'N (station 51). The larvae ranged from 3.9-10.5 ($\bar{x}$ = 6.7) mm SL and were found at 31% of the stations occupied.

Icichthys lockingtoni (Figure 25) - Medusafish eggs from the bongo were found south of 45°30'N, predominately near the continental shelf and were most abundant (220/10 m^2) at 42°N (station 64). Eggs occurred at 23% of the bongo stations occupied. Medusafish eggs from the neuston had a similar distribution and had a percent occurrence of 24% (Figure 26).

Bothidae (Figures 27 and 28) - Lefteye flounder eggs from the bongo were found in coastal waters throughout the sampling area and were also found at some offshore stations at 40°N. Eggs occurred at 20% of the bongo stations occupied. Lefteye flounder eggs from the neuston were found mostly in coastal waters north of 42°30'N. Eggs occurred at 19% of the neuston stations occupied.

Citharichthys spp. (Figure 29) - Sanddab eggs from the neuston were found at coastal stations north of 42°30'N. Some sanddab eggs were caught offshore at station 36. Eggs occurred at 11% of the neuston stations occupied.

Pleuronectidae (Figures 30 and 31) - Righteye flounder eggs were collected in both bongo and neuston tows mostly at coastal stations north of 42°N. Eggs occurred at 13% of the bongo

stations and 19% of the neuston stations occupied.

COMMUNITY STRUCTURE

Recurrent group analysis at the 0.4 affinity level for neuston egg and larvae catches showed three groups whose members had five or more occurrences (Figure 33). The first major nearshore group was composed of Pleuronectidae, Bothidae, Citharichthys spp., Parophrys vetulus, and Isopsetta isolepis. The second major nearshore group was composed of Hexagrammos decagrammus, Hemilepidotus spinosus, and Scorpaenichthys marmoratus. Chauliodus macouni and Icichthys lockingtoni comprised the only offshore group from the neuston. Groups in the neuston catches were aligned mainly in an onshore-offshore pattern, as was indicated in an earlier study of the area (Richardson et al. 1980).

In the bongo catches a more complex pattern emerged (Figure 32). There were five groups whose members had more than five occurrences. The central offshore group consisted of three myctophid members, three bathylagid members, and Icichthys lockingtoni. Stenobrachius leucopsarus, with 46 occurrences, was the most abundant species of the group. Chauliodus macouni and Bathylagus spp. had a greater than .4 affinity with all but two species in the main offshore group. Tarletonbeania crenularis and Trachipterus altivelis formed another offshore group with more than five occurrences. Sebastes spp. and Icosteus aenigmaticus comprised another offshore group.

The major nearshore group of eggs and larvae from the bongo was composed of Osmeridae, Citharichthys spp., Platichthys stellatus, Pleuronectidae, Bothidae, and Parophrys vetulus. The group had few outside associations at the .4 affinity level. Osmeridae had affinity with two taxa outside the central nearshore group: Hemilepidotus spinosus and Cyclopteridae. Parophrys vetulus had overlap outside its group with Bathylagidae, which was from the central offshore group.

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Figure 32.--Results of recurrent group analysis on bongo catches (both fish eggs and larvae) from cruise 1MF87, January 1987, at an affinity level of 0.400. Taxa in rectangles are members of recurrent groups. Lines connect taxa with affinities outside their groups. Numbers in parentheses following taxa names are the number of occurrences of the taxa.

Figure 33.--Results of recurrent group analysis on neuston catches (both fish eggs and larvae) from cruise 1MF87, January 1987, at an affinity level of 0.400. Taxa in rectangles are members of recurrent groups. Lines connect taxa with affinities outside their groups. Numbers in parentheses following taxa names are the number of occurrences of the taxa.

1MF87 NEUSTON AND BONGO STATION SUMMARY

STATION	POSITION LAT (N)	POSITION LONG (W)	DATE YYMMDD	POLYGONAL AREA KM2	TIME GMT	NEUSTON TOW STANDARD HAUL FACTORS* A	NEUSTON TOW STANDARD HAUL FACTORS* B	TIME GMT	BONGO TOW STANDARD HAUL FACTORS* A	BONGO TOW STANDARD HAUL FACTORS* B
G001A	48 0.7	124 49.6	870107	2117	1812	0.035	23.570	1846	5.527	13.160
G002A	48 0.0	125 10.5	870107	2000	2103	0.028	18.690	2039	6.439	4.700
G003A	47 59.6	125 33.2	870107	2182	2308	0.028	18.712	2324	7.391	4.348
G004A	47 59.7	125 55.0	870108	1865	0304	0.023	15.105	0220	6.416	3.224
G005A	48 0.3	126 14.3	870108	1994	0600	0.028	18.681	0630	8.564	4.002
G006A	47 21.6	124 26.6	870112	1777	1253	0.028	18.700	1240	3.723	12.410
G007A	47 19.6	124 46.0	870112	2051	1542	0.029	19.222	1600	6.439	3.172
G008A	47 18.2	125 9.8	870112	2787	2026	0.030	20.014	1958	8.008	3.673
G009A	47 19.4	125 42.6	870112	4298	2349	0.029	19.101	0009	7.006	2.969
G010A	46 39.7	124 17.0	870113	1723	0958	0.027	17.944	0942	4.504	8.189
G011A	46 39.9	124 39.4	870113	2064	1233	0.026	17.495	1307	5.739	4.381
G012A	46 41.2	125 2.2	870113	3450	1706	0.023	15.287	1627	5.687	2.977
G013A	46 40.3	125 52.6	870114	5041	0143	0.026	17.563	0200	7.706	3.741
G014A	46 40.3	126 49.7	870114	5553	0816	0.027	17.955	0745	7.538	3.426
G015A	47 20.8	126 40.9	870114	5960	1359	0.028	18.339	1416	7.635	3.502
G016A	47 21.3	127 40.6	870114	5380	1952	0.029	19.463	1923	6.060	2.928
G017A	46 40.4	127 48.2	870115	5385	0038	0.029	19.596	0141	6.745	3.339
G018A	46 38.7	128 54.0	870115	6587	0743	0.027	18.156	0628	8.871	3.942
G019A	46 0.8	128 30.6	870115	5174	1200	0.029	19.345	1219	8.254	4.007
G020A	45 59.6	127 32.0	870115	5056	1622	0.023	15.241	1553	7.231	3.545
G021A	46 0.9	126 34.2	870115	5269	2129	0.028	18.550	2151	7.849	3.651
G022A	46 1.0	125 36.5	870116	4963	0350	0.026	17.315	0323	9.121	4.146
G023A	46 0.2	124 46.3	870116	3443	0937	0.027	17.808	0953	6.869	3.522
G024A	46 0.8	124 20.0	870116	2046	1219	0.028	18.574	1157	7.154	5.816
G025A	45 59.9	124 3.7	870116	830	1342	0.025	16.603	1402	6.242	12.484
G026A	45 20.5	124 7.0	870116	1661	2244	0.028	18.760	2227	6.710	7.456
G027A	45 20.0	124 27.3	870117	2038	0107	0.027	18.270	0123	9.207	3.935
G028A	45 20.5	124 47.5	870117	3975	0335	0.026	17.516	0307	8.350	3.902
G029A	45 20.2	125 44.1	870117	5606	0709	0.027	17.813	0725	8.011	3.761
G030A	45 21.3	126 40.6	870117	5659	1119	0.028	18.467	1052	8.632	3.888
G031A	45 20.2	127 37.0	870117	5659	1438	0.030	19.717	1458	6.374	3.541
G032A	45 21.0	128 34.4	870117	5774	1909	0.024	16.260	1839	6.340	3.664
G033A	44 39.9	128 35.1	870117	5130	2236	0.025	16.548	2355	10.141	4.507
G034A	44 39.9	127 39.9	870118	5178	0342	0.025	16.411	0433	8.681	4.019
G035A	44 39.9	126 43.7	870118	5509	0907	0.026	17.325	0923	8.774	4.043
G036A	44 40.8	125 48.0	870118	5416	1413	0.027	17.706	1346	7.216	3.720
G037A	44 40.0	124 52.4	870118	3803	2003	0.026	17.621	2019	8.547	4.070
G038A	44 39.4	124 29.6	870118	2093	2229	0.026	17.423	2209	6.834	5.467

* "A" CONVERTS CATCH TO CATCH PER 10M2, "B" CONVERTS CATCH TO CATCH PER 1000M3 (SEE SMITH AND RICHARDSON 1977)

Table 1a.--Data associated with neuston and bongo tows during cruise 1MF87, January 1987.

	POSITION		DATE	POLYGONAL AREA	TIME	NEUSTON TOW STANDARD HAUL FACTORS*		TIME	BONGO TOW STANDARD HAUL FACTORS*	
	LAT (N)	LONG (W)	YYMMDD	KM2	GMT	A	B	GMT	A	B
G039A	44 40.5	124 10.0	870119	1502	0012	0.027	18.328	0027	6.701	11.168
G040A	43 59.5	124 12.8	870119	1247	0403	0.024	16.220	0351	6.160	14.000
G041A	44 0.3	124 32.9	870119	1893	0541	0.026	17.610	0556	7.369	5.226
G042A	44 0.7	124 54.2	870119	3670	0759	0.026	17.259	0743	6.176	6.501
G043A	44 0.2	125 48.9	870119	5317	1121	0.027	17.922	1146	8.351	4.034
G044A	44 0.7	126 43.3	870119	5393	1541	0.024	16.326	1515	7.558	3.916
G045A	44 0.1	127 39.3	870119	5499	1903	0.025	16.525	1920	7.671	3.618
G046A	43 59.4	128 34.8	870119	5154	2303	0.024	16.286	2240	7.956	3.701
G047A	43 20.1	128 52.2	870120	5311	0315	0.026	17.658	0421	10.086	4.348
G048A	43 19.2	127 52.0	870120	5068	0956	0.027	17.781	0840	8.292	4.006
G049A	43 20.3	127 2.1	870120	5199	1356	0.027	18.139	1510	7.780	3.653
G050A	43 22.1	126 3.6	870120	5201	2049	0.028	18.754	1935	7.687	3.787
G051A	43 20.6	125 13.1	870121	3734	0258	0.027	18.111	0357	8.837	4.017
G052A	43 18.9	124 51.9	870121	2053	0734	0.028	18.520	0610	8.879	4.228
G053A	43 19.4	124 29.8	870121	1741	0921	0.029	19.549	0939	4.934	6.579
G054A	42 39.4	124 32.4	870121	1260	1338	0.025	16.420	1330	4.283	6.490
G055A	42 39.8	124 53.8	870121	1978	1515	0.024	16.172	1534	7.455	3.420
G056A	42 39.1	125 14.5	870121	3736	1744	0.026	17.542	1714	8.325	3.819
G057A	42 39.9	126 8.8	870121	5284	2114	0.027	17.781	2129	8.544	3.797
G058A	42 38.8	127 2.9	870122	5404	0144	0.026	17.134	0117	6.910	3.455
G059A	42 39.8	127 57.2	870122	5259	0523	0.024	16.077	0537	6.765	3.487
G060A	42 39.1	128 57.6	870122	5329	0955	0.026	17.179	0928	6.858	3.362
G061A	41 59.5	128 37.5	870122	5787	1439	0.023	15.386	1500	8.935	3.971
G062A	41 58.7	127 41.6	870122	5769	2004	0.027	17.917	1941	7.306	3.367
G063A	41 59.0	126 50.2	870123	5570	0013	0.029	19.629	0031	8.124	4.276
G064A	41 59.1	125 55.6	870123	5559	0531	0.025	16.992	0506	8.166	3.746
G065A	41 59.2	125 3.9	870123	3990	1131	0.028	18.345	1147	8.304	3.844
G066A	41 58.6	124 43.3	870123	2458	1532	0.027	17.743	1504	8.005	3.776
G067A	41 59.9	124 21.9	870123	1423	1715	0.026	17.584	1731	5.060	9.035
G068A	41 19.9	124 15.3	870123	2468	2124	0.026	17.264	2112	4.615	7.566
G069A	41 19.8	124 34.6	870123	2141	2333	0.024	16.150	2348	6.862	3.555
G070A	41 20.3	125 55.1	870124	3641	1740	0.026	17.075	1757	8.355	3.633
G071A	41 19.8	125 49.6	870124	5714	2215	0.027	18.050	2151	9.833	4.313
G072A	40 39.3	125 55.1	870125	5659	0236	0.027	18.123	0334	8.347	3.829
G073A	40 38.0	125 0.2	870125	4003	1132	0.024	15.857	1012	6.989	3.297
G074A	40 39.9	124 43.0	870125	1942	1311	0.023	15.248	1412	7.899	3.038
G075A	40 39.5	124 24.0	870125	1614	1726	0.026	17.637	1714	4.517	15.056
G076A	39 59.8	124 11.4	870126	2010	0701	0.025	16.424	0715	6.730	3.332
G077A	40 0.2	124 32.3	870126	2135	0919	0.026	17.569	0852	8.785	3.939
G078A	39 59.9	124 51.1	870126	3900	1042	0.026	17.551	1057	9.522	4.104
G079A	39 59.3	125 43.6	870126	5431	1513	0.022	14.811	1445	8.084	3.760
G080A	40 0.2	126 35.6	870126	5310	1840	0.025	16.461	1859	9.269	4.175

* "A" CONVERTS CATCH TO CATCH PER 10M2, "B" CONVERTS CATCH TO CATCH PER 1000M3 (SEE SMITH AND RICHARDSON 1977)

Table 1b.--Data associated with neuston and bongo tows during cruise 1MF87, January 1987, continued.

	POSITION		DATE	POLYGONAL AREA	TIME	NEUSTON TOW STANDARD HAUL FACTORS*		TIME	BONGO TOW STANDARD HAUL FACTORS*	
	LAT (N)	LONG (W)	YYMMDD	KM2	GMT	A	B	GMT	A	B
G081A	39 59.4	127 27.7	870127	5597	2258	0.026	17.654	2232	9.506	4.133
G082A	39 59.9	128 20.2	870127	5409	0225	0.026	17.182	0225	8.483	4.059
G083A	40 37.5	128 28.9	870127	6017	0834	0.026	17.242	0721	7.072	3.320
G084A	40 39.9	127 39.1	870127	5590	1222	0.024	16.139	1238	7.938	3.308
G085A	40 38.9	126 48.5	870127	5284	2159	0.019	12.883	2133	8.869	3.696
G086A	41 19.9	126 42.6	870128	5500	0139	0.031	20.736	0155	6.247	3.471
G087A	41 20.5	127 36.8	870128	5461	0643	0.027	18.100	0616	6.536	3.188
G088A	41 19.9	128 30.0	870128	5636	1139	0.024	15.942	1157	9.865	3.868

* "A" CONVERTS CATCH TO CATCH PER 10M2, "B" CONVERTS CATCH TO CATCH PER 1000M3 (SEE SMITH AND RICHARDSON 1977)

Table 1c.--Data associated with neuston and bongo tows during cruise 1MF87, January 1987, continued.

1MF87 TUCKER STATION SUMMARY

STATION	POSITION LAT (N)	POSITION LONG (W)	DATE YYMMDD	POLYGONAL AREA KM2	TIME GMT	TUCKER STANDARD TOW HAUL FACTORS* A	B
G012A	46 40.0	125 0.1	870113	3450	1743	2.682	0.743
G013A	46 40.2	125 50.8	870113	5041	0050	3.251	0.834
G014A	46 40.7	126 52.2	870114	5553	0815	2.658	0.678
G017A	46 41.2	127 48.3	870115	5385	0057	2.473	0.681
G018A	46 38.5	128 49.4	870115	6587	0656	3.004	0.751
G047A	43 20.4	128 50.9	870120	5311	0338	2.826	0.666
G048A	43 19.2	127 53.9	870120	5068	0909	2.398	0.623
G049A	43 20.7	127 1.4	870120	5199	1414	2.785	0.665
G050A	43 21.5	126 5.1	870120	5201	2005	2.427	0.632
G051A	43 20.8	125 12.2	870121	3734	0313	2.578	0.661
G052A	43 19.9	124 51.1	870121	2053	0648	2.720	0.633
G072A	40 38.7	125 55.4	870125	5659	0251	3.077	0.749
G073A	40 39.3	125 0.8	870125	4003	1043	2.293	0.586
G074A	40 39.1	124 42.8	870125	1942	1329	2.570	0.747
G083A	40 38.8	128 29.3	870127	6017	0747	2.379	0.599
G084A	40 38.8	127 38.7	870127	5590	1307	3.257	0.754
G085A	40 38.4	126 46.6	870128	5284	2049	3.334	0.805
G089A	43 19.9	128 52.1	870128	5311	2236	2.457	0.647
G090A	43 19.9	127 56.9	870129	5068	0237	3.204	0.722
G091A	43 19.8	127 0.9	870129	5199	0640	2.864	0.690
G092A	43 19.8	126 6.0	870129	5201	1044	2.632	0.648
G093A	43 19.9	125 12.3	870129	3734	1503	2.781	0.688
G094A	46 40.3	124 49.0	870130	2064	1111	3.051	0.895
G095A	46 39.9	125 0.0	870130	3450	1247	3.063	0.792
G096A	46 40.0	125 50.0	870130	5041	1721	3.552	0.834
G097A	46 39.3	126 49.4	870130	5553	2142	3.603	0.848
G098A	46 39.0	127 30.7	870131	5385	0103	2.601	0.665

* "A" CONVERTS CATCH TO CATCH PER 10M2, "B" CONVERTS CATCH TO CATCH PER 1000M3
(SEE SMITH AND RICHARDSON 1977)

Table 1d.--Data associated with Tucker trawls during cruise 1MF87, January 1987.

CRUISE: 1MF87

STAGE: EGG

SPECIES	NEUSTON OCCUR. %	NEUSTON LOG NO. IN AREA	BONGO OCCUR. %	BONGO LOG NO. IN AREA
UNIDENTIFIED	1.14	7.0091	6.82	10.6391
TELEOST TYPE E			1.14	9.1858
TELEOST TYPE G	1.14	7.3101	11.36	10.8306
TELEOST TYPE P	1.14	6.9636	5.68	10.3555
ARGENTINIDAE	1.14	7.1314		
NANSENIA CANDIDA	2.27	7.4855	5.68	10.6043
BATHYLAGIDAE	10.23	8.4877	45.45	12.2007
BATHYLAGUS SPP.	9.09	8.0595	21.59	11.2627
BATHYLAGUS MILLERI			23.86	11.2549
BATHYLAGUS OCHOTENSIS			2.27	10.0049
CHAULIODUS MACOUNI	22.73	8.6044	34.09	11.3809
TRACHIPTERIDAE	1.14	7.1309		
TRACHIPTERUS ALTIVELIS	42.05	8.9648	31.82	11.2238
ICOSTEUS AENIGMATICUS	17.05	8.3338	18.18	11.0547
ICICHTHYS LOCKINGTONI	23.86	9.0839	22.73	11.5647
BOTHIDAE	19.32	10.3452	20.45	11.8307
CITHARICHTHYS SPP.	11.36	9.1564	12.50	10.7536
PLEURONECTIDAE	19.32	10.0707	13.64	11.8616
GLYPTOCEPHALUS ZACHIRUS	1.14	6.6975	2.27	9.4116
ISOPSETTA ISOLEPIS	6.82	7.6436	2.27	9.5001
LYOPSETTA EXILIS	2.27	7.4694		
MICROSTOMUS PACIFICUS			2.27	9.5795
PAROPHRYS VETULUS	11.36	8.4482	7.95	10.5400
PLATICHTHYS STELLATUS	5.68	8.1518	7.95	10.4243
PLEURONICHTHYS DECURRENS	4.55	7.6813	3.41	9.4706
PSETTICHTHYS MELANOSTICTUS	5.68	7.8353	3.41	9.3934

Table 2.--Fish eggs collected in bongo and neuston tows during cruise 1MF87, January 1987.

CRUISE:1MF87

STAGE: LARVAE

SPECIES	NEUSTON OCCUR. %	NEUSTON LOG NO. IN AREA	BONGO OCCUR. %	BONGO LOG NO. IN AREA
UNIDENTIFIED			1.14	9.7496
DISINTEGRATED	1.14	6.6975	1.14	9.9139
ENGRAULIS MORDAX	1.14	6.6160		
OSMERIDAE	3.41	7.4840	11.36	11.2736
MICROSTOMA MICROSTOMA			1.14	9.6616
BATHYLAGIDAE	1.14	6.9778	6.82	10.7210
BATHYLAGUS SPP.	1.14	6.6664		
BATHYLAGUS MILLERI			3.41	10.0915
BATHYLAGUS OCHOTENSIS			36.36	11.5319
BATHYLAGUS PACIFICUS			2.27	9.7564
CHAULIODUS MACOUNI			13.64	10.7616
MYCTOPHIDAE			2.27	10.0089
LAMPANYCTUS SPP.			1.14	9.6616
STENOBRACHIUS LEUCOPSARUS	1.14	7.1513	40.91	11.5705
TARLETONBEANIA CRENULARIS	21.59	9.1570	42.05	11.5208
DIOGENICHTHYS ATLANTICUS			1.14	9.6616
PROTOMYCTOPHUM CROCKERI	1.14	6.6664	25.00	11.2141
PROTOMYCTOPHUM THOMPSONI			21.59	11.1453
LESTIDIOPS RINGENS			9.09	10.4831
COLOLABIS SAIRA	19.32	8.7758	1.14	9.5572
TRACHIPTERUS ALTIVELIS			2.27	9.8790
MELAMPHAEIDAE			4.55	10.2572
MELAMPHAES SPP.			1.14	9.6102
MELAMPHAES LUGUBRIS			1.14	9.1655
SEBASTES SPP.	7.95	7.8842	46.59	11.8291
HEXAGRAMMOS SPP.	1.14	6.9636		
HEXAGRAMMOS DECAGRAMMUS	43.18	9.4747	5.68	9.7943
HEXAGRAMMOS LAGOCEPHALUS	28.41	8.7336		
HEXAGRAMMOS STELLERI	1.14	7.1752	1.14	9.0682
OPHIODON ELONGATUS	3.41	7.1164	1.14	8.8572
OXYLEBIUS PICTUS			1.14	8.8572
ARTEDIUS FENESTRALIS			1.14	9.0682
ARTEDIUS HARRINGTONI			1.14	9.0029

Table 3a.--Fish larvae collected in bongo and neuston tows during cruise 1MF87, January 1987.

CRUISE: 1MF87

STAGE: LARVAE

SPECIES	NEUSTON OCCUR. %	NEUSTON LOG NO. IN AREA	BONGO OCCUR. %	BONGO LOG NO. IN AREA
HEMILEPIDOTUS HEMILEPIDOTUS	9.09	8.0886	3.41	9.7637
HEMILEPIDOTUS SPINOSUS	30.68	9.8450	7.95	10.4269
LEPTOCOTTUS ARMATUS	3.41	7.4754	2.27	9.1093
RADULINUS ASPRELLUS			1.14	8.9341
SCORPAENICHTHYS MARMORATUS	18.18	8.4925	2.27	9.2693
AGONIDAE			2.27	9.5686
CYCLOPTERIDAE			9.09	10.2010
BATHYMASTER SPP.	1.14	6.8742		
STICHAEIDAE			2.27	9.5005
CHIROLOPHIS SPP.			1.14	8.9341
LYCONECTES ALEUTENSIS	1.14	7.5341	1.14	8.7321
PHOLIS SPP.			1.14	9.0029
LEPIDOGOBIUS LEPIDUS			2.27	9.2222
ICICHTHYS LOCKINGTONI			3.41	10.3161
CITHARICHTHYS SPP.	1.14	7.8543	3.41	9.7530
CITHARICHTHYS SORDIDUS	1.14	6.6812	7.95	10.5509
CITHARICHTHYS STIGMAEUS	1.14	6.6812	10.23	10.6187
MICROSTOMUS PACIFICUS			1.14	9.6165
PAROPHRYS VETULUS			6.82	11.0234
REINHARDTIUS HIPPOGLOSSOIDES			3.41	9.8476

Table 3b.--Fish larvae collected in bongo and neuston tows during cruise 1MF87, January 1987, continued.

CRUISE: 1MF87

STAGE: JUVENILE

SPECIES	NEUSTON OCCUR. %	NEUSTON LOG NO. IN AREA	BONGO OCCUR. %	BONGO LOG NO. IN AREA
TACTOSTOMA MACROPUS			4.55	10.0984
DIAPHUS THETA			30.68	11.2357
LAMPANYCTUS SPP.			1.14	9.6472
LAMPANYCTUS RITTERI			5.68	10.3916
STENOBRACHIUS LEUCOPSARUS			23.86	10.9872
SYMBOLOPHORUS CALIFORNIENSE	3.41	7.9669		
TARLETONBEANIA CRENULARIS	35.23	9.7938	9.09	10.7574
PROTOMYCTOPHUM CROCKERI			3.41	10.0998
PARVILUX INGENS			1.14	9.6742
COLOLABIS SAIRA	5.68	7.9549		
LYOPSETTA EXILIS			1.14	9.1312

Table 4.--Juvenile fish collected in bongo and neuston tows during cruise 1MF87, January 1987.

CRUISE: 1MF87

STAGE: EGG

SPECIES	TUCKER TRAWL OCCUR. %	NUMBER CAUGHT
UNIDENTIFIED	51.85	53
TELEOST TYPE E	88.89	155
TELEOST TYPE G	37.04	62
TELEOST TYPE P	7.41	4
DISINTEGRATED	3.70	2
SALMONIFORMES	7.41	25
NANSENIA CANDIDA	18.52	9
MICROSTOMA MICROSTOMA	7.41	3
BATHYLAGIDAE	88.89	554
BATHYLAGUS SPP.	66.67	193
BATHYLAGUS OCHOTENSIS	33.33	30
CHAULIODUS MACOUNI	51.85	37
MYCTOPHIDAE	11.11	18
THERAGRA CHALCOGRAMMA	3.70	17
TRACHIPTERUS ALTIVELIS	66.67	61
ANOPLOPOMA FIMBRIA	40.74	47
ICOSTEUS AENIGMATICUS	33.33	28
ICICHTHYS LOCKINGTONI	44.44	57
TETRAGONURUS CUVIERI	3.70	1
BOTHIDAE	3.70	2
HIPPOGLOSSOIDES ELASSODON	3.70	2

Table 5.--Fish eggs collected in Tucker trawls during cruise 1MF87, January 1987.

CRUISE: 1MF87

STAGE: LARVAE

SPECIES	TUCKER TRAWL OCCUR. %	NUMBER CAUGHT
UNIDENTIFIED	44.44	49
DISINTEGRATED	14.81	6
BATHYLAGIDAE	11.11	24
BATHYLAGUS SPP.	7.41	9
BATHYLAGUS MILLERI	18.52	5
BATHYLAGUS OCHOTENSIS	48.15	103
BATHYLAGUS PACIFICUS	22.22	14
MACROPINNA MICROSTOMA	3.70	1
ARGYROPELECUS LYCHNUS	3.70	1
DANAPHOS OCULATUS	11.11	4
CHAULIODUS MACOUNI	33.33	20
STENOBRACHIUS LEUCOPSARUS	77.78	137
TARLETONBEANIA CRENULARIS	77.78	122
PROTOMYCTOPHUM CROCKERI	55.56	28
PROTOMYCTOPHUM THOMPSONI	62.96	50
LESTIDIOPS RINGENS	29.63	12
BENTHALBELLA DENTATA	3.70	1
GADUS MACROCEPHALUS	3.70	1
TRACHIPTERUS ALTIVELIS	3.70	1
MELAMPHAEIDAE	7.41	5
MELAMPHAES SPP.	11.11	3
SEBASTES SPP.	44.44	55
SEBASTES PAUCISPINUS	11.11	11
SEBASTES PINNIGER	3.70	5
SEBASTOLOBUS SPP.	14.81	5
HEXAGRAMMOS DECAGRAMMUS	7.41	2
HEXAGRAMMOS LAGOCEPHALUS	3.70	1
HEMILEPIDOTUS SPINOSUS	29.63	36
SCORPAENICHTHYS MARMORATUS	3.70	1
CYCLOPTERIDAE	7.41	2
CITHARICHTHYS SORDIDUS	11.11	4
CITHARICHTHYS STIGMAEUS	25.93	13
ISOPSETTA ISOLEPIS	3.70	1
MICROSTOMUS PACIFICUS	11.11	3
PAROPHRYS VETULUS	7.41	2

Table 6.--Fish larvae collected in Tucker trawls during cruise 1MF87, January 1987.

CRUISE: 1MF87

STAGE: JUVENILE

SPECIES	TUCKER TRAWL OCCUR. %	NUMBER CAUGHT
CYCLOTHONE SPP.	48.15	29
CHAULIODUS MACOUNI	14.81	4
TACTOSTOMA MACROPUS	11.11	3
IDIACANTHUS SPP.	3.70	1
CERATOSCOPELUS TOWNSENDI	3.70	1
DIAPHUS THETA	48.15	17
LAMPANYCTUS RITTERI	14.81	4
STENOBRACHIUS LEUCOPSARUS	88.89	112
STENOBRACHIUS NANNOCHIR	7.41	2
SYMBOLOPHORUS CALIFORNIENSE	3.70	1
TARLETONBEANIA CRENULARIS	40.74	45
PROTOMYCTOPHUM CROCKERI	18.52	6
PROTOMYCTOPHUM THOMPSONI	25.93	14
MELAMPHAES LUGUBRIS	3.70	1

Table 7.--Juvenile fish collected in Tucker trawls during cruise 1MF87, January 1987.

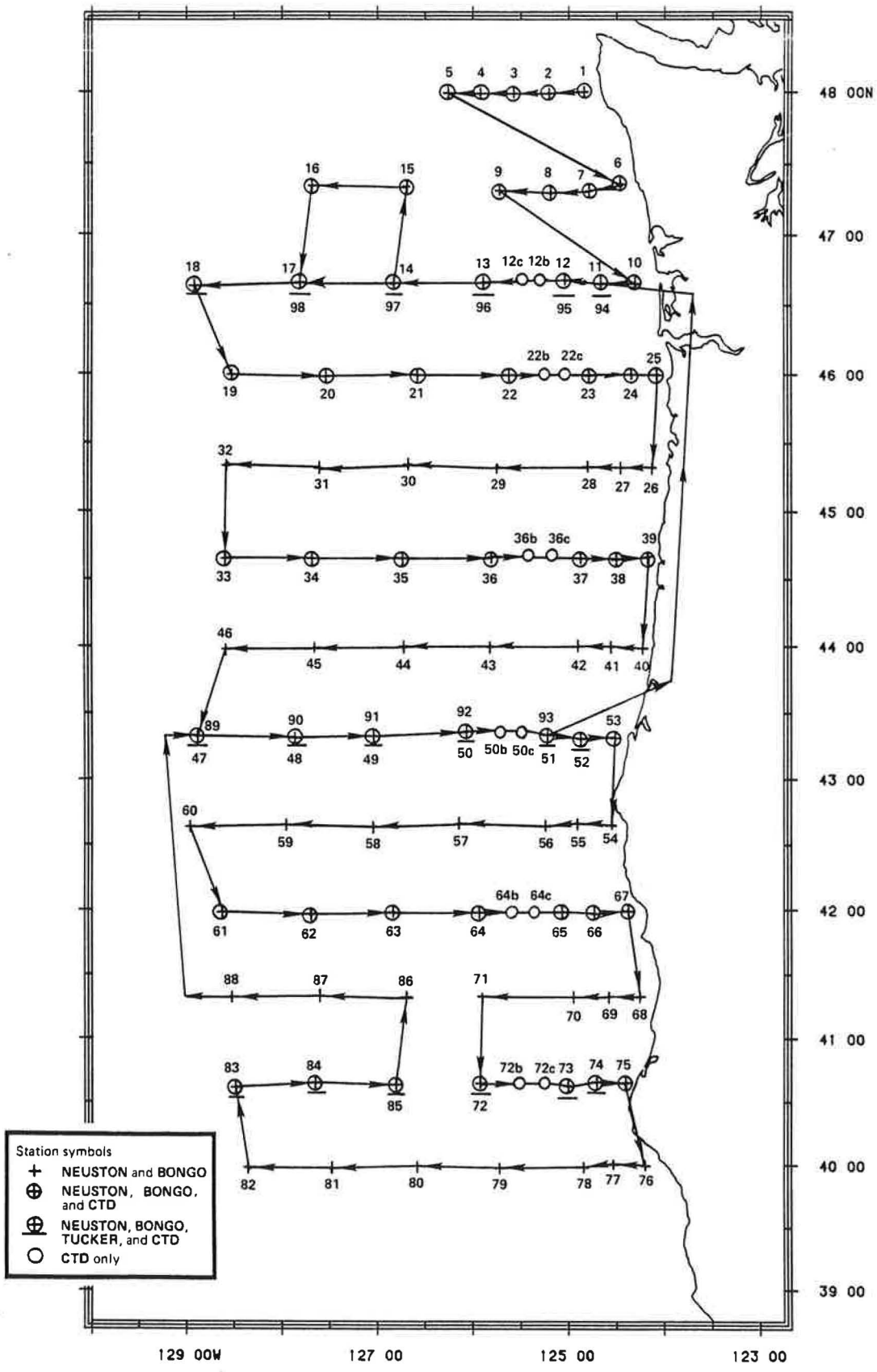

Figure 1.--Bongo, neuston, Tucker trawl, and CTD station locations and cruise track for cruise 1MF87, January 1987.

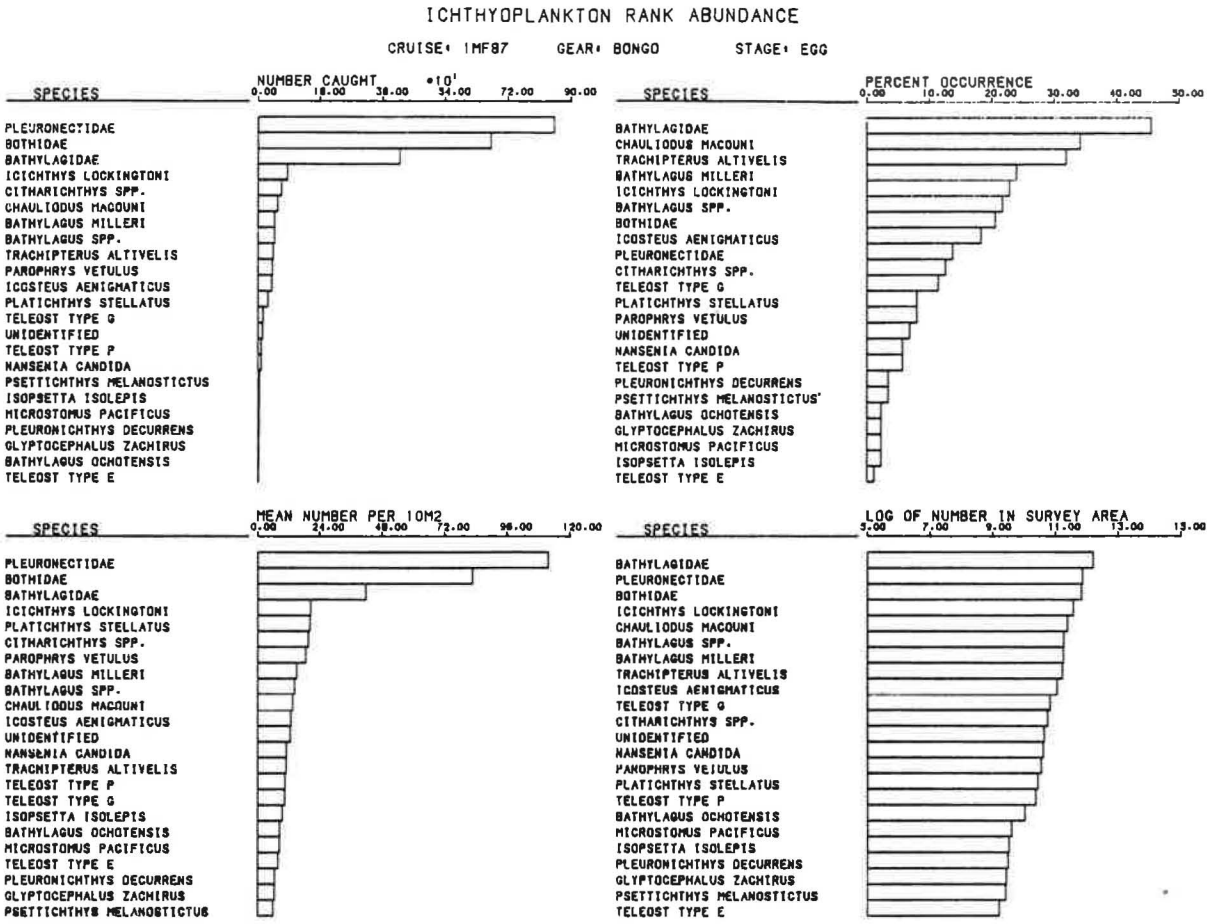

Figure 2.--Rank abundance of fish eggs caught in bongo tows during cruise 1MF87, January 1987.

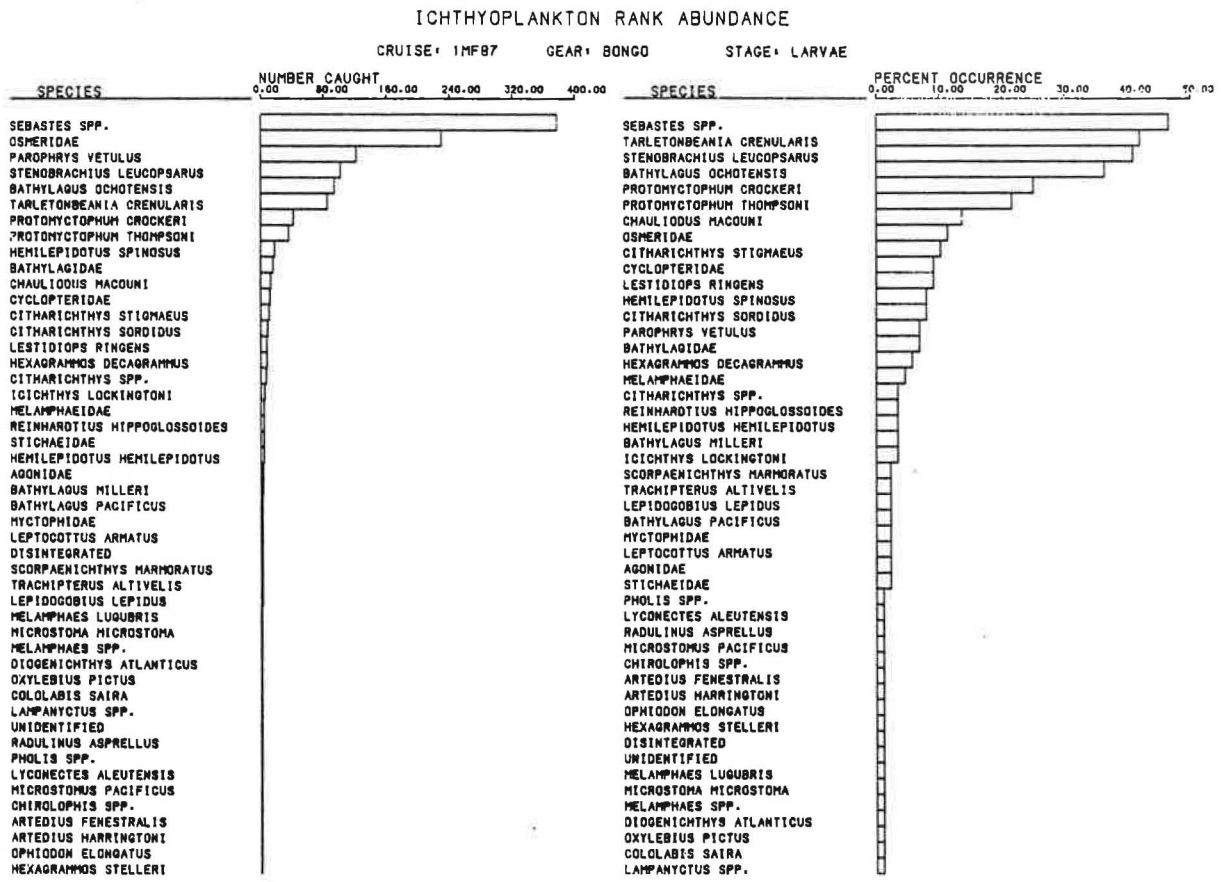

Figure 3a.--Rank abundance of fish larvae caught in bongo tows during cruise 1MF87, January 1987.

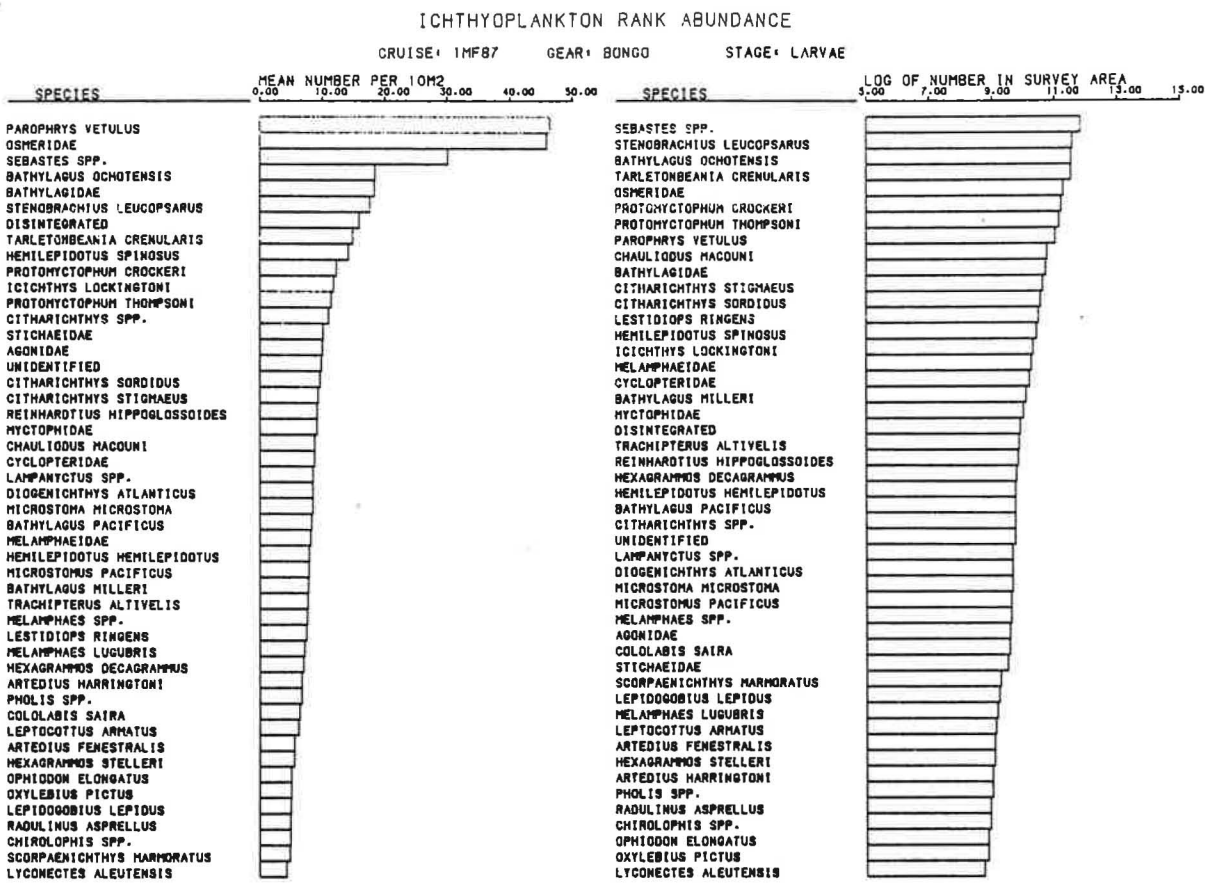

Figure 3b.--Rank abundance of fish larvae caught in bongo tows during cruise 1MF87, January 1987.

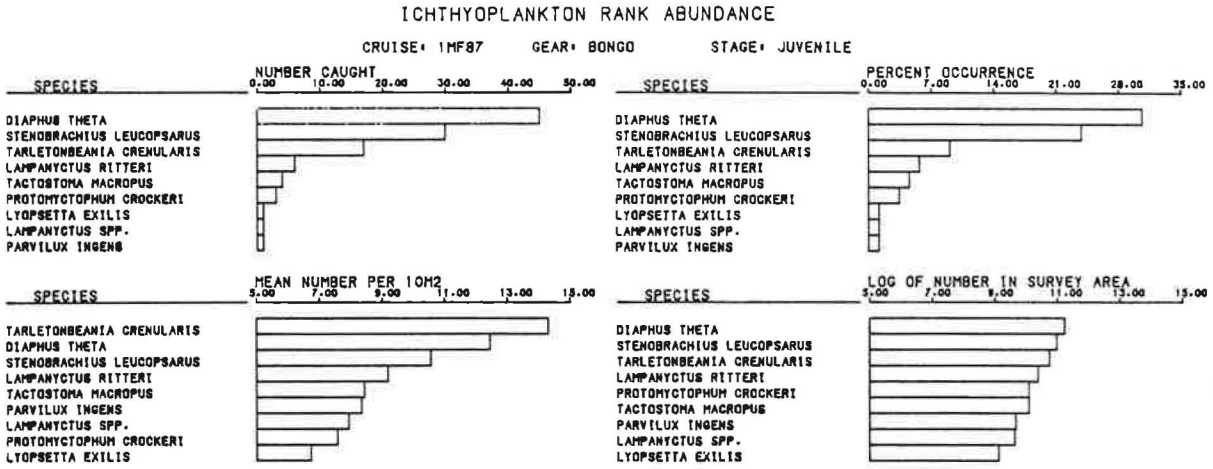

Figure 4.--Rank abundance of juvenile fish caught in bongo tows during cruise 1MF87, January 1987.

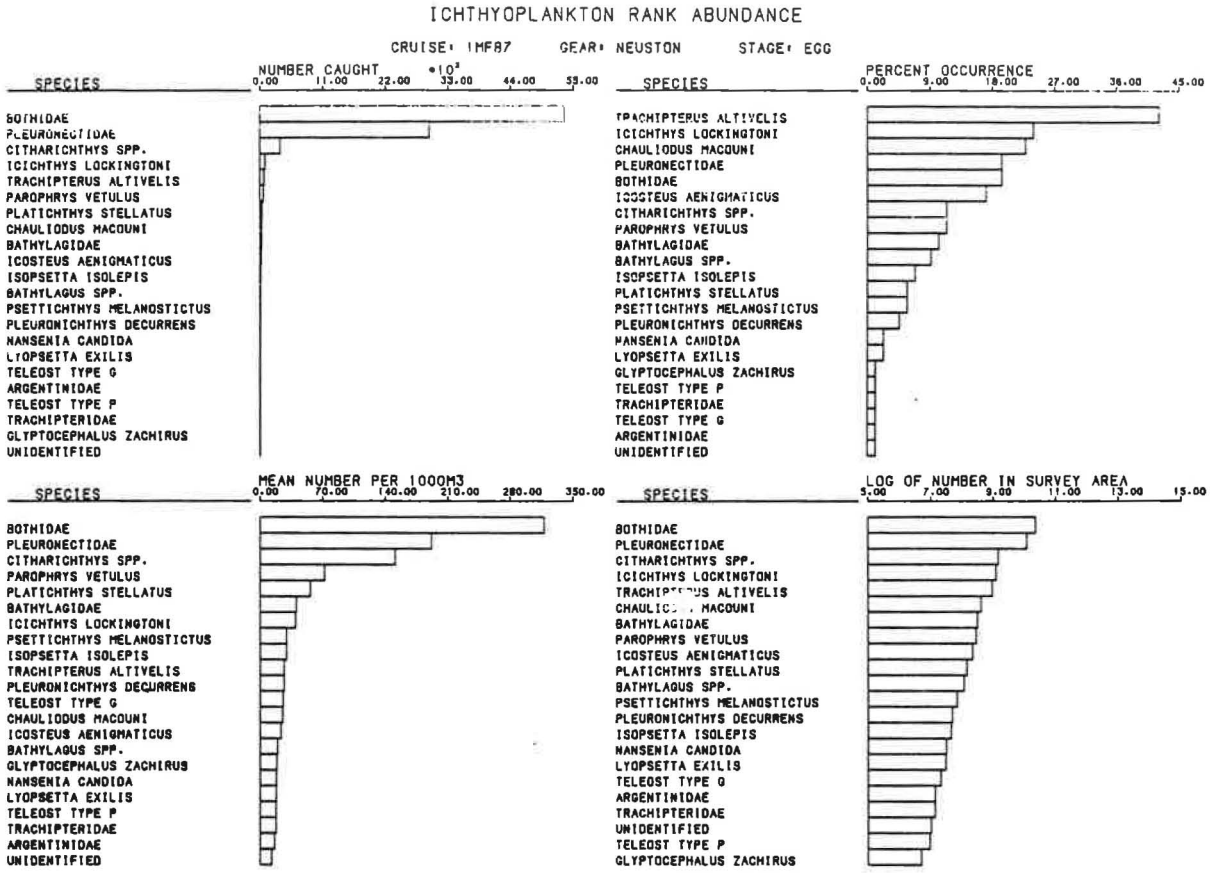

Figure 5.--Rank abundance of fish eggs caught in neuston tows during cruise 1MF87, January 1987.

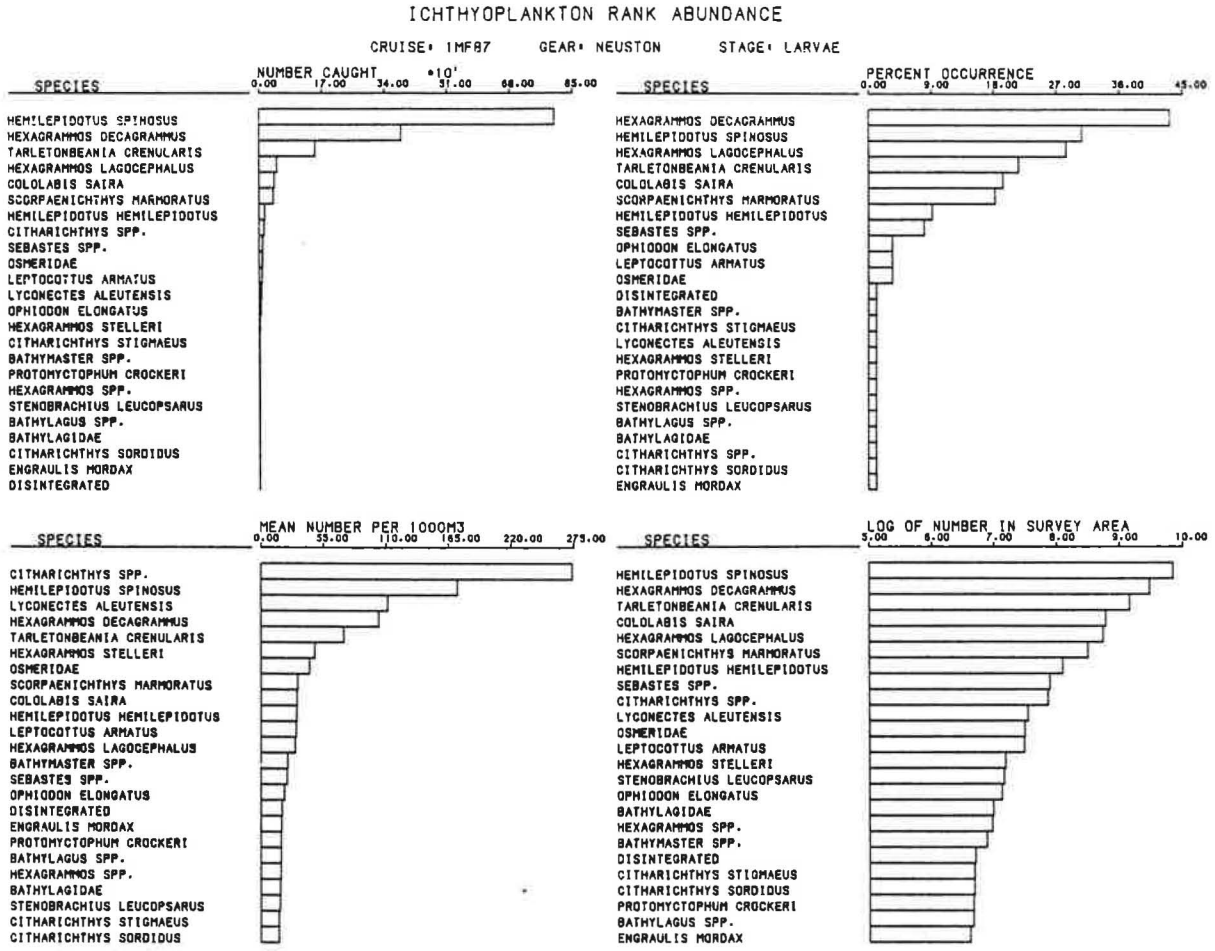

Figure 6.--Rank abundance of fish larvae caught in neuston tows during cruise 1MF87, January 1987.

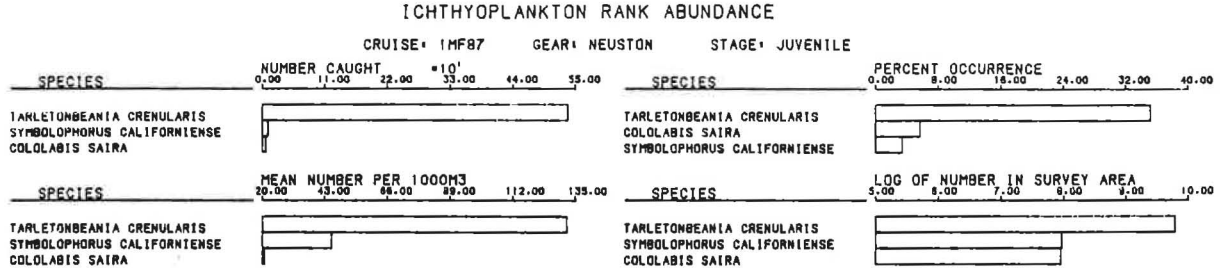

Figure 7.--Rank abundance of juvenile fish caught in neuston tows during cruise 1MF87, January 1987.

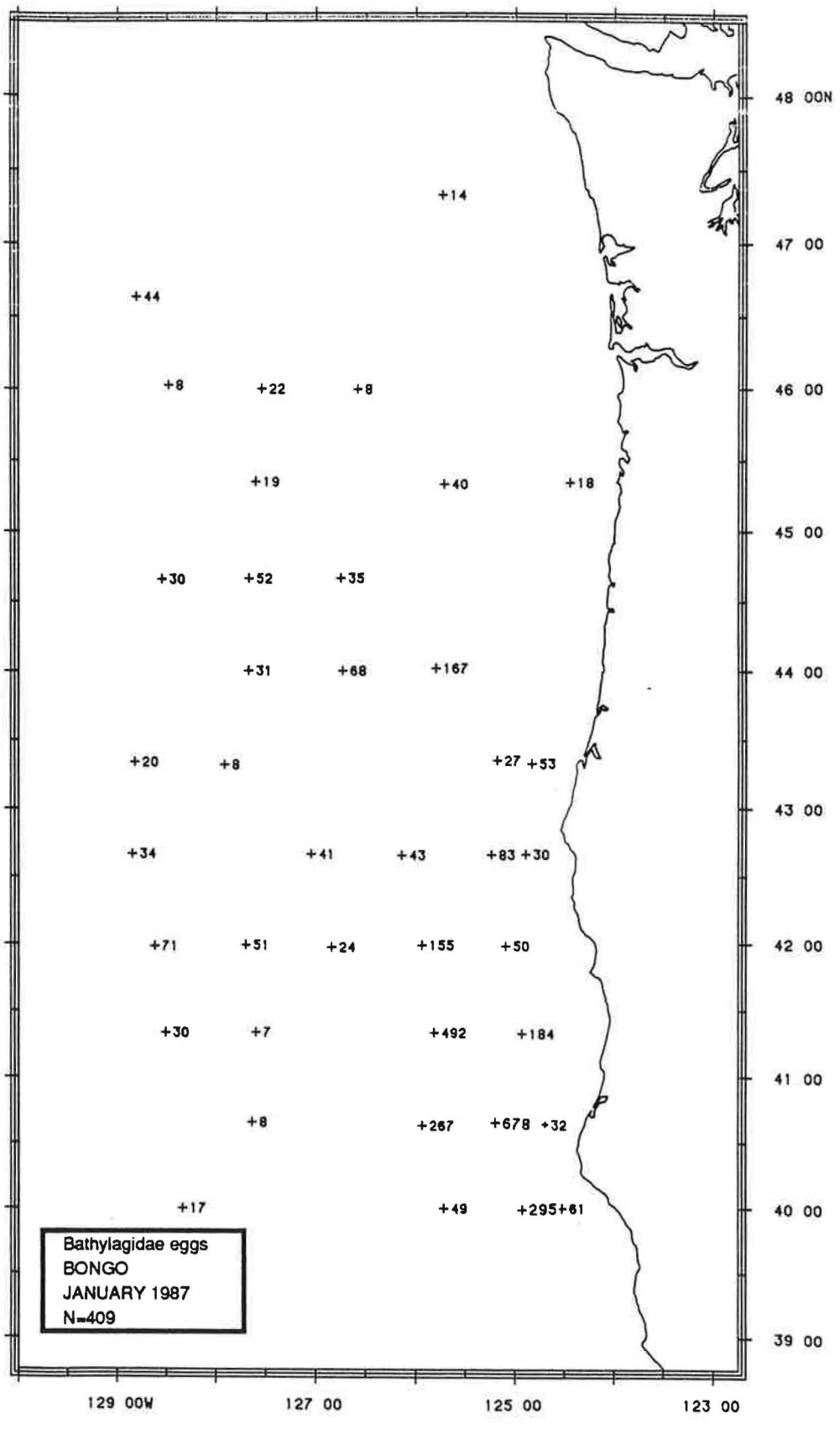

Figure 8.--Distribution of Bathylagidae eggs from bongo tows during cruise 1MF87, January 1987. Abundance expressed as number per 10 m^2.

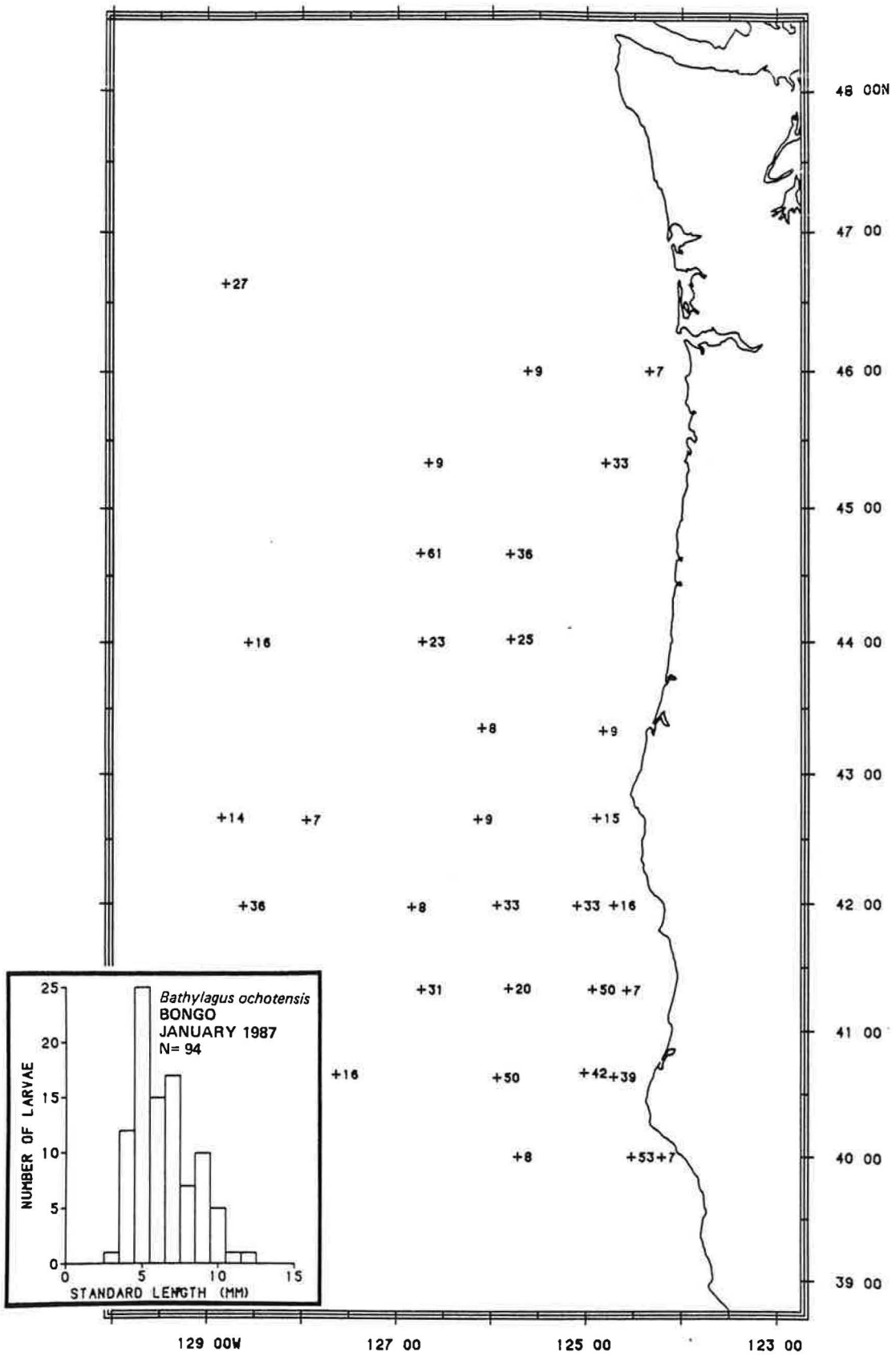

Figure 9.--Distribution of Bathylagus ochotensis larvae from bongo tows during cruise 1MF87, January 1987. Abundance expressed as number per 10 m^2.

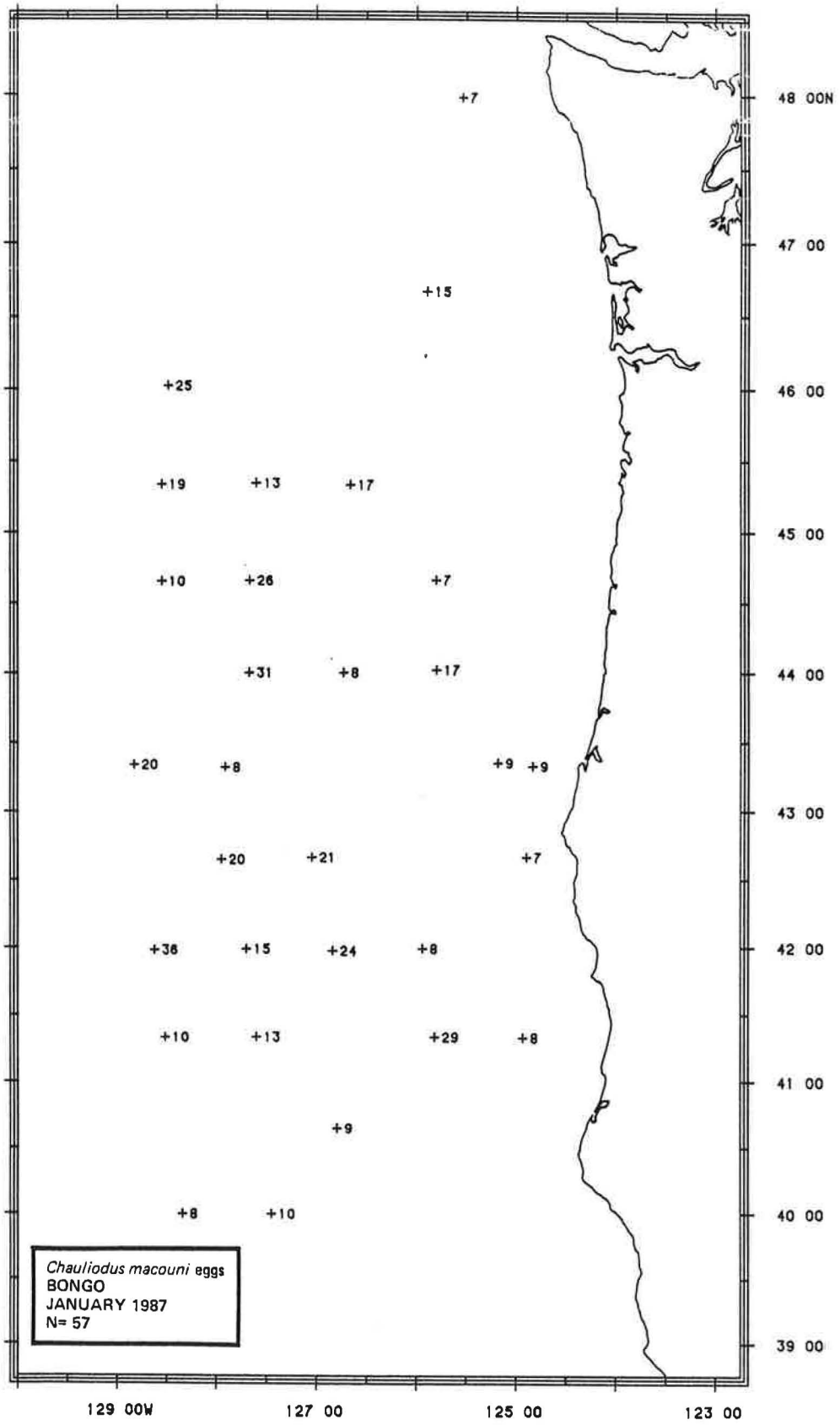

Figure 10.--Distribution of Chauliodus macouni eggs from bongo tows during cruise 1MF87, January 1987. Abundance expressed as number per 10 m^2.

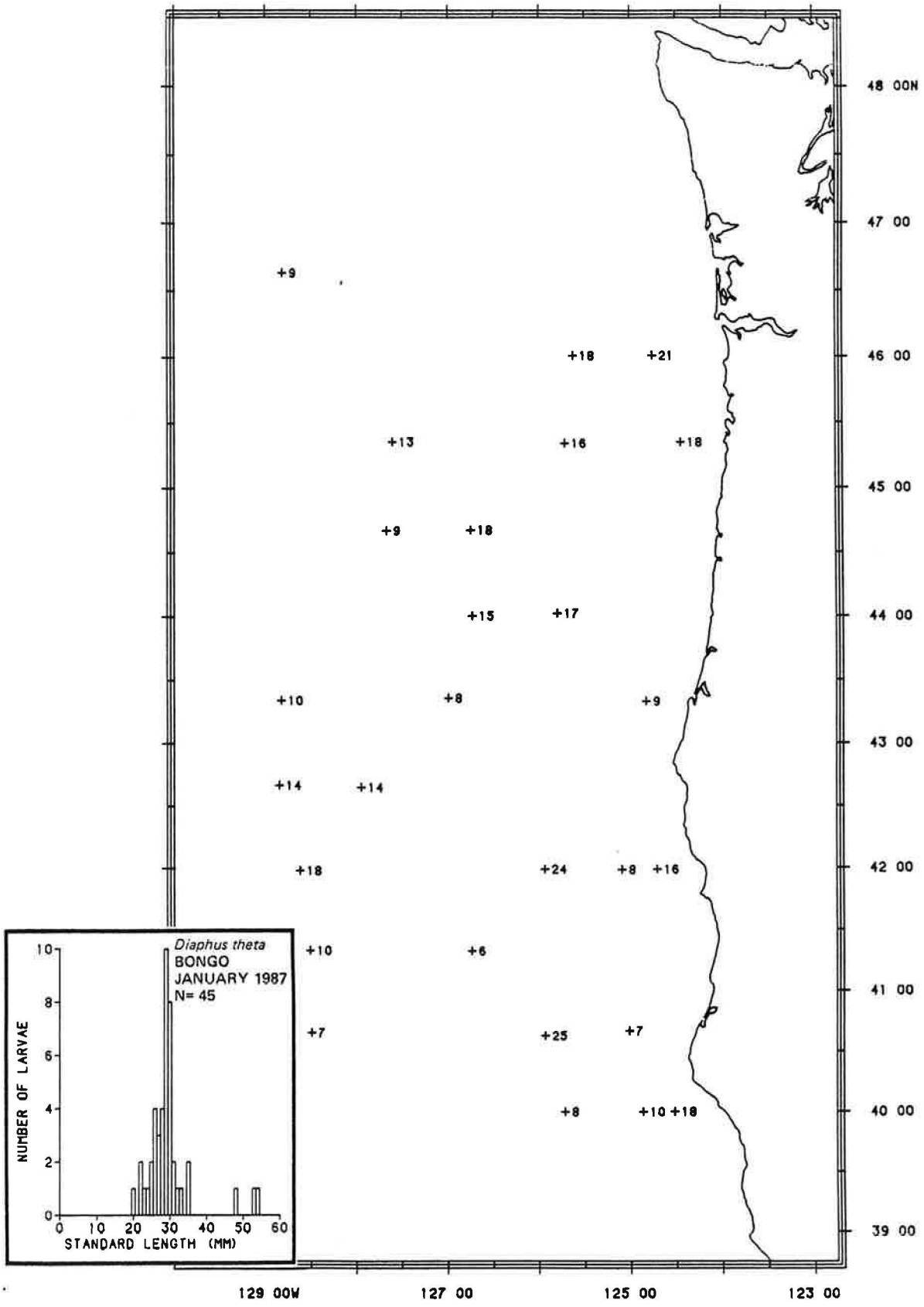

Figure 11.--Distribution of Diaphus theta juveniles from bongo tows during cruise 1MF87, January 1987. Abundance expressed as number per 10 m^2.

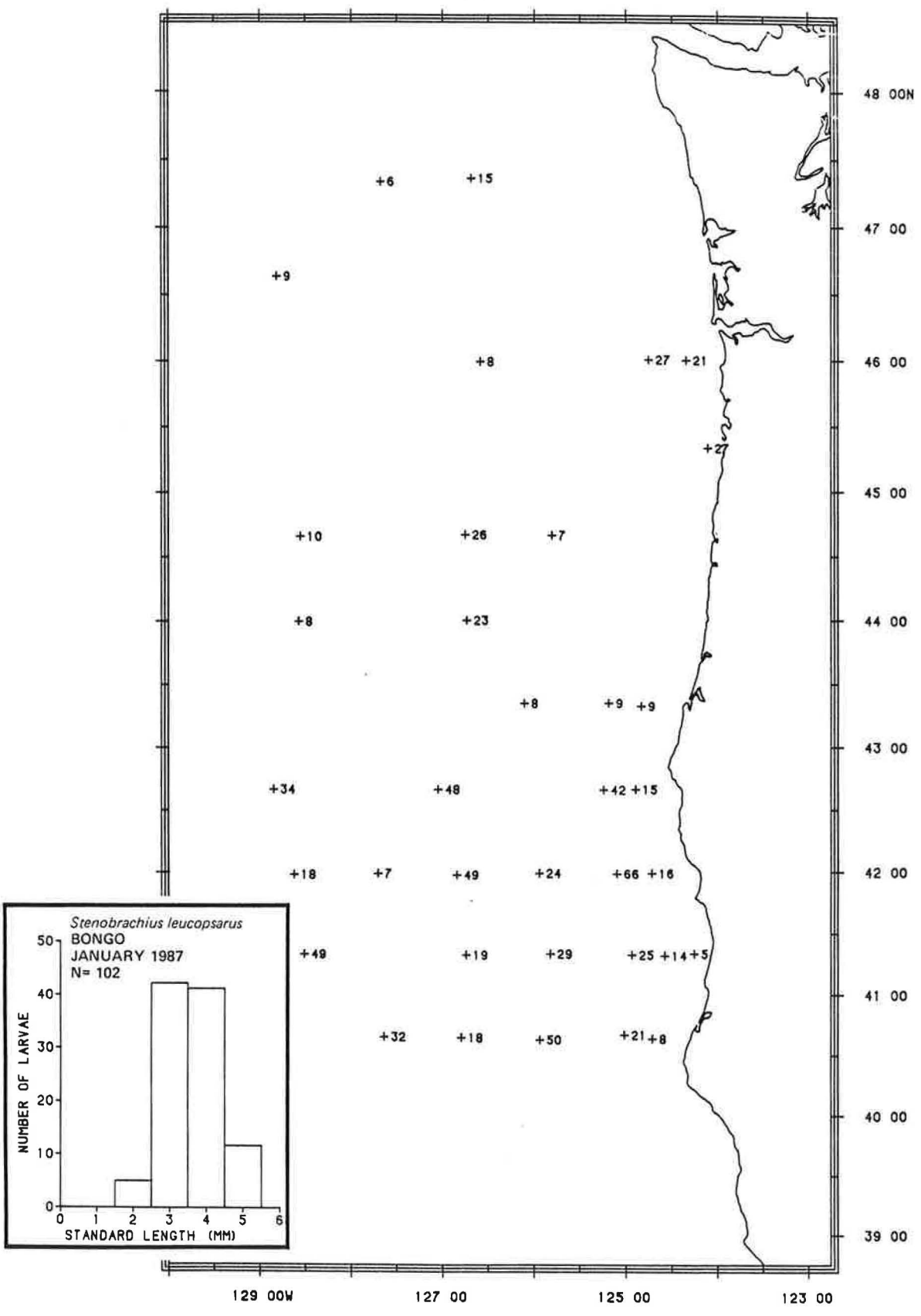

Figure 12.--Distribution of Stenobrachius leucopsarus larvae from bongo tows during cruise 1MF87, January 1987. Abundance expressed as number per 10 m^2.

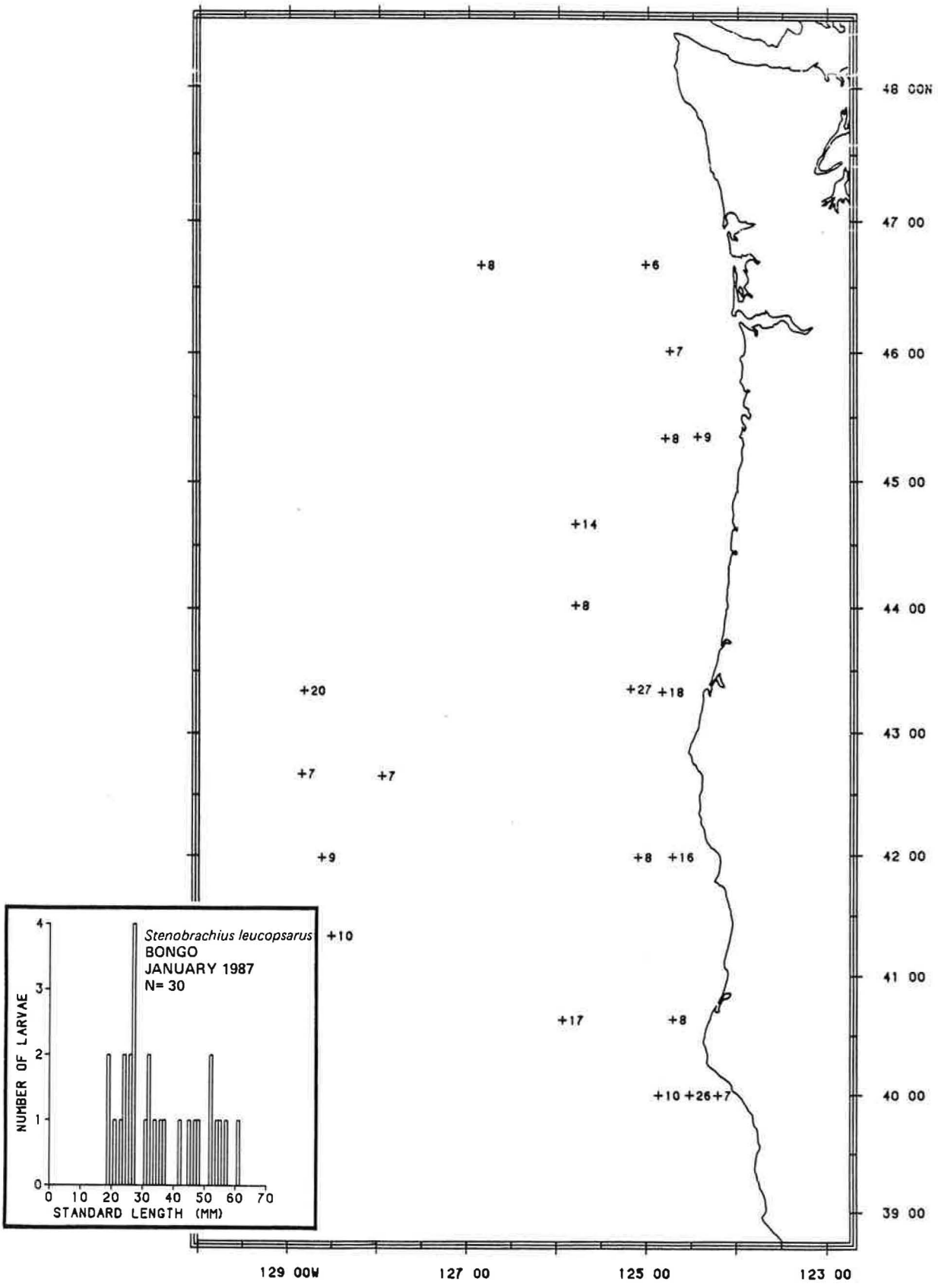

Figure 13.--Distribution of Stenobrachius leucopsarus juveniles from bongo tows during cruise 1MF87, January 1987. Abundance expressed as number per 10 m^2.

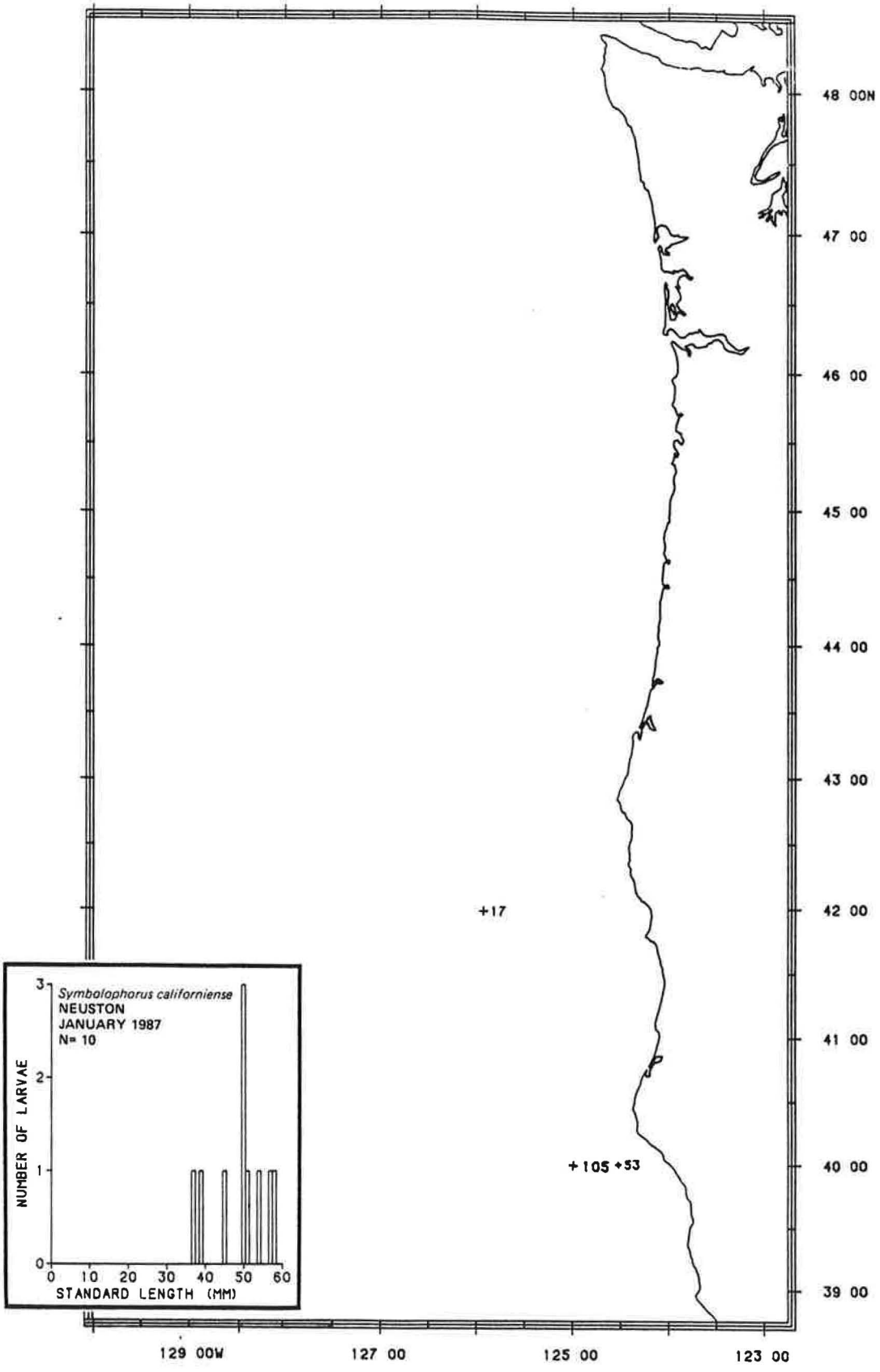

Figure 14.--Distribution of Symbolophorus californiense juveniles from neuston tows during cruise 1MF87, January 1987. Abundance expressed as number per 1,000 m^3.

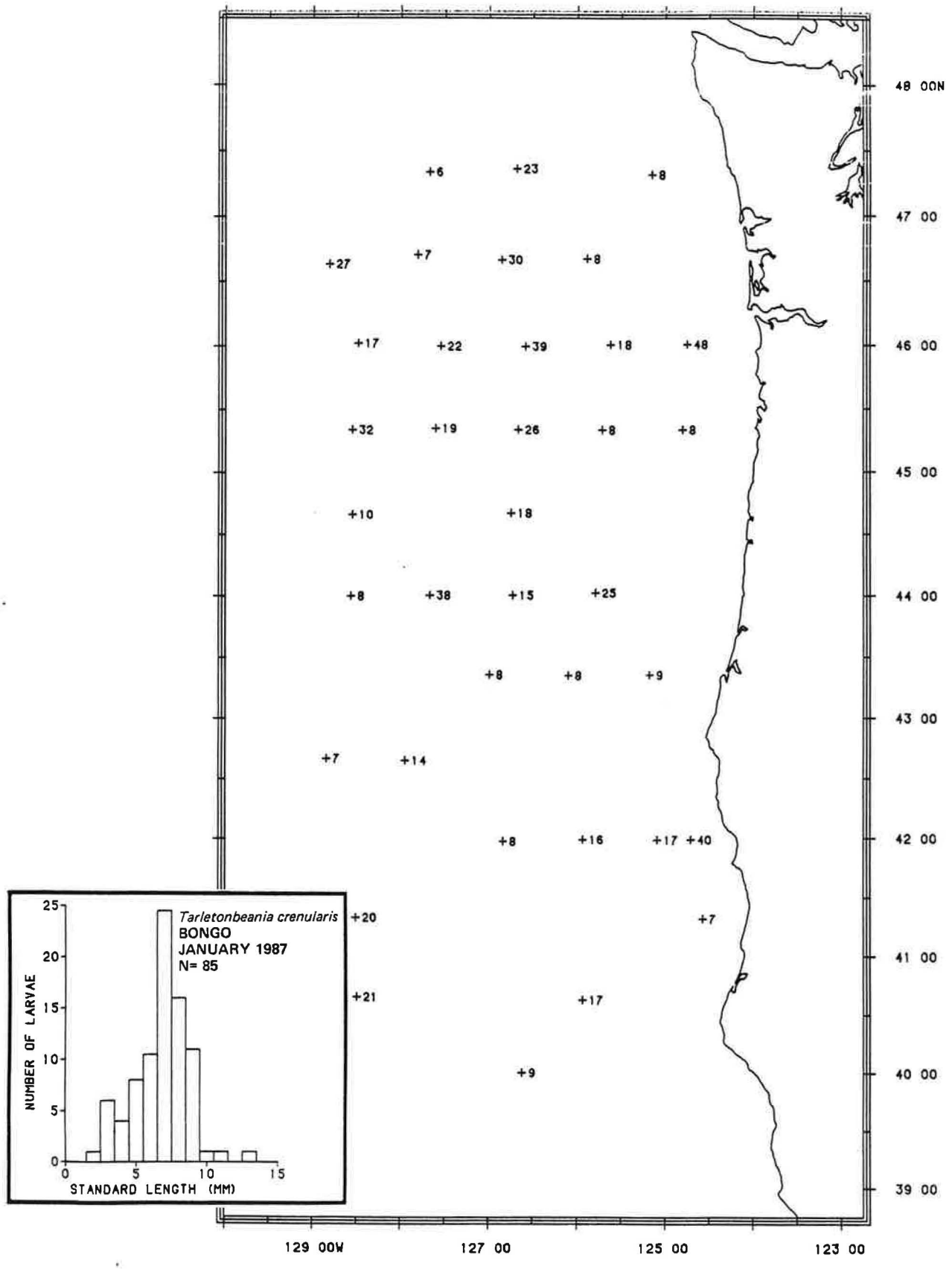

Figure 15.--Distribution of Tarletonbeania crenularis larvae from bongo tows during cruise 1MF87, January 1987. Abundance expressed as number per 10 m^2.

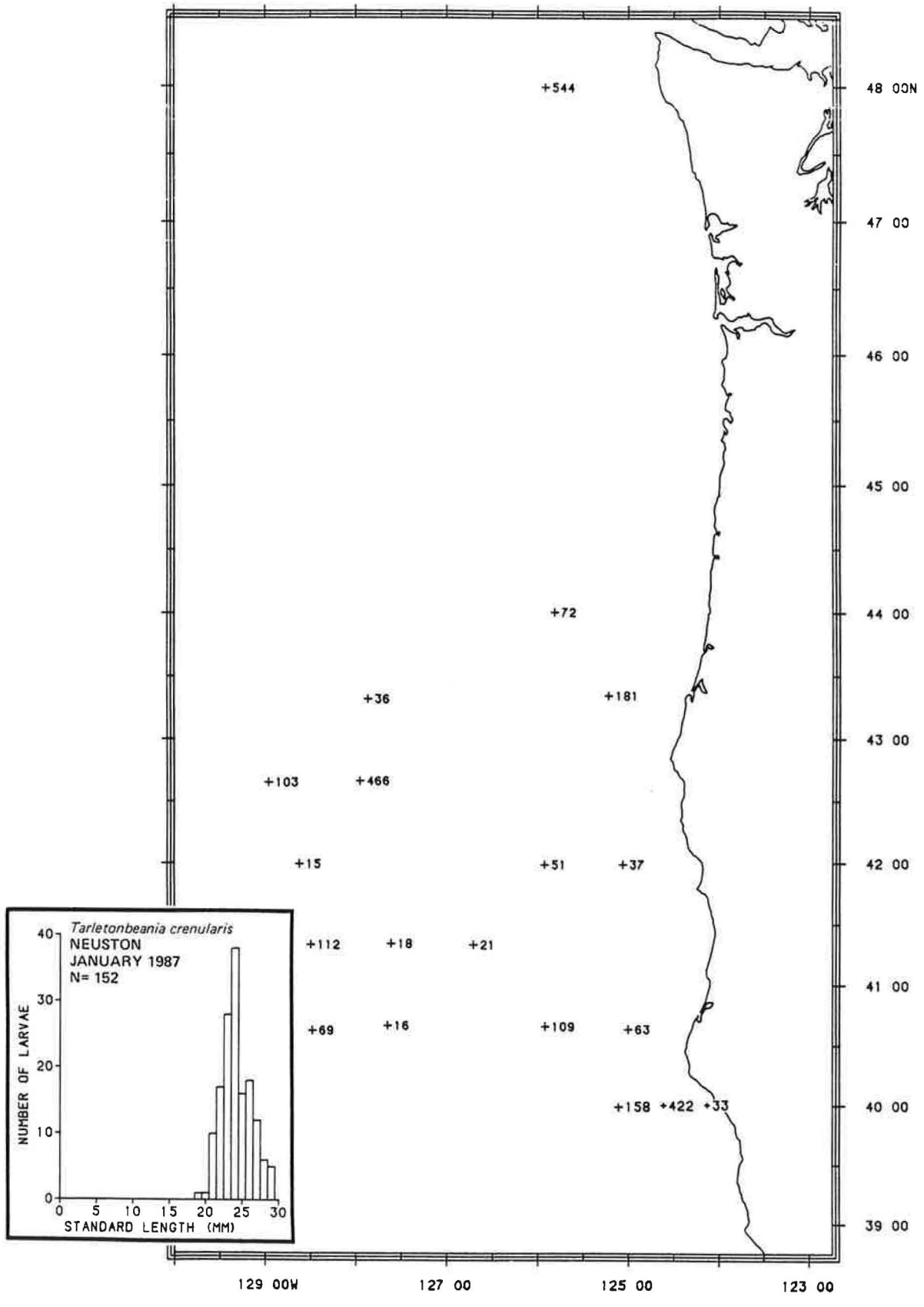

Figure 16.--Distribution of Tarletonbeania crenularis larvae from neuston tows during cruise 1MF87, January 1987. Abundance expressed as number per 1,000 m^3.

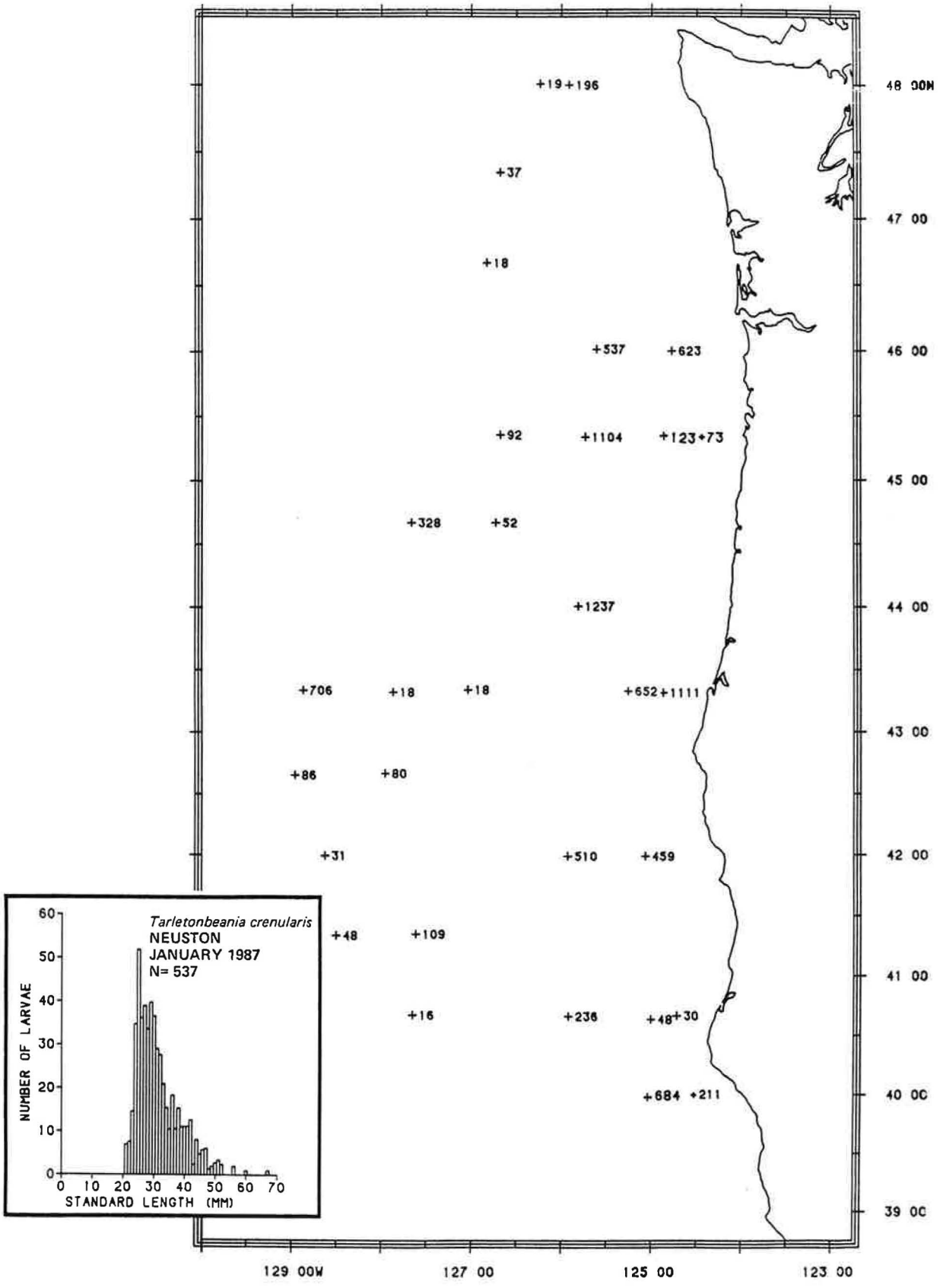

Figure 17.--Distribution of Tarletonbeania crenularis juveniles from neuston tows during cruise 1MF87, January 1987. Abundance expressed as number per 1,000 m^3.

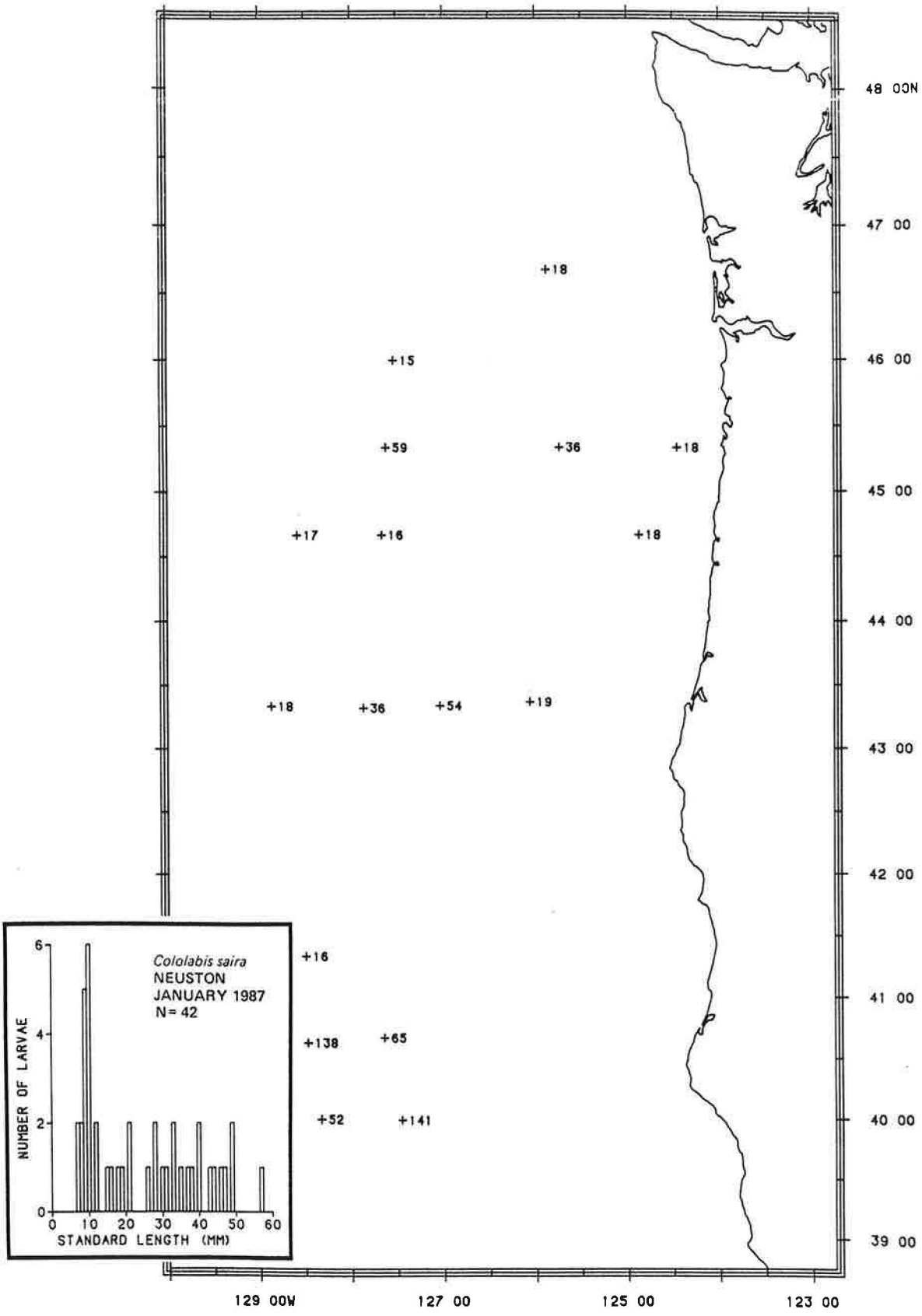

Figure 18.--Distribution of Cololabis saira larvae from neuston tows during cruise 1MF87, January 1987. Abundance expressed as number per 1,000 m^3.

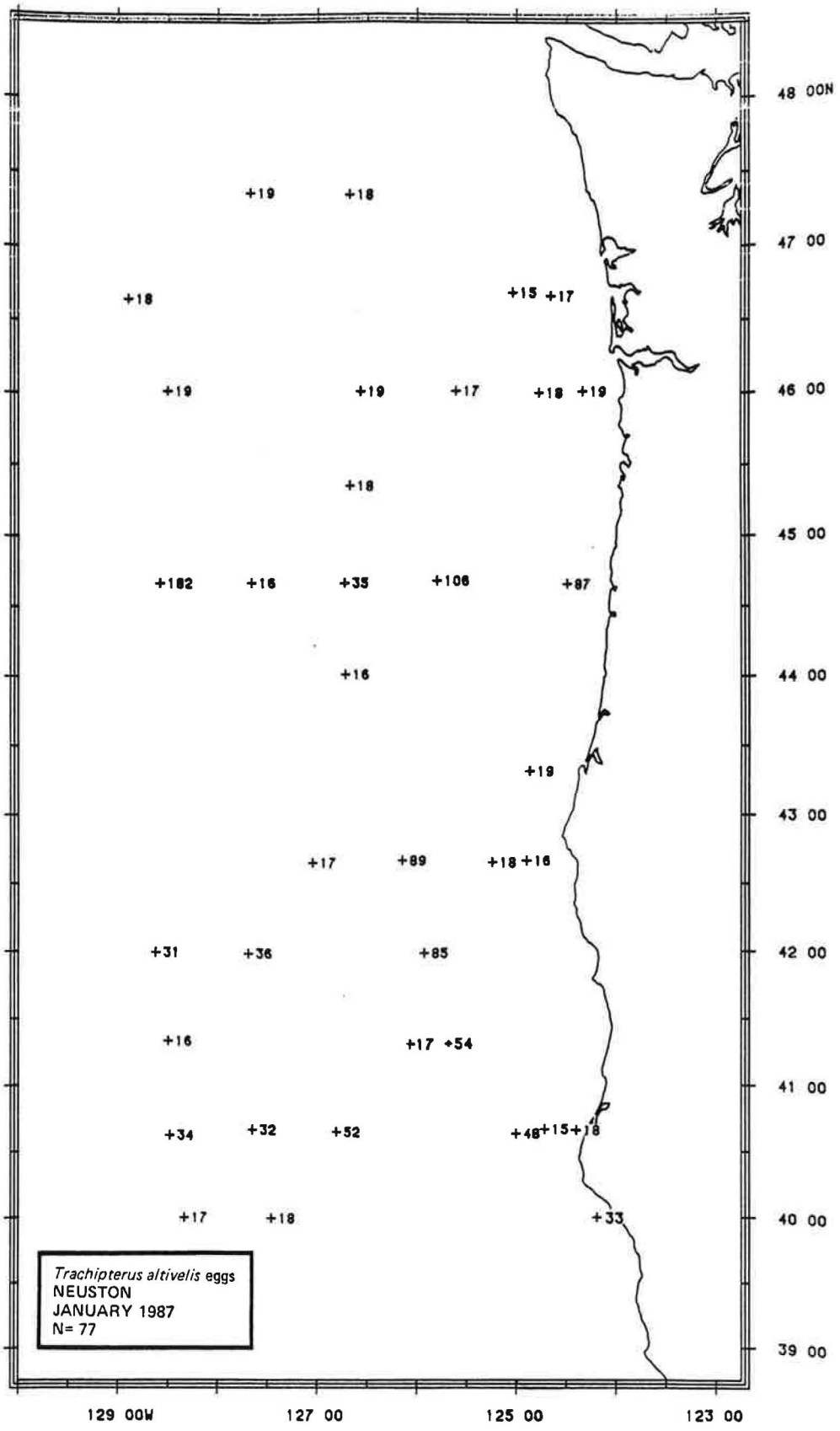

Figure 19.--Distribution of Trachipterus altivelis eggs from neuston tows during cruise 1MF87, January 1987. Abundance expressed as number per 1,000 m^3.

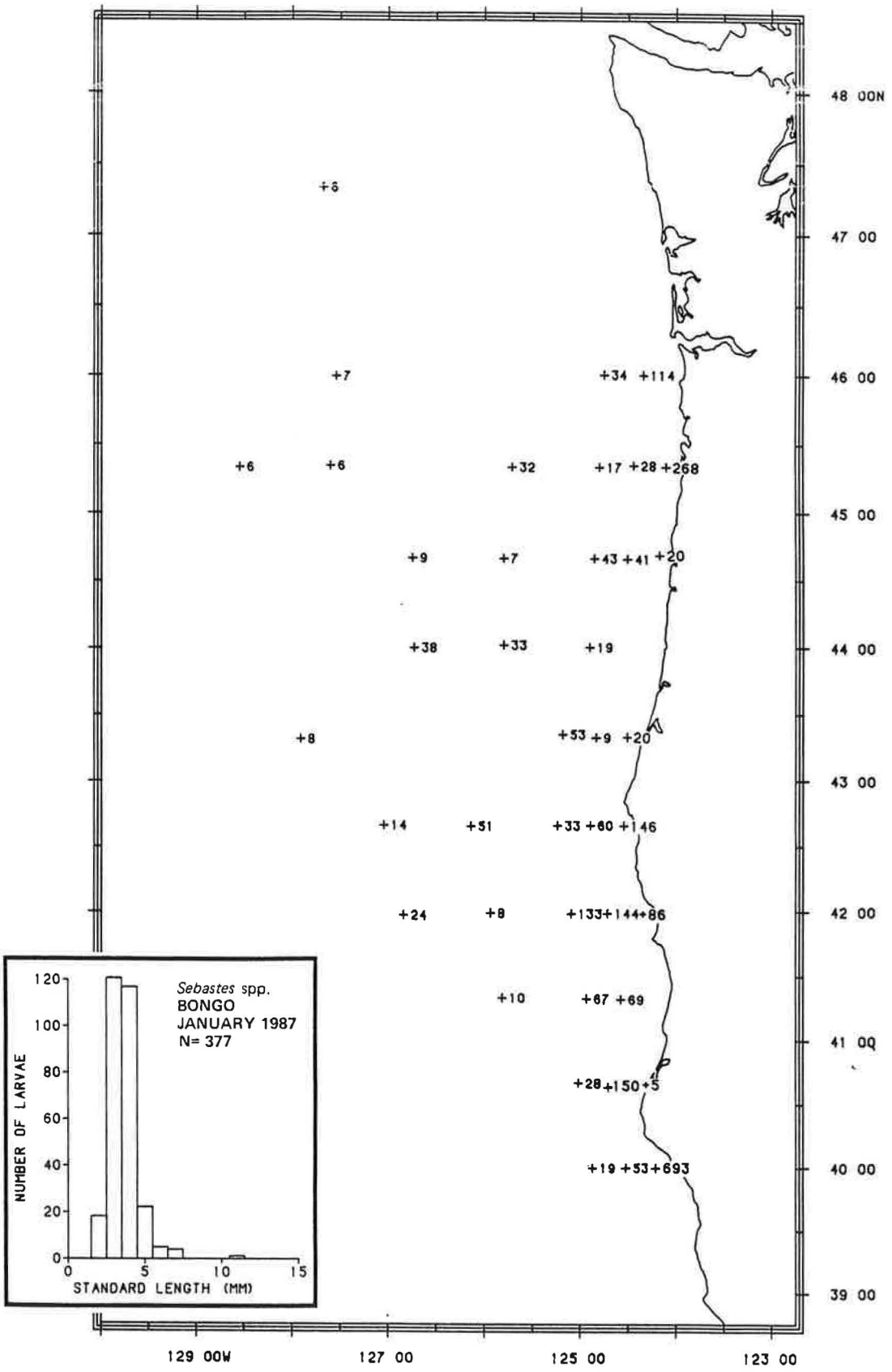

Figure 20.--Distribution of Sebastes spp. larvae from bongo tows during cruise 1MF87, January 1987. Abundance expressed as number per 10 m^2.

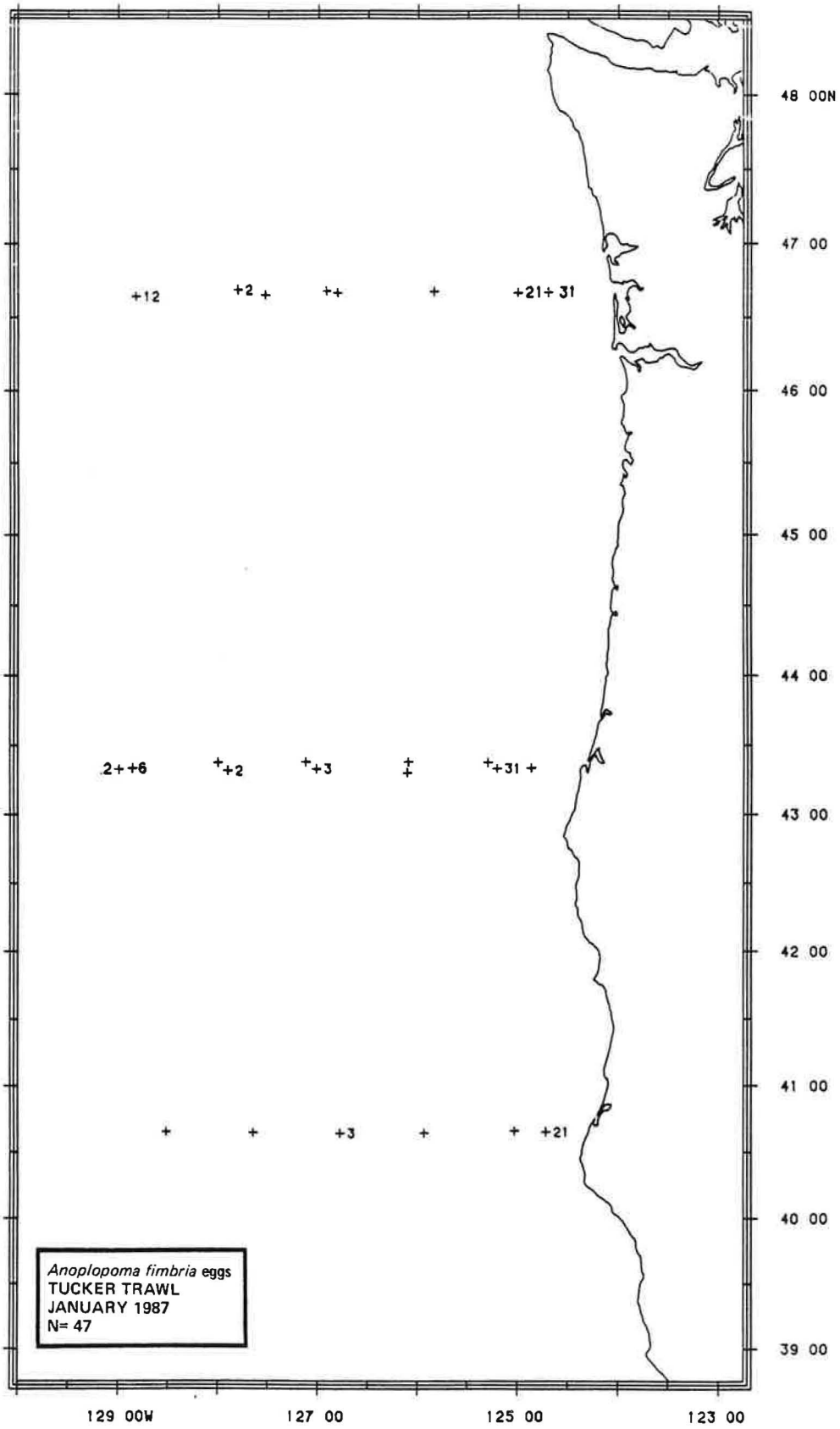

Figure 21.--Distribution of Anoplopoma fimbria eggs from Tucker trawls during cruise 1MF87, January 1987. Abundance expressed as number per 10 m^2.

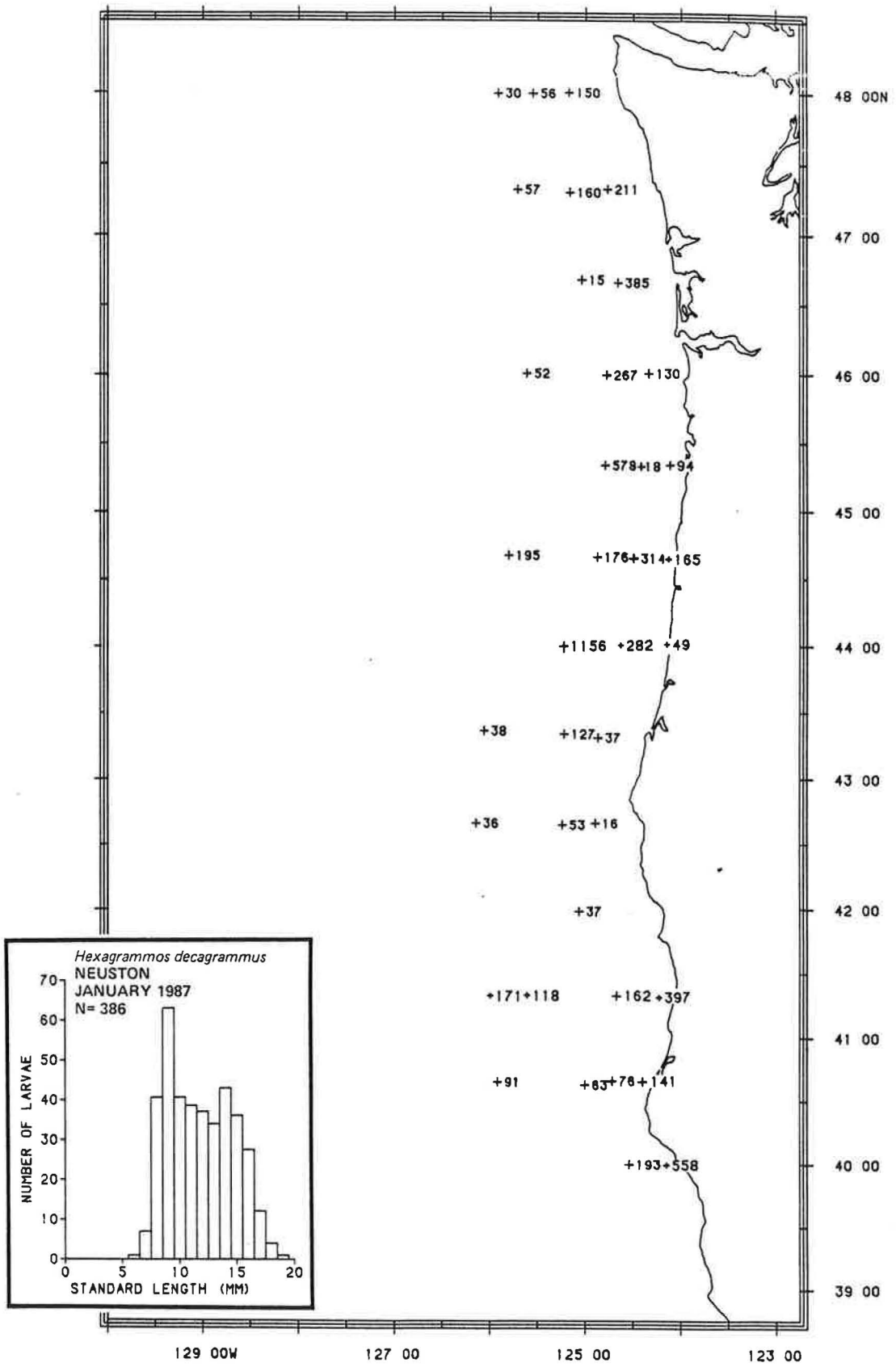

Figure 22.--Distribution of Hexagrammos decagrammus larvae from neuston tows during cruise 1MF87, January 1987. Abundance expressed as number per 1,000 m^3.

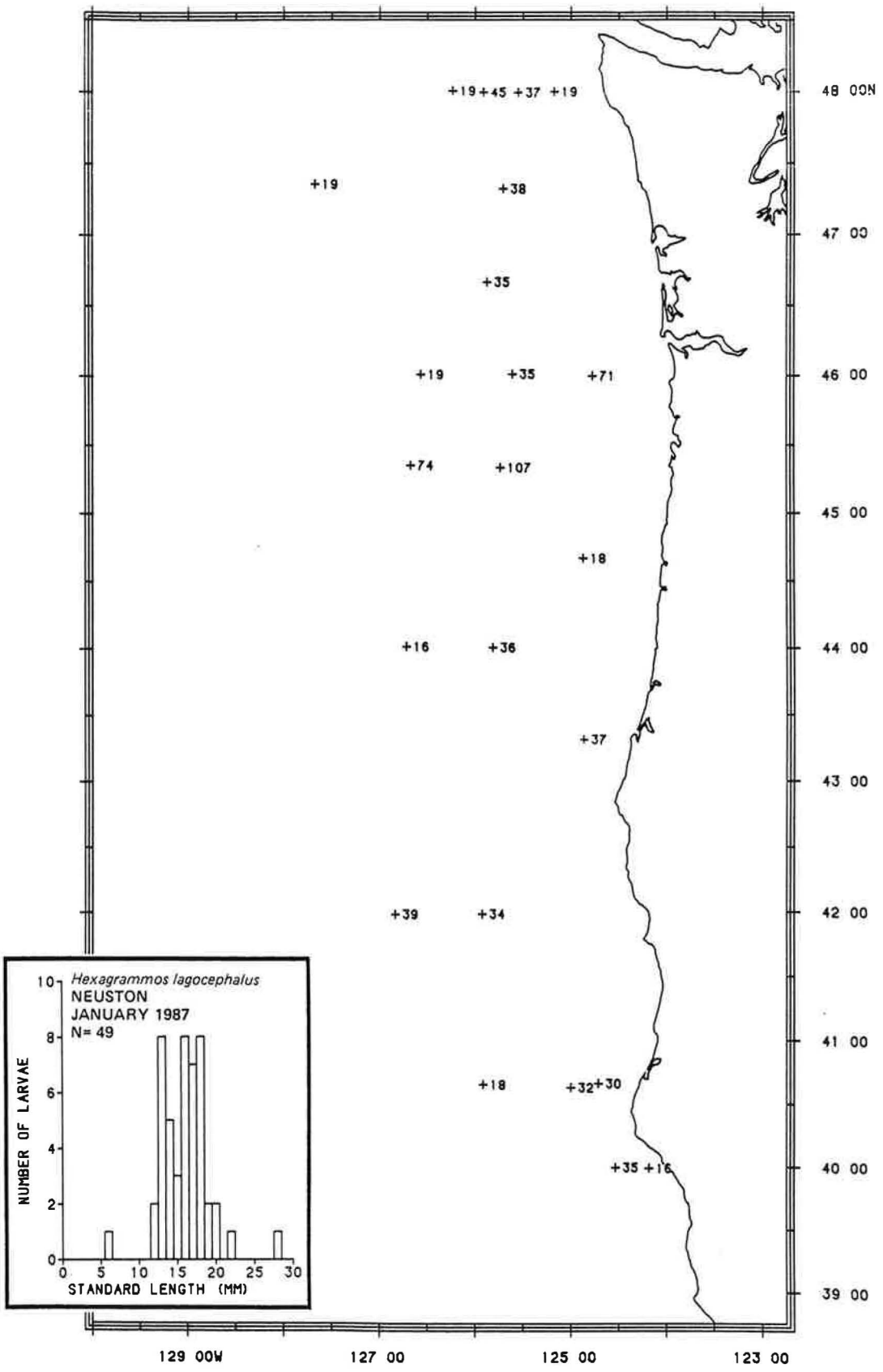

Figure 23.--Distribution of Hexagrammos lagocephalus larvae from neuston tows during cruise 1MF87, January 1987. Abundance expressed as number per 1,000 m^3.

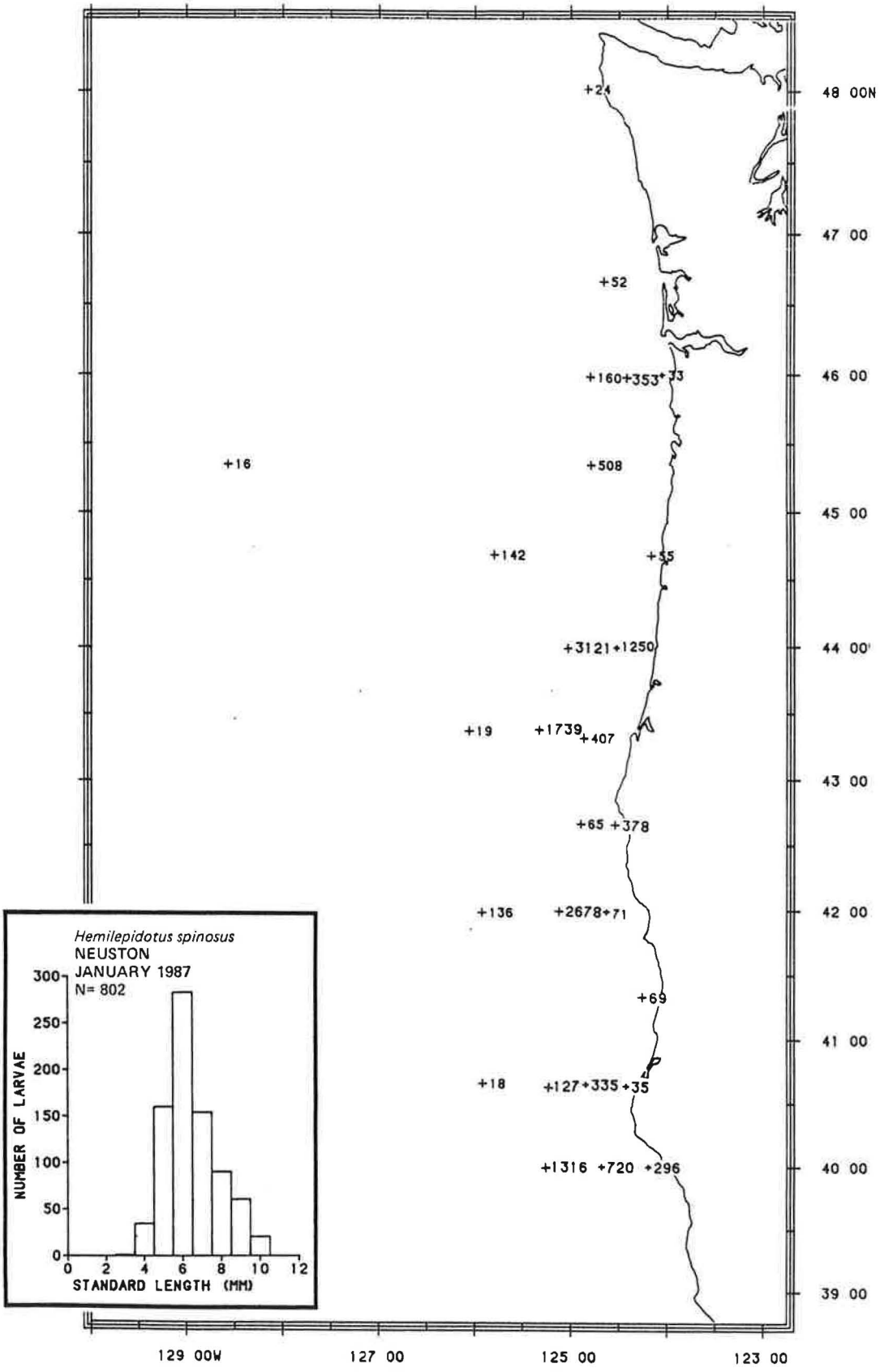

Figure 24.--Distribution of Hemilepidotus spinosus larvae from neuston tows during cruise 1MF87, January 1987. Abundance expressed as number per 1,000 m^3.

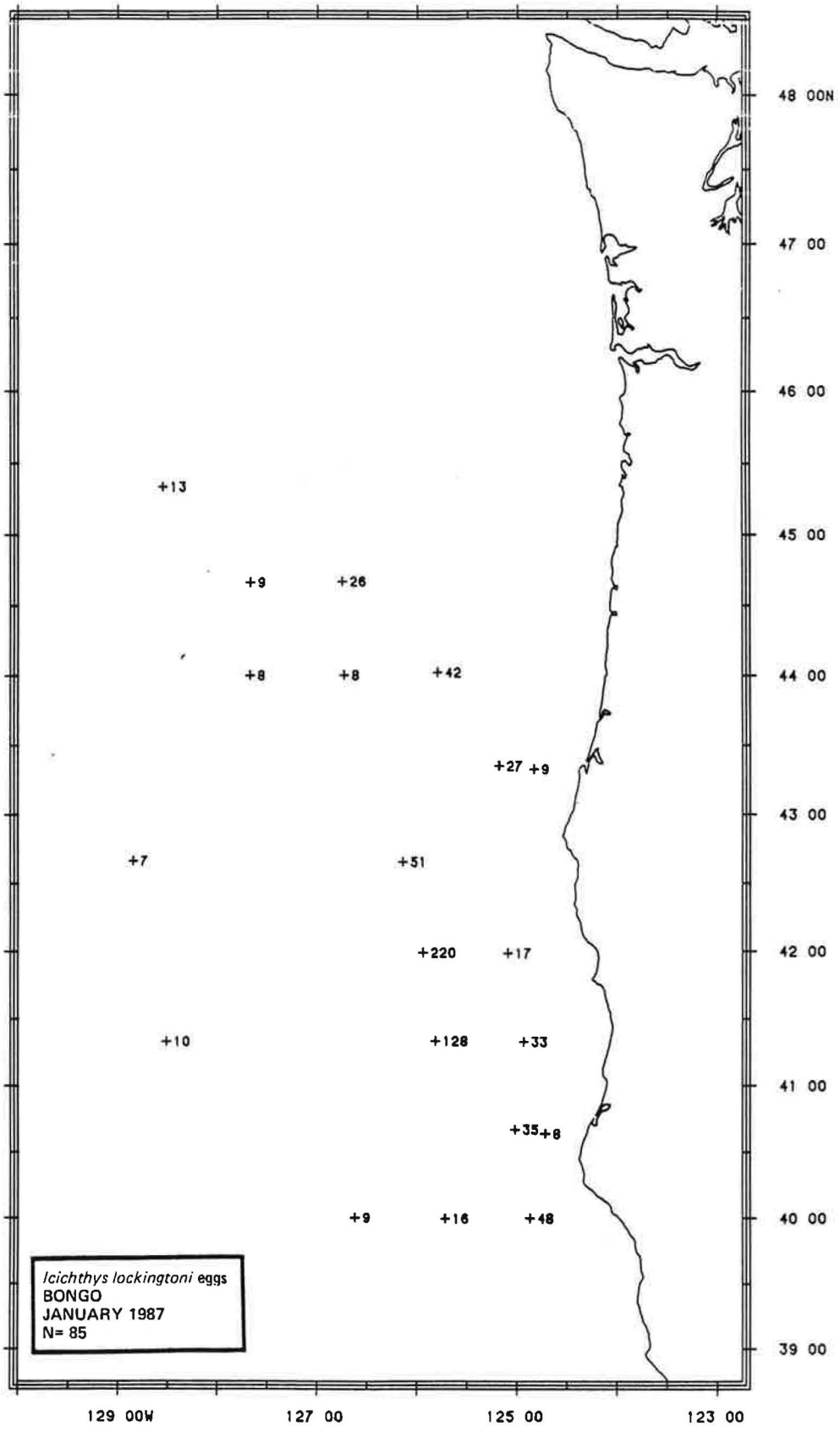

Figure 25.--Distribution of Icichthys lockingtoni eggs from bongo tows during cruise 1MF87, January 1987. Abundance expressed as number per 10 m^2.

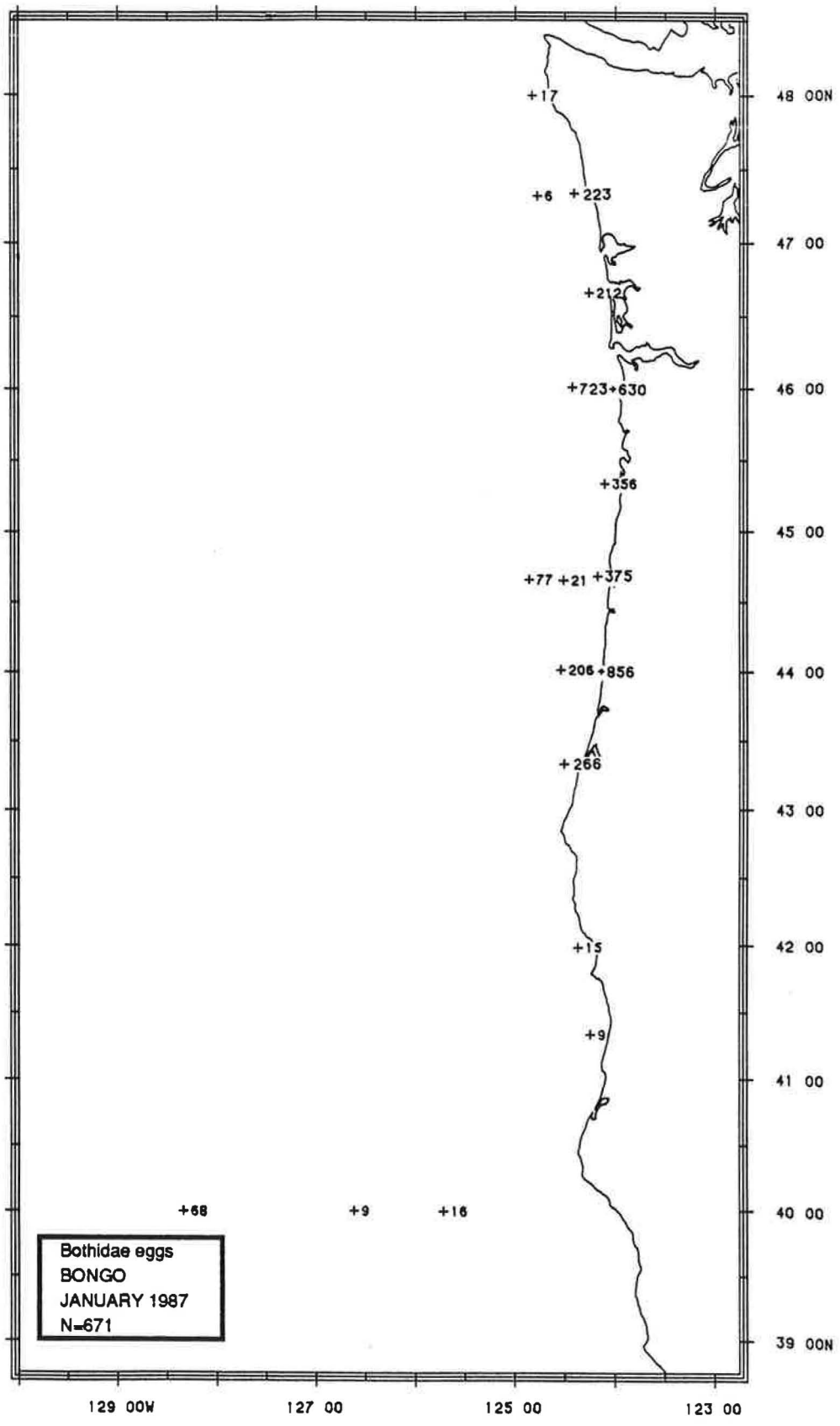

Figure 27.--Distribution of Bothidae eggs from bongo tows during cruise 1MF87, January 1987. Abundance expressed as number per 10 m^2.

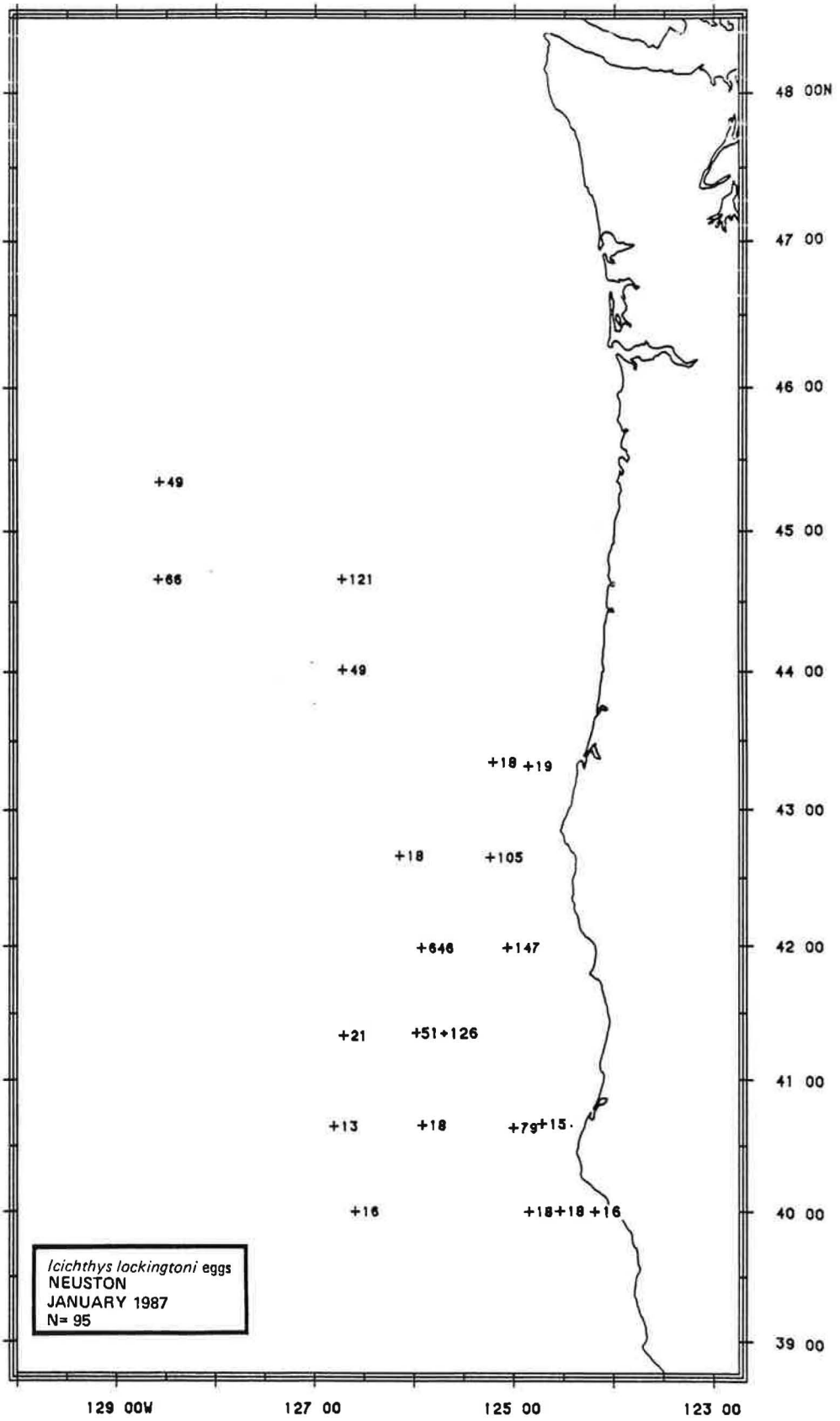

Figure 26.--Distribution of Icichthys lockingtoni eggs from neuston tows during cruise 1MF87, January 1987. Abundance expressed as number per 1,000 m^3.

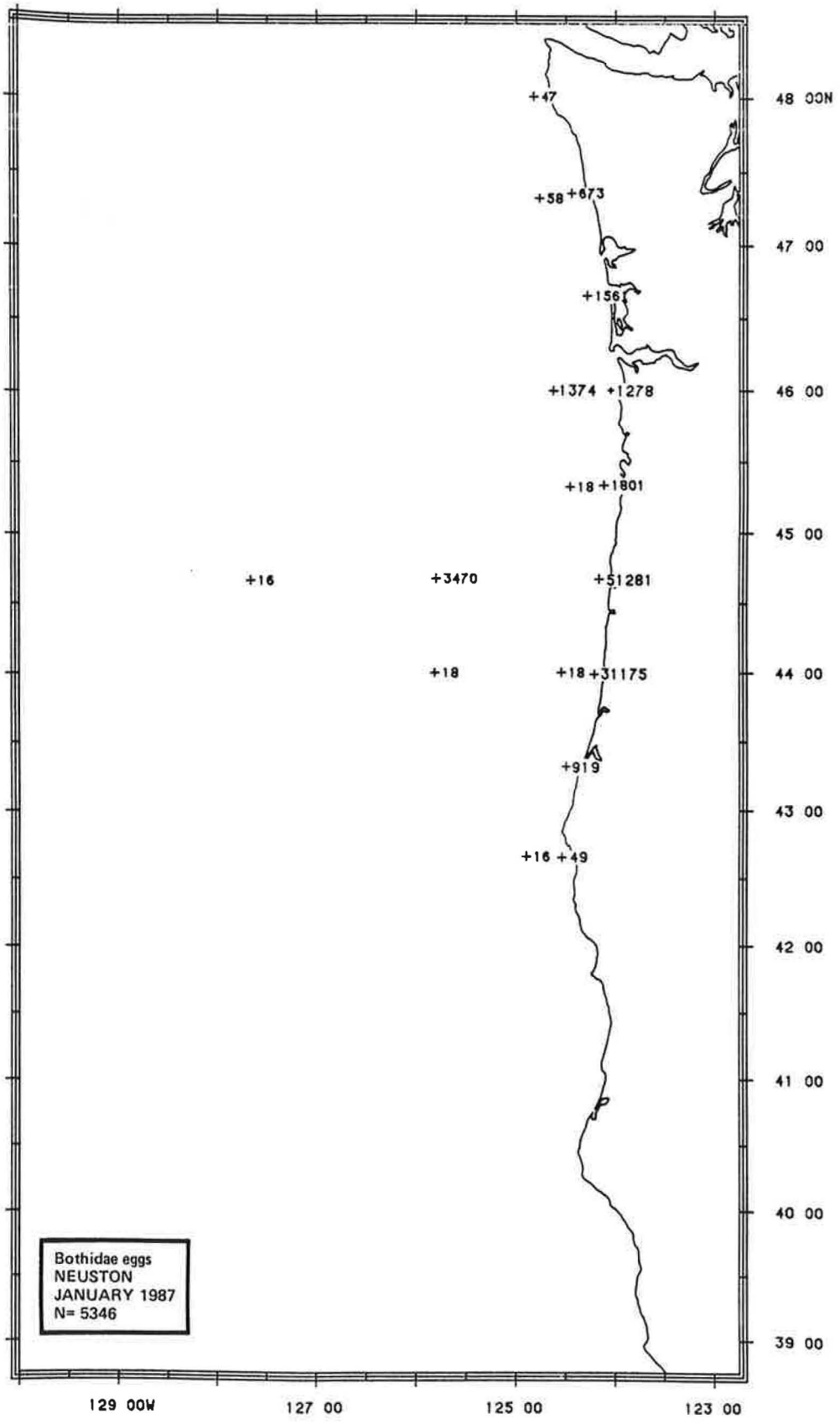

Figure 28.--Distribution of Bothidae eggs from neuston tows during cruise 1MF87, January 1987. Abundance expressed as number per 1,000 m^3.

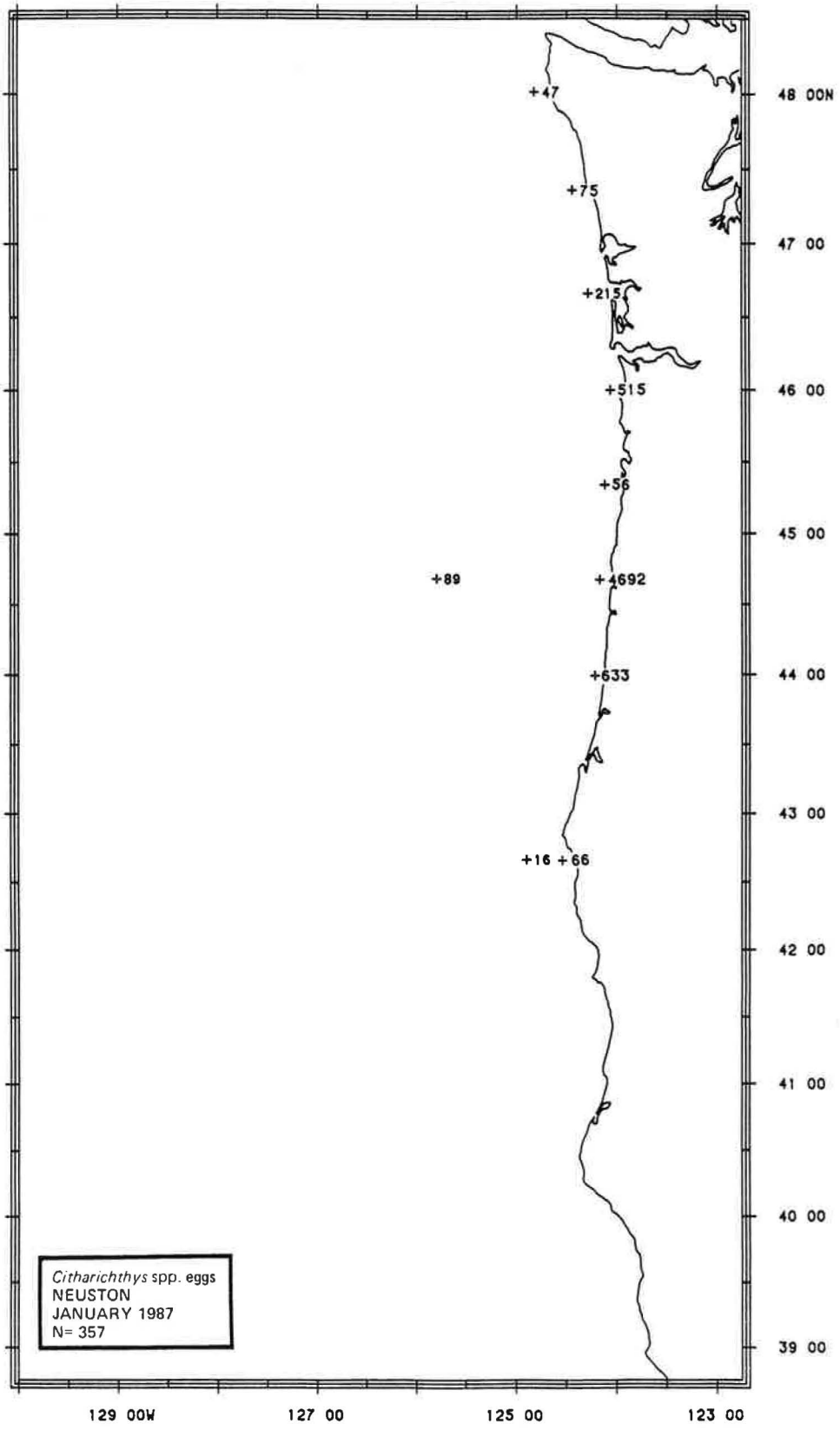

Figure 29.--Distribution of Citharichthys spp. eggs from neuston tows during cruise 1MF87, January 1987. Abundance expressed as number per 1,000 m^3.

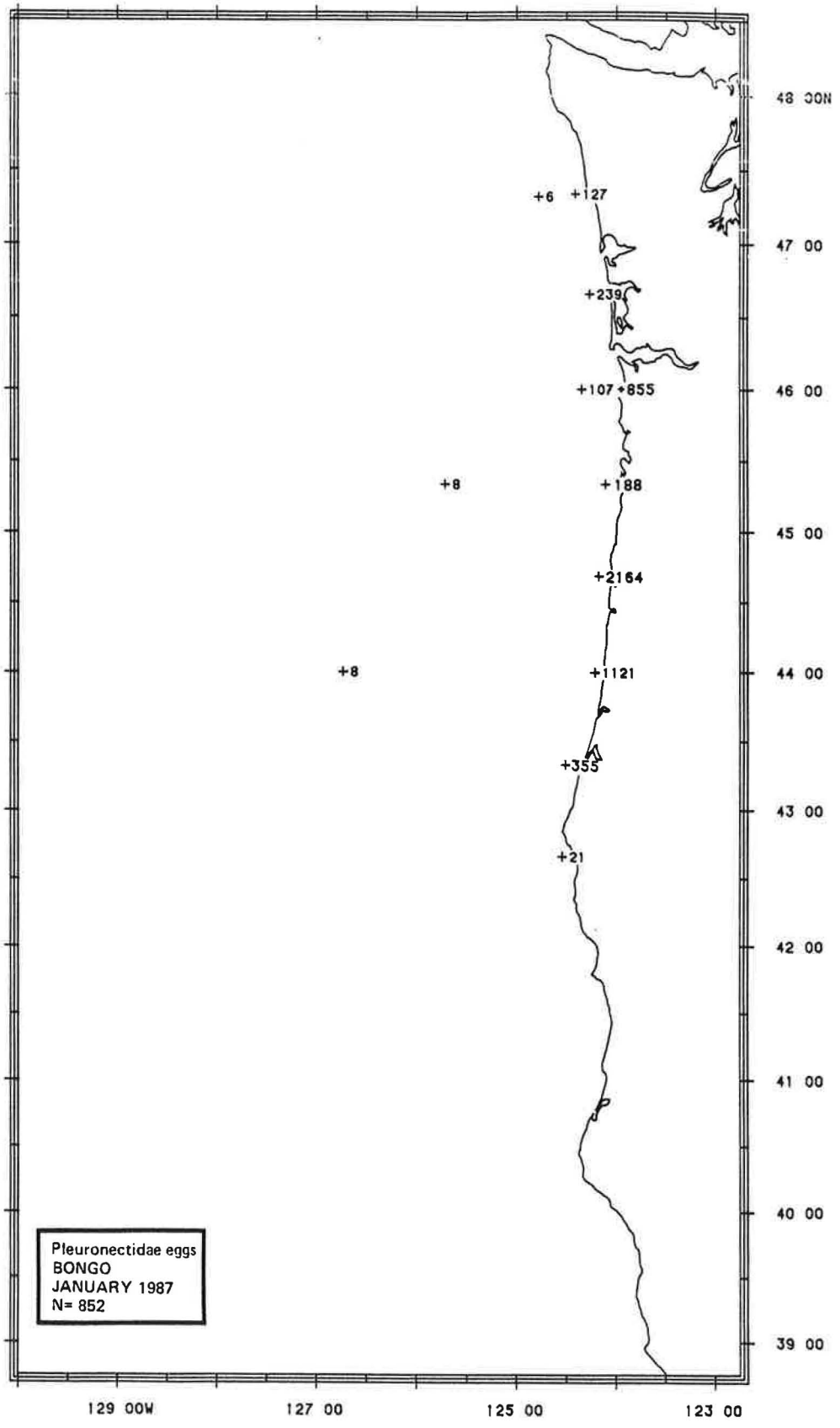

Figure 30.--Distribution of Pleuronectidae eggs from bongo tows during cruise 1MF87, January 1987. Abundance expressed as number per 10 m^2.

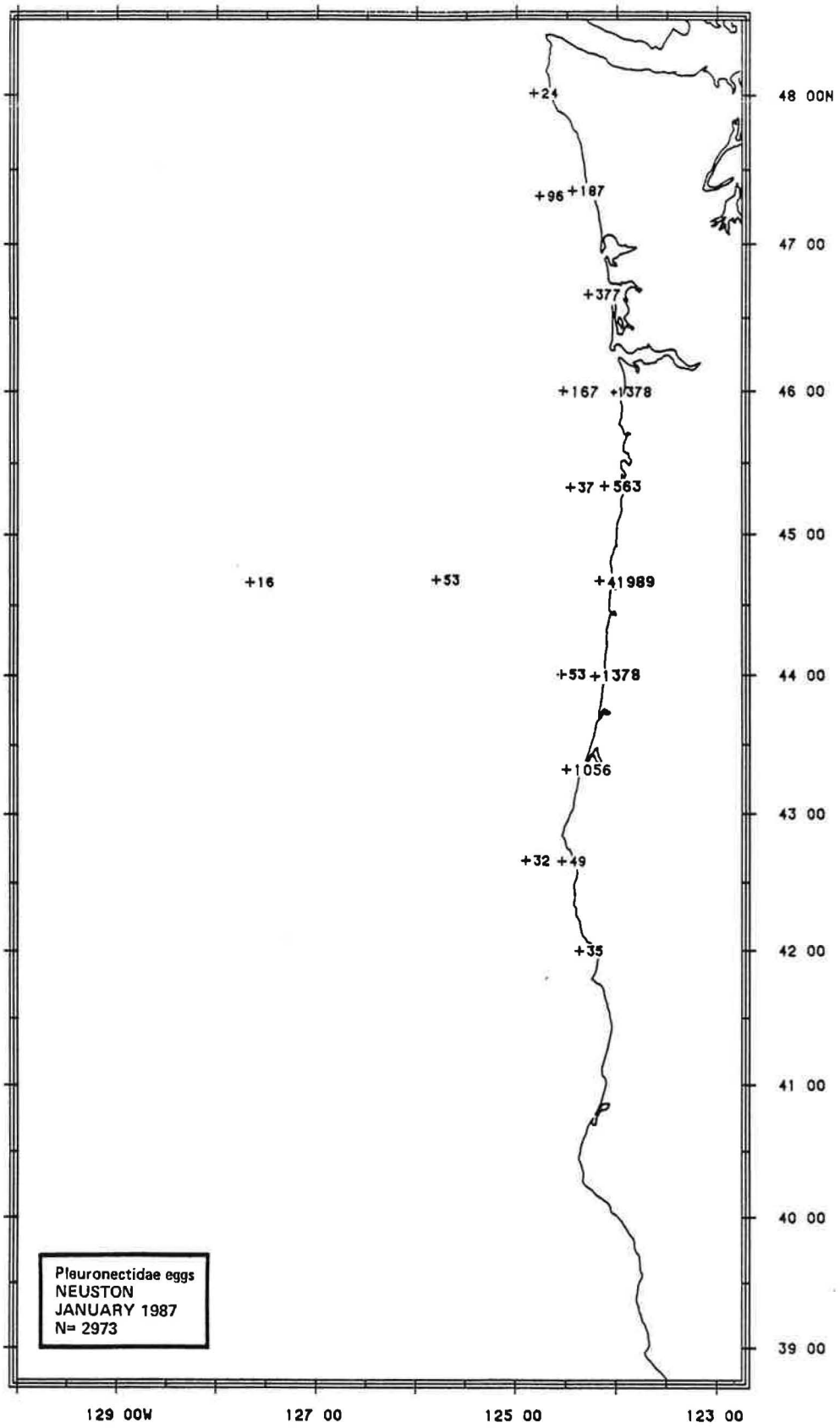

Figure 31.--Distribution of Pleuronectidae eggs from neuston tows during cruise 1MF87, January 1987. Abundance expressed as number per 1,000 m^3.

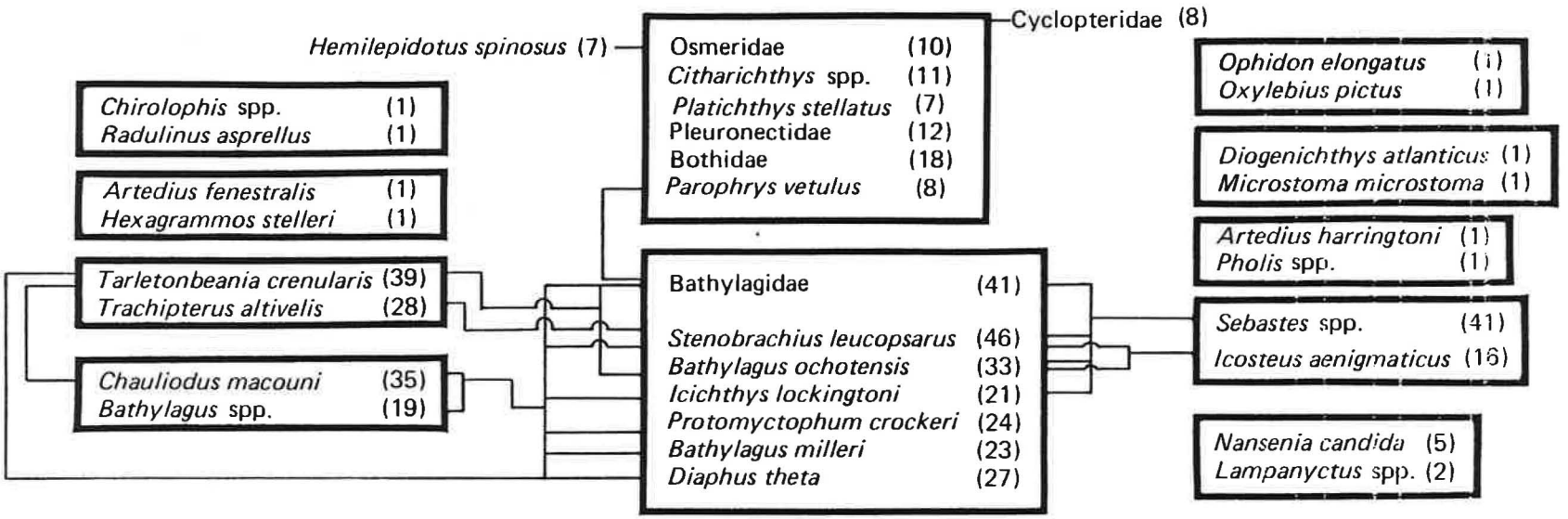

Figure 32.--Results of recurrent group analysis on bongo catches (both fish eggs and larvae) from cruise 1MF87, January 1987, at an affinity level of 0.400. Taxa in rectangles are members of recurrent groups. Lines connect taxa with affinities outside their groups. Numbers in parentheses following taxa names are the number of occurrences of the taxa.

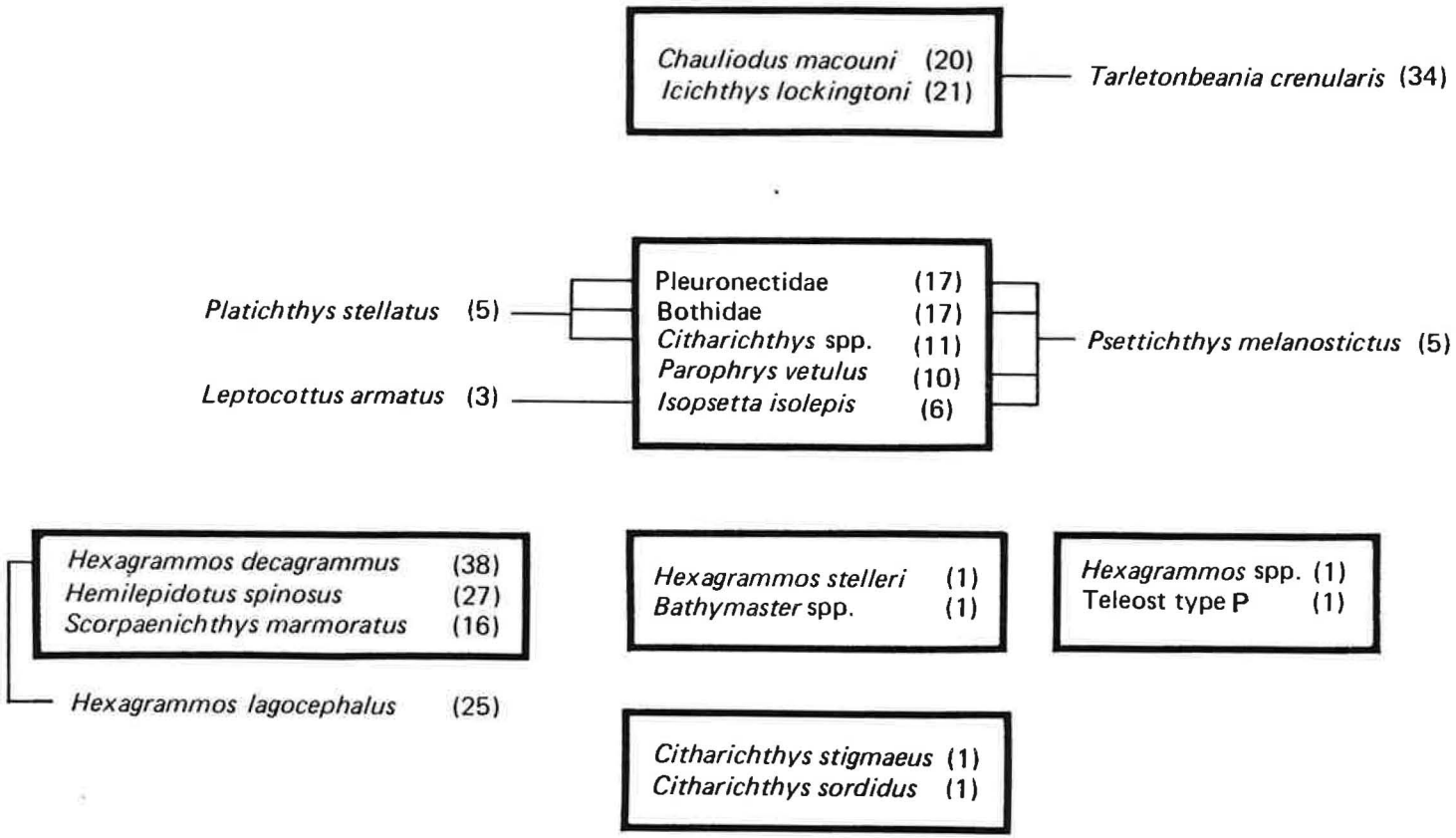

Figure 33.--Results of recurrent group analysis on neuston catches (both fish eggs and larvae) from cruise 1MF87, January 1987, at an affinity level of 0.400. Taxa in rectangles are members of recurrent groups. Lines connect taxa with affinities outside their groups. Numbers in parentheses following taxa names are the number of occurrences of the taxa.