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Spatial and Temporal Distribution of Larval Fish in the Western Gulf of Alaska, with Emphasis on the Period of Peak Abundance of Walleye Pollock *(Theragra chalcogramma)* Larvae

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ERRATA NOTICE

Spatial and Temporal Distribution of Larval Fish in the Western Gulf of Alaska, with Emphasis on the Period of Peak Abundance of Walleye Pollock (*Theragra chalcogramma*) Larvae

by

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INTRODUCTION

The western Gulf of Alaska is an important nursery area for the early life history stages of many species of fish (Kendall and Dunn 1985), and is of particular importance to walleye pollock (*Theragra chalcogramma*) (Dunn et al. 1984). Within the Gulf of Alaska, Shelikof Strait is a major spawning site for a large aggregation of walleye pollock (Dunn et al. 1984, Bates 1987). In 1985, the Fisheries-Oceanography Coordinated Investigation (FOCI) program was established to study this large spawning aggregation. The main areas of research for FOCI include the following: determining the distribution and abundance of early life history stages, investigating the effect of biotic and abiotic factors on early life history stages, and understanding the causes of interannual variability in recruitment for walleye pollock.

Since FOCI's formation, many aspects of the early life history of walleye pollock have been investigated: Bates (1987) and Kendall and Kim (in press) have studied the egg stage; Kendall et al. (1987) investigated the distribution, abundance, and feeding of pollock larvae; Kim and Kendall (in press) and Incze et al. (1989) have studied the interaction of the physical environment and pollock larvae. However, there has been little investigation of the interaction between walleye pollock larvae and the larvae of other fish. The main objectives of this report are as follows: (1) examine the larval fish community structure and identify what species co-occur with pollock larvae; (2) examine how the composition of this community changes as the year progresses, with an emphasis on March through early July, when pollock spawning and pollock larval abundance are at their peaks.

METHODS

Ichthyoplankton was routinely collected with two types of sampling gear. A Sameoto sampler (Sameoto and Jaroszyinski 1969), with a mouth opening 0.3 m high by 0.5 m wide and a 0.505 mm mesh net, was used on many cruises to sample the neuston layer. The water column between the surface and near bottom was sampled using a MARMAP bongo sampler (Posgay and Marak 1980) with an inside diameter of 0.6 m and a 0.333 or 0.505 mm mesh net.

The bongo nets were lowered at a rate of 50 m/min of wire out and retrieved at a rate of 20 m/min. Since 1985, sampling depth has been to near bottom on cruises focusing on the collection of pollock eggs and early larval stages. Before that year, standard MARMAP tows were made only to 200 m, because the vertical distribution of pollock eggs and larvae was unknown. Sampling followed standard MARMAP procedures (Smith and Richardson 1977). During the lowering and retrieval of the bongo nets, the ship's speed was adjusted to maintain a constant wire angle of 45 degrees. Actual sampling depths were calculated using observed wire angles or bathykymograph traces.

Plankton samples were preserved in the field using a 5% formalin-seawater solution buffered with calcium carbonate chips or sodium tetraborate. A settled volume of plankton was later determined. Since 1980, all fish eggs and larvae have been removed and larvae identified to the lowest possible taxon at the Plankton Sorting Center in Szczecin, Poland. For many specimens of unknown specific identity, series were established and referred to as a "type" within the lowest certain category (i.e., Agonidae A, *Myoxocephalus* B). This was done in hopes that a series could be assigned to a species as time progresses. Some larvae were identified only to genus because of inadequate knowledge of individual species or poor physical condition of the specimen (i.e., *Sebastes* spp.). In the appendix figures, spp. and sp. are used interchangeably. Up to 50 individuals per species per station have been measured to the nearest 0.1 mm SL. Prior to 1980, only species that were regularly abundant or economically important were measured (e.g. *Mallotus villosus*, species of Hexagrammidae).

The numbers of each taxon from each tow were converted to numbers/unit area or density as follows:

Unit area (number/10 m^2)
- for bongo tows: $(n)(d)(10)/[(r^2)(\pi)(l)]$
- for neuston tows: $(n)(d)(10)/[(h)(w)(l)]$

Density (number/1000 m^3)
- for neuston tow: $(n)(1000)/[(h)(w)(l)]$

where:
n = number of taxa in sample
r = radius of net opening (0.3 m for bongo net)
h = effective fishing height of net opening (0.15 m for neuston sampler)
w = width of net opening (0.5 m for neuston sampler)

l = length of tow, in meters (calculated from calibrated flowmeter readings)
d = depth of water column sampled (calculated from wire angles or bathykymograph traces for bongo samples; 0.15 m for neuston samples)

To investigate changes in the abundance and composition of the larval fish community as the year progresses, all cruise data were combined and then broken down into 2 week periods or date windows (Table 1). The station patterns and locations of the date windows vary greatly because the objectives of the cruises often varied.

Within the time frame of the date window, sets of rankings for larval abundances were generated for each gear. These rankings were based on the actual numbers of larvae of a taxon that were captured, and on the percent occurrence (number of stations where a taxon was collected divided by the total number of stations sampled in the date window).

Co-occurrence of taxa was investigated using REGROUP and a support program CONNEX (based on Fager 1957). This analysis places taxa that co-occur into groups which are based on a set affinity level. For this report, the affinity level was set at 0.4, the level used by Kendall and Dunn (1985) in their report on the ichthyoplankton around Kodiak Island, Alaska.

Distribution maps were generated for taxa that had large abundances or were frequently caught between March and mid-July, the period of peak pollock larvae abundance. The area sampled was broken down into sectors of approximately 215 mi^2. Within each sector, the number of times a sector was sampled during that date window is represented by stippling. The average catch/10 m^2 of a taxon is represented by a dot, whose area is proportional to the average catch/10 m^2 of that taxon at the stations within that sector. Using the maps, an estimate of the catch/10 m^2 can be calculated by:

$$C = P^2/2.5281$$

where: C= catch/10 m^2
P= percentage of the width of the sector that is covered by the diameter of "catch dot"

Length/frequency graphs were generated when data were available. Also, species that were abundant between September through February, during times of low larval pollock abundances, are discussed briefly in the results.

OCEANOGRAPHY

Topography of the western Gulf of Alaska is characterized by numerous troughs and shallow banks. The shelf area, as defined by the 200 m isobath, is generally wide (65-175 km) and drops abruptly to depths of 5000-6000 m in the Aleutian Trench.

Offshore near surface circulation is dominated by the Alaskan Stream (Fig. 1) which runs southwesterly and roughly parallel to the shelf break at 50-100 cm/sec (Meunch and Schumacher 1980, Reed et al. 1980). Nearshore, the Alaskan Coastal Current (ACC) is the dominant feature. This also flows southwesterly, at mean speeds of 20-70 cm/sec (Schumacher and Reed 1980). Some water from the ACC enters the Bering Sea through Unimak Pass (Schumacher and Reed 1983).

Reed and Schumacher (1986) reported that the salinity of coastal waters may change seasonally by as much as $7^{o}/_{oo}$. Likewise, the temperature can fluctuate about 7°C from winter to summer. They also reported that some upwelling occurs for 2-3 months during the summer in the northern Gulf. In the western Gulf however, even though wind stress conditions appear to be in the proper direction to induce upwelling, the observational evidence indicates that upwelling does not occur.

Between March and June, many transitional oceanographic conditions occur. Reduced precipitation and river runoff, combined with weak wind strength results in reduced baroclinic water transport and current speeds in the upper layer of Shelikof Strait (Kim 1989). Also, as the days lengthen, the photic zone deepens, the mixed layer depth becomes shallower, and the surface layer warms. These are the basic conditions needed for a phytoplankton bloom, which in turn leads to increased zooplankton production (Kim 1989).

RESULTS

Rankings for all the larvae captured in the bongo and neuston nets are presented in Appendix Figures 1-2. Rankings by date window are shown in Appendix Figures 3-19.

There were sixty-six taxa identified in the neuston samples (App. Fig. 1). Larvae of Bathymaster spp. and Hexagrammos decagrammus were the dominant species. Hemilepidotus spp., Hexagrammos lagocephalus, and Ammodytes hexapterus larvae were also abundant. Species of Hexagrammidae accounted for 5 of the top 10 taxa. Cottidae was the only other family that was commonly present in the neuston samples.

In the bongo tows, 118 taxa were identified (App. Fig. 2). Larvae of Theragra chalcogramma were by far the most commonly captured. Other larvae regularly taken were Ammodytes hexapterus, Bathymaster spp., Sebastes spp., Hemilepidotus spp., and Osmeridae. The most abundant families were Pleuronectidae, Hexagrammidae, Cottidae, and Gadidae.

An account of seasonal and geographic distribution of the most abundant taxa is given first. Families are discussed in order of potential importance to walleye pollock larvae. Then, the structure of the larval fish community is described.

Seasonal and geographic distribution

Gadidae (App. Figs. 20-28)-- Larvae of Theragra chalcogramma were the most abundant of any taxa taken in the western Gulf of Alaska. Walleye pollock accounted for 82.3% of the larvae taken in the bongo tows, and 65.3% of all the larvae caught. This dominance is, in part, because walleye pollock has been the target species of Alaska Fisheries Science Center (AFSC) ichthyoplankton sampling since 1981. The major flux of walleye pollock larvae occurred mainly in southern Shelikof Strait between April 1-June 15. Other large concentrations of pollock larvae were found to the northeast and southwest of Kodiak Island (App. Figs. 20-22). Between April 1 and June 15, the mean length of pollock larvae increased from 4.3-7.4 mm SL. Pollock larvae were taken more commonly in the bongo nets, with large catch values found in the neuston net only during periods of high abundance (App. Figs. 24-25). Low numbers of pollock larvae were collected in the bongo net throughout the year. A more in-depth study of walleye pollock larvae in Shelikof Strait was presented in Kendall et al. (1987), and they are the focus of several ongoing studies.

Pacific cod (Gadus macrocephalus) larvae were taken only in the bongo tows (App. Figs. 26-28), starting in early April and continuing until mid-July (Rugen and Matarese 1988). The mean lengths of larvae ranged from 4.1 mm SL in early April, to 8.9 mm SL in early June. The lengths of Pacific cod larvae that were collected in July ranged between 12.4-36.0 mm SL (Rugen and Matarese 1988).

Large concentrations of Pacific cod larvae were found initially in an area to the northeast of Kodiak Island, and between the Shumagin Islands and Unimak Pass. Fewer larvae were found in waters surrounding Kodiak Island (App. Fig. 26). In early May they began to appear in Shelikof Strait, and by late May, larvae were evenly spread throughout Shelikof Strait and southwest to the Shumagin Islands (App. Fig. 27). More information about distribution and the relative abundances of Pacific cod larvae in the western Gulf of Alaska is available in Rugen and Matarese (1988).

Hexagrammidae (App. Figs. 29-42)-- Hexagrammidae was the dominant taxon in the neuston layer for most of the year, and was present in the bongo samples during most date windows.

Hexagrammos decagrammus larvae were present in the bongo samples from late February to mid-June, and then reappeared in November. The vast majority of *H. decagrammus* larvae were found in the neuston layer virtually year-round, with only the summer months showing a large decrease in abundance. Mean lengths of the larvae were smallest in October (9.3 mm SL), and largest in July (23.8 mm SL). The mean length of *H. decagrammus* larvae in the neuston tows increased only 3.4 mm between late October (9.3 mm SL) and mid-June (12.9 mm SL). The distribution of *H. decagrammus* larvae in the western Gulf was shelf-wide (App. Figs. 29-37). They were found from nearshore to the shelf break, north and south of Kodiak, and in and out of Shelikof Strait.

The other hexagrammid larvae that were plentiful in the western Gulf of Alaska included *Pleurogrammus monopterygius*, *Hexagrammos stelleri*, and *Hexagrammos lagocephalus*. In the spring, *H. stelleri* (App. Figs. 38-39) and *P. monopterygius* (App. Figs. 41-42) were found in the neustonic layer from late February through late April. The mean lengths of these larvae were between 14.3 and 29.0 mm SL. These species appeared again between September and mid-November, at which time the mean lengths were between 8.4-12.4 mm SL. They were found only occasionally in the bongo samples. Hexagrammos lagocephalus larvae were found in both the neuston and bongo samples beginning in early September, and were captured in the neuston nets through early November. During that period, the mean length increased from 8.3-12.0 mm SL.

Ammodytidae (App. Figs. 43-50)-- Ammodytes hexapterus larvae were abundant over the first half of the year in both neuston and bongo samples. High abundances of larvae initially appeared in early March in the bongo tows, and in late March in the neuston tows. Larvae remained in relatively high numbers through early July, but were not collected during the remainder of the year. The mean lengths of the larvae were slightly larger in the neuston nets (9.6-29.7 mm SL) than in the bongo nets (5.4-18.7 mm SL).

Spatially, A. hexapterus larvae were quite widespread in the western Gulf of Alaska. Both gears initially collected large numbers of larvae near Kodiak Island (App. Figs. 43,47,48). In the bongo samples, larvae were taken in an area much farther northeast (App. Fig. 44). The pattern of high concentrations was generally more homogenous in the bongo tows than in the neuston tows. In the neuston, large catch values were often discontinuous (App. Figs. 48-49). For the neuston tows, the large catch/10 m^2 values for A. hexapterus larvae usually occurred near Kodiak Island or in the slope waters, while in the bongo, large numbers of larvae were found to the northeast and southwest of Kodiak Island, in Shelikof Strait, and in the nearshore waters near the Shumagin Islands (App. Figs. 43-45).

Bathymasteridae (App. Figs. 51-55)-- There are three species of Bathymaster found in the study area, B. caeruleofasciatus, B. leurolepis, and B. signatus. They are all identified as Bathymaster spp., because it is not possible at this time to differentiate the early life history stages from one another (Matarese et al. 1989). These larvae were captured in highest abundances from June to October in the neuston net, and from May to September in the bongo net. They were collected in both types of gear and in most date windows. The mean lengths decreased between mid-April and mid-June.

Large numbers of Bathymaster spp. larvae were taken in bongo tows during late May to the east and southwest of Kodiak Island (App. Figs. 52-53). The concentrations of larvae were mostly over the middle shelf area. In the neuston, large numbers of Bathymaster spp. were not found until late June, mainly near Kodiak Island (App. Fig. 55). In late June and July, the average number of Bathymaster spp. per station in the neuston samples was 568 and 130 respectively (Table 2).

Scorpaenidae (App. Figs. 56-60)-- In the Gulf of Alaska, there may be as many as 27 species of Sebastes (Matarese et al. 1989).

Larvae of the genus Sebastes are difficult to specifically identify, and therefore they are generally lumped together as Sebastes spp.. Mostly, these larvae were found in the bongo samples during the periods from May through mid-July. The largest numbers of Sebastes spp. larvae were found near the shelf break, with smaller, homogenous concentrations found over the middle shelf (App. Figs. 57-58,60). The mean lengths of Sebastes spp. larvae were between 5 and 6 mm SL.

Osmeridae (App. Figs. 61-67)-- Osmerid larvae were found in all of the date windows. Although several species of osmerids are present in the western Gulf of Alaska, only Mallotus villosus larvae can be specifically identified. They can only be positively identified once the fin elements can be clearly seen (~33 mm SL); larvae without distinguishable fin elements are labeled Osmeridae.

Mallotus villosus larvae were captured in all of the date windows, except late June. The period of greatest abundance was in the fall. The spatial distribution of M. villosus larvae was similar for both the bongo and neuston nets. Most of these larvae were found over the middle shelf area and around Kodiak Island. The mean lengths of M. villosus larvae ranged from 23.4-46.3 mm SL. The larvae in the neuston and bongo were generally smallest in the fall and largest in the summer.

Osmerid larvae began to appear in the bongo samples during late June. They ranked in the top three based on numbers caught and percent occurrence in September and October (App. Fig 10). These larvae were present in the neuston samples during the same periods but made up a much smaller proportion of the total catch.

Bathylagidae (App. Figs. 68-71)-- By far the most abundant bathylagid was Leuroglossus schmidti. The numbers of larvae were relatively small, but the distribution was widespread, especially in late May (App. Fig. 70). The larvae were found mostly in offshore waters. The mean lengths of L. schmidti larvae ranged from 10.0 mm SL in early March, to 19.5 mm SL in early June.

The only other bathylagid larvae frequently taken were Bathylagus pacificus. These larvae were most abundant in April and May. Their mean length larvae increased from 8.3 mm SL in early April to 11.4 mm SL in early June.

Myctophidae (App. Figs. 72-75)-- Although numerous species of Myctophidae occur in the Gulf of Alaska, only Stenobrachius leucopsarus larvae were relatively abundant in our collections. These larvae were found in the bongo samples during all the date windows, with the largest numbers found from April through May. Between early March and early June, the mean length increased from 3.8 to 7.8 mm SL.

The larvae of S. leucopsarus initially occurred only near the shelf break (App. Figs. 72-73). Later they were found in the northern end of Shelikof Strait and over much of the rest of the shelf (App. Figs. 73-75). A dichotomy of sizes is quite apparent; a majority of larvae were under 10 mm SL, and a smaller number measured ~20 mm SL.

Protomyctophum thompsoni larvae were also present, but were much less abundant than S. leucopsarus. They were most abundant in April and May, and the mean lengths of larvae ranged between 9.5 and 12.8 mm SL.

Cryptacanthodidae (App. Figs. 76-79)-- Lyconectes aleutensis larvae were a frequent component of the neuston samples. Large collections were made from March to July, with peak occurrences in May and June. These larvae initially appeared in the area around Kodiak Island (App. Fig. 76). Once the abundances began to increase however, high abundances (300-500/10 m^2) became widespread across the shelf (App. Figs. 77-78). The smallest mean length, 14.8 mm SL, was found in late March, and the largest, 26.5 mm SL, in late June.

Anoplopomatidae (App. Figs. 80-81)-- High abundances of Anoplopoma fimbria larvae were found in the neuston samples only during late May and early June. During this period, the mean length of A. fimbria larvae increased from 13.3-17.4 mm SL. Before and after these date windows, A. fimbria larvae were rarely found.

Pleuronectidae (App. Figs. 82-92)-- Pleuronectidae larvae were quite abundant in the samples. A total of 15 taxa of flatfish larvae were identified from the bongo samples, and 10 taxa were identified in the neuston samples. The abundances were much lower in the neuston samples.

Hippoglossoides elassodon were the most abundant pleuronectid larvae. These larvae began to appear in small numbers in early April, but only in Shelikof Strait (App. Fig. 82). By late May, the numbers of larvae had increased significantly, and the distribution had spread to most areas of the shelf (App. Fig. 83). The largest concentrations were still in Shelikof Strait, with other sizeable collections occurring to the northeast and southeast of Kodiak Island. After late May, larval collections dropped off drastically. Mean lengths of larvae increased from 5.6 mm SL in late April, to 15.3 mm SL in early July.

Lepidopsetta bilineata larvae also had a wide distribution over the shelf. These larvae were first found in the northern part of Shelikof Strait in late March (App. Fig. 85). During April, large concentrations of larvae first appear to the southeast of Kodiak Island, and eventually large numbers of larvae were found from Lower Cook Inlet to Unimak Pass (App. Figs. 85-87). The mean lengths of larvae increased from 3.8 mm SL in early April to 11.9 mm SL in late June. In general, the highest abundances of larvae were found to the east of Kodiak Island and farther to the southwest along the Alaska Peninsula.

Atheresthes stomias larvae were another commonly occurring pleuronectid. They were found from early March through early June. The majority of the larvae were taken near the shelf break during April (App. Fig. 90); however, in late May (App. Fig. 91) they were captured in the northern end of Shelikof Strait. Mean lengths of A. stomias larvae ranged between 7.7 mm SL in early March, to 16.5 mm SL in early June.

Hippoglossus stenolepis larvae were often taken between mid-March and mid-June. The mean lengths ranged from 11.2 mm SL in late March to 20.1 mm SL in late May. Glyptocephalus zachirus (8.7-13.7 mm SL), Psettichthys melanostictus (5.5-12.7 mm SL), Microstomus pacificus (7.2-8.0 mm SL), and Isopsetta isolepis (4.7-7.4 mm SL) larvae were caught between late May and mid-July.

Cottidae (App. Figs. 93-104)-- There were 33 cottid taxa identified in the bongo samples, and 16 in the neuston samples.

There are several species of Hemilepidotus in the western Gulf of Alaska (Matarese et al. 1989). Hemilepidotus larvae were identified to species at the flexion and postflexion stages; H. hemilepidotus and H. jordani larvae in the preflexion stage were identified as Hemilepidotus spp.. Hemilepidotus spp. larvae were the most commonly identified cottid larvae in our sampling area. Larvae identified as Hemilepidotus spp. were collected with both gears, although they were much more abundant in the neuston samples. In the neuston net, Hemilepidotus spp. larvae were common during the periods of February through April and September through early October. The largest abundances were found just south and east of Kodiak Island, and further to the southwest around the Shumagin Islands (App. Fig. 95-96). The areas of concentrations were widely separated. The catches in the bongo nets were comparatively quite small.

Very large numbers of Hemilepidotus hemilepidotus were found in the neustonic layer. These larvae were taken beginning in late March, and continued to be taken through late June (App. Figs. 97-100). During this period, the mean length of the larvae increased from 9.8-19.7 mm SL. Areas of high abundance were widely spaced between 145° W and Unimak Pass. Hemilepidotus spinosus and H. jordani larvae were less abundant than either Hemilepidotus spp. or H. hemilepidotus. Hemilepidotus spinosus and H. jordani larvae were found mostly in the neuston samples from late March through late May. The mean lengths of H. spinosus larvae ranged from 7.2-9.3 mm SL, and H. jordani larvae increased in length from 16.0-23.6 mm SL during this period.

Larvae identified only as Cottidae were present almost exclusively between early March and late June in the bongo samples (App. Figs. 101-104). The numbers of Cottidae larvae were relatively small, but the larvae were quite evenly and widely spread across the shelf area. The mean lengths of these larvae ranged from 5.7-9.7 mm SL.

Other cottid larvae that were less commonly caught included Artedius harringtoni, and those identified as Gymnocanthus type A, and Myoxocephalus type B.

Stichaeidae-- Many types of stichaeid larvae were present in the bongo tows, but generally they occurred in small numbers. Lumpenus maculatus, L. sagitta, and Lumpenella longirostris larvae were by far the most abundant stichaeids taken. These larvae were present mainly during April and May. The mean lengths of these larvae were mostly between 10 and 20 mm SL.

Regroup analysis (App. Figs. 105-116)

Neuston (App. Figs. 105-109)-- The regroup analysis of the neuston samples shows a relatively simple structure. In the neuston samples, the date windows had fewer groups and fewer taxa with significant affinities than the bongo samples. Hexagrammidae larvae were a component in all the date windows.

Hexagrammidae and Hemilepidotus spp. were the only taxa with significant affinities in February and early March (App. Fig. 105). In late March, a group composed of Stichaeidae and Lyconectes aleutensis was added (App. Fig. 105). From April until late June, Hexagrammidae, Lyconectes aleutensis, Ammodytes hexapterus, and Hemilepidotus spp. were the most prevalent taxa with significant affinities (App. Figs. 106-107). In July, a group composed of Bathymaster spp., Sebastes spp., and Anoplopoma fimbria was present. Bathymaster spp. also had a significant affinity with Hexagrammos decagrammus (App. Fig. 108). For the remainder of the date windows, the larvae with significant affinities were Bathymaster spp., Hemilepidotus spp, and an osmerid and hexagrammid (App. Figs. 108-109).

Bongo (App. Figs. 110-116)-- The bongo samples had a much more complex community structure than the neuston tows. In general, there were more groups present, more interaction between groups, and more single taxa with affinities to taxa within groups.

In February, Hemilepidotus spp. and Hexagrammos decagrammus formed the only group, with Hemilepidotus spp. also showing a significant affinity to Mallotus villosus (App. Fig. 110). In March, the recurrent group analysis showed a structure with little interaction outside the groups (App. Fig. 110). Two groups composed of Leuroglossus schmidti and Atheresthes stomias and Ammodytes hexapterus and Hexagrammos decagrammus were present throughout the month. In April and May a very complex structure of interactions was present (App. Figs. 111-113). Generally, the structure was composed of a main group of 4 to 10 taxa, one or two smaller groups, and many taxa with affinities to taxa inside groups. There was much interaction between taxa in different groups, and between taxa in groups and those not in groups. In June, the complexity and number of taxa involved had decreased greatly (App. Fig. 114). In both June date windows, the structure was composed of four small groups and two other taxa not in groups. None of the groups present in early June were present in late June. For the remainder of the date windows, the structure was composed of a central group and up to three other taxa with affinities to members of the group (App. Figs. 114-116). From September to mid-November the central group always contained Osmeridae or Mallotus villosus, and usually Hemilepidotus spp. or a hexagrammid.

DISCUSSION

The western Gulf of Alaska appears to be an important area of larval production for many species of fish. Theragra chalcogramma, Bathymaster spp., Ammodytes hexapterus, Gadus macrocephalus, and many hexagrammids, pleuronectids, and cottids use this area extensively.

Theragra chalcogramma is the dominant taxon in the samples. Though present mainly from late March to late June, they account for over 65% of the larvae taken in all sampling, and 82.3% of the larvae taken in the bongo nets. At their peak abundance, the average number taken per station is over 800 (Table 3). From late April to the end of May, the average number taken per station is greater than 100.

There were quite a few taxa whose larvae hatch at the same time as Theragra chalcogramma. Ammodytes hexapterus, Atheresthes stomias, Stenobrachius leucopsarus, and Leuroglossus schmidti appear to spawn sometime during the winter. These larvae first appear in early March and continue to be a component of the larval community into June and July. Most pleuronectid, stichaeid, cyclopterid, and agonid larvae were also components of the sub-surface larval community between March and July.

Bathymaster spp. and Sebastes spp. also spawn in early spring. Their larvae are first found in April and frequently appear in the bongo net through September. Bathymaster spp. continue to be a component of the neuston samples through early November.

The data suggest that osmerids spawn during late spring/early summer in the western Gulf of Alaska. Osmerid larvae begin to appear in the neuston and bongo nets in late June in high abundances and were a component of the samples through late October. The smallest larvae identified as Mallotus villosus were taken in September and were present until May in the bongo samples and into June in the neuston samples.

Species of Hexagrammidae appear to spawn in the late summer and fall months. The hexagrammid larvae had the smallest mean lengths in the fall, and were found mostly in the neuston layer. These larvae continued to be a major component of the neuston samples into the following spring.

Species of Hemilepidotus appear to spawn during the summer. Small Hemilepidotus spp. larvae were first taken by both gears in September. They continue to be abundant until the following April, at which time the various species of Hemilepidotus are readily identifiable. Hemilepidotus hemilepidotus, H. jordani, and H. spinosus were all present in the neuston samples from late March until May and June, but were rarely found in the bongo samples.

There are a number of other taxa whose larvae were of the same size as pollock larvae and might be using the same food source. However, because *Theragra chalcogramma* larvae were so dominant in the samples, intraspecific competition would appear to be a much more important factor than interspecific competition. All the other taxa in the bongo samples combined account for less than 18% of the total catch. There were only two taxa that had an average number of larvae greater than 100/station. In late June and early July, *Bathymaster* spp. had 567 and 130 larvae/station respectively. Also in late June, Osmeridae had 146 larvae/station. These larval abundances, however, occurred in the neuston layer, and therefore, would probably have a minimal effect on pollock larvae.

For most of the spring and early summer, the sub-surface waters exhibited a great abundance and diversity of larval fish (Table 3) and a very complex structure of interaction (App. Figs. 111-114). During the rest of the year, the neuston layer held the greatest abundance of larvae, while the diversity was relatively the same as in the sub-surface waters.

There is no evidence that any significant hatching takes place between late fall and early spring. All of the larvae present during that period had smaller mean lengths at the end of October than they did at the beginning of March, indicating that no significant amount of smaller, newly hatched larvae were present. This may be associated with the lack of appropriately sized food sources during the winter months. The spring and summer zooplankton composition is dominated by *Pseudocalanus* spp., whose nauplii production lasts from April to November (McLaren 1978), and are highly important to the survival of first feeding larvae (Cooney 1986). However, in the winter months the dominant zooplankters are larger, offshore species (Cooney 1986), unsuitable for first feeding larvae.

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Appendix Figure 94.--Distribution of _Hemilepidotus_ spp. larvae in bongo tows, Apr. 1-15 (catch/10 m^2=P^2/2.5281, where P=percentage of width of sector taken up by dot, for catches >500/10 m^2, P=42.8%).

Appendix Figure 95.--Distribution of _Hemilepidotus_ spp. larvae in neuston tows, A. Mar. 1-15, B. Mar. 16-31 (catch/10 m^2=P^2/2.5281, where P=percentage of width of sector taken up by dot, for catches >500/10 m^2, P=42.8%).

Appendix Figure 96.--Distribution of _Hemilepidotus_ spp. larvae in neuston tows, A. Apr. 1-15, B. Apr. 16-30 (catch/10 m^2=P^2/2.5281, where P=percentage of width of sector taken up by dot, for catches >500/10 m^2, P=42.8%).

Appendix Figure 97.--Distribution of _Hemilepidotus_ _hemilepidotus_ larvae in neuston tows, A. Mar. 16-31, B. Apr. 1-15 (catch/10 m^2=P^2/2.5281, where P=percentage of width of sector taken up by dot, for catches >500/10 m^2, P=42.8%).

Appendix Figure 98.--Distribution of _Hemilepidotus_ _hemilepidotus_ larvae in neuston tows, A. Apr. 16-30, B. May 1-15 (catch/10 m^2=P^2/2.5281, where P=percentage of width of sector taken up by dot, for catches >500/10 m^2, P=42.8%).

Appendix Figure 99.--Distribution of _Hemilepidotus_ _hemilepidotus_ larvae in neuston tows, A. May 16-31, B. June 1-15 (catch/10 m^2=P^2/2.5281, where P=percentage of width of sector taken up by dot, for catches >500/10 m^2, P=42.8%).

Appendix Figure 100.--Distribution of _Hemilepidotus_ _hemilepidotus_ larvae in neuston tows, June 16-30 (catch/10 m^2=P^2/2.5281, where P=percentage of width of sector taken up by dot, for catches >500/10 m^2, P=42.8%).

Appendix Figure 101.--Distribution of Cottidae larvae in bongo tows, A. Mar. 16-31, B. Apr. 1-15 (catch/10 m^2=P^2/2.5281, where P=percentage of width of sector taken up by dot, for catches >500/10 m^2, P=42.8%).

Appendix Figure 102.--Distribution of Cottidae larvae in bongo tow, A. Apr. 16-30, B. May 1-15 (catch/10 m^2=P^2/2.5281, where P=percentage of width of sector taken up by dot, for catches >500/10 m^2, P=42.8%).

Appendix Figure 103.--Distribution of Cottidae larvae in bongo tows, A. May 16-31, B. June 1-15 (catch/10 m^2=P^2/2.5281, where P=percentage of width of sector taken up by dot, for catches >500/10 m^2, P=42.8%).

Appendix Figure 104.--Distribution of Cottidae larvae in bongo tows, June 16-30 (catch/10 m^2=P^2/2.5281, where P=percentage of width of sector taken up by dot, for catches >500/10 m^2, P=42.8%).

Appendix Figure 105.--Results of recurrent group analysis of neuston catches by date window, A. Feb. 13-28, B. Mar. 1-15, C. Mar. 16-31. Boxes enclose members of recurrent groups. Lines connect taxa with affinities outside their groups. Numbers of occurrences are in parentheses.

Appendix Figure 106.--Results of recurrent group analysis of neuston catches by date window, A. Apr. 1-15, B. Apr. 16-30, C. May 1-15. Boxes enclose members of recurrent groups. Lines connect taxa with affinities outside their groups. Numbers of occurrences are in parentheses.

Appendix Figure 107.--Results of recurrent group analysis of neuston catches by date window, A. May 16-31, B. June 1-15, C. June 16-30. Boxes enclose members of recurrent groups. Lines connect taxa with affinities outside their groups. Numbers of occurrences are in parentheses.

Appendix Figure 108.--Results of recurrent group analysis of neuston catches by date window, A. July 1-15, B. Sept. 1-15, C. Sept. 16-30. Boxes enclose members of recurrent groups. Lines connect taxa with affinities outside their groups. Numbers of occurrences are in parentheses.

Appendix Figure 109.--Results of recurrent group analysis of neuston catches by date window, A. Oct. 1-15, B. Oct. 16-31, C. Nov. 1-17. Boxes enclose members of recurrent groups. Lines connect taxa with affinities outside their groups. Numbers of occurrences are in parentheses.

Appendix Figure 110.--Results of recurrent group analysis of bongo catches by date window, A. Feb. 13-28, B. Mar. 1-15, C. Mar. 16-31. Boxes enclose members of recurrent groups. Lines connect taxa with affinities outside their groups. Numbers of occurrences are in parentheses.

Appendix Figure 111.--Results of recurrent group analysis of bongo catches by date window, A. Apr. 1-15, B. Apr. 16-30. Boxes enclose members of recurrent groups. Lines connect taxa with affinities outside their groups. Numbers of occurrences are in parentheses.

Appendix Figure 112.--Results of recurrent group analysis of bongo catches by date window, May 1-15. Boxes enclose members of recurrent groups. Lines connect taxa with affinities outside their groups. Numbers of occurrences are in parentheses.

Appendix Figure 113.--Results of recurrent group analysis of bongo catches by date window, May 16-31. Boxes enclose members of recurrent groups. Lines connect taxa with affinities outside their groups. Numbers of occurrences are in parentheses.

Appendix Figure 114.--Results of recurrent group analysis of bongo catches by date window, A. June 1-15, B. June 16-30, C. July 1-15. Boxes enclose members of recurrent groups. Lines connect taxa with affinities outside their groups. Numbers of occurrences are in parentheses.

Appendix Figure 115.--Results of recurrent group analysis of bongo catches by date window, A. Sept. 1-15, B. Sept. 16-30, C. Oct. 1-15. Boxes enclose members of recurrent groups. Lines connect taxa with affinities outside their groups. Numbers of occurrences are in parentheses.

Appendix Figure 116.--Results of recurrent group analysis of bongo catches by date window, A. Oct. 16-31, B. Nov. 1-17. Boxes enclose members of recurrent groups. Lines connect taxa with affinities outside their groups. Numbers of occurrences are in parentheses.

Table 1. -- Collection data of larvae in the western Gulf of Alaska. Cruises are arranged in chronological order.

Cruise	Cruise dates	Number of bongo stations	Number of neuston stations
2KE72	Apr. 19-May 11, 1972	67	0
4MF77	Oct. 31-Nov. 14, 1977	59	83
4DI78	Mar. 28-Apr. 20, 1978	86	113
2MF78	June 19-July 9, 1978	88	113
3MF78	Sept. 8-21, 1978	26	28
4MF78	Sept. 24-Oct. 7, 1978	66	45
5MF78	Oct. 15-Nov. 1, 1978	19	11
1WE78	Oct. 25-Nov. 17, 1978	97	101
6MF78	Nov. 5-24, 1978	43	21
1MF79	Feb. 13-Mar. 11, 1979	88	89
5TI79	May 16-24, 1979	58	0
1PO79	Sept. 2-Oct. 11, 1979	17	47
1SH81	Mar. 5-18, 1981	131	130
1MF81	Mar. 12-20, 1981	31	0
2MF81	Mar. 30-Apr. 8, 1981	89	0
2SH81	Apr. 16-24, 1981	60	60
3MF81	Apr. 26-May 2, 1981	79	0
4MF81	May 20-24, 1981	75	0
3SH81	May 20-28, 1981	57	0
1DA82	Apr. 4-23, 1981	83	0
2DA82	May 21-31, 1981	62	0
1CH83	May 16-31, 1983	62	62
1SH84	Apr. 17-May 9, 1984	160	154
1DI85	Mar. 11-Apr. 2, 1985	69	0
1PO85	Mar. 29-Apr. 21, 1985	154	151
2MF85	May 1-12, 1985	62	0
2PO85	May 16-June 8, 1985	189	189
1GI86	Mar. 30-Apr. 20, 1986	149	149
1MF86	Apr. 2-13, 1986	80	0
2MF86	May 1-19, 1986	108	0
Totals		2,414	1,546

Table 2.-- Mean lengths (SL) and average number of taxa caught per neuston station by date window of the more commonly caught species. (Average no./station = total no. caught divided by no. of stations where taxa were captured).

Species	Feb 13-28 Avg no caught	Feb 13-28 Mean length	Mar 1-15 Avg no caught	Mar 1-15 Mean length	Mar 16-31 Avg no caught	Mar 16-31 Mean length	Apr. 1-15 Avg no caught	Apr. 1-15 Mean length	Apr. 16-30 Avg no caught	Apr. 16-30 Mean length	May 1-15 Avg no. caught	May 1-15 Mean length	May 16-31 Avg no caught	May 16-31 Mean length	June 1-15 Avg no caught	June 1-15 Mean length	June 16-30 Avg no caught	June 16-30 Mean length	July 1-15 Avg no caught	July 1-15 Mean length	Sept 1-15 Avg no caught	Sept 1-15 Mean length	Sept 16-30 Avg no caught	Sept 16-30 Mean length	Oct 1-15 Avg no caught	Oct 1-15 Mean length	Oct 16-31 Avg no caught	Oct 16-31 Mean length	Nov 1-17 Avg no caught	Nov 1-17 Mean length
Hexagrammos decagrammus	30.0	10.5	8.5	11.5	38.6	11.2	35.0	11.3	19.0	11.8	9.4	12.2	20.9	12.9	9.0	13.7	5.7	21.6	3.3	23.8					1.7	10.3	11.7	9.3	6.8	10.3
Hexagrammos lagocephalus																					37.1	8.3	68.9	8.5	72.0	9.9	16.8	10.3	4.0	12.0
Hexagrammos stelleri	2.3	19.3	1.6	19.6	1.6	22.2	2.1	23.7	1.3	27.8			1.5	34.4			5.7	54.6					30.3	8.4	4.2	8.3	13.7	9.9	15.2	12.4
Pleurogrammus monopterygius	35.1	14.3	6.6	15.4	4.5	18.6	12.3	17.8	3.0	29.0															11.8	8.6	31.7	10.5	33.1	10.2
Hexagrammos octogrammus	1.4	24.7			1.0	24.8															12.8	7.7	31.9	8.8	11.4	10.2	12.1	9.9	3.5	14.2
Hemilepidotus spp	22.1	8.5	19.4	8.2	15.4	10.0	37.3	10.9	3.4	10.8													34.0				7.2		48.5	
Hemilepidotus hemilepidotus					16.8	9.8	24.6	10.6	34.8	11.8	8.7	12.1	2.2	15.6	7.6	15.8	2.2	19.7												
Hemilepidotus spinosus					19.0	7.2	4.7	7.8	3.5	7.8			3.6	9.3																
Hemilepidotus jordani					4.0	18.0	5.0	19.8	6.1	18.4			3.1	23.6																
Mallotus villosus	2.1	41.4	2.6	39.0	15.2	35.6	6.6	51.1	7.4	43.4	8.5	46.2	30.1	46.3	8.0	44.5					11.0	23.4	27.8	32.7	3.0	31.5	5.1	34.8	16.9	32.5
Bathymaster spp													3.5	10.7	4.7	9.6	566.7		129.9		22.4		21.8		6.4		3.1		3.2	
Sebastes spp													23.8	5.4					6.8											
Ammodytes hexapterus					10.4	17.1	3.7	21.6	12.7	9.6	23.0	14.2	157.1	22.9	29.7	23.8	11.3	36.1	28.0	53.5										
Lyconectes aleutensis					9.0	14.8	5.1	15.1	5.0	15.7	16.6	14.7	31.2	16.7	27.2	17.7	4.3	26.5	3.5	23.2										
Anoplopoma fimbria													49.0	13.3	12.1	13.7	1.5	17.4												
Zaprora silenus							2.8	11.9			11.0	15.7	2.0	13.5	2.8	12.6														
Theragra chalcogramma							3.5	4.7	19.6	4.8			4.6	8.2																
Hexagrammos spp					33.6	16.8	10.7						3.0										9.2	8.2						
Osmeridae																	146.0				17.6		5.4				22.0		4.4	

Table 3.-- Mean lengths (SL) and average number of taxa caught per bongo station by date window of the more commonly caught species. (Average no./station = total no. caught divided by no. of stations where taxa were captured).

Species	Feb 13-28 Avg no caught	Feb 13-28 Mean length	Mar 1-15 Avg no caught	Mar 1-15 Mean length	Mar 16-31 Avg no caught	Mar 16-31 Mean length	Apr 1-15 Avg no caught	Apr 1-15 Mean length	Apr 16-30 Avg no caught	Apr 16-30 Mean length	May 1-15 Avg no caught	May 1-15 Mean length	May 16-31 Avg no caught	May 16-31 Mean length
Theragra chalcogramma					1.1	4.3	24.5	4.6	804.0	4.4	123.3	5.2	157.3	8.1
Gadus macrocephalus							9.2	4.1	15.3	4.4	3.9	5.0	3.8	7.5
Ammodytes hexapterus	1.0	15.5	5.4	34.7	6.3	17.4	8.1	20.1	10.7		11.6	10.9	8.6	16.7
Bathymaster spp									1.9	7.1	2.7	6.4	25.4	6.1
Sebastes spp							1.7	5.2	3.4	5.4	1.5		5.7	5.1
Mallotus villosus	5.8	32.0	3.4	38.4	3.0	36.7	1.8	36.6	1.4	41.1	1.6	44.1		
Hippoglossoides elassodon									1.8	5.6	4.8	6.2	10.9	6.9
Lepidopsetta bilineata					2.9	3.8	5.8	4.1	5.8	4.5	6.0	4.9	3.6	8.0
Atheresthes stomias			2.0	7.7	2.9	7.1	5.3	8.2	5.5	8.6	1.7	11.2	2.9	13.6
Hippoglossus stenolepis					4.5	11.2	1.4	14.3	1.6	14.8			1.3	20.1
Glyptocephalus zachirus													2.2	8.7
Platichthys stelleri													2.6	4.1
Psettichthys melanostictus													1.9	12.7
Microstomus pacificus														
Isopsetta isolepis													3.0	4.7
Hemilepidotus spp	2.7	6.6	2.1	8.2	1.2	9.4	1.8	10.9						
Stenobrachius leucopsarus			2.3	3.8	1.7	4.2	2.5	5.0	2.1	5.2	3.9	5.5	2.1	7.2
Protomyctophum thompsoni							1.1	9.8	1.2	9.5			1.0	12.8
Leuroglossus schmidti			2.2	10.0	2.5	10.5	1.8	11.0	1.9	11.9	1.8	13.2	1.5	15.9
Bathylagus pacificus							1.4	8.3	1.5	8.8	2.8	9.5	1.4	11.7
Hexagrammos decagrammus	1.6	10.6	3.1	10.9	1.7	11.0	1.6	11.6	3.2	10.7	1.2	12.4	1.2	11.9
Hexagrammos lagocephalus /														
Hexagrammos stelleri														
Pleurogrammus monopterygius	1.4	14.2												
Cyclopteridae					1.3	5.7	1.6	5.2	2.5	5.6	2.2	5.2	1.5	6.4
Agonidae							1.2	6.6	1.3	7.4	1.4	7.3	1.4	9.8
Lumpenus maculatus							1.8	11.2	2.0	12.1	1.8	12.7	1.6	18.6
Lumpenus sagitta					2.7	16.4	1.3	18.5	1.2	22.1	1.1	20.1		
Lumpenella longirostris									3.2	12.5	1.8	18.8		
Lyconectes aleutensis									1.3	14.4	1.1	16.9	1.4	16.2
Cottidae					1.9	5.7	2.2	5.7	1.8	6.8	2.5	6.7	2.1	8.5
Gymnocanthus A							2.6	7.6	2.0	9.4	3.9	8.1		
Myoxocephalus B							3.7		2.5	7.4	5.6	9.8	2.0	9.8
Artedius harringtoni									1.4	3.8	1.7	3.6	1.3	4.8
Osmeridae														

Species	June 1-15 Avg no caught	June 1-15 Mean length	June 16-30 Avg no caught	June 16-30 Mean length	July 1-15 Avg no caught	July 1-15 Mean length	Sept 1-15 Avg no caught	Sept 1-15 Mean length	Sept 16-30 Avg no caught	Sept 16-30 Mean length	Oct 1-15 Avg no caught	Oct 1-15 Mean length	Oct 16-31 Avg no caught	Oct 16-31 Mean length	Nov 1-17 Avg no caught	Nov 1-17 Mean length
Theragra chalcogramma	6.4	7.4	1.5	18.1												
Gadus macrocephalus	7.8	8.9														
Ammodytes hexapterus	4.2	18.7														
Bathymaster spp	27.1	5.8	22.1		14.6		6.6		2.0							
Sebastes spp	5.1	5.8	19.2		47.8		1.9									
Mallotus villosus							(7.0)	40.2	3.2	25.1	16.1	27.4	17.7	22.3	9.2	25.8
Hippoglossoides elassodon	2.4	8.3	1.9	9.3	1.6	15.3										
Lepidopsetta bilineata	2.5	9.2	1.8	11.9												
Atheresthes stomias	2.9	16.5														
Hippoglossus stenolepis	1.3	16.8														
Glyptocephalus zachirus	2.0	9.1	1.5	10.6	2.1	13.7										
Platichthys stelleri																
Psettichthys melanostictus			3.8	5.5												
Microstomus pacificus			1.9	7.2	2.0	8.0										
Isopsetta isolepis			2.2	7.4												
Hemilepidotus spp									14.1	4.3	21.2	4.7	16.0	5.3	9.3	5.8
Stenobrachius leucopsarus	2.3	7.8	1.5				9.8		2.6							
Protomyctophum thompsoni																
Leuroglossus schmidti	2.3	19.5													1.5	
Bathylagus pacificus	1.7	11.4														
Hexagrammos decagrammus	5.5	13.3														
Hexagrammos lagocephalus /							28.1	8.4	4.0	8.2	2.4	11.6				
Hexagrammos stelleri									1.7	9.4			5.8	11.2	2.0	11.0
Pleurogrammus monopterygius															13.3	10.6
Cyclopteridae																
Agonidae	1.4	8.5														
Lumpenus maculatus																
Lumpenus sagitta																
Lumpenella longirostris																
Lyconectes aleutensis																
Cottidae	3.9	9.7	3.1													
Gymnocanthus A																
Myoxocephalus B																
Artedius harringtoni																
Osmeridae			53.9				88.6		71.9		27.9		73.5			

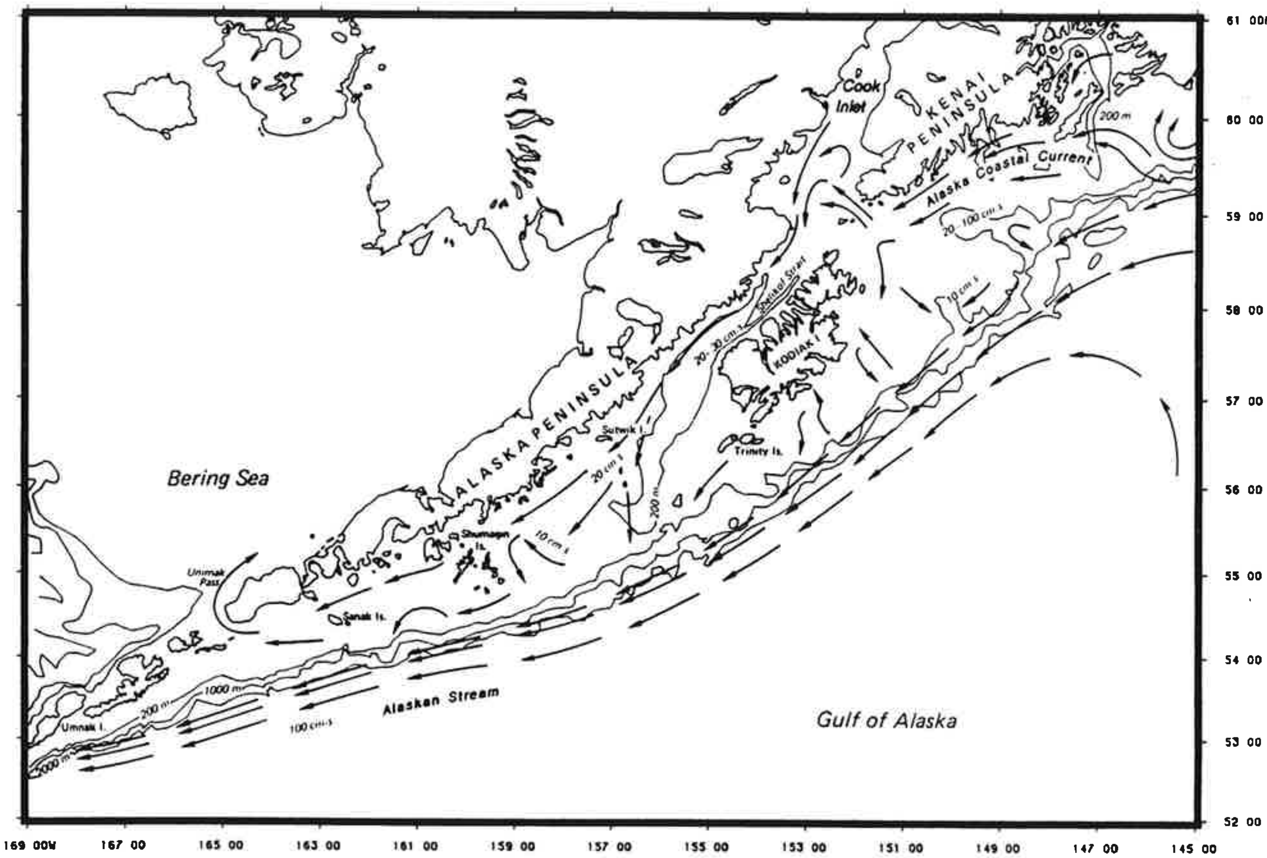
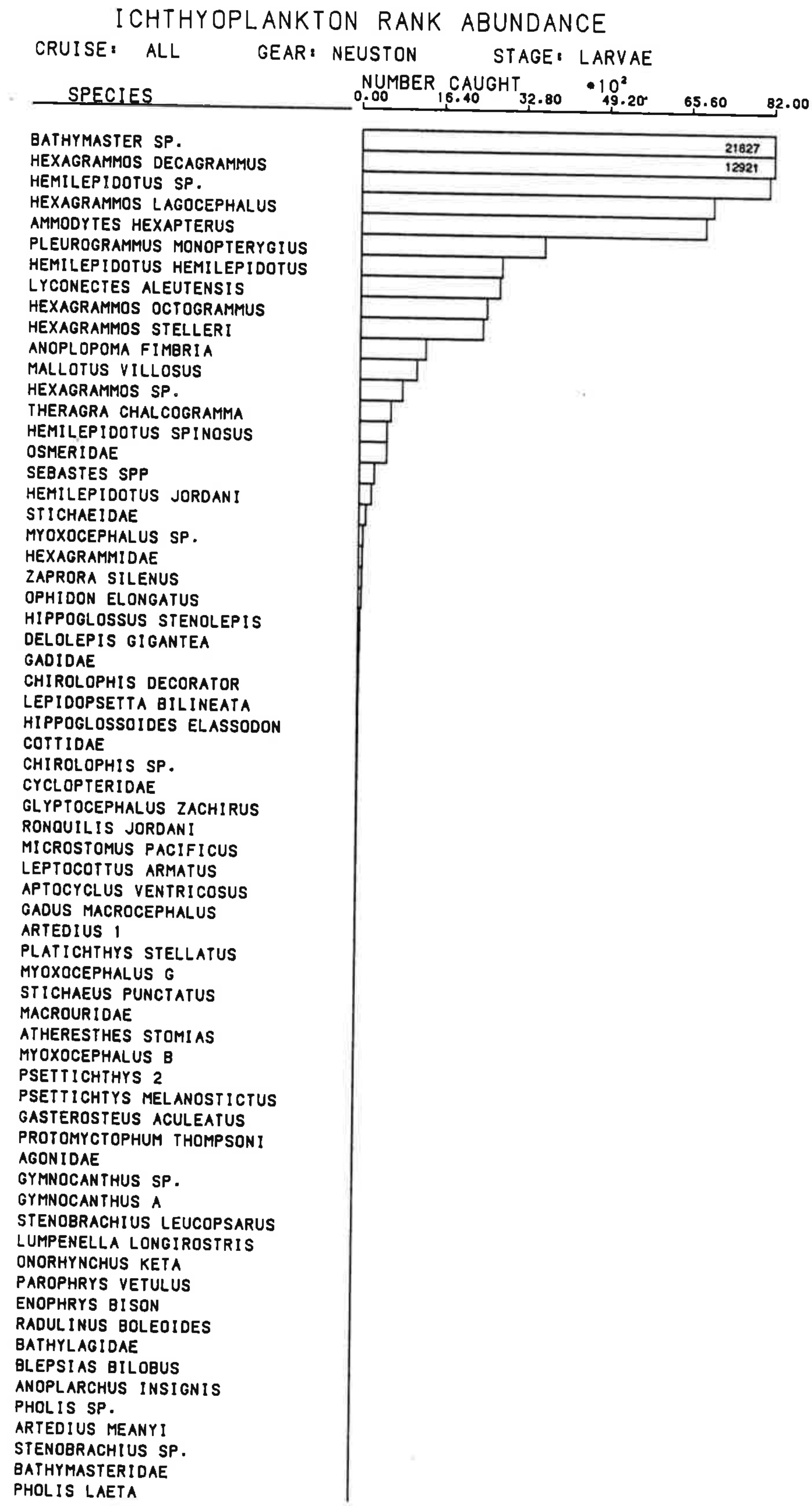
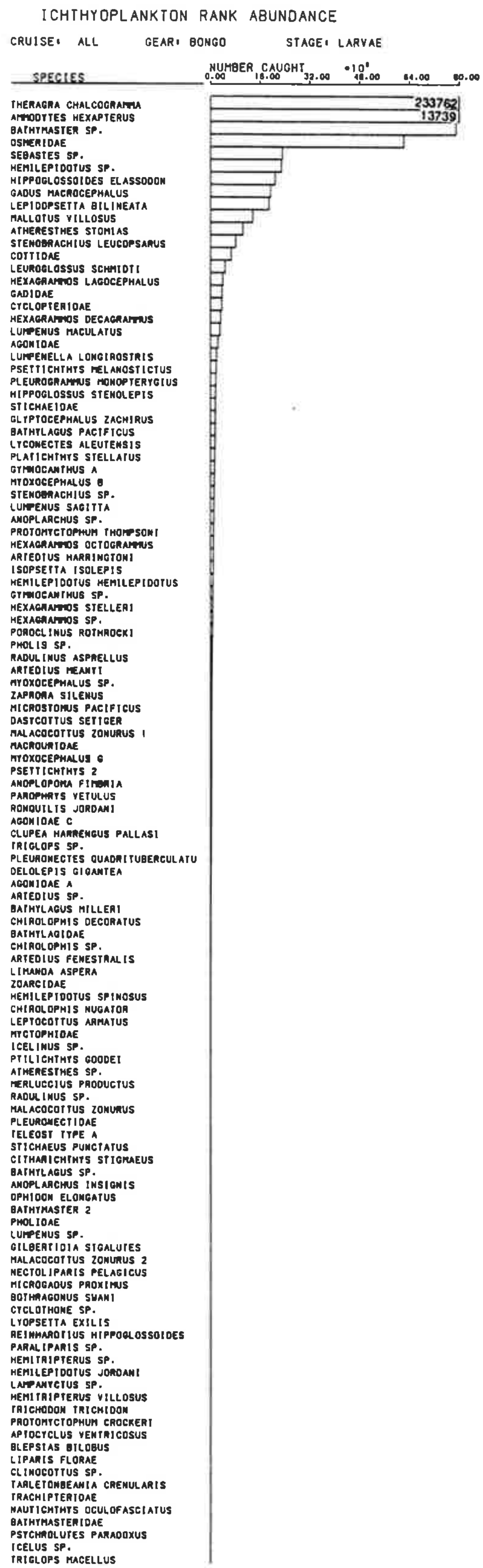


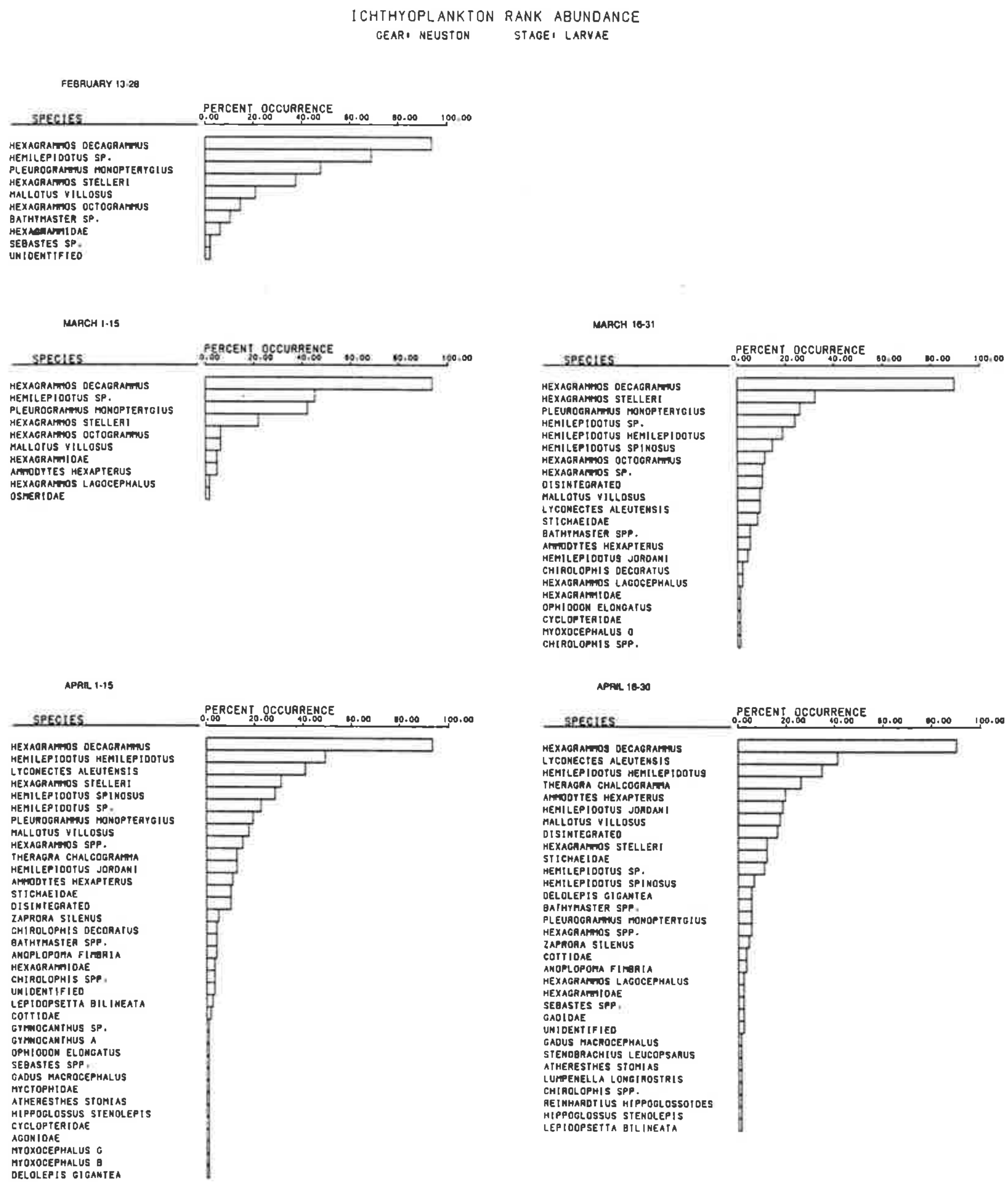
Figure 1.--Near surface currents and some geographic and bathygraphic features of the western Gulf of Alaska. Currents based on Reed and Schumacher (1986).



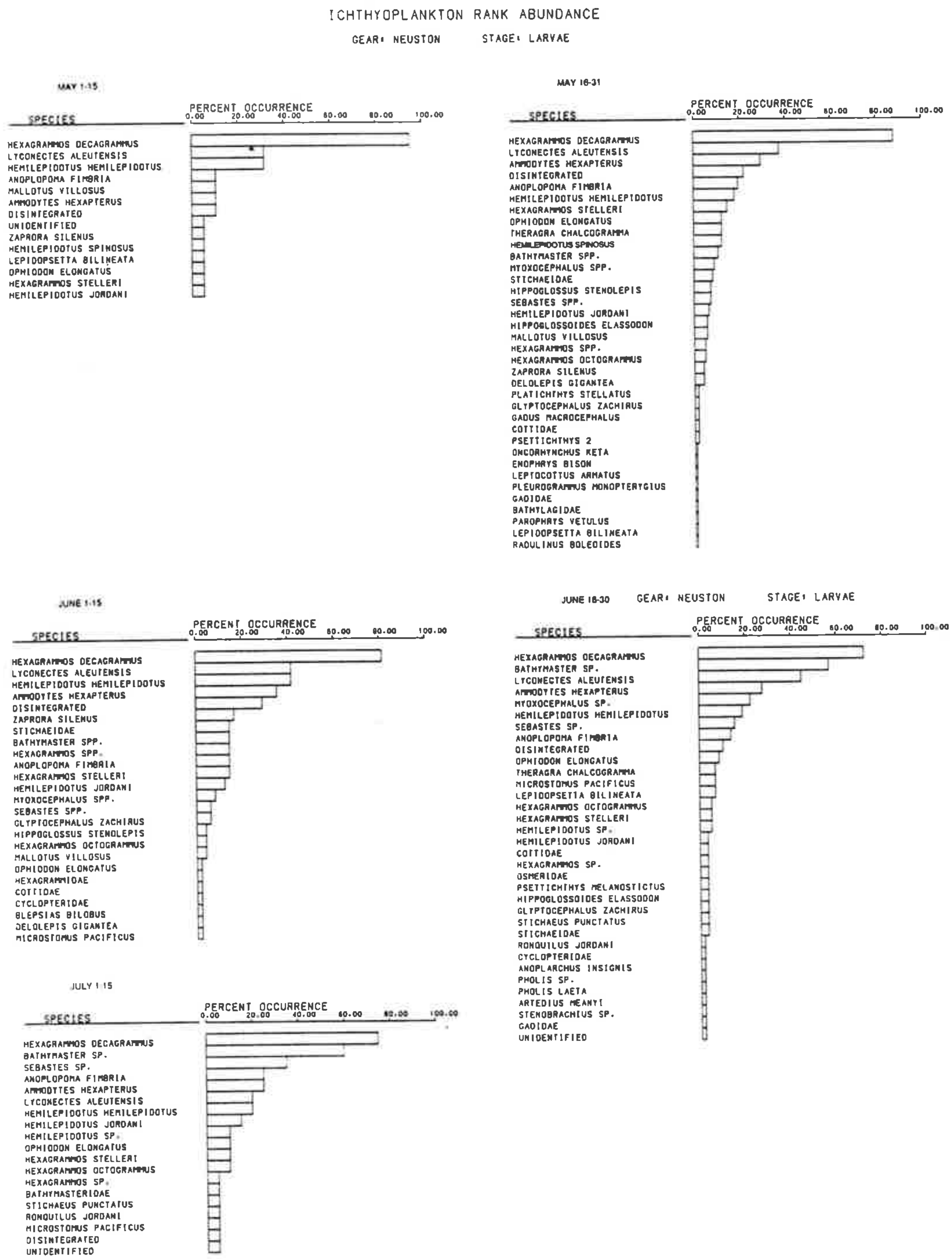
Appendix Figure 1.--Relative abundance (based on number caught) of fish larvae in the neuston tows.



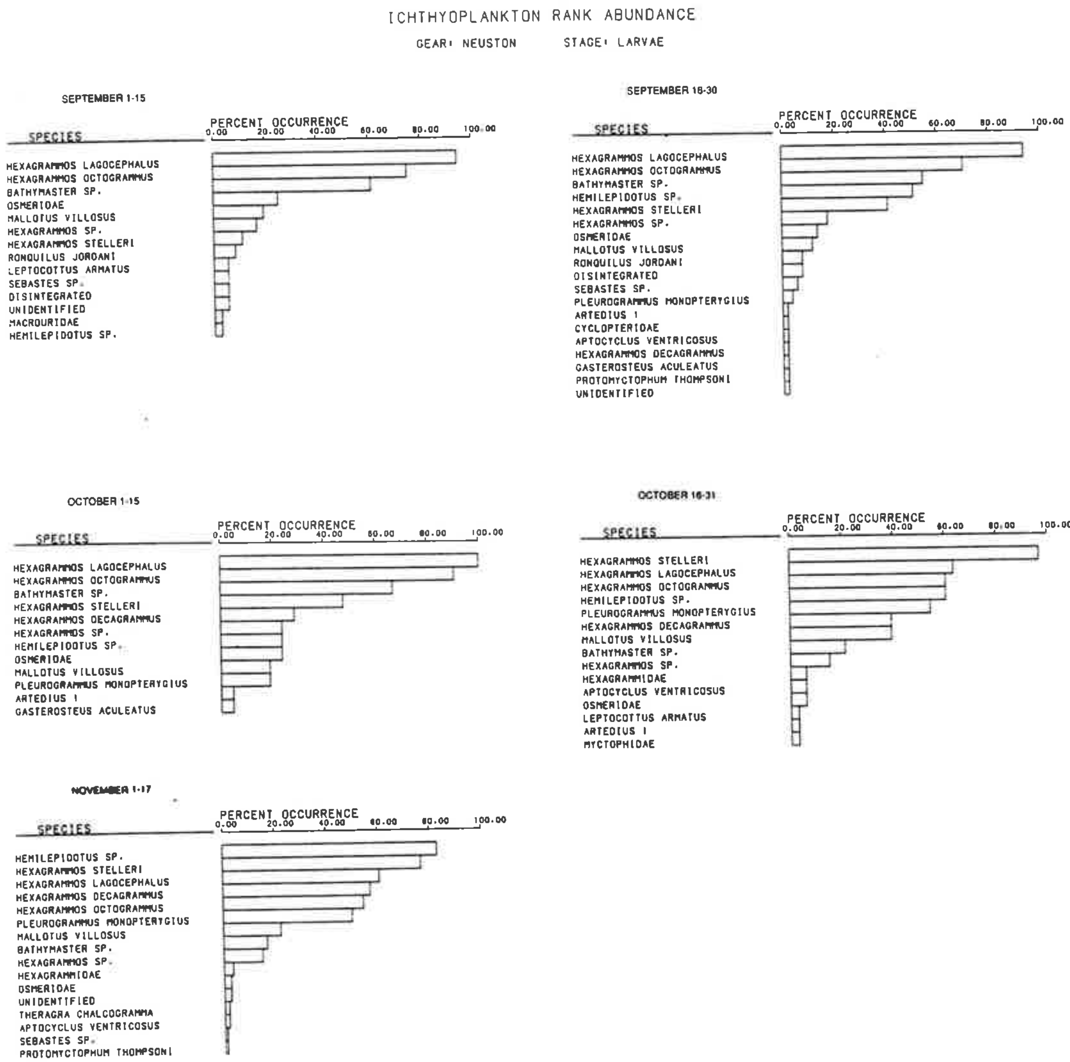
Appendix Figure 2.--Relative abundance (based on number caught) of fish larvae in the bongo tows.



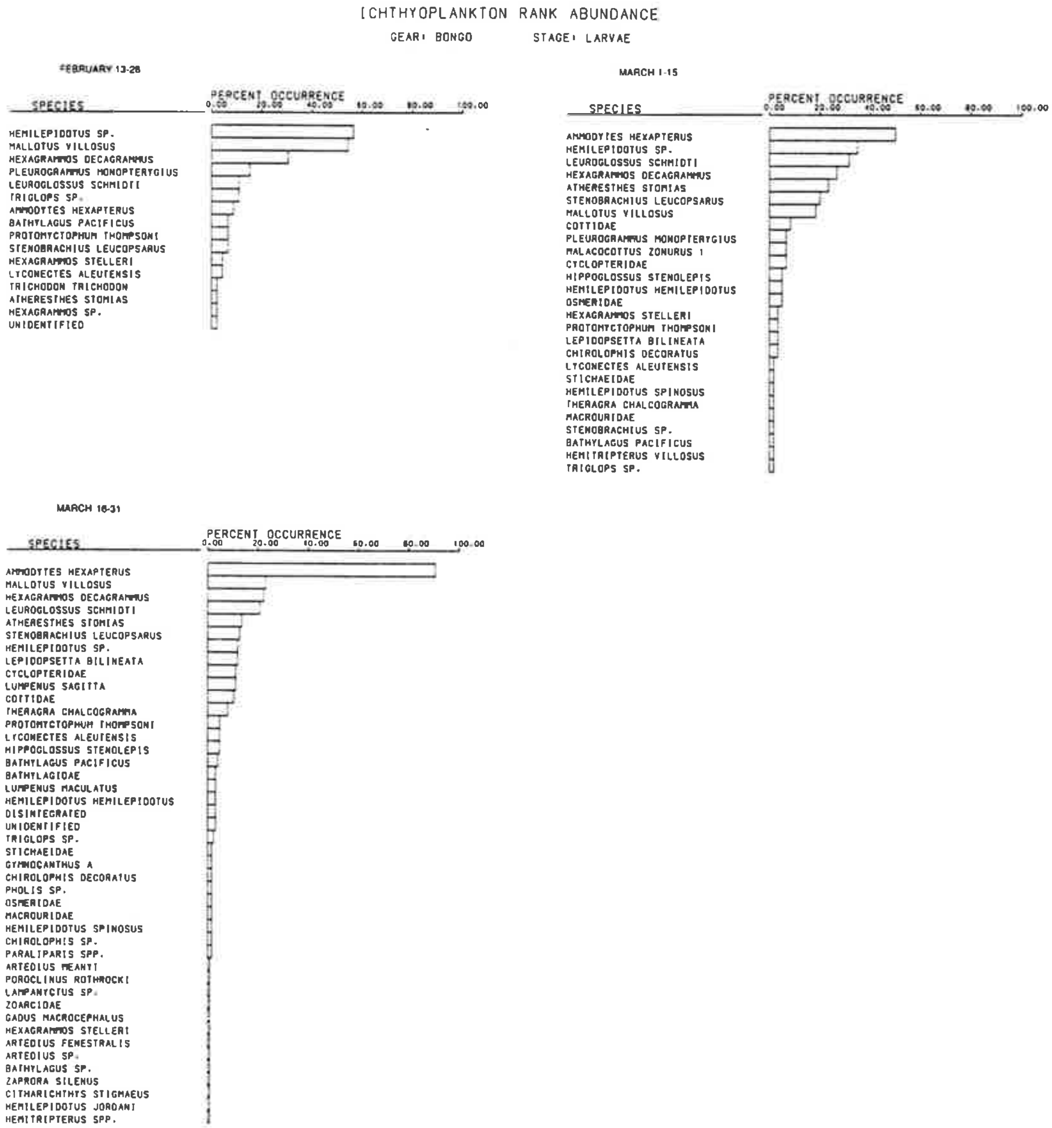
Appendix Figure 3.--Relative abundance (based on percent occurrence) of fish larvae in neuston tows, Feb. 13-28, Mar. 1-15, Mar. 16-31, Apr. 1-15, Apr. 16-30.



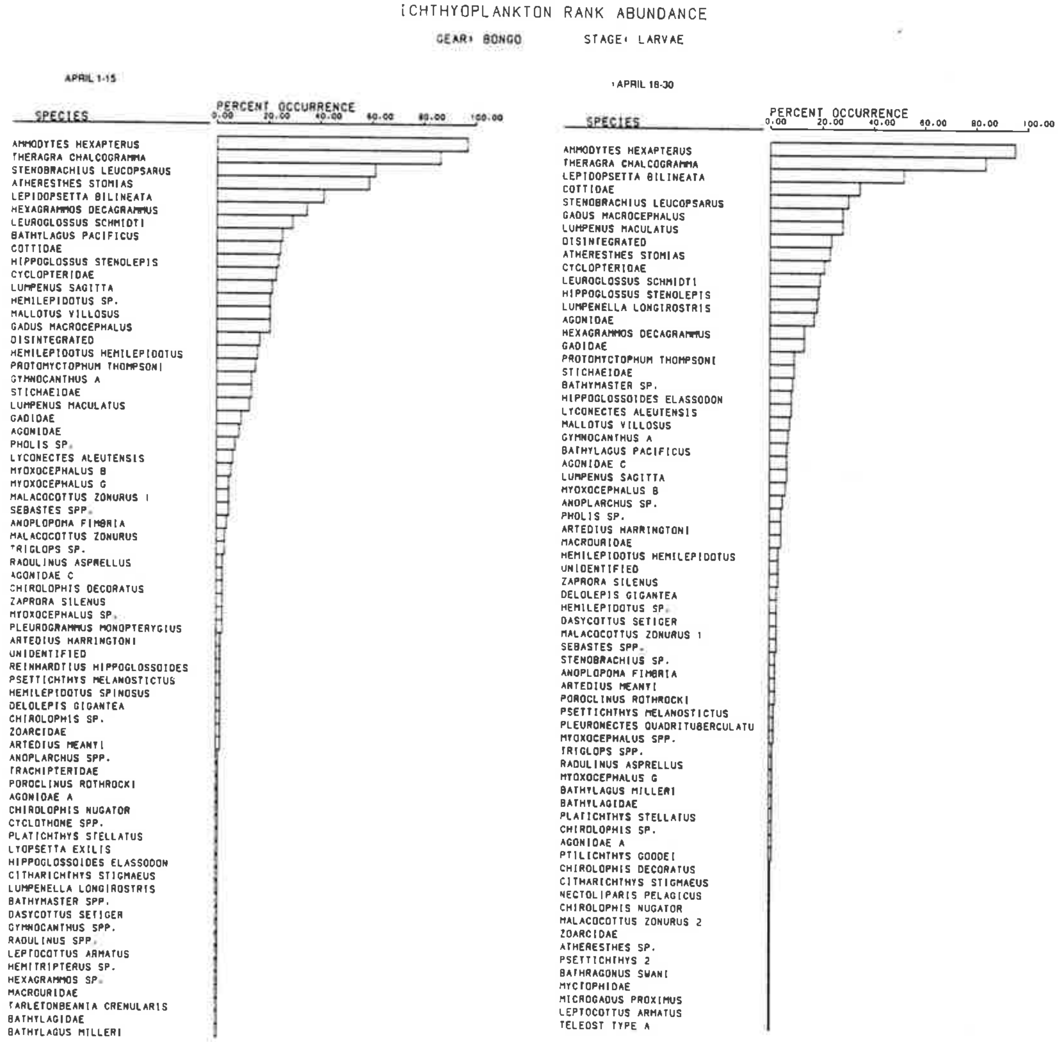
Appendix Figure 4.--Relative abundance (based on percent occurrence) of fish larvae in neuston tows, May 1-15, May 16-31, June 1-15, June 16-30, July 1-15.



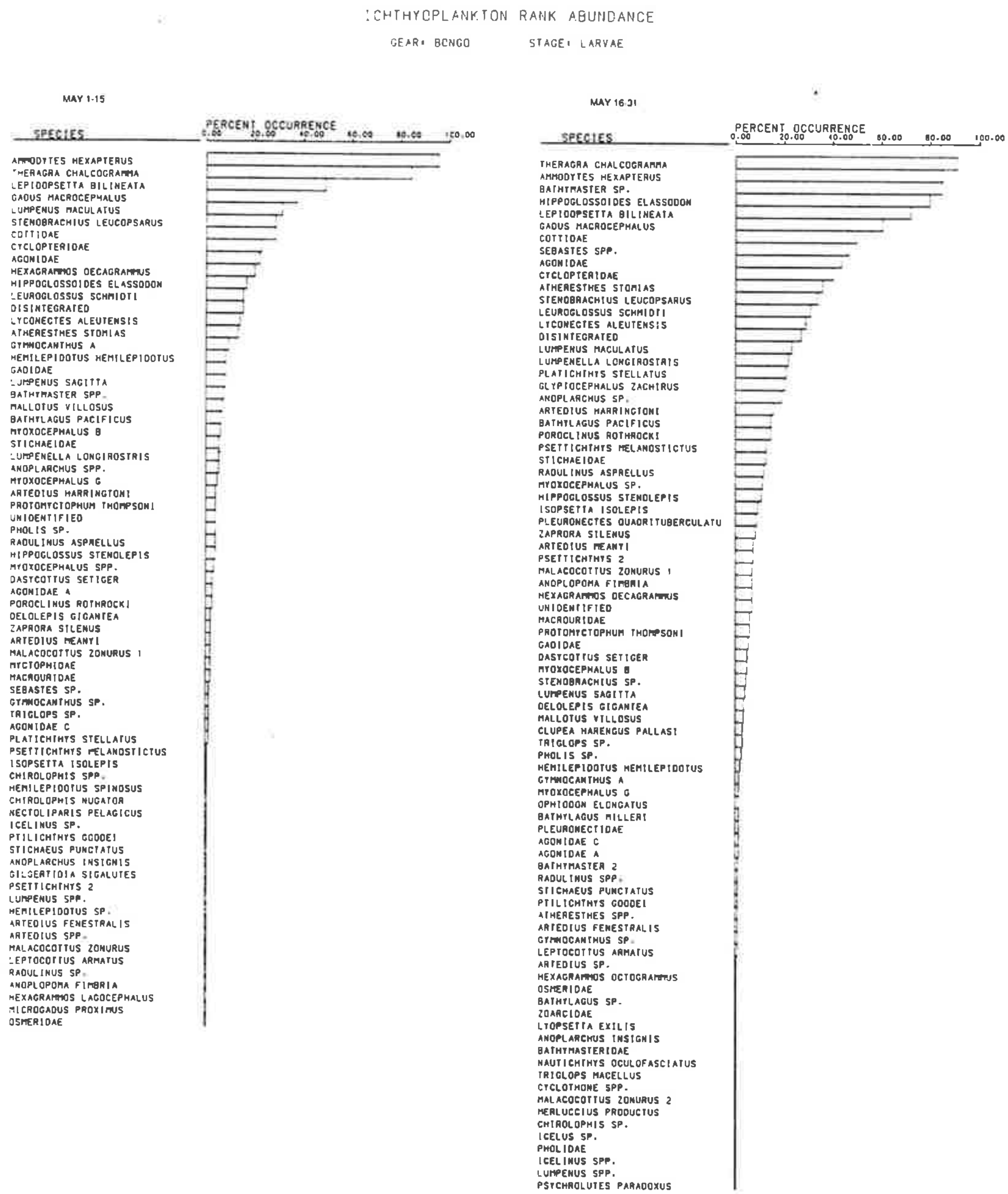
Appendix Figure 5.--Relative abundance (based on percent occurrence) of fish larvae in neuston tows, Sept. 1-15, Sept. 16-30, Oct. 1-15, Oct. 16-31, Nov. 1-17.



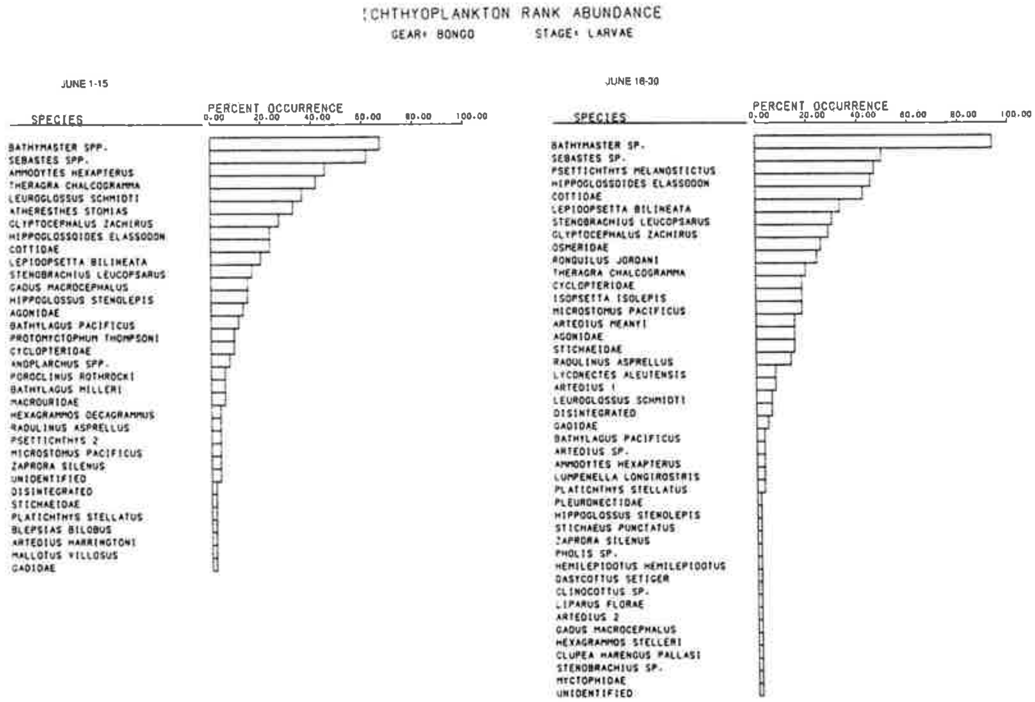
Appendix Figure 6.--Relative abundance (based on percent occurrence) of fish larvae in bongo tows, Feb. 13-28, Mar. 1-15, Mar. 16-31.



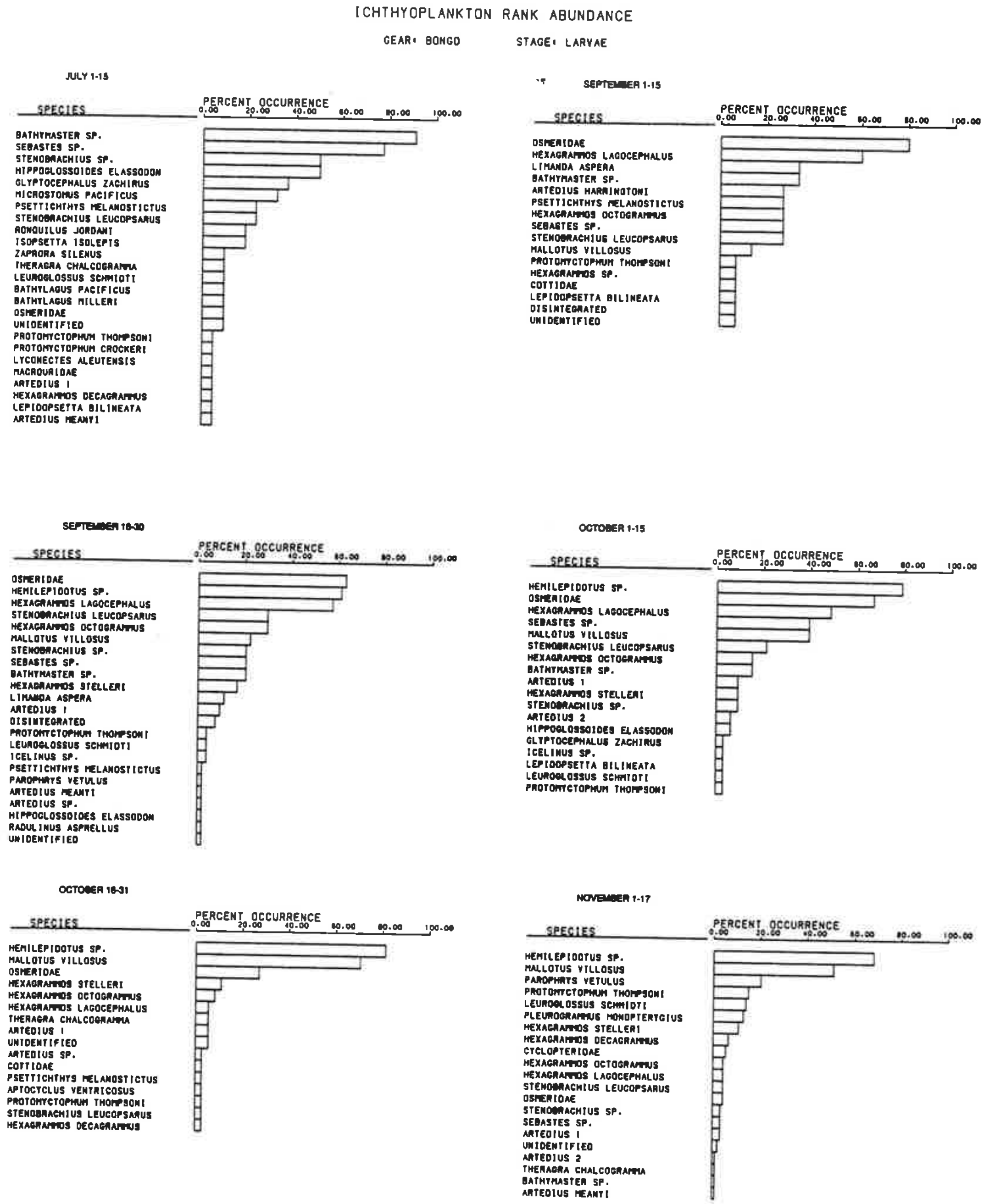
Appendix Figure 7.--Relative abundance (based on percent occurrence) of fish larvae in bongo tows, Apr. 1-15, Apr. 16-30.



Appendix Figure 8.--Relative abundance (based on percent occurrence) of fish larvae in bongo tows, May 1-15, May 16-31.



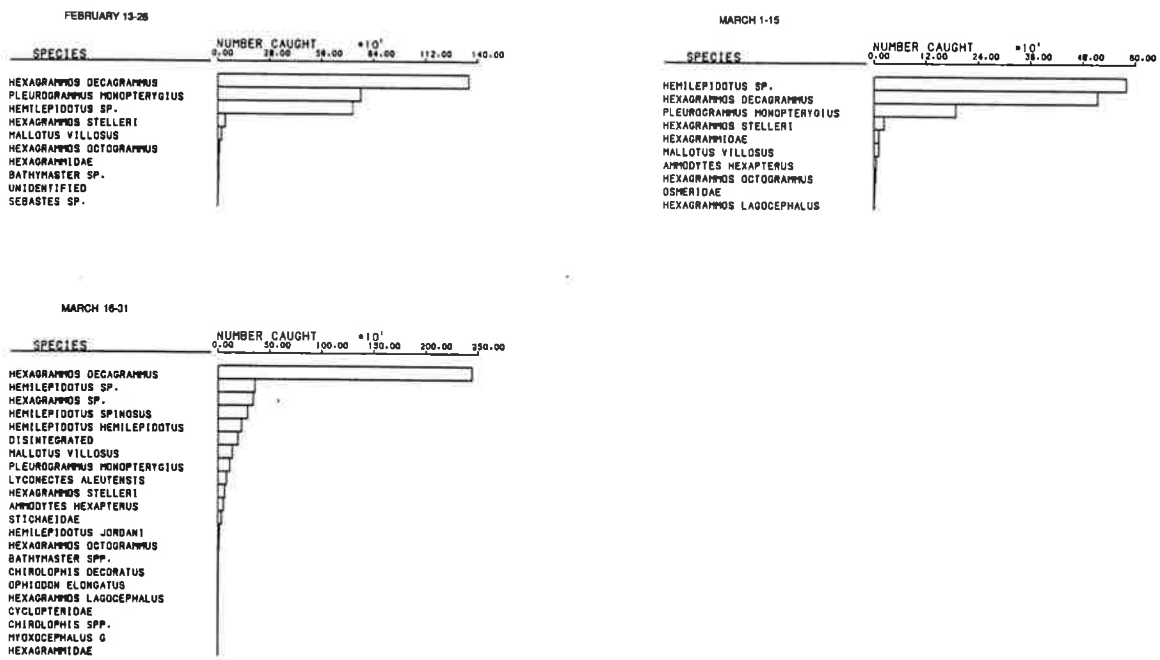
Appendix Figure 9.--Relative abundance (based on percent occurrence) of fish larvae in bongo tows, June 1-15, June 16-30.



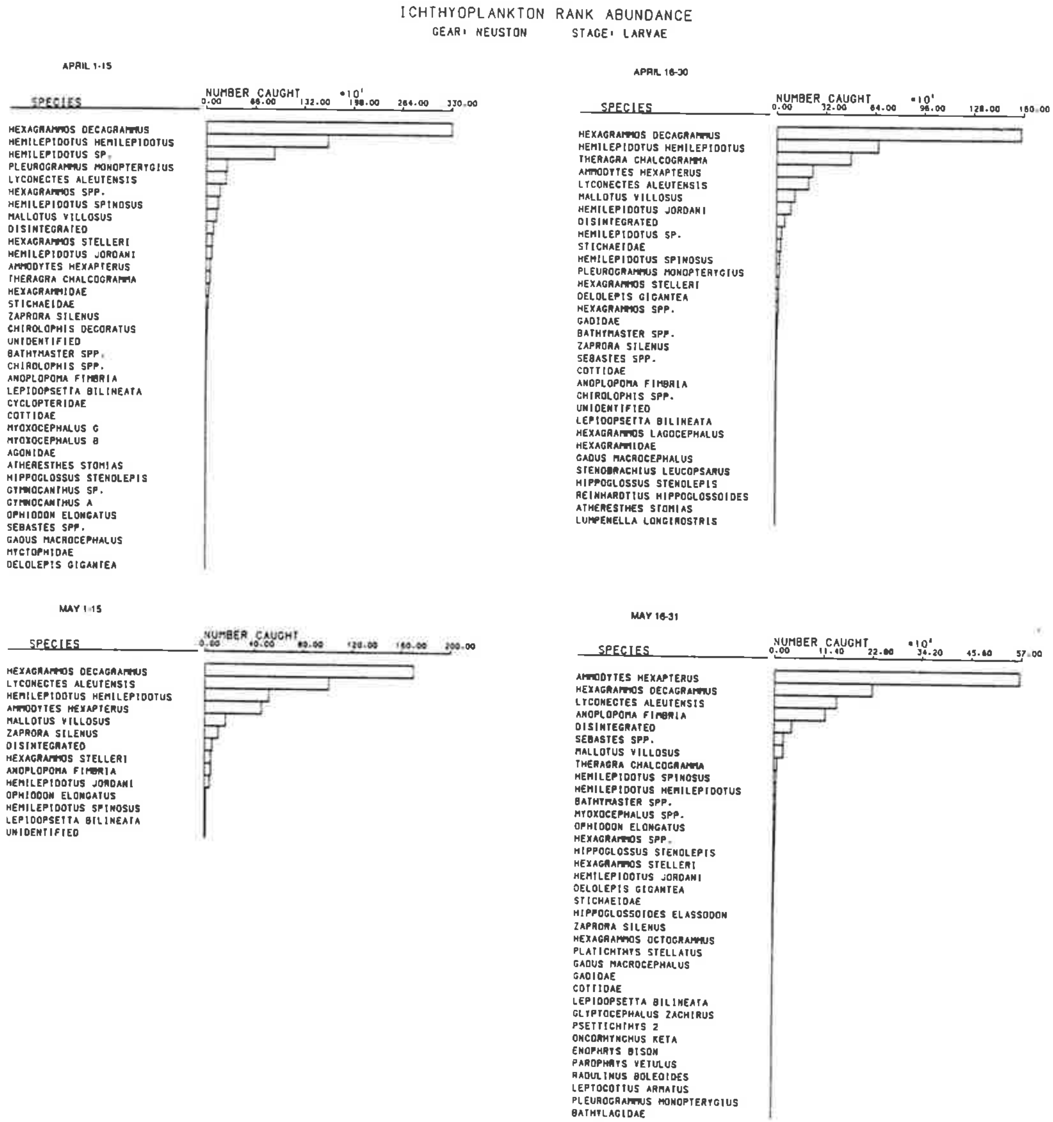
Appendix Figure 10.--Relative abundance (based on percent occurrence) of fish larvae in bongo tows, July 1-15, Sept. 1-15, Sept. 16-30, Oct. 1-15, Oct. 16-31, Nov. 1-17.

ICHTHYOPLANKTON RANK ABUNDANCE

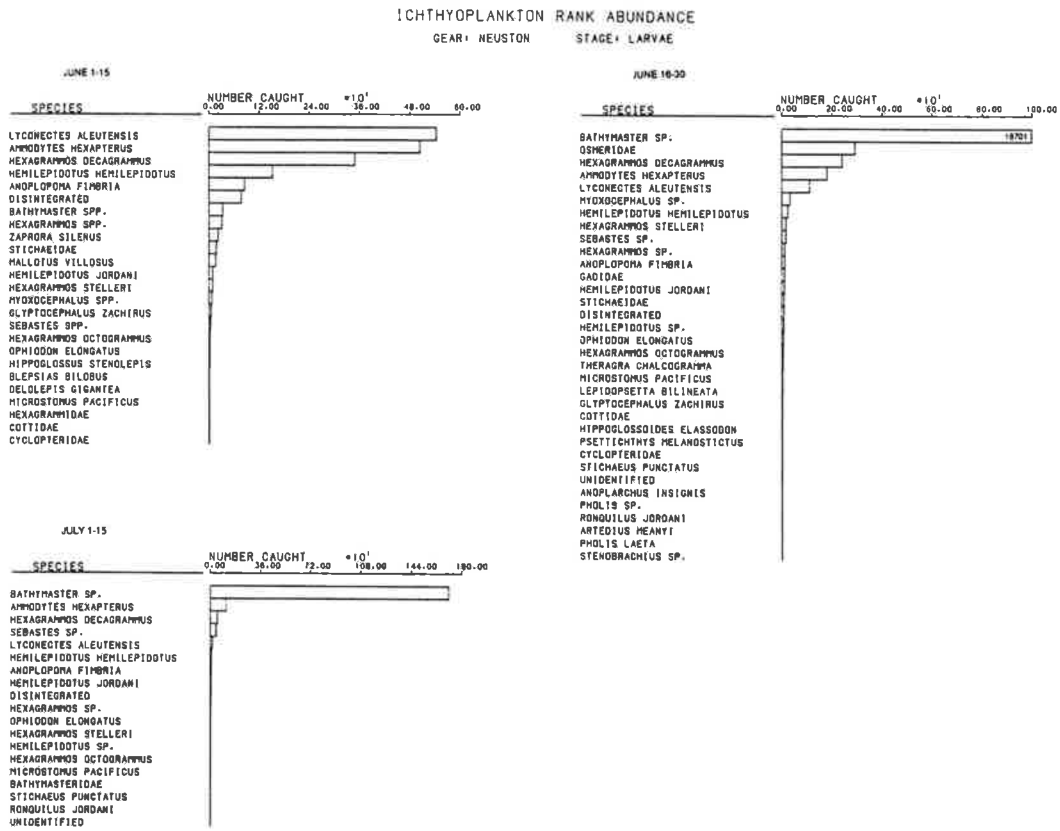
GEAR: NEUSTON STAGE: LARVAE



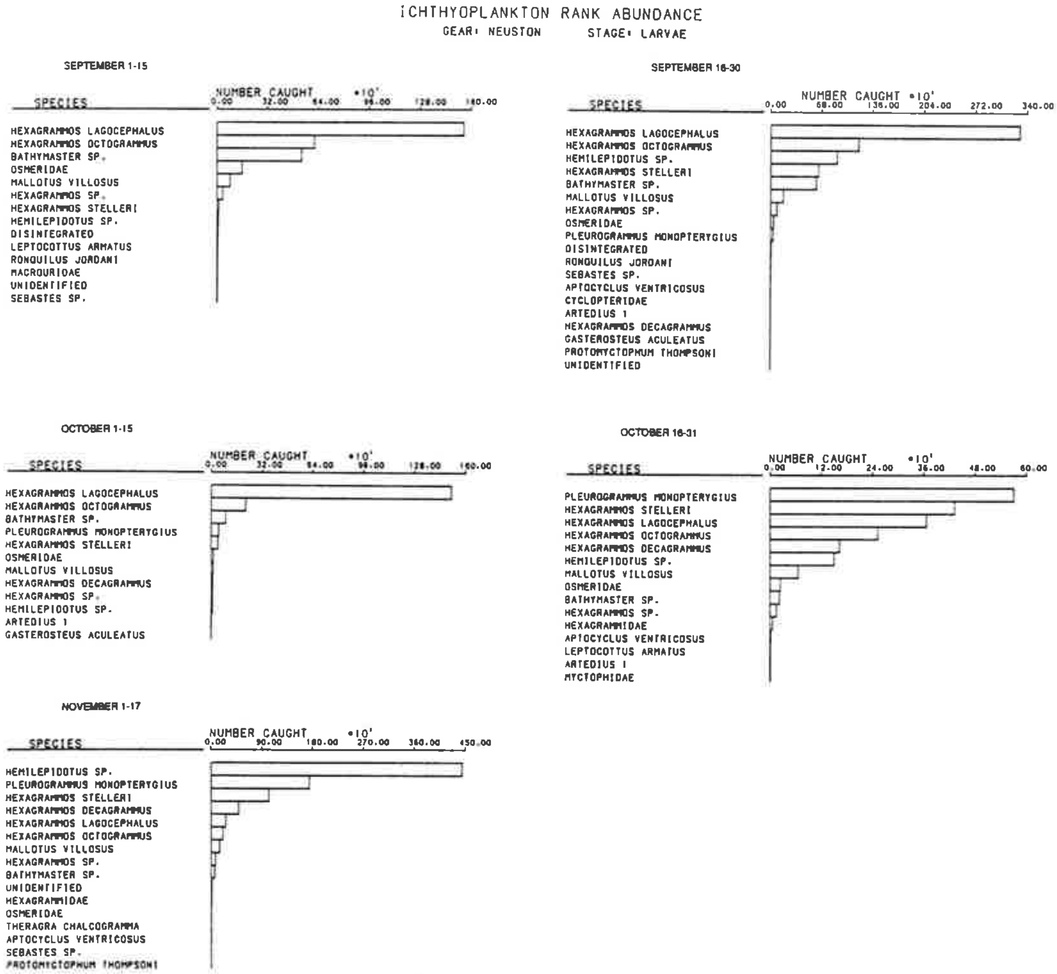
Appendix Figure 11.--Relative abundance (based on number caught) of fish larvae in neuston tows, Feb. 13-28, Mar. 1-15, Mar. 16-31.



Appendix Figure 12.--Relative abundance (based on number caught) of fish larvae in neuston tows, Apr. 1-15, Apr. 16-30, May 1-15, May 16-31.



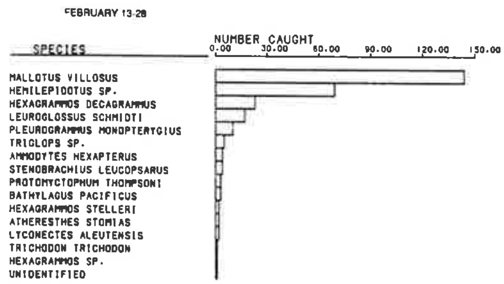
Appendix Figure 13.--Relative abundance (based on number caught) of fish larvae in neuston tows, June 1-15, June 16-30, July 1-15.

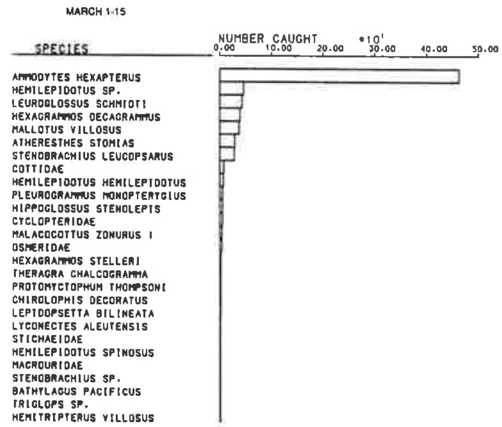


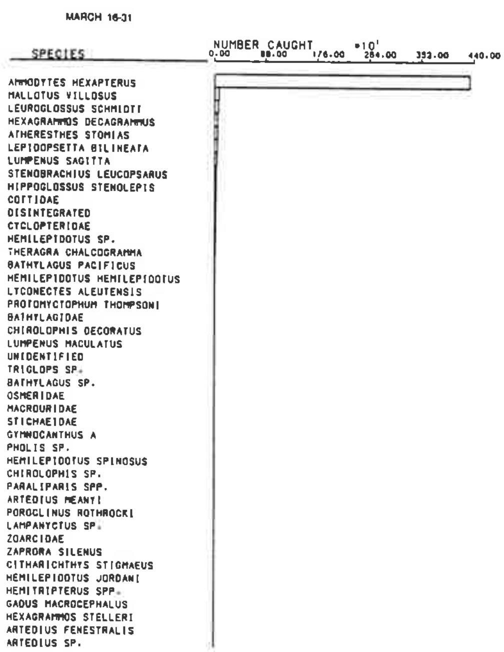
Appendix Figure 14.--Relative abundance (based on number caught) of fish larvae in neuston tows, Sept. 1-15, Sept. 16-30, Oct. 1-15, Oct. 16-31, Nov. 1-17.

ICHTHYOPLANKTON RANK ABUNDANCE

GEAR: BONGO STAGE: LARVAE



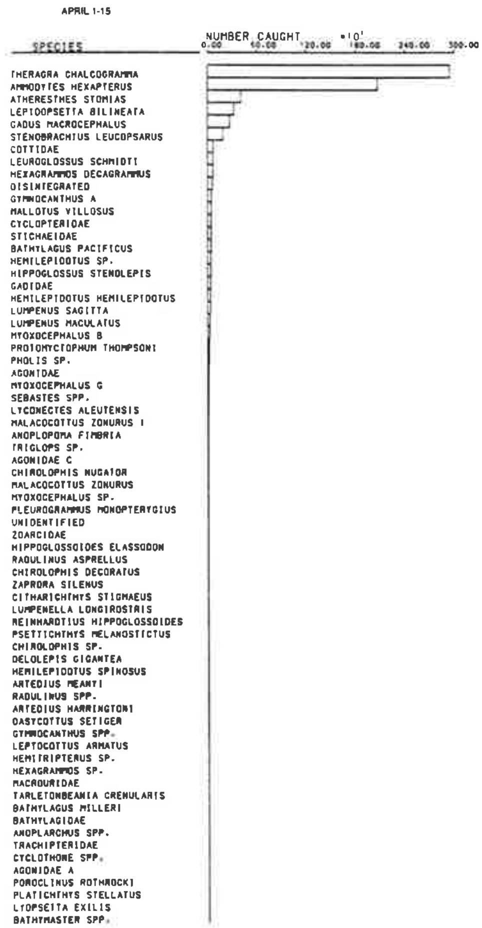


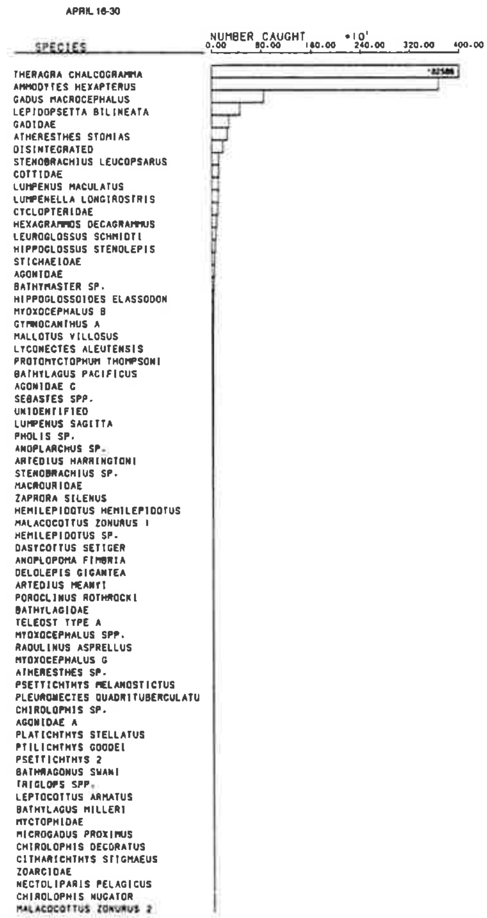


Appendix Figure 15.--Relative abundance (based on number caught) of fish larvae in bongo tows, Feb. 13-28, Mar. 1-15, Mar. 16-31.

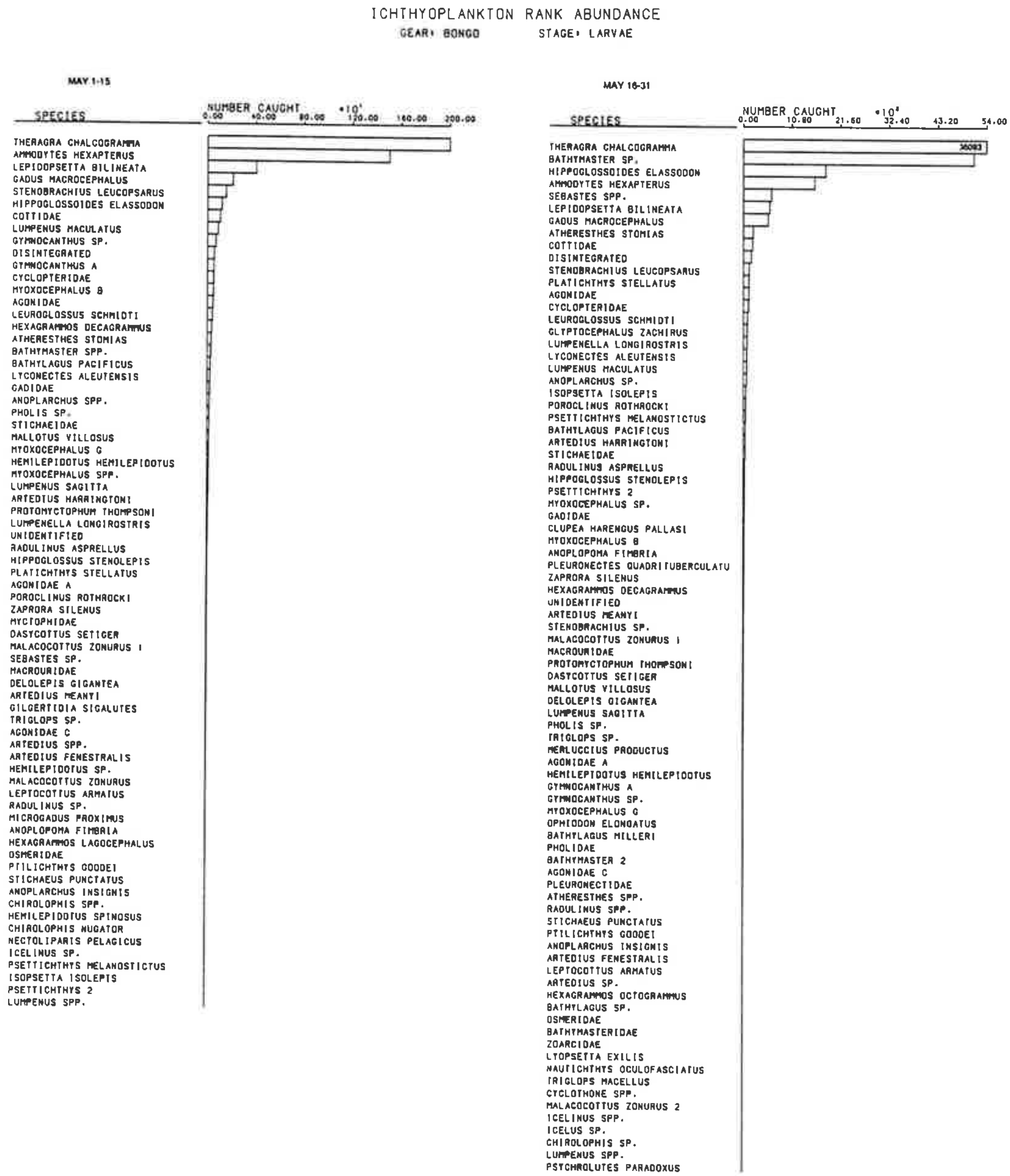
ICHTHYOPLANKTON RANK ABUNDANCE

GEAR: BONGO STAGE: LARVAE

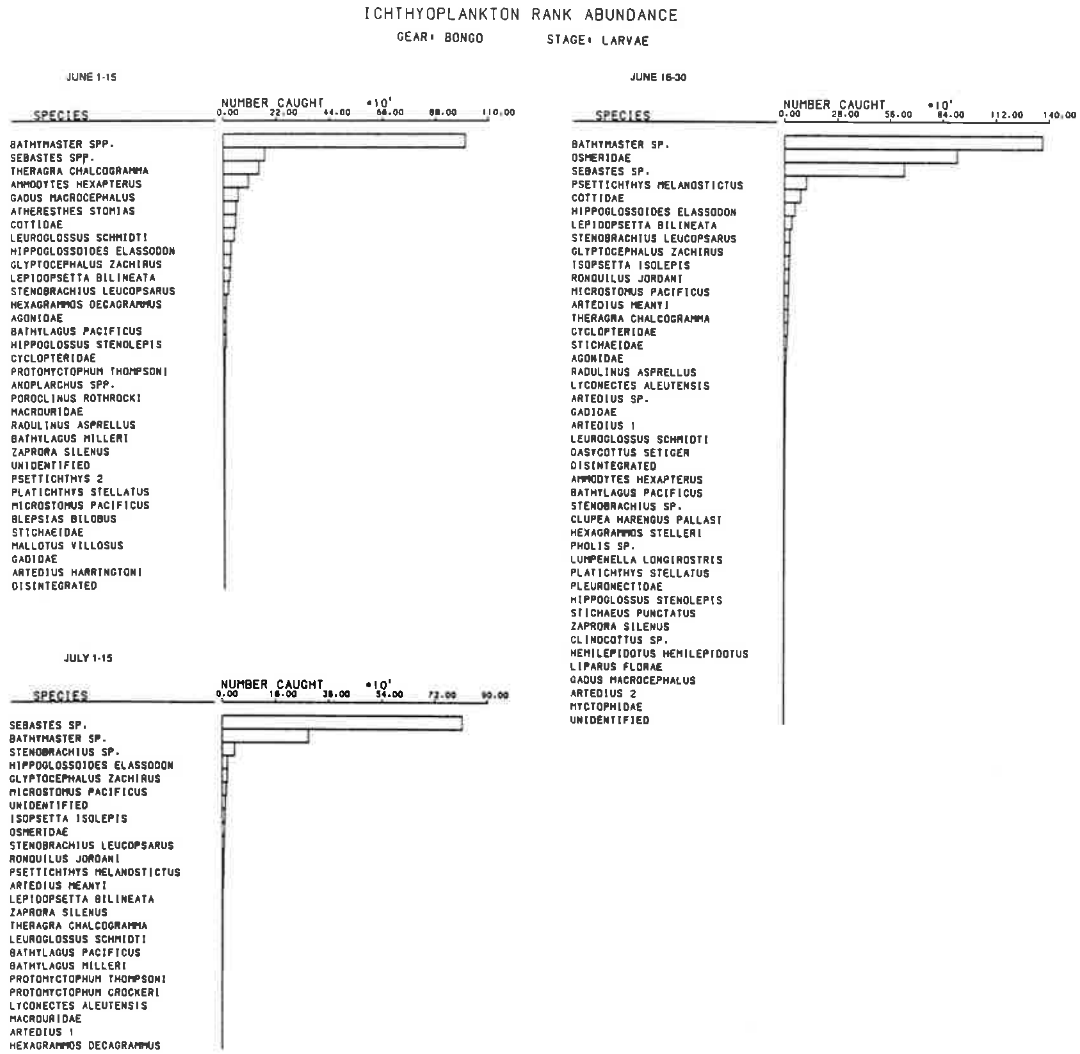




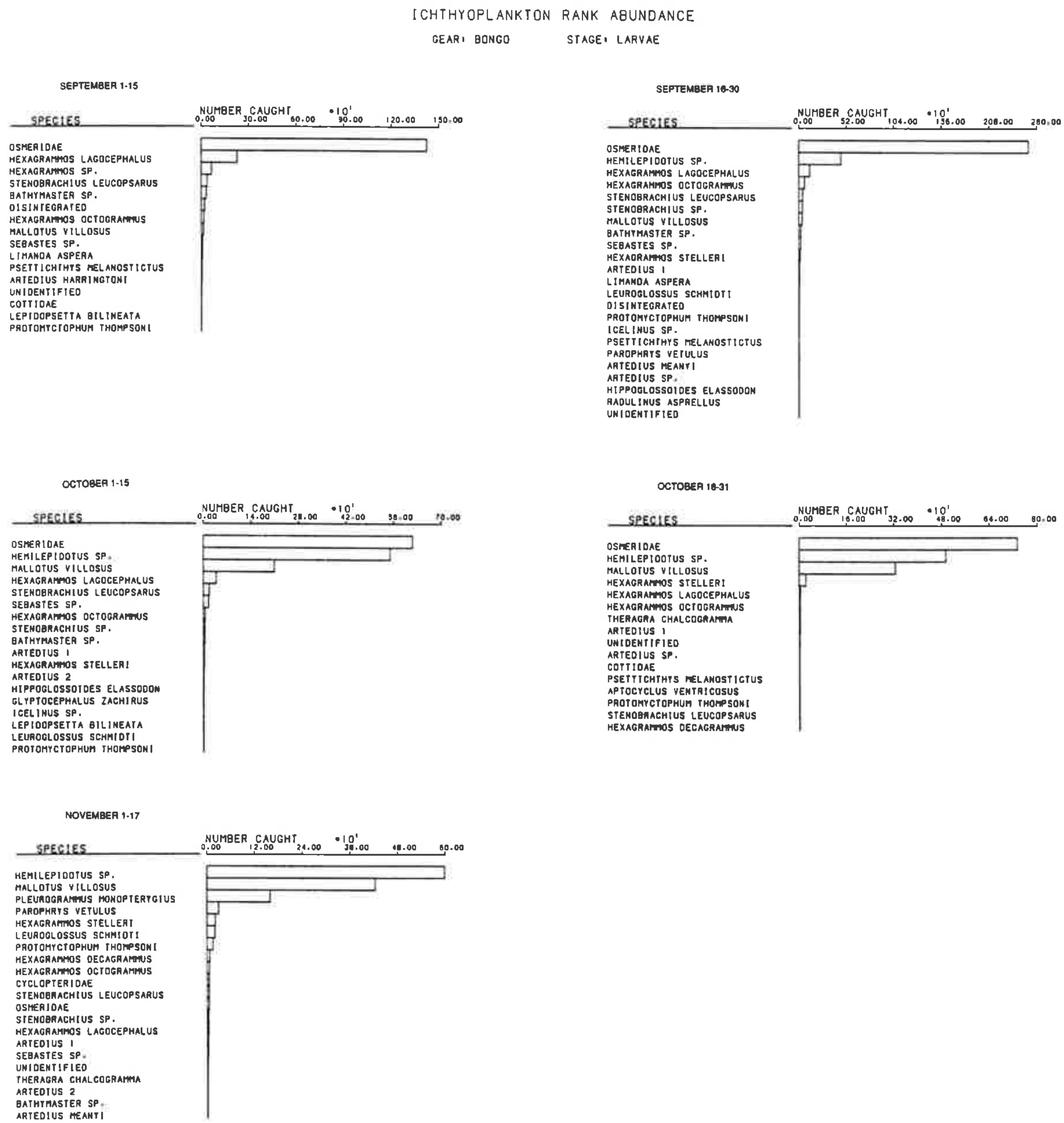
Appendix Figure 16.--Relative abundance (based on number caught) of fish larvae in bongo tows, Apr. 1-15, Apr. 16-30.



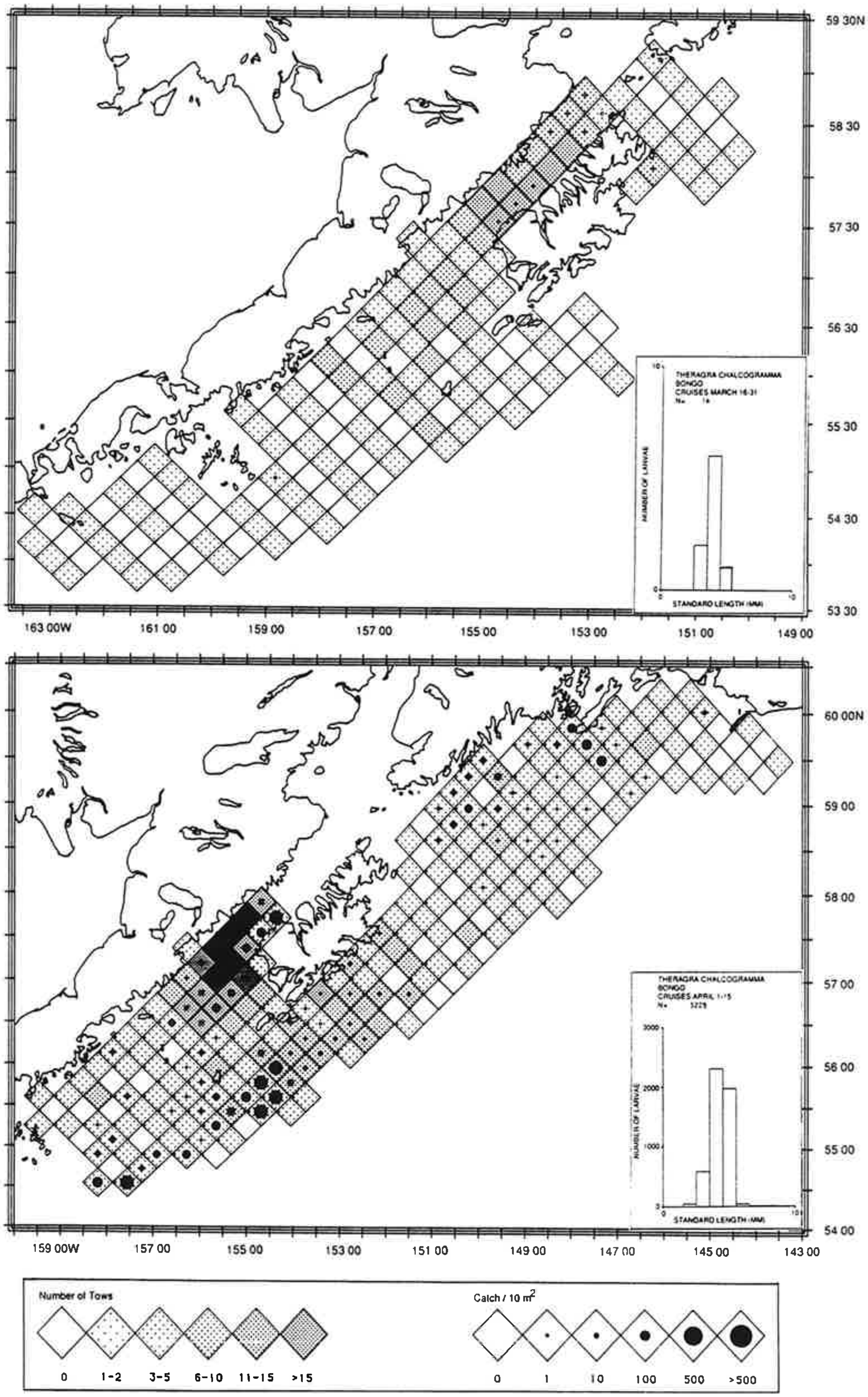
Appendix Figure 17.--Relative abundance (based on number caught) of fish larvae in bongo tows, May 1-15, May 16-31.



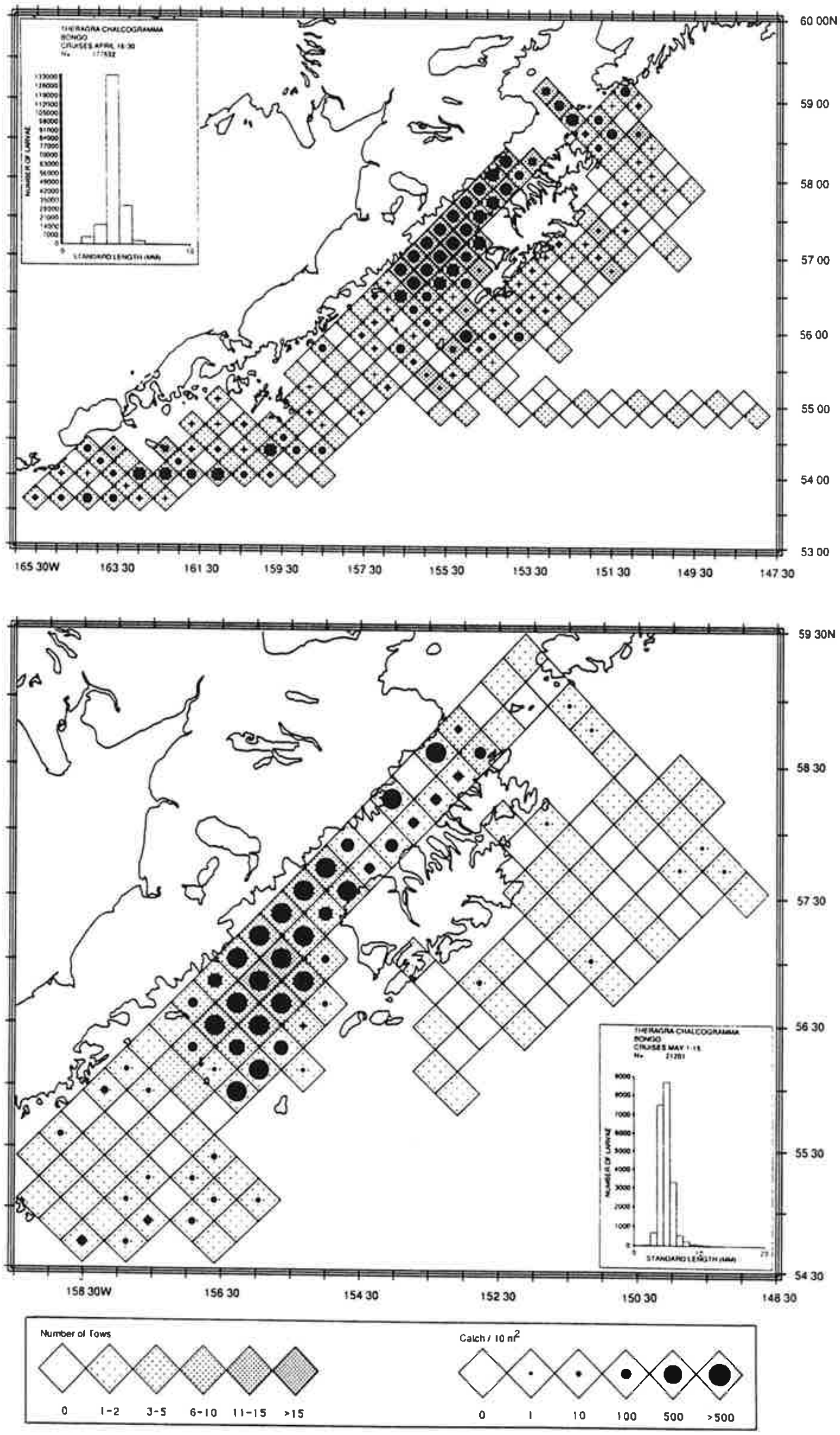
Appendix Figure 18.--Relative abundance (based on number caught) of fish larvae in bongo tows, June 1-15, June 16-30, July 1-15.



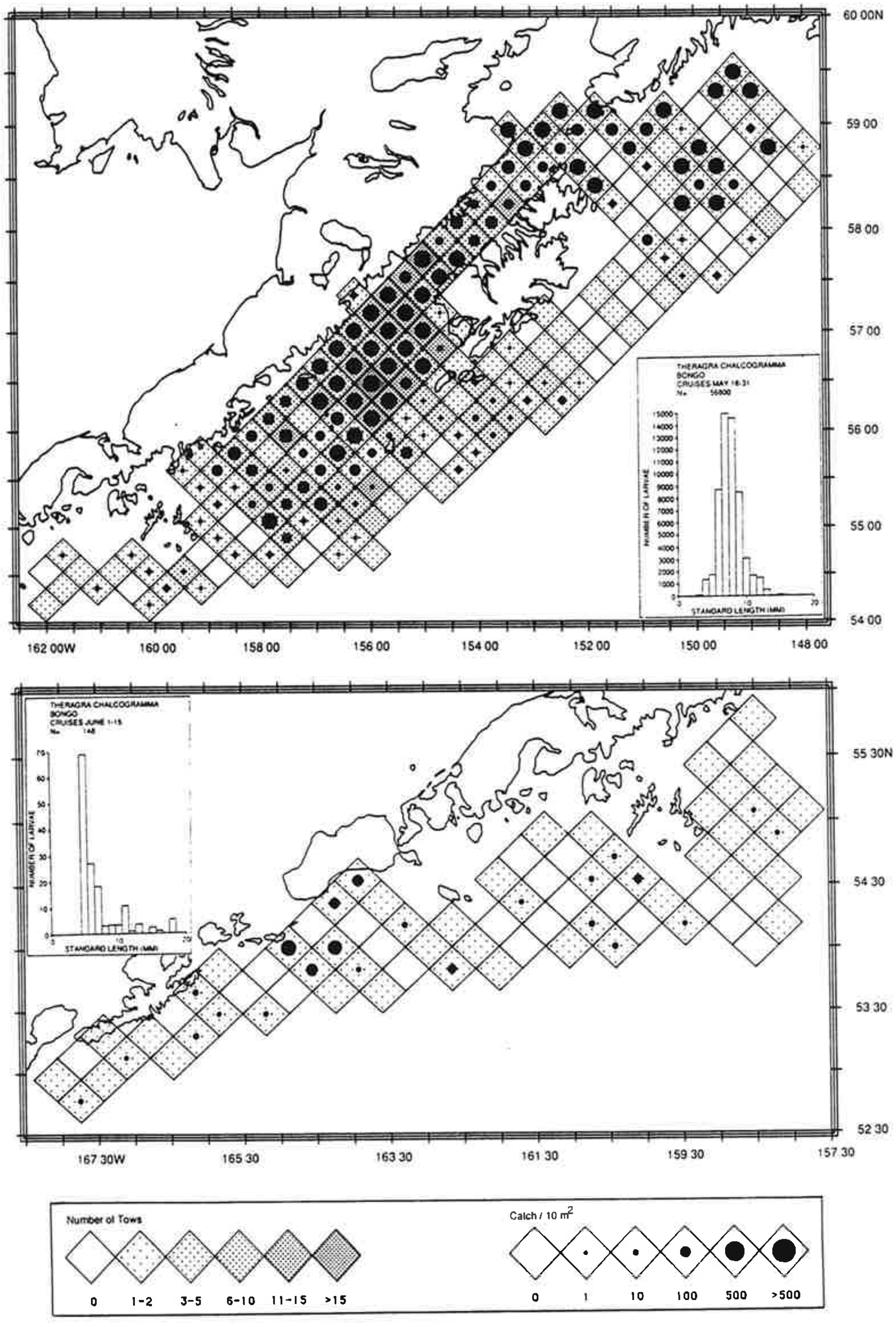
Appendix Figure 19.--Relative abundance (based on number caught) of fish larvae in bongo tows, Sept. 1-15, Sept. 16-30, Oct. 1-15, Oct. 16-31, Nov. 1-17.



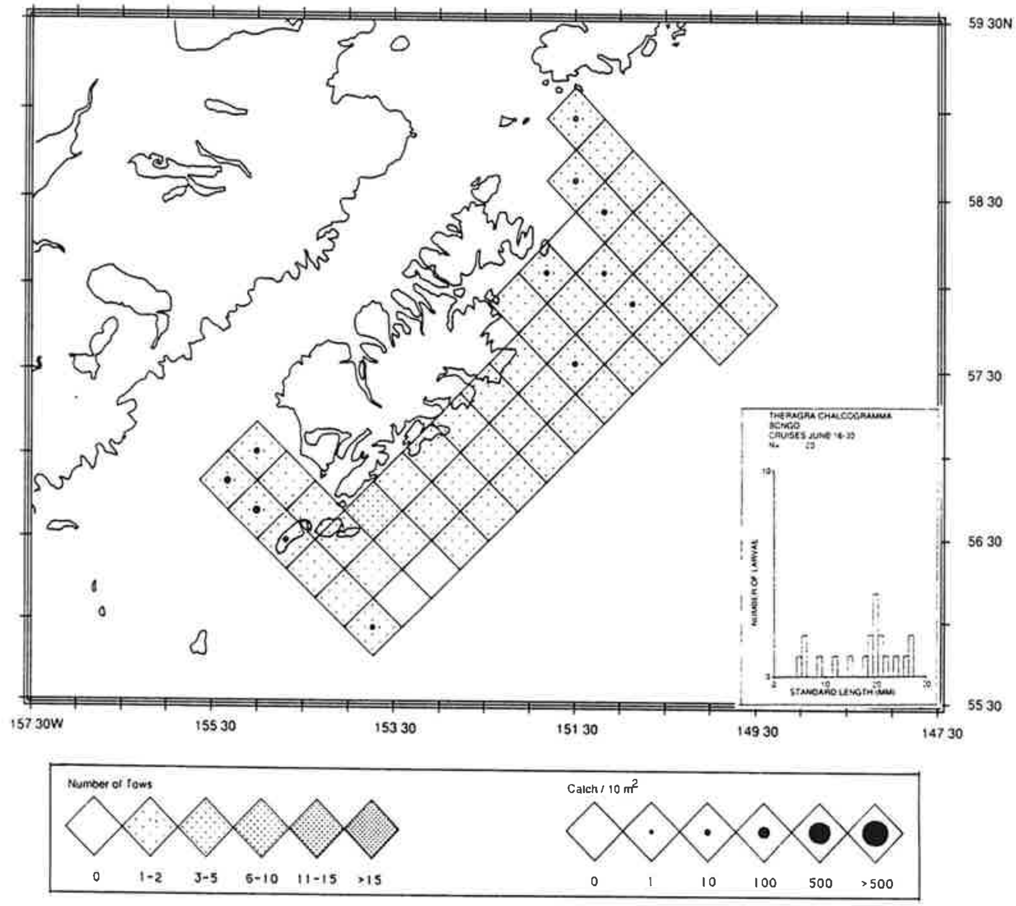
Appendix Figure 20.--Distribution of <u>Theragra</u> <u>chalcogramma</u> larvae in bongo tows, A. Mar. 16-31, B. Apr. 1-15 (catch/10 m^2=P^2/2.5281, where P=percentage of width of sector taken up by dot, for catches >500/10 m^2, P=42.8%).



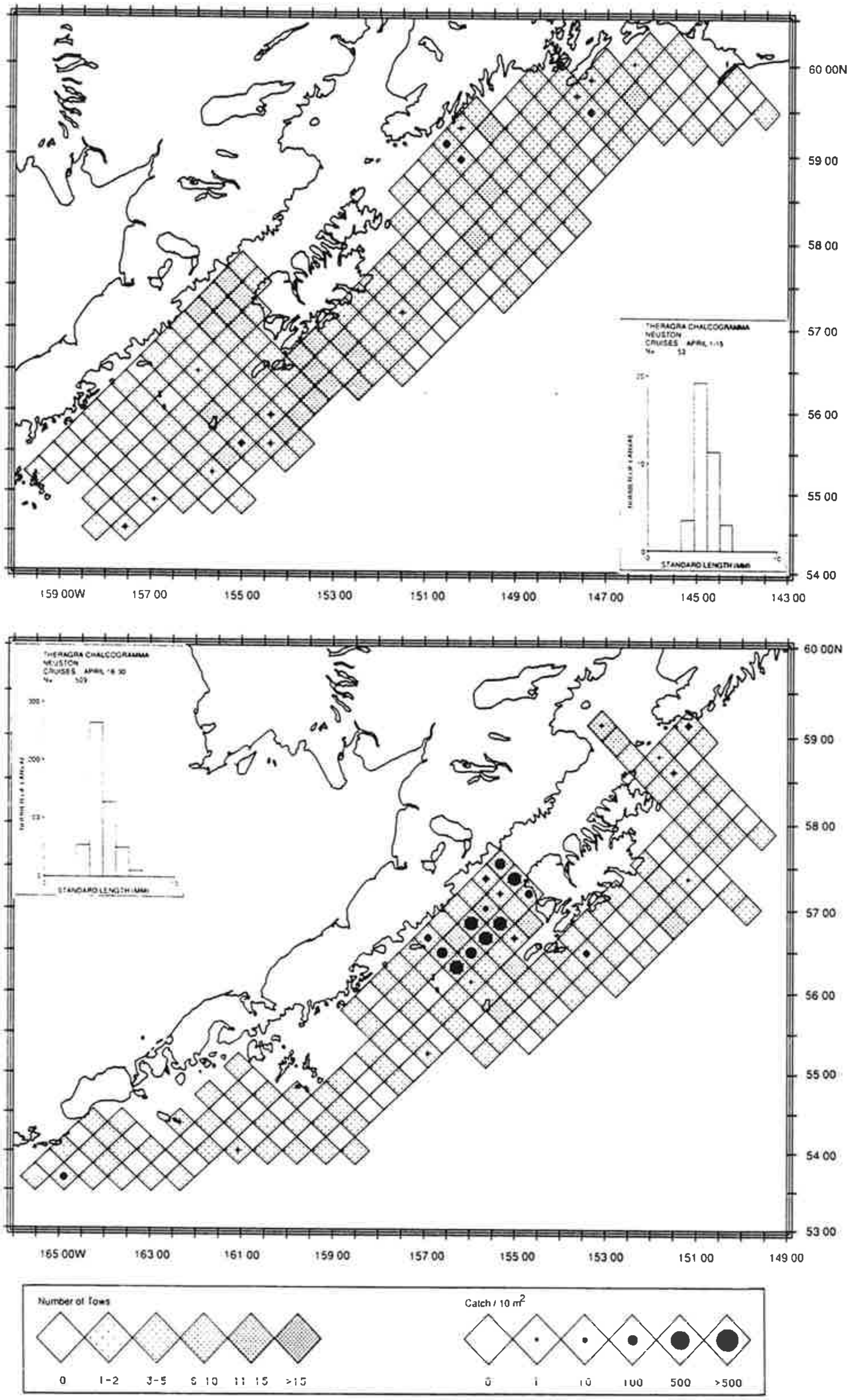
Appendix Figure 21.--Distribution of *Theragra chalcogramma* larvae in bongo tows, A. Apr. 16-30, B. May 1-15 (catch/10 m^2=P^2/2.5281, where P=percentage of width of sector taken up by dot, for catches >500/10 m^2, P=42.8%).



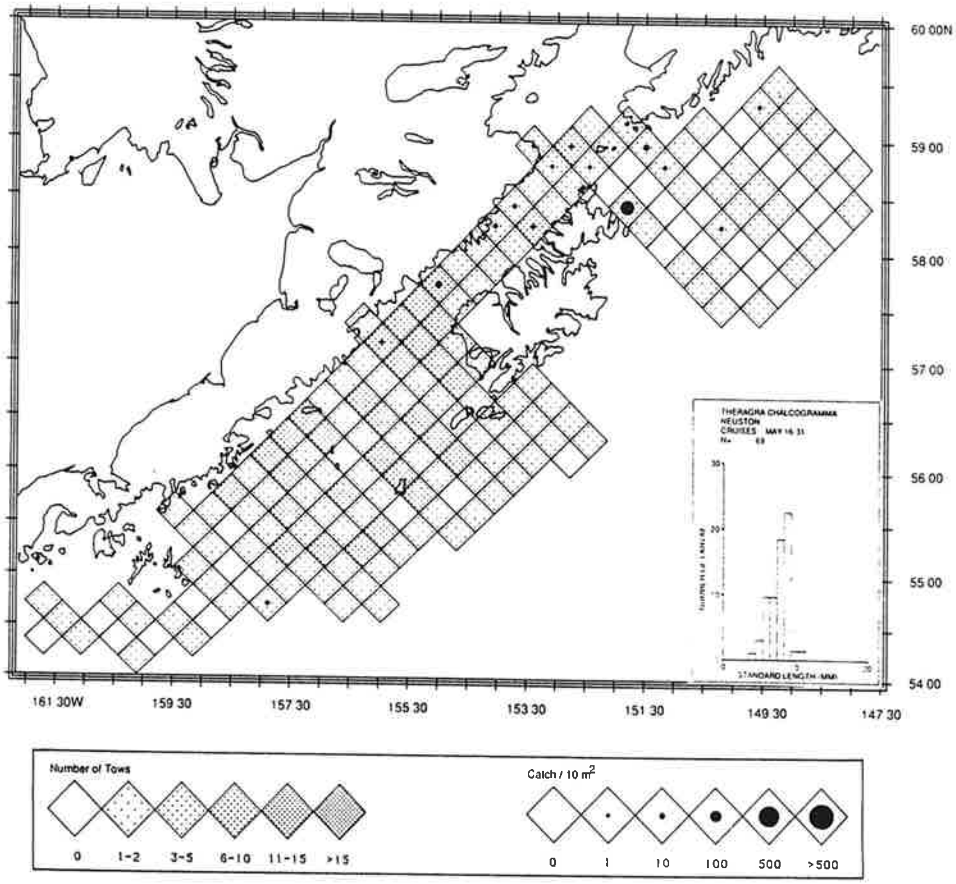
Appendix Figure 22.--Distribution of <u>Theragra chalcogramma</u> larvae in bongo tows, A. May 16-31, B. June 1-15 (catch/10 $m^2=P^2/2.5281$, where P=percentage of width of sector taken up by dot, for catches >500/10 m^2, P=42.8%).



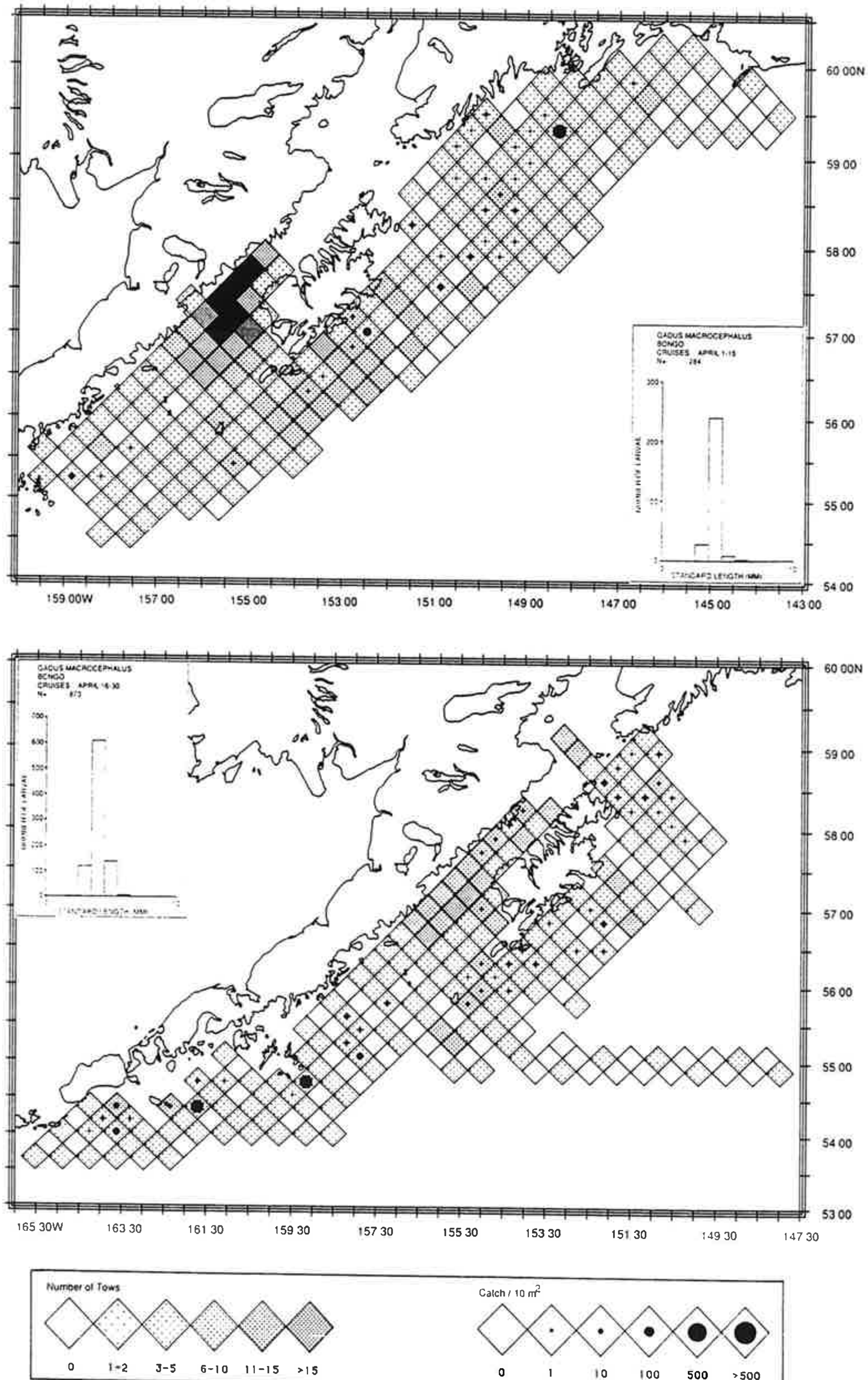
Appendix Figure 23.--Distribution of <u>Theragra</u> <u>chalcogramma</u> larvae in bongo tows, June 16-30 (catch/10 $m^2 = P^2/2.5281$, where P=percentage of width of sector taken up by dot, for catches >500/10 m^2, P=42.8%).



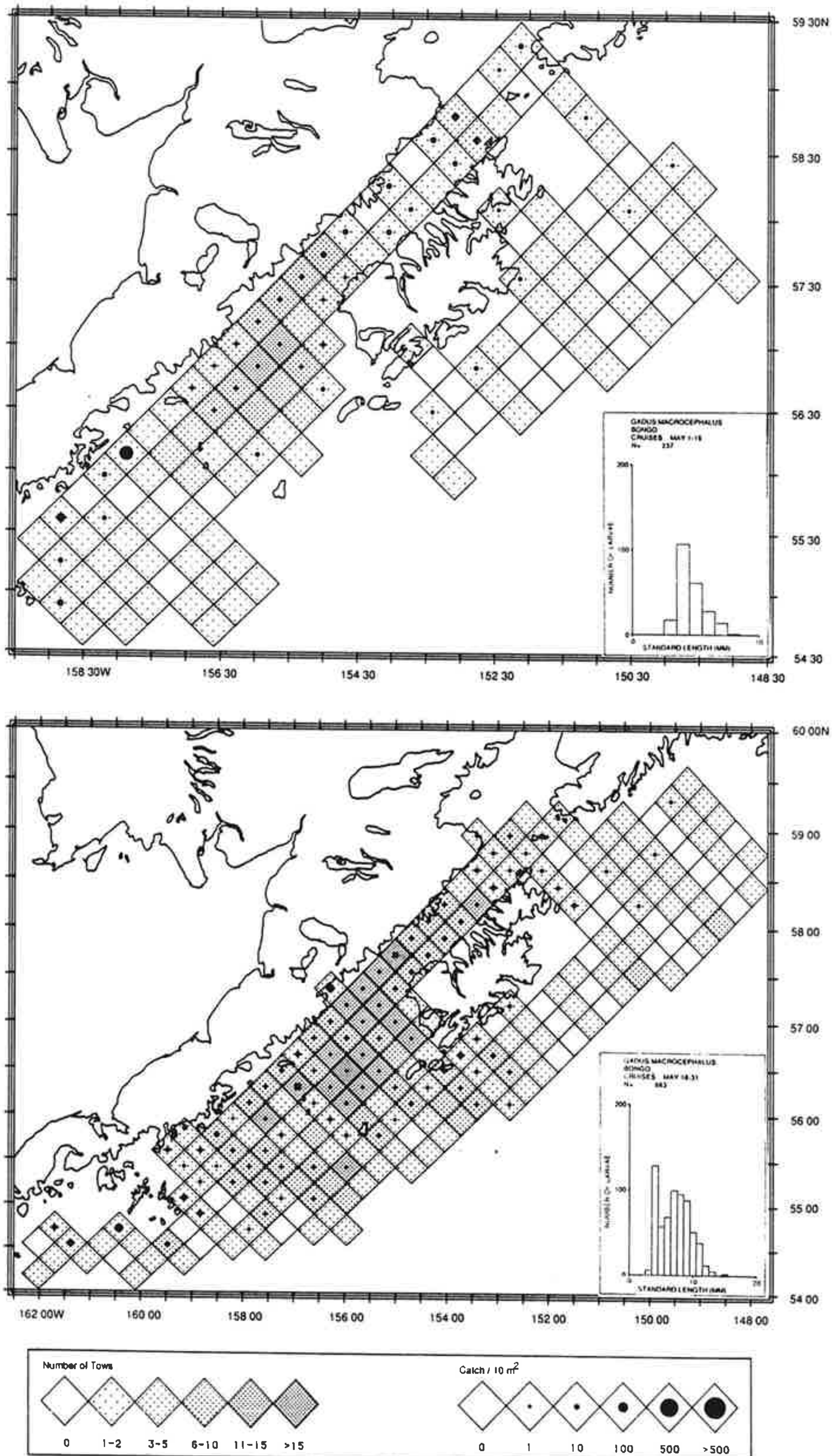
Appendix Figure 24.--Distribution of Theragra chalcogramma larvae in neuston tows, A. Apr. 1-15, B. Apr. 16-30 (catch/10 m^2=P^2/2.5281, where P=percentage of width of sector taken up by dot, for catches >500/10 m^2, P=42.8%).



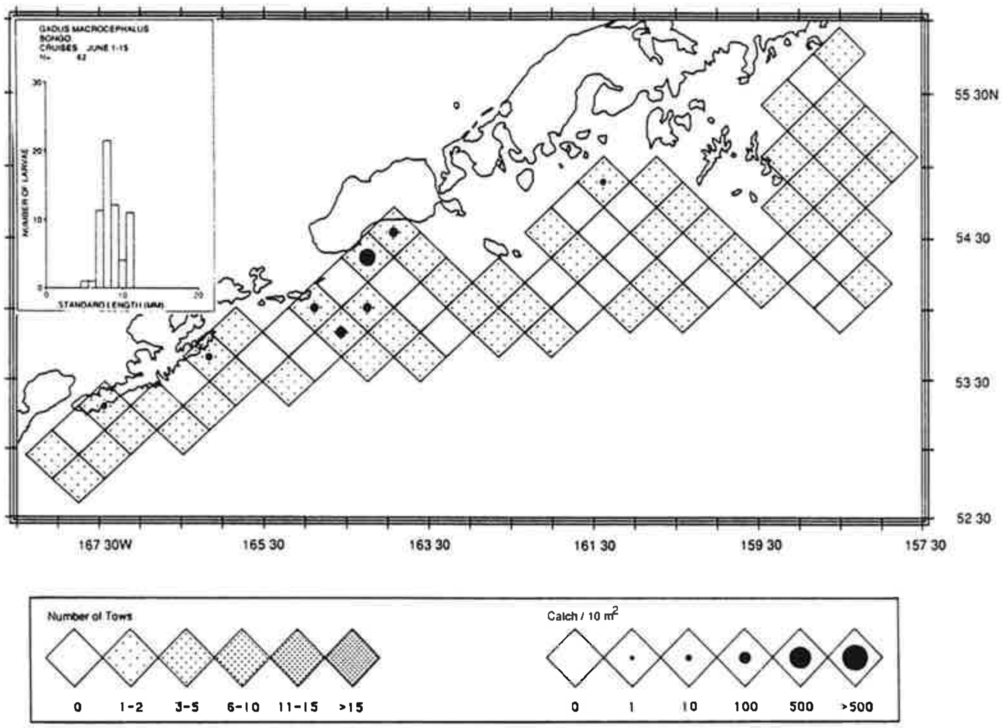
Appendix Figure 25.--Distribution of Theragra chalcogramma larvae in neuston tows, May 16-31 (catch/10 $m^2=P^2/2.5281$, where P=percentage of width of sector taken up by dot, for catches >500/10 m^2, P=42.8%).



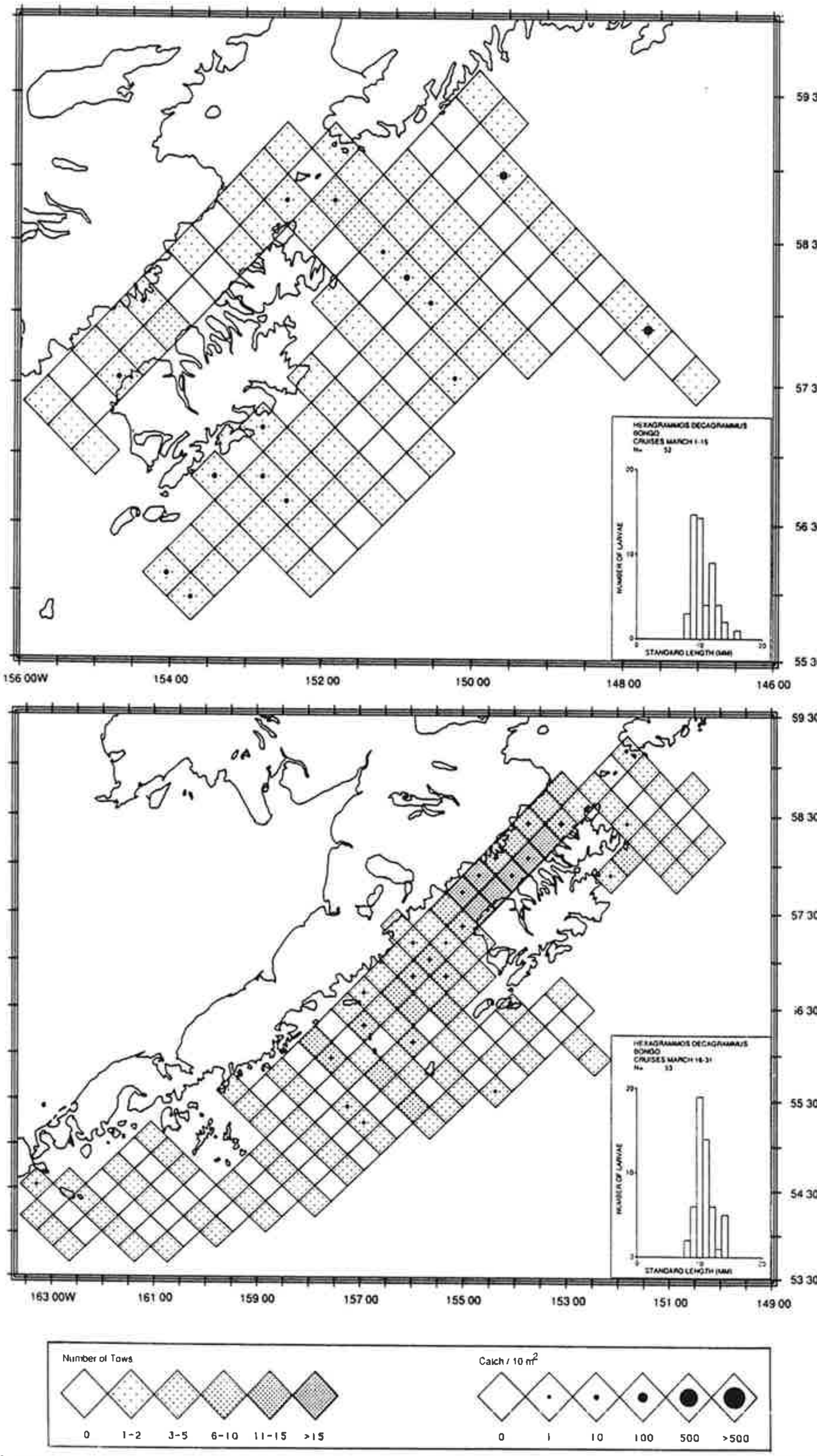
Appendix Figure 26.--Distribution of Gadus macrocephalus larvae in bongo tows, A. Apr. 1-15, B. Apr. 16-30 (catch/10 m^2=P^2/2.5281, where P=percentage of width of sector taken up by dot, for catches >500/10 m^2, P=42.8%).



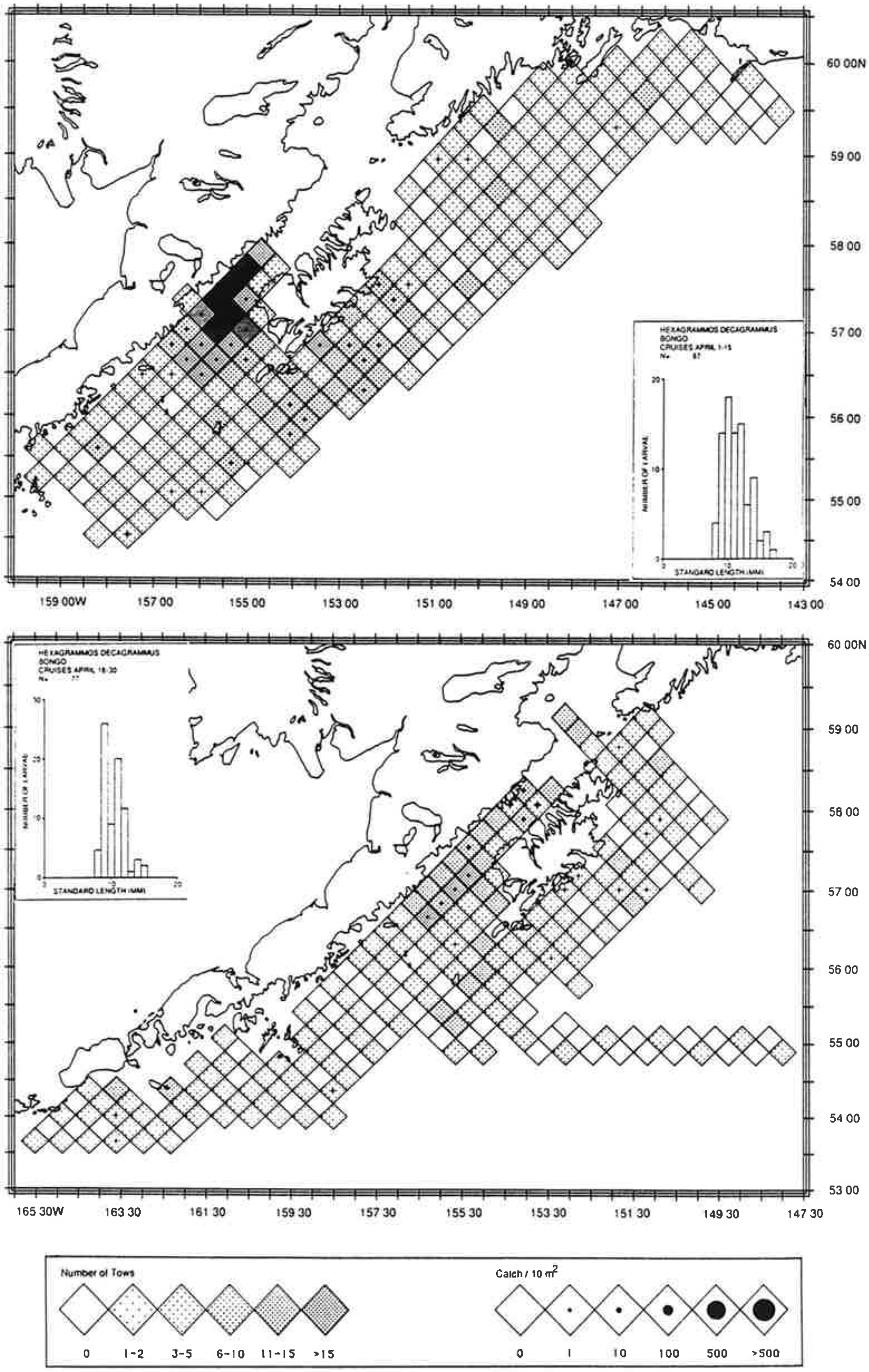
Appendix Figure 27.--Distribution of Gadus macrocephalus larvae in bongo tows, A. May 1-15, B. May 16-31 (catch/10 m^2=P^2/2.5281, where P=percentage of width of sector taken up by dot, for catches >500/10 m^2, P=42.8%).



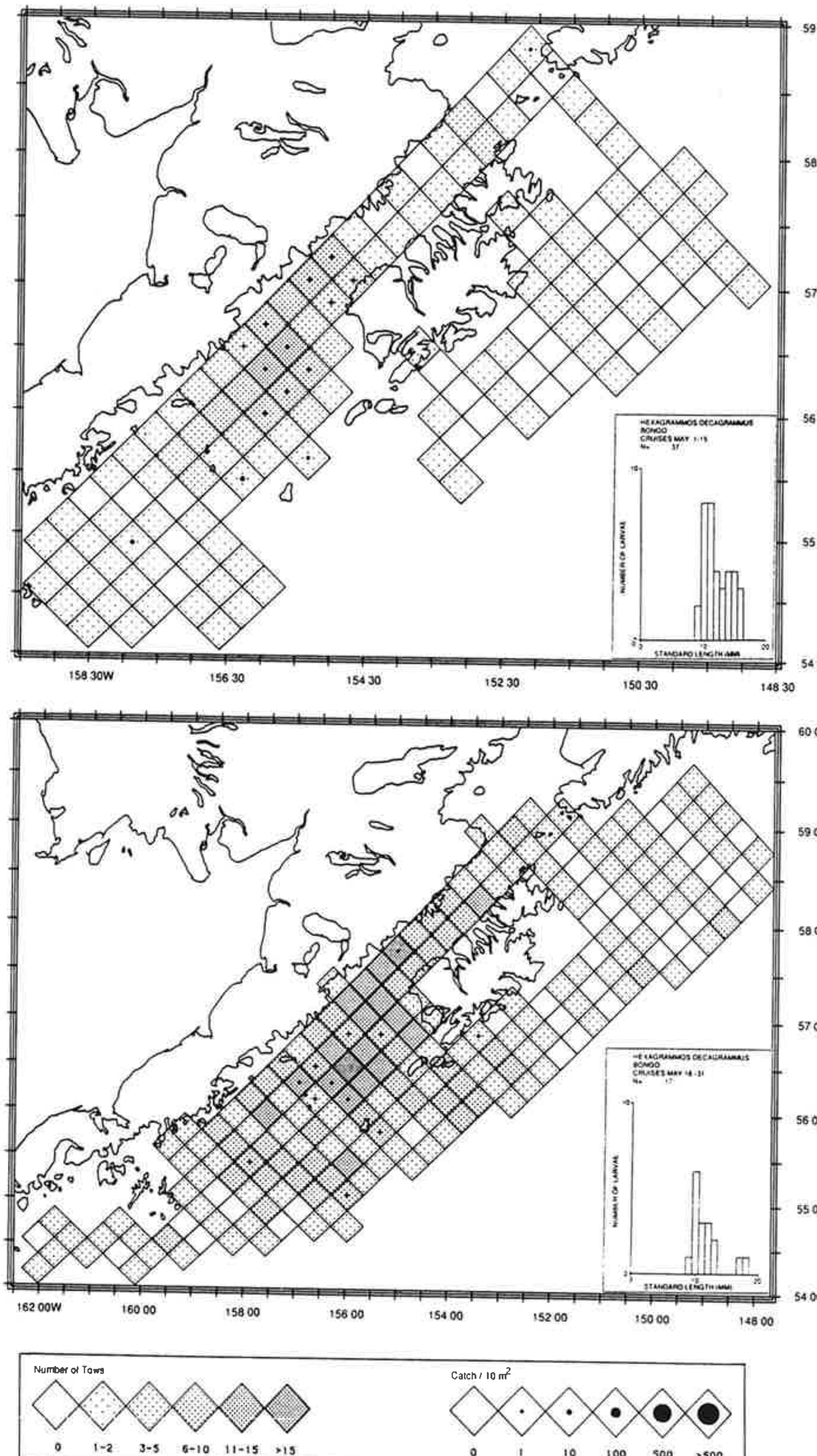
Appendix Figure 28.--Distribution of <u>Gadus</u> <u>macrocephalus</u> larvae in bongo tow, June 1-15 (catch/10 m^2=P^2/2.5281, where P=percentage of width of sector taken up by dot, for catches >500/10 m^2, P=42.8%).



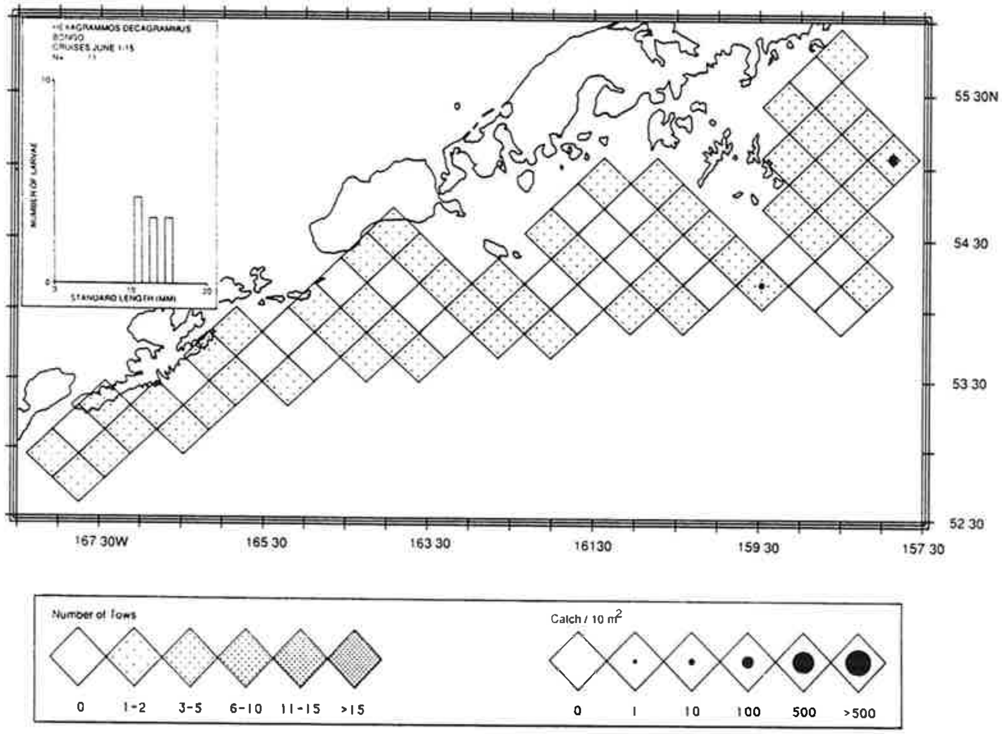
Appendix Figure 29.--Distribution of <u>Hexagrammos</u> <u>decagrammus</u> larvae in bongo tows, A. Mar. 1-15, B. Mar. 16-31 (catch/10 $m^2=P^2/2.5281$, where P=percentage of width of sector taken up by dot, for catches >500/10 m^2, P=42.8%).



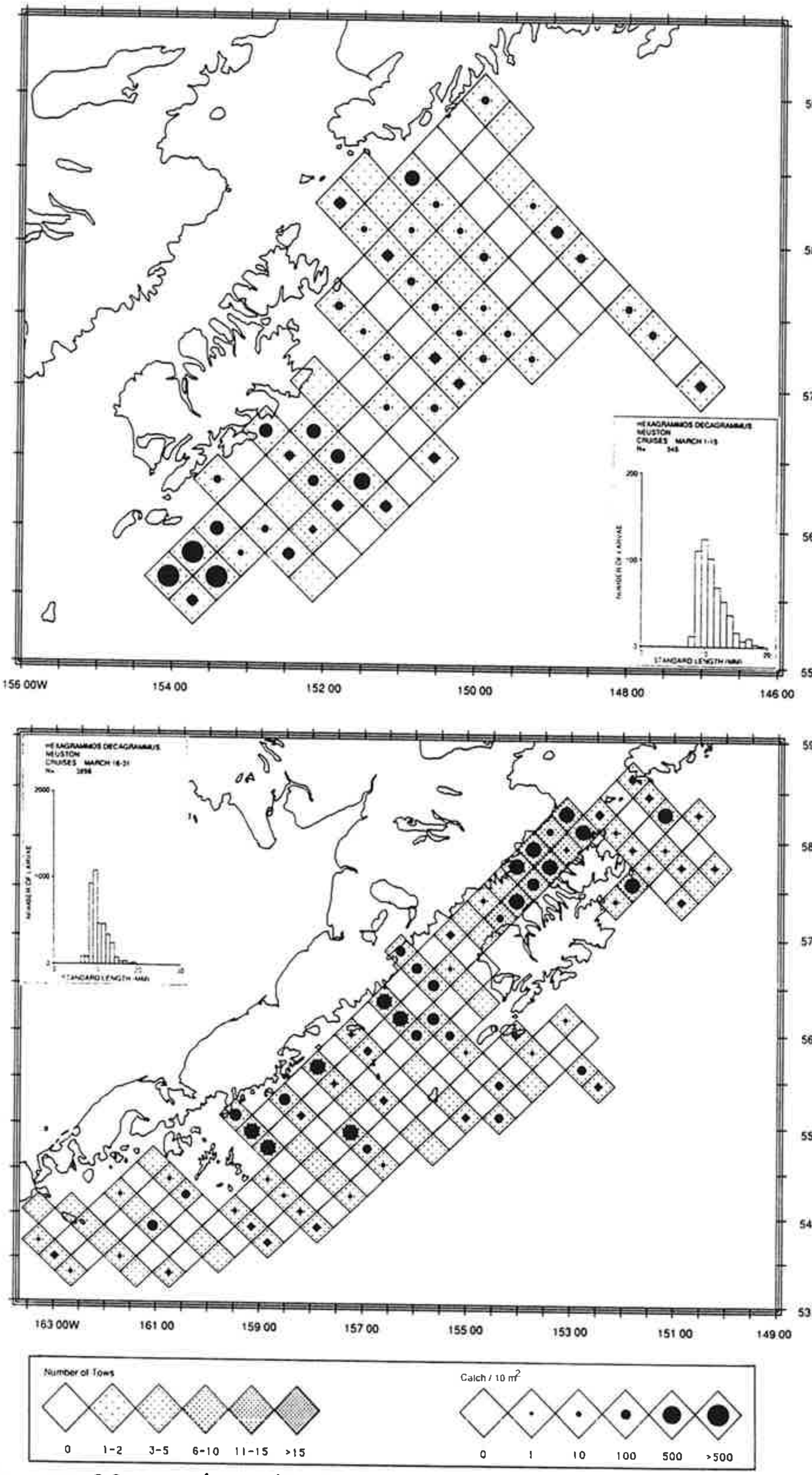
Appendix Figure 30.--Distribution of Hexagrammos decagrammus larvae in bongo tows, A. Apr. 1-15, B. Apr. 16-30 (catch/10 $m^2=P^2/2.5281$, where P=percentage of width of sector taken up by dot, for catches >500/10 m^2, P=42.8%).



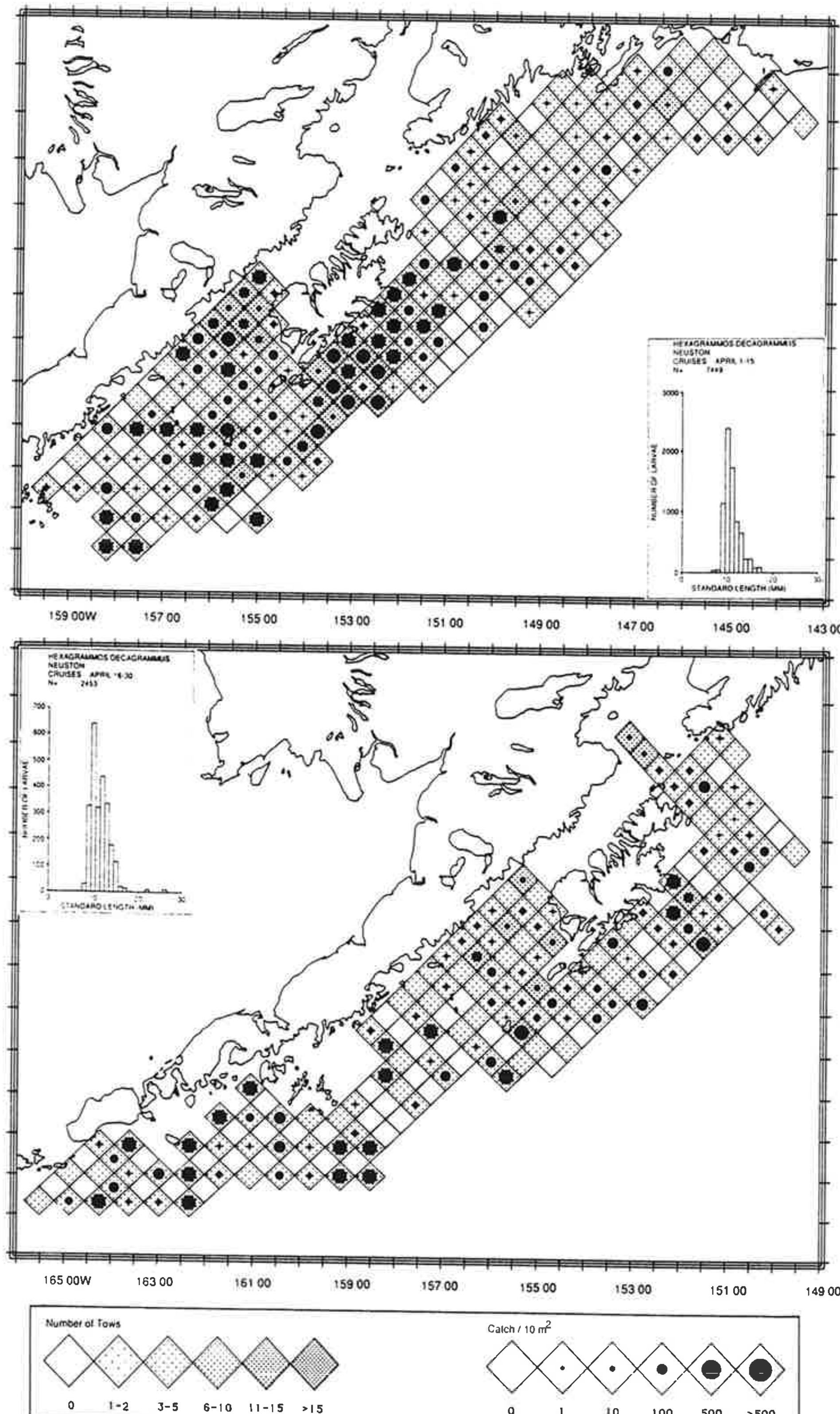
Appendix Figure 31.--Distribution of <u>Hexagrammos decagrammus</u> larvae in bongo tows, A. May 1-15, B. May 16-31 (catch/10 $m^2=P^2/2.5281$, where P=percentage of width of sector taken up by dot, for catches >500/10 m^2, P=42.8%).



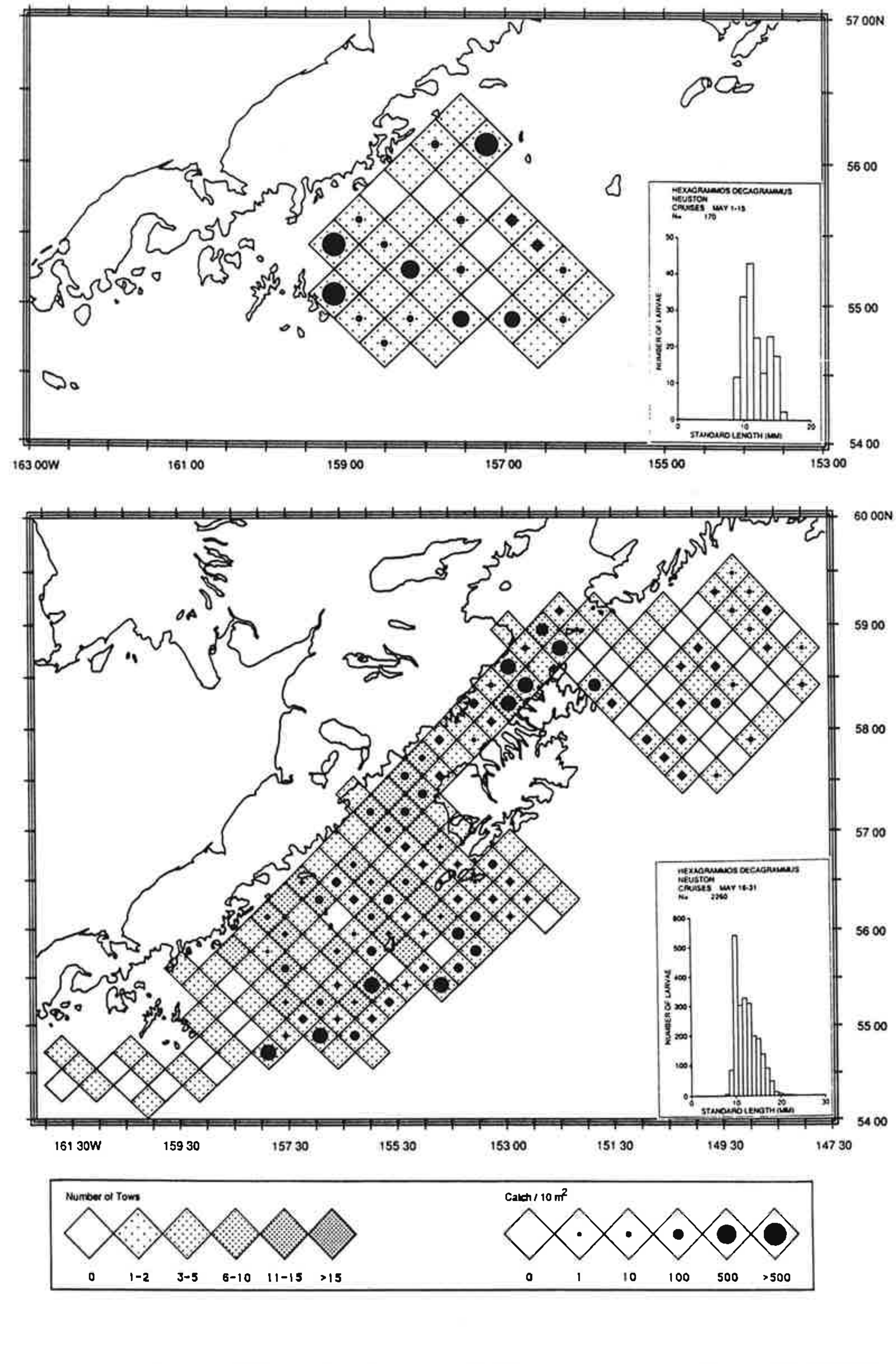
Appendix Figure 32.--Distribution of Hexagrammos decagrammus larvae in bongo tows, June 1-15 (catch/10 $m^2=P^2/2.5281$, where P=percentage of width of sector taken up by dot, for catches >500/10 m^2, P=42.8%).



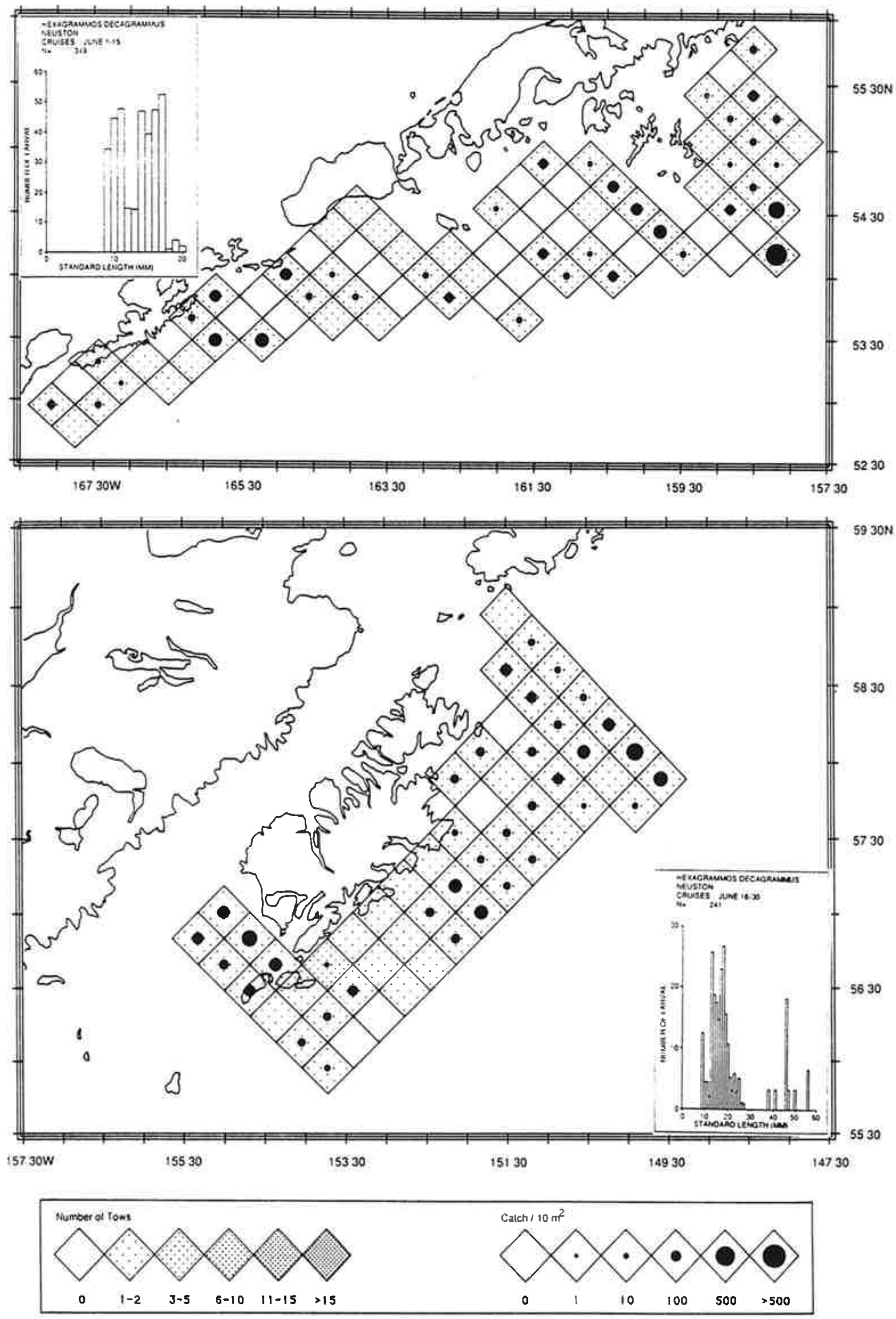
Appendix Figure 33.--Distribution of <u>Hexagrammos</u> <u>decagrammus</u> larvae in neuston tows, A. Mar. 1-15, B. Mar. 16-31 (catch/10 $m^2=P^2/2.5281$, where P=percentage of width of sector taken up by dot, for catches >500/10 m^2, P=42.8%).



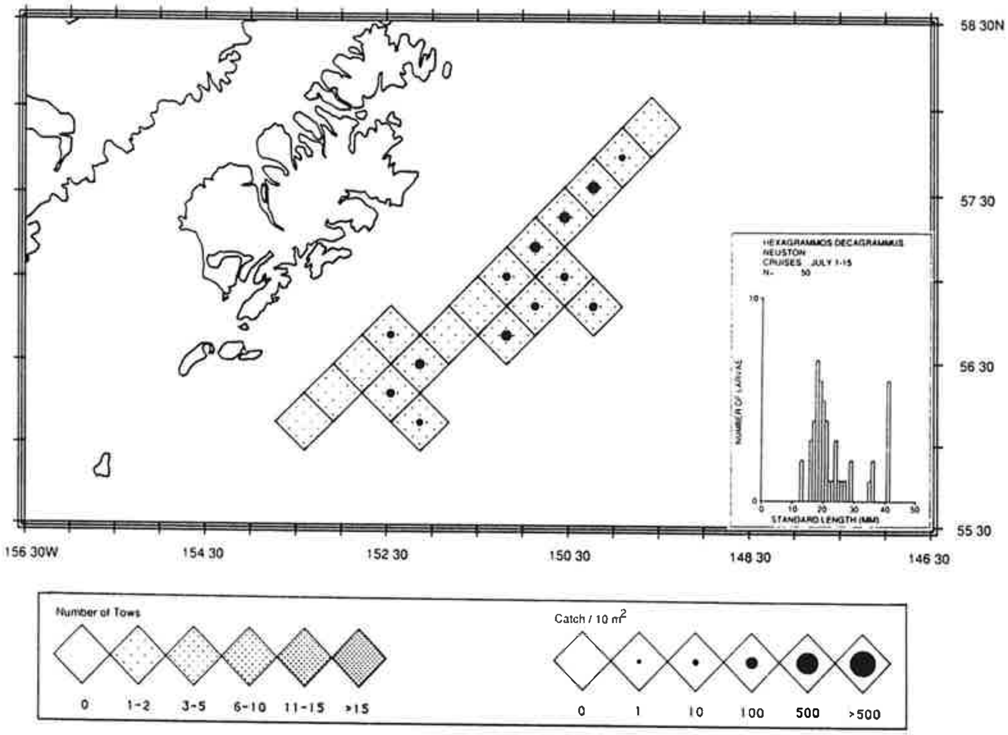
Appendix Figure 34.--Distribution of _Hexagrammos_ _decagrammus_ larvae in neuston tows, A. Apr. 1-15, B. Apr. 16-30 (catch/10 m^2=P^2/2.5281, where P=percentage of width of sector taken up by dot, for catches >500/10 m^2, P=42.8%).



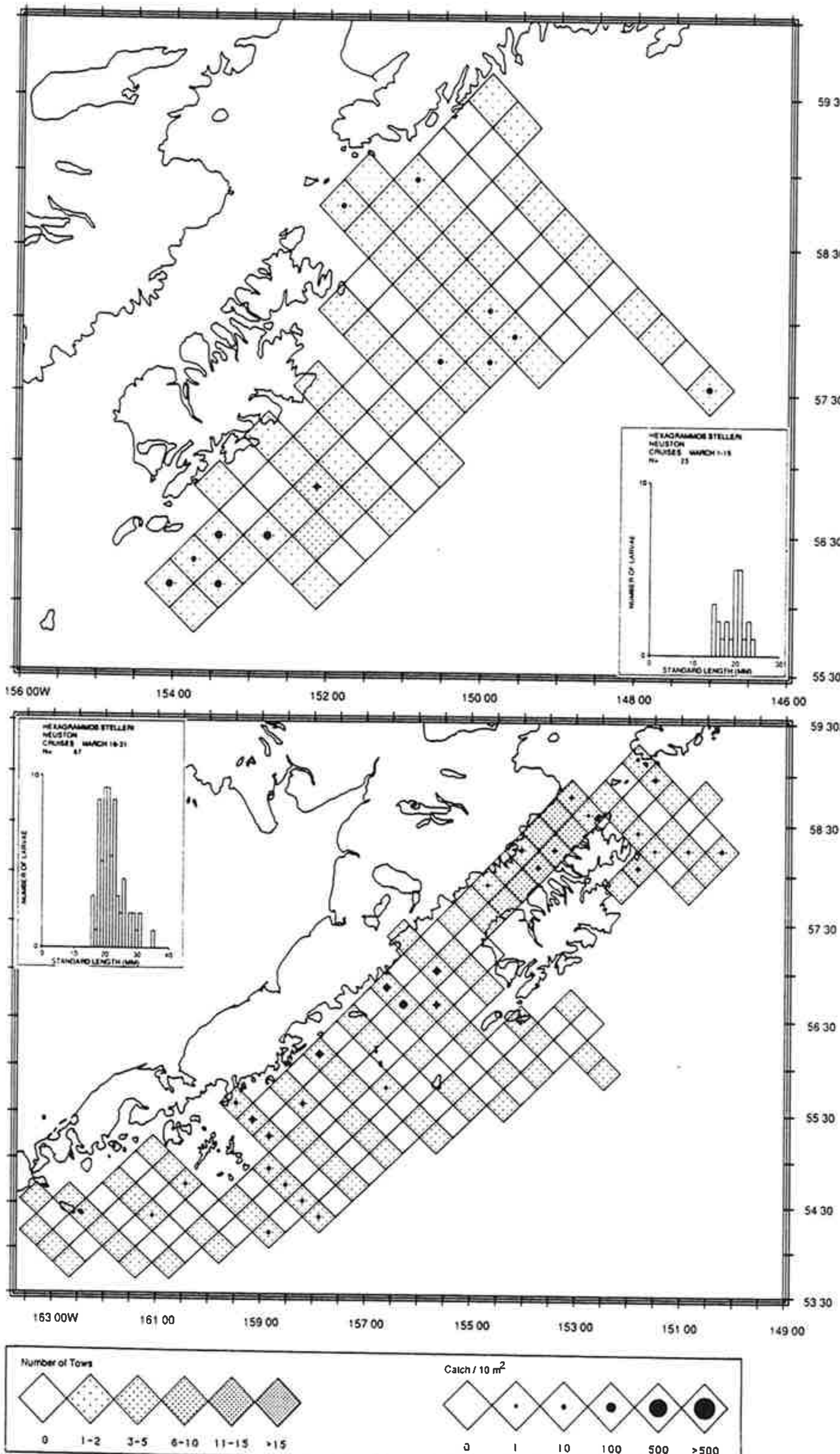
Appendix Figure 35.--Distribution of <u>Hexagrammos</u> <u>decagrammus</u> larvae in neuston tows, A. May 1-15, B. May 16-31 (catch/10 m^2=P^2/2.5281, where P=percentage of width of sector taken up by dot, for catches >500/10 m^2, P=42.8%).



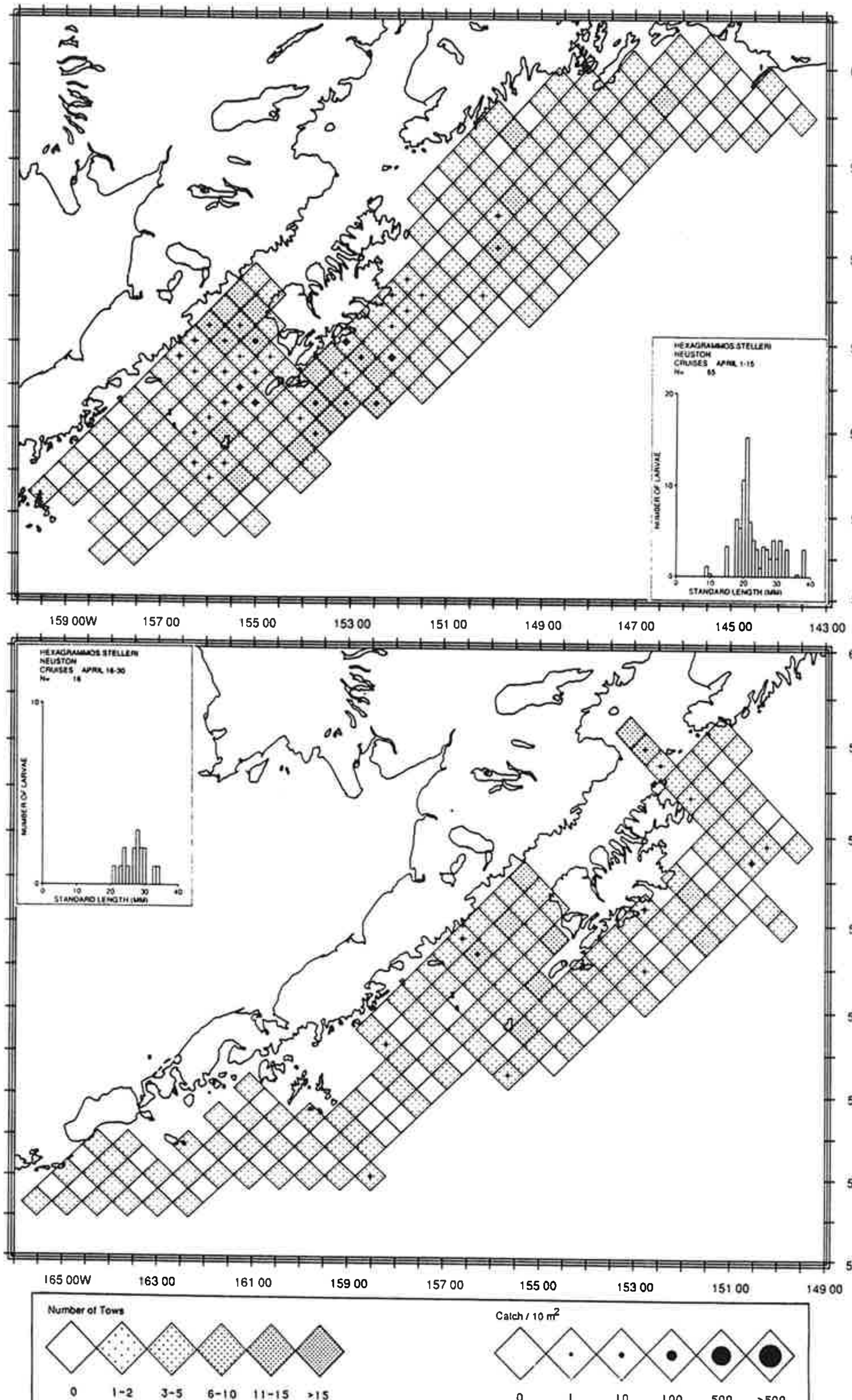
Appendix Figure 36.--Distribution of Hexagrammos decagrammus larvae in neuston tows, A. June 1-15, B. June 16-30 (catch/10 m^2=P^2/2.5281, where P=percentage of width of sector taken up by dot, for catches >500/10 m^2, P=42.8%).



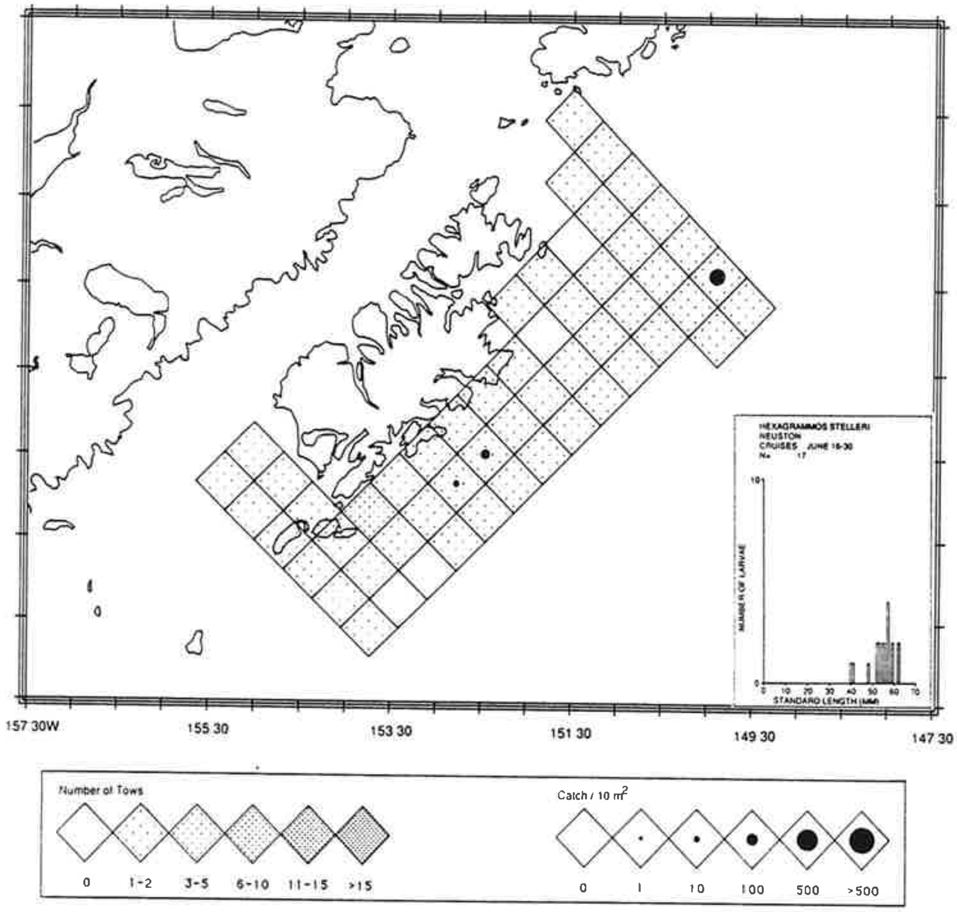
Appendix Figure 37.--Distribution of <u>Hexagrammos</u> <u>decagrammus</u> larvae in neuston tows, July 1-15 (catch/10 $m^2=P^2/2.5281$, where P=percentage of width of sector taken up by dot, for catches >500/10 m^2, P=42.8%).



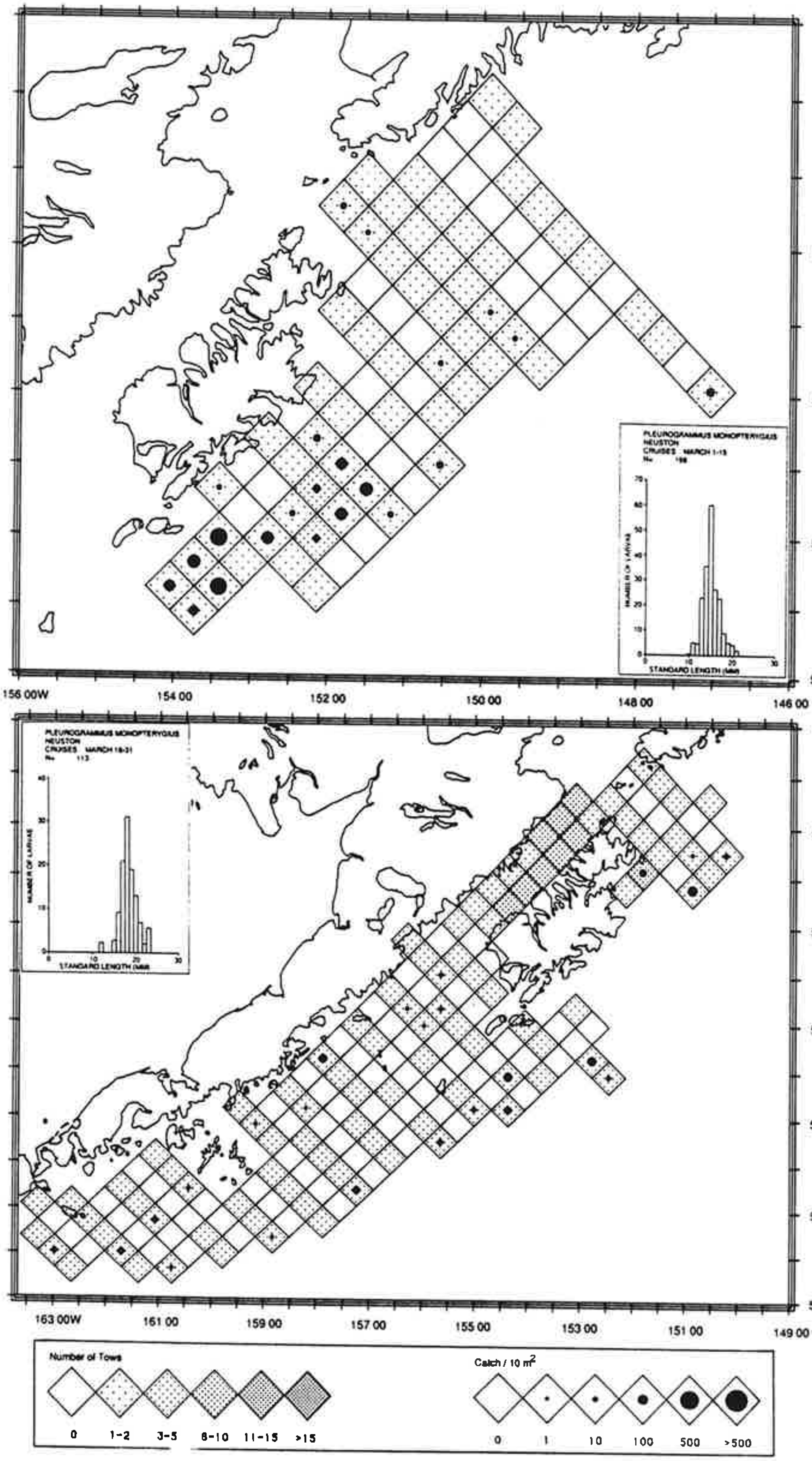
Appendix Figure 38.--Distribution of <u>Hexagrammos</u> <u>stelleri</u> larvae in neuston tows, A. Mar. 1-15, B. Mar. 16-31 (catch/10 $m^2=P^2/2.5281$, where P=percentage of width of sector taken up by dot, for catches >500/10 m^2, P=42.8%).



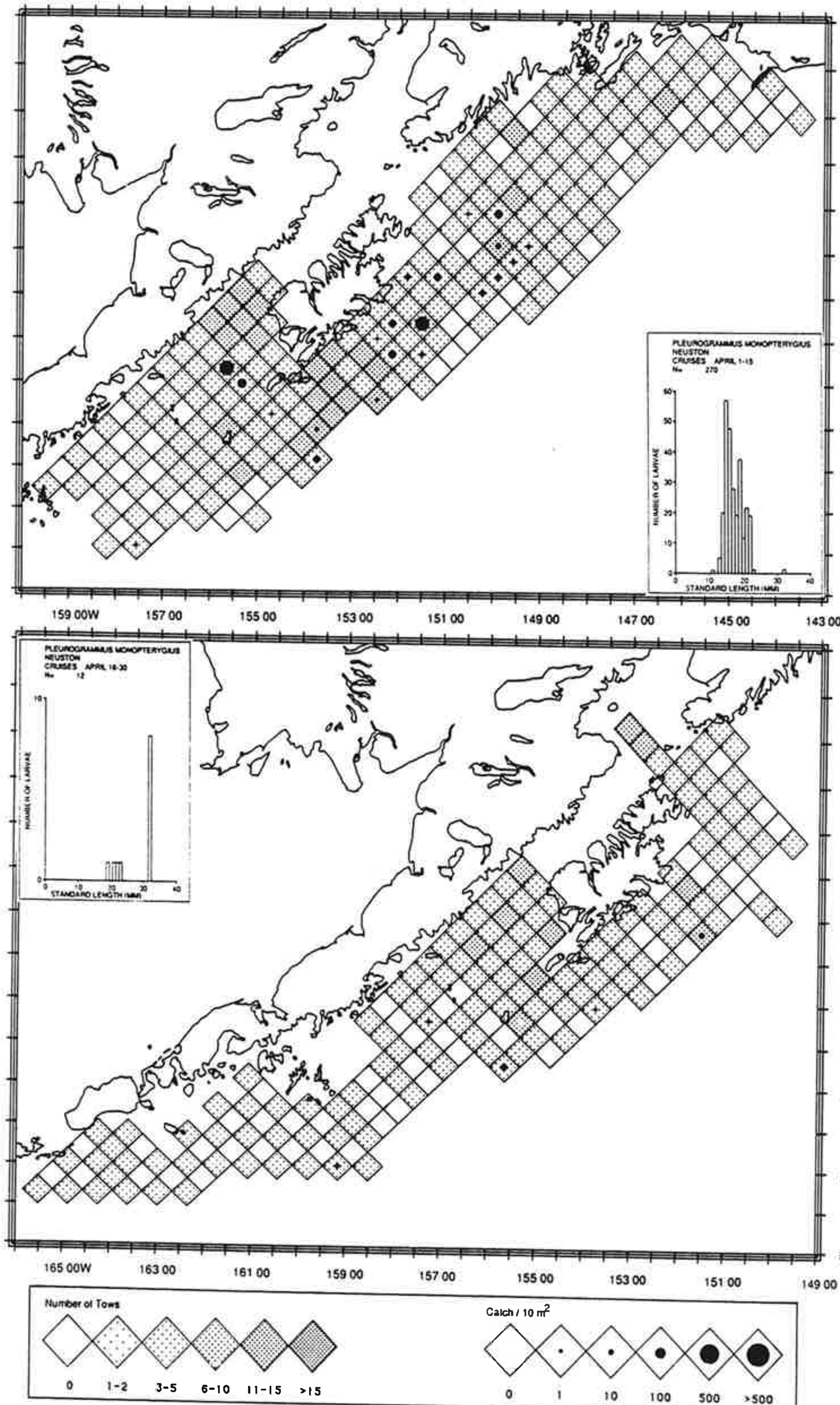
Appendix Figure 39.--Distribution of <u>Hexagrammos</u> <u>stelleri</u> larvae in neuston tows, A. Apr. 1-15, B. Apr. 16-30 (catch/10 m^2=P^2/2.5281, where P=percentage of width of sector taken up by dot, for catches >500/10 m^2, P=42.8%).



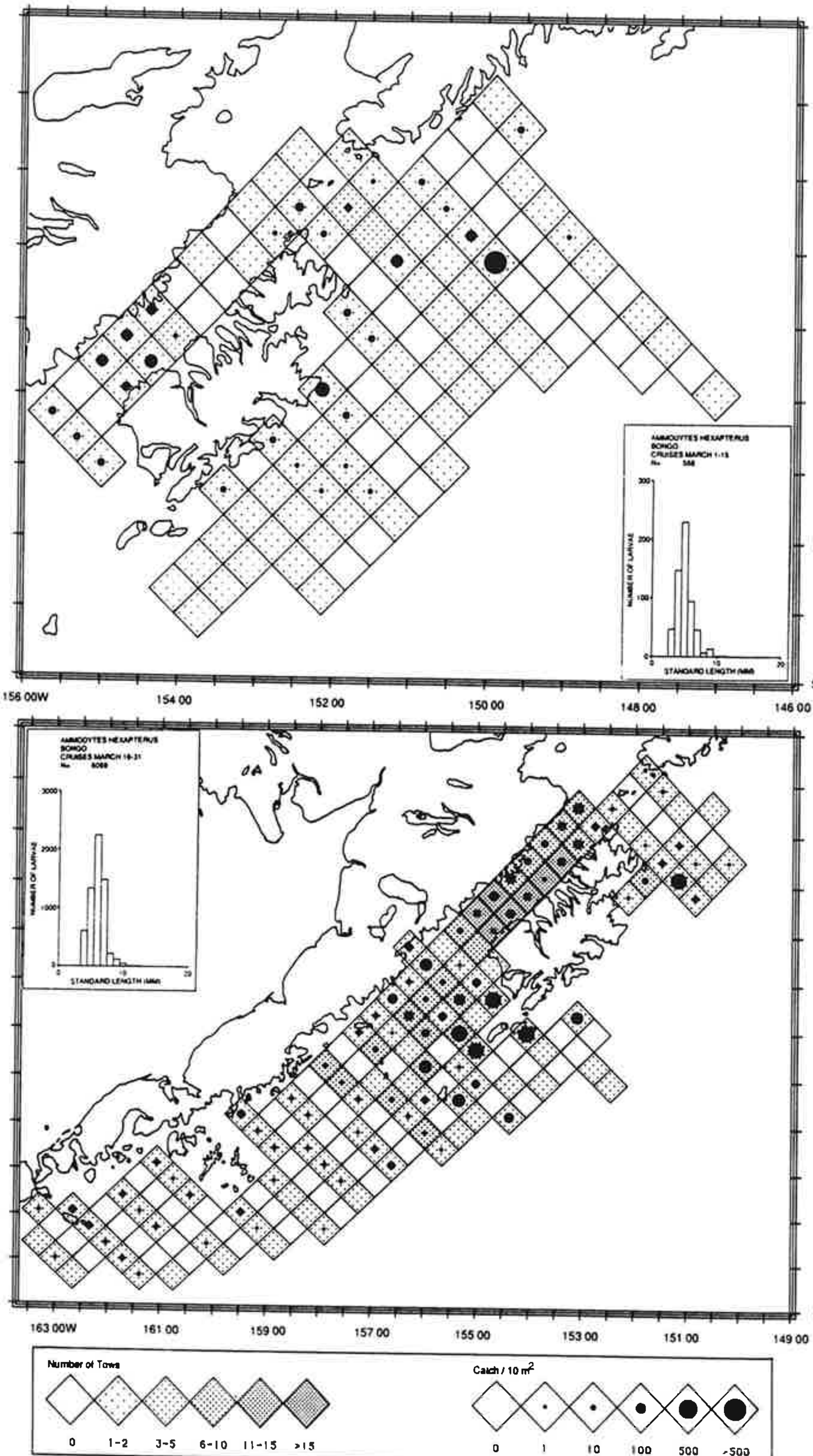
Appendix Figure 40.--Distribution of <u>Hexagrammos</u> <u>stelleri</u> larvae in neuston tows, June 16-30 (catch/10 m^2 $=P^2/2.5281$, where P=percentage of width of sector taken up by dot, for catches >500/10 m^2, P=42.8%).



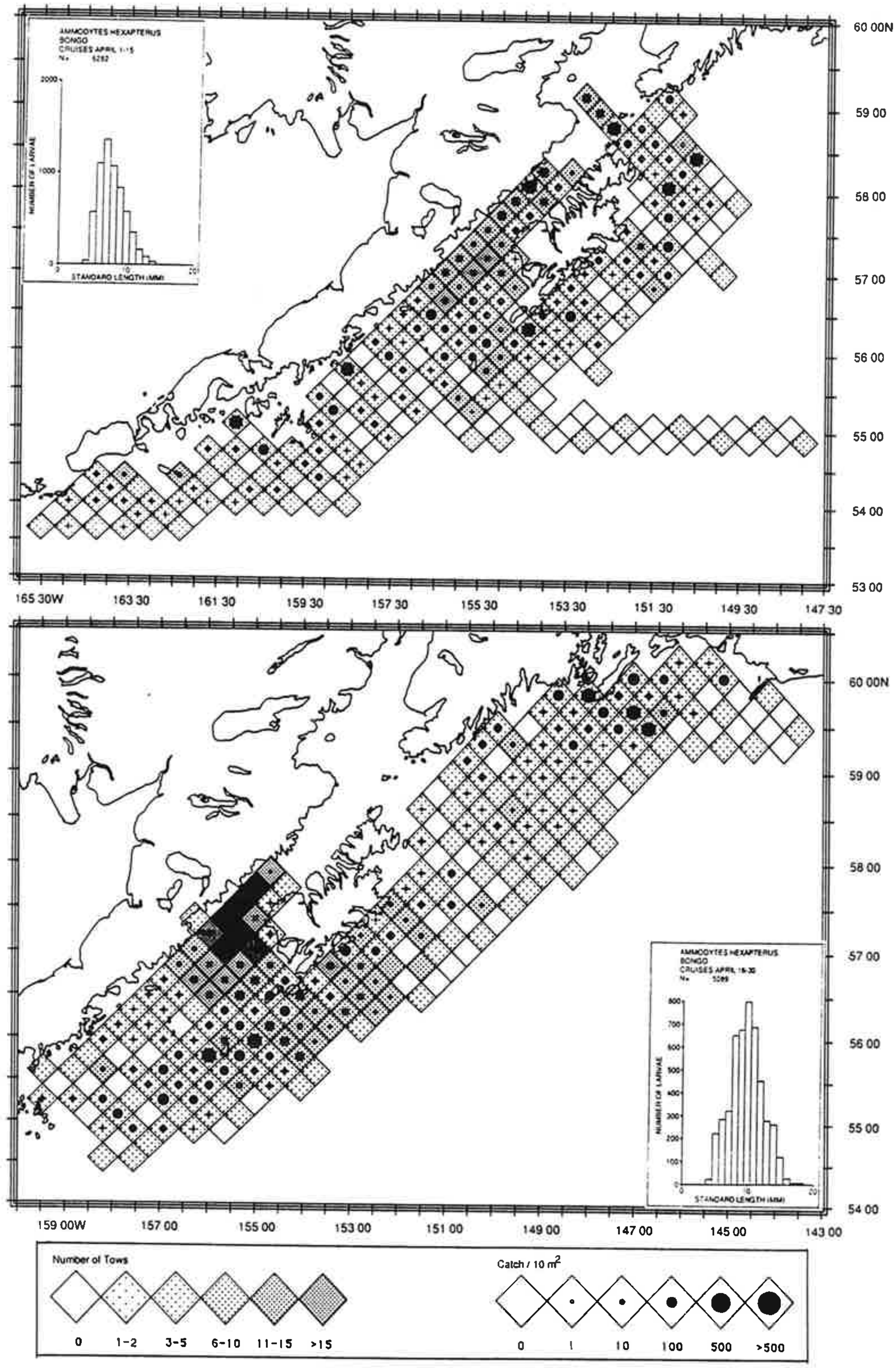
Appendix Figure 41.--Distribution of <u>Pleurogrammus</u> <u>monopterygius</u> larvae in neuston tows, A. Mar. 1-15, B. Mar. 16-31 (catch/10 $m^2=P^2/2.5281$, where P=percentage of width of sector taken up by dot, for catches >500/10 m^2, P=42.8%).



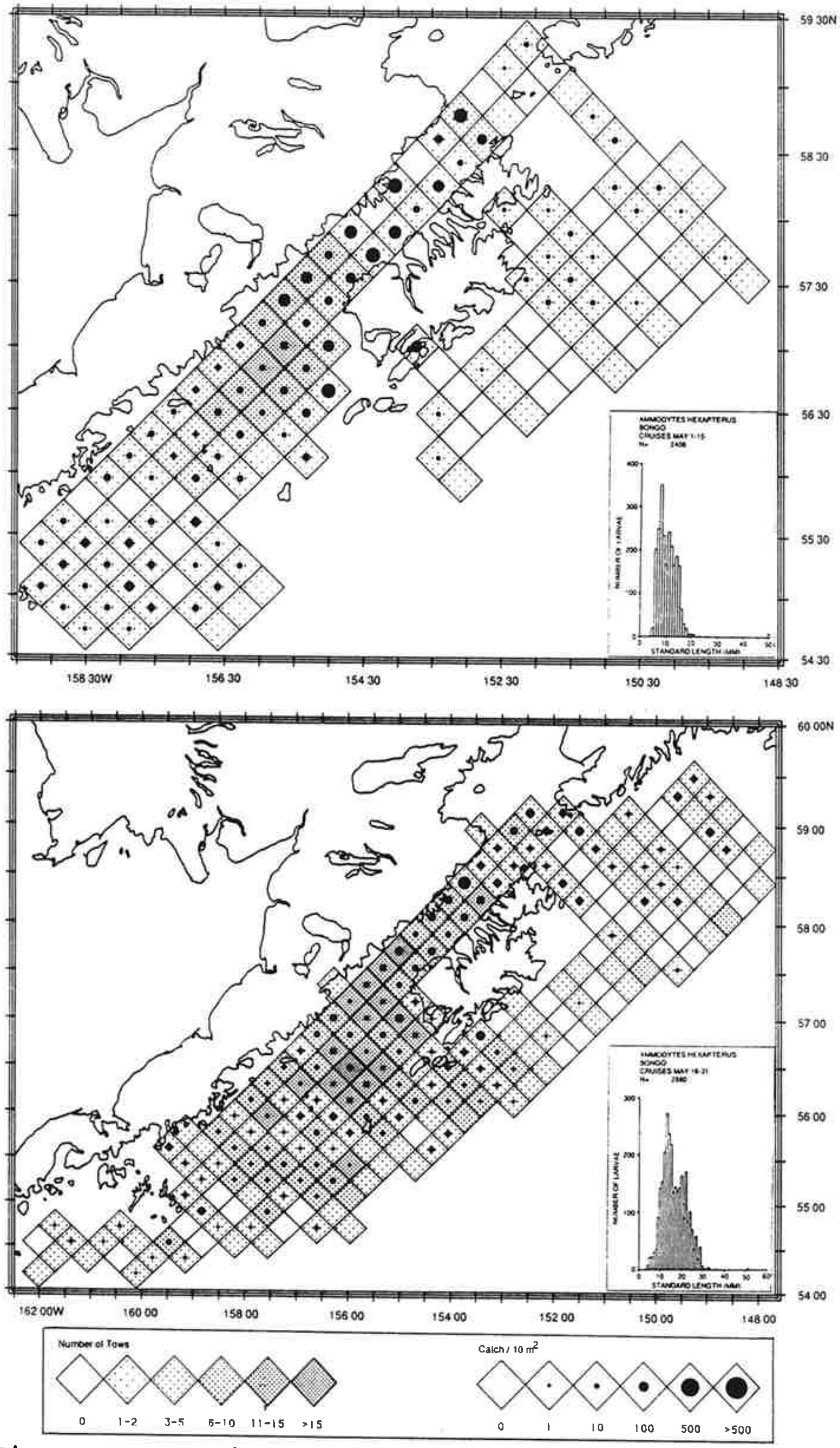
Appendix Figure 42.--Distribution of Pleurogrammus monopterygius larvae in neuston tows, A. Apr. 1-15, B. Apr. 16-30 (catch/10 $m^2=P^2/2.5281$, where P=percentage of width of sector taken up by dot, for catches >500/10 m^2, P=42.8%).



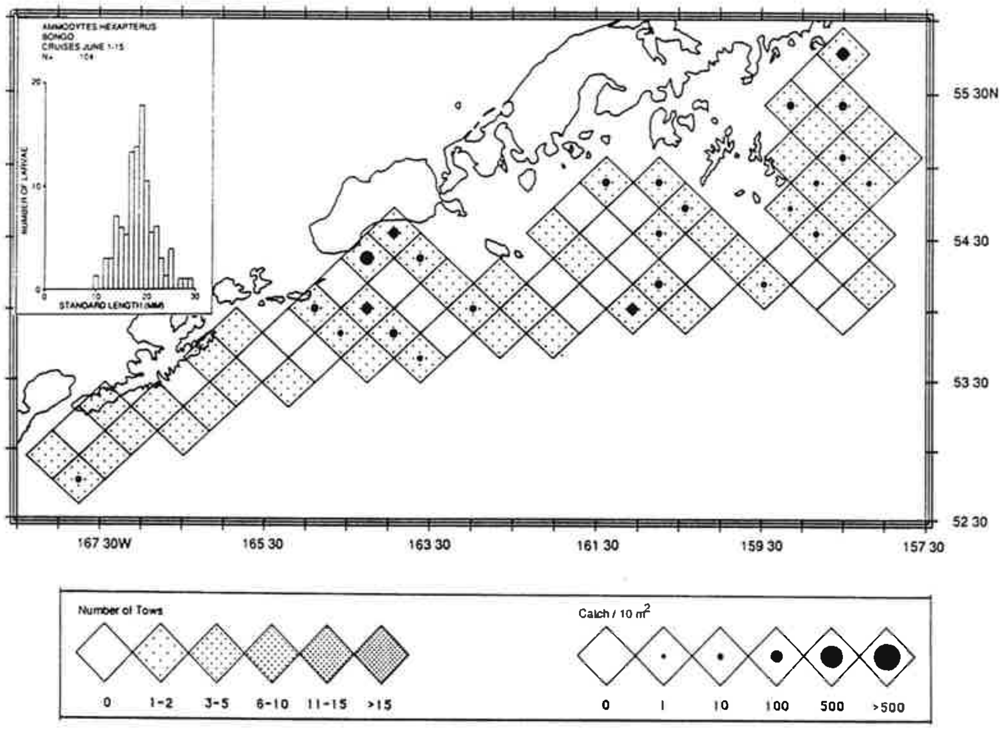
Appendix Figure 43.--Distribution of <u>Ammodytes</u> <u>hexapterus</u> larvae in bongo tows, A. Mar. 1-15, B. Mar. 16-31 (catch/10 m^2=P^2/2.5281, where P=percentage of width of sector taken up by dot, for catches >500/10 m^2, P=42.8%).



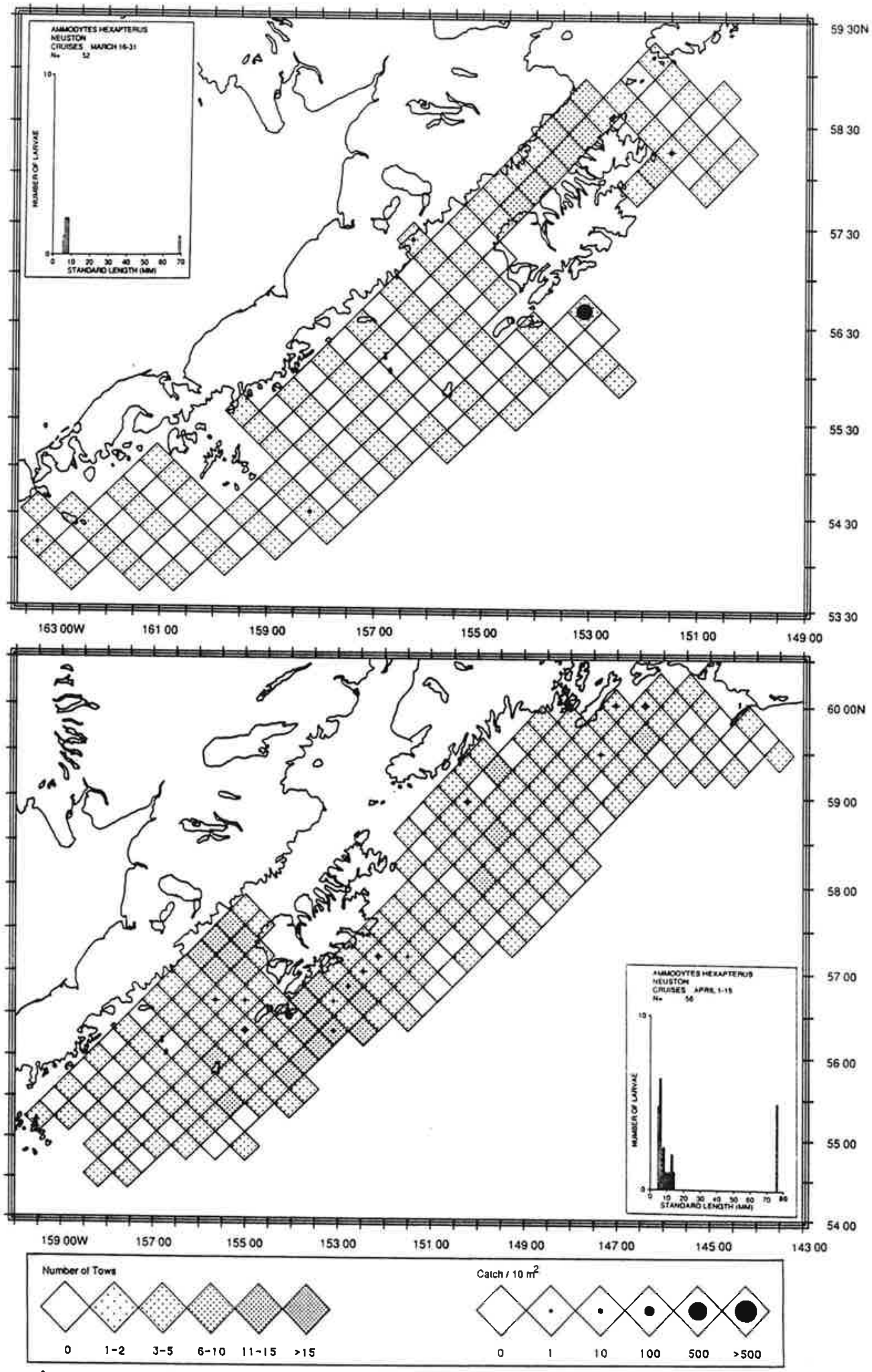
Appendix Figure 44.--Distribution of <u>Ammodytes</u> <u>hexapterus</u> larvae in bongo tows, A. Apr. 1-15, B. Apr. 16-30 (catch/10 $m^2=P^2/2.5281$, where P=percentage of width of sector taken up by dot, for catches >500/10 m^2, P=42.8%).



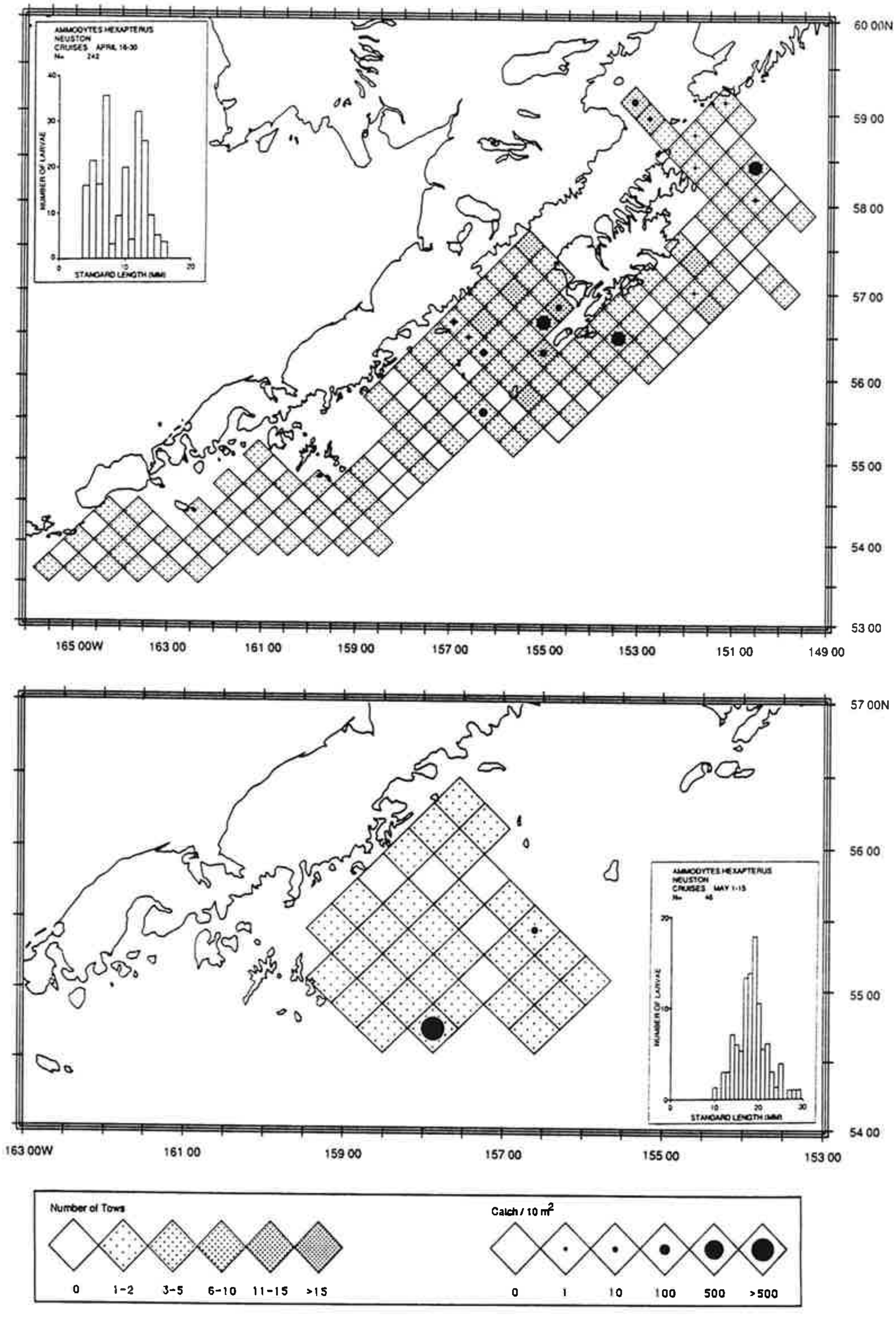
Appendix Figure 45.--Distribution of <u>Ammodytes</u> <u>hexapterus</u> larvae in bongo tows, A. May 1-15, B. May 16-31 (catch/10 $m^2 = P^2/2.5281$, where P=percentage of width of sector taken up by dot, for catches >500/10 m^2, P=42.8%).



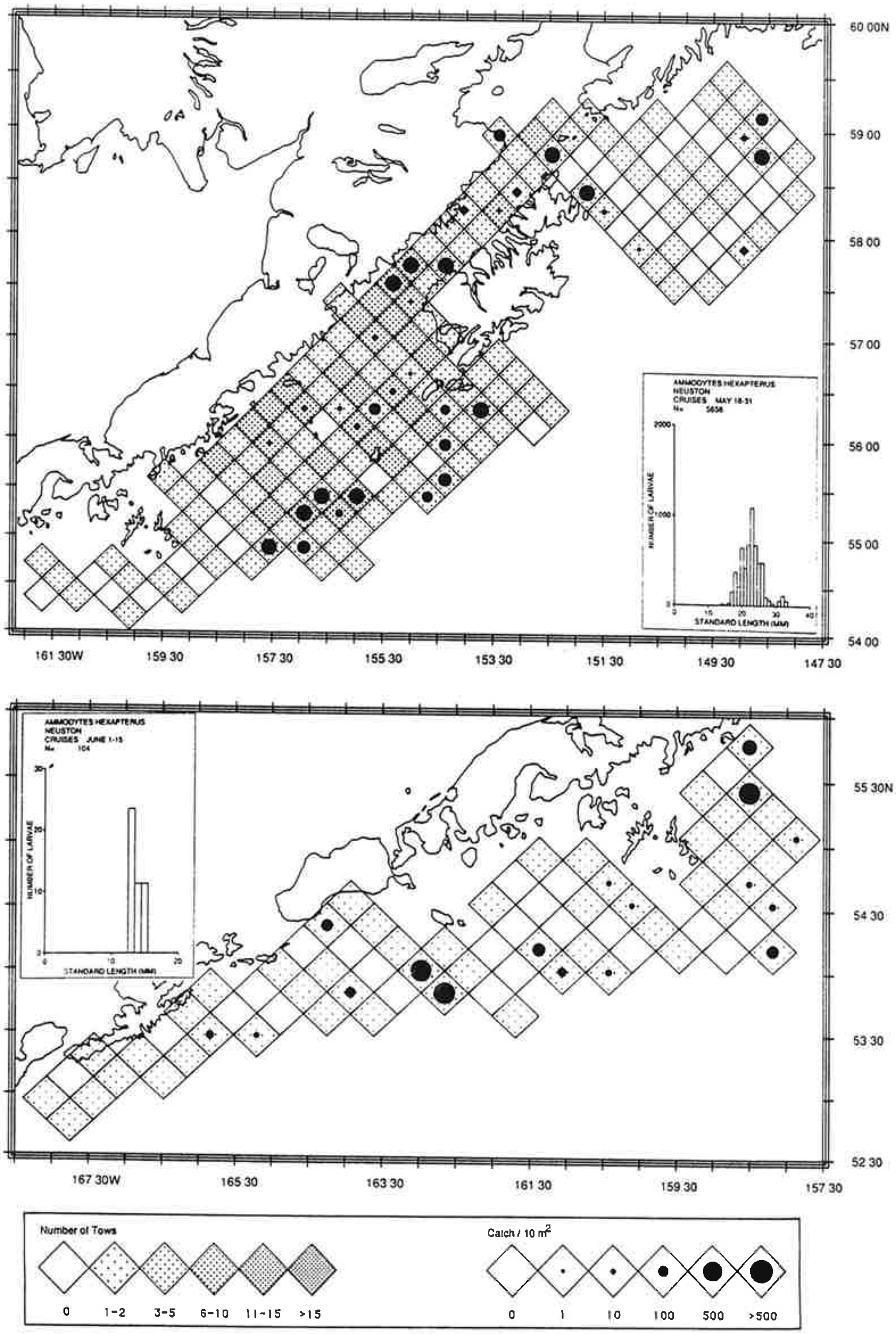
Appendix Figure 46.--Distribution of Ammodytes hexapterus larvae in bongo tows, June 1-15 (catch/10 $m^2=P^2/2.5281$, where P=percentage of width of sector taken up by dot, for catches >500/10 m^2, P=42.8%).



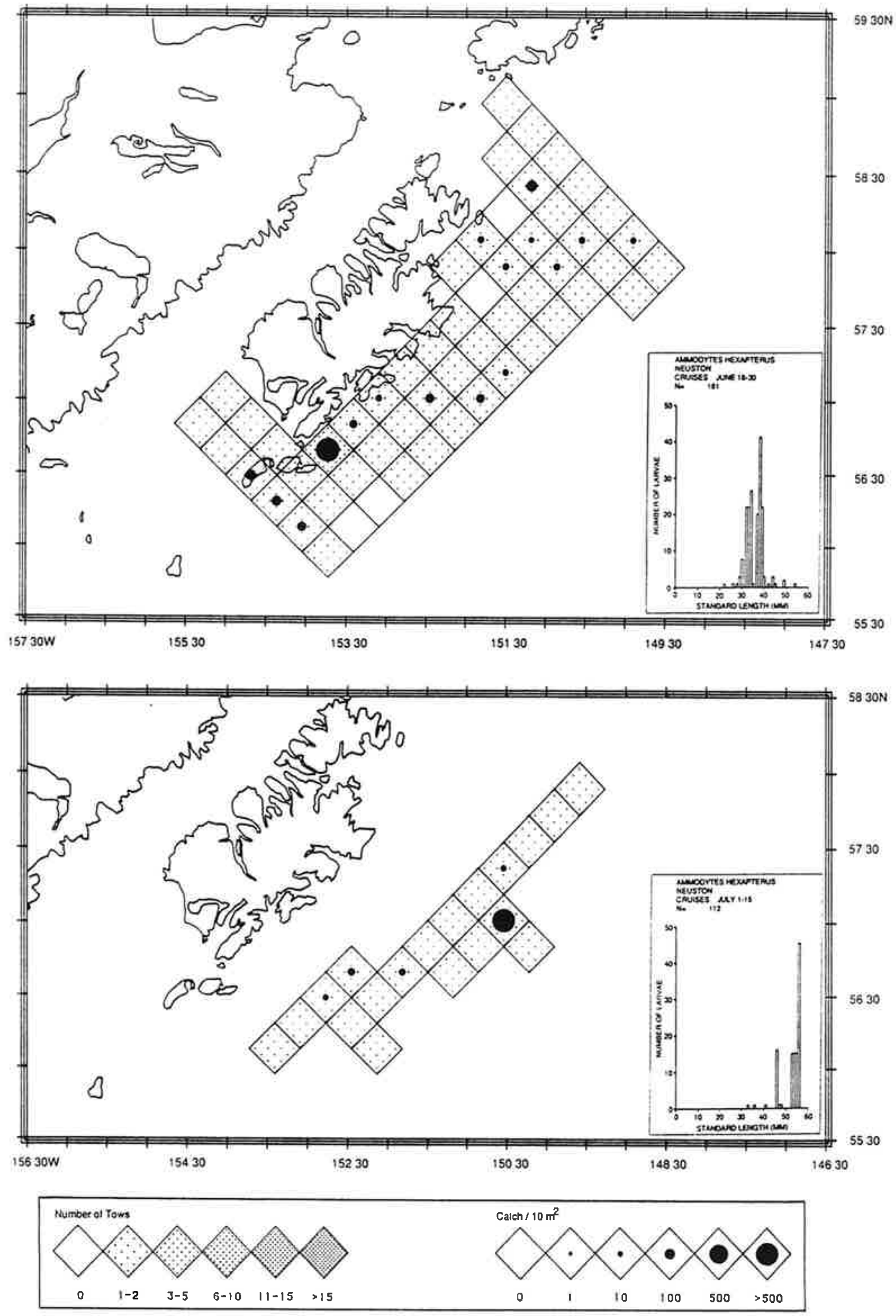
Appendix Figure 47.--Distribution of <u>Ammodytes</u> <u>hexapterus</u> larvae in neuston tows, A. Mar. 16-31, B. Apr. 1-15 (catch/10 $m^2=P^2/2.5281$, where P=percentage of width of sector taken up by dot, for catches >500/10 m^2, P=42.8%).



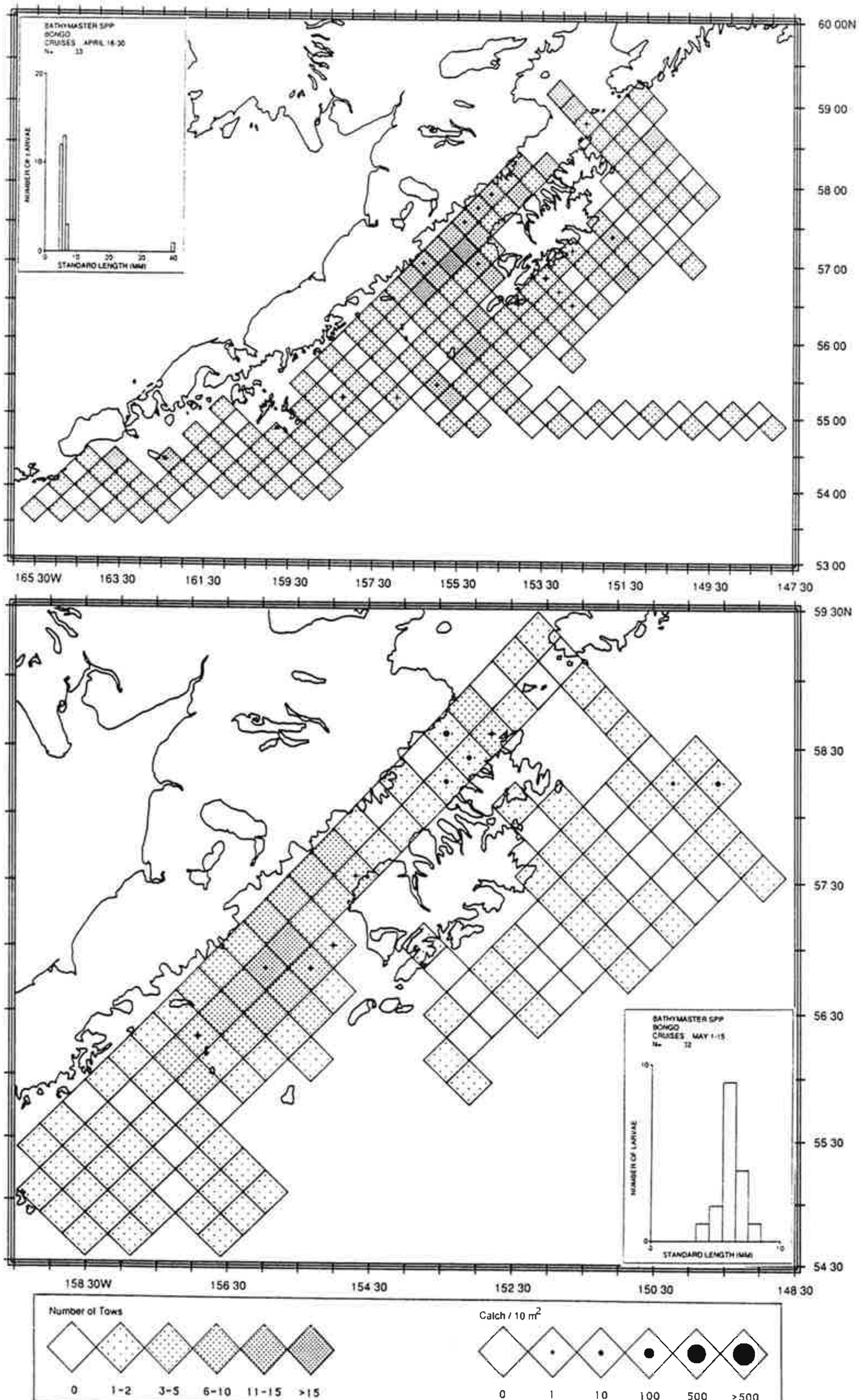
Appendix Figure 48.--Distribution of <u>Ammodytes</u> <u>hexapterus</u> larvae in neuston tows, A. Apr. 16-30, B. May 1-15 (catch/10 $m^2=P^2/2.5281$, where P=percentage of width of sector taken up by dot, for catches >500/10 m^2, P=42.8%).



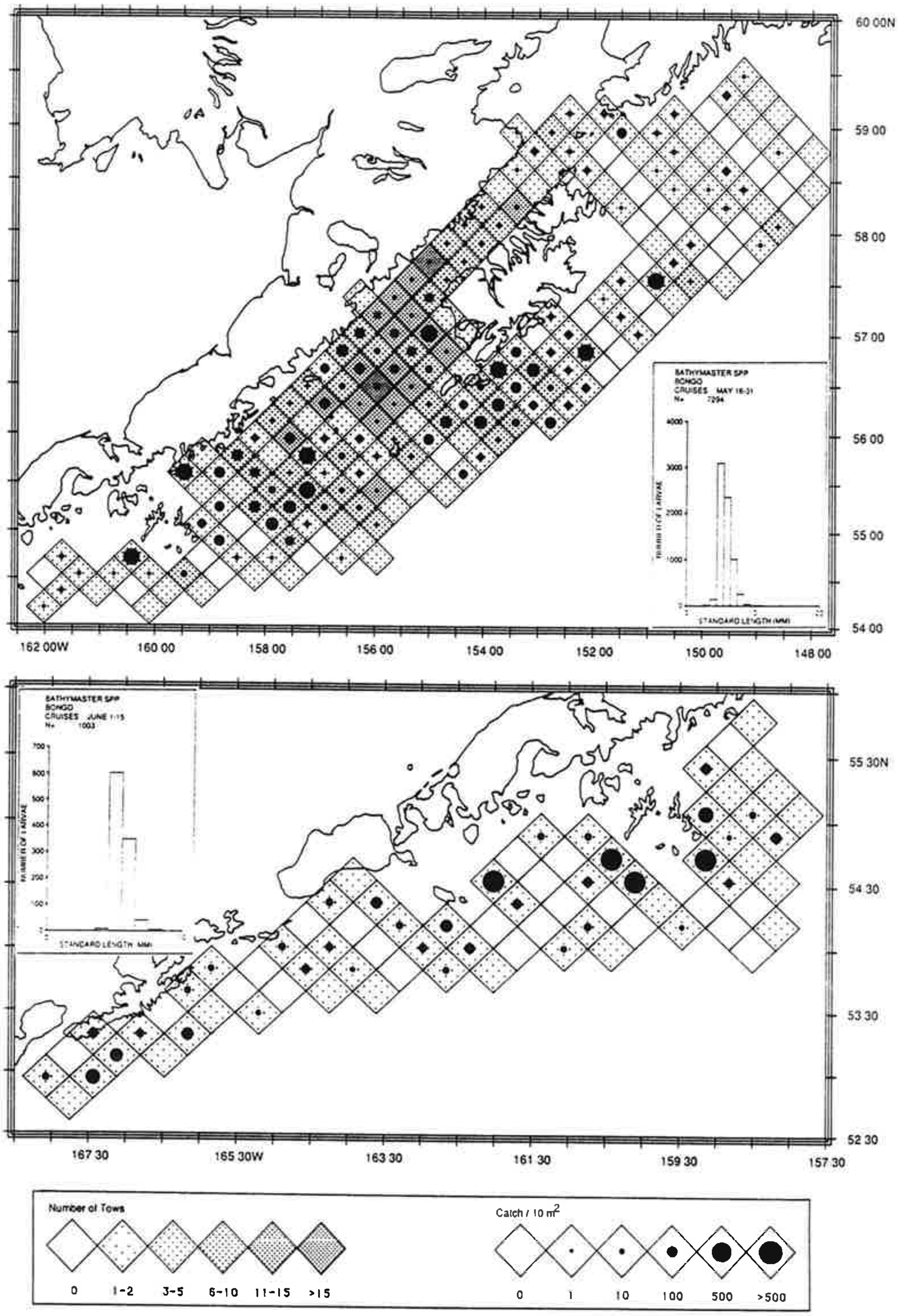
Appendix Figure 49.--Distribution of Ammodytes hexapterus larvae in neuston tows, A. May 16-31, B. June 1-15 (catch/10 m^2=P^2/2.5281, where P=percentage of width of sector taken up by dot, for catches >500/10 m^2, P=42.8%).



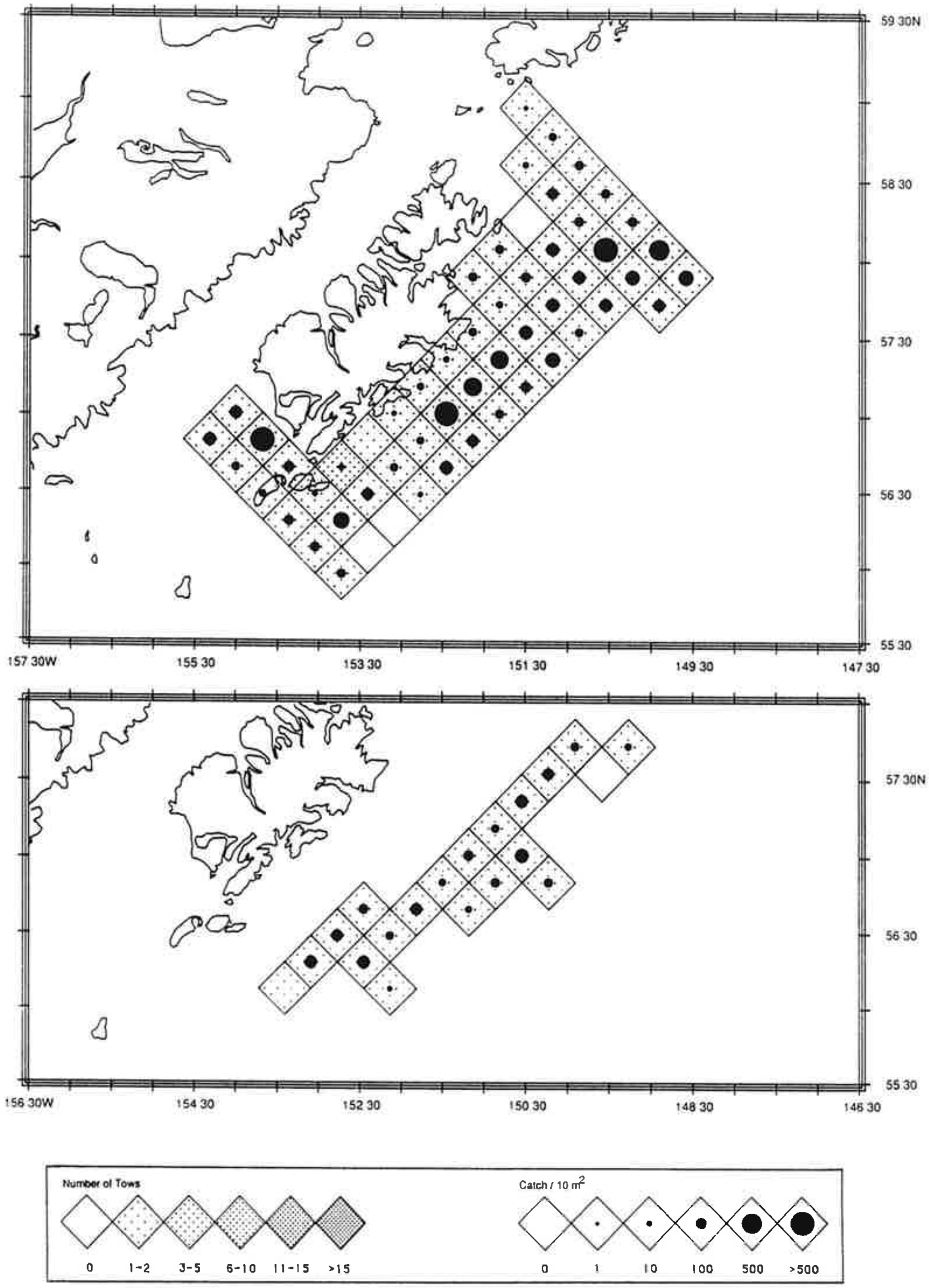
Appendix Figure 50.--Distribution of Ammodytes hexapterus larvae in neuston tows, A. June 16-30, B. July 1-15 (catch/10 m^2=P^2/2.5281, where P=percentage of width of sector taken up by dot, for catches >500/10 m^2, P=42.8%).



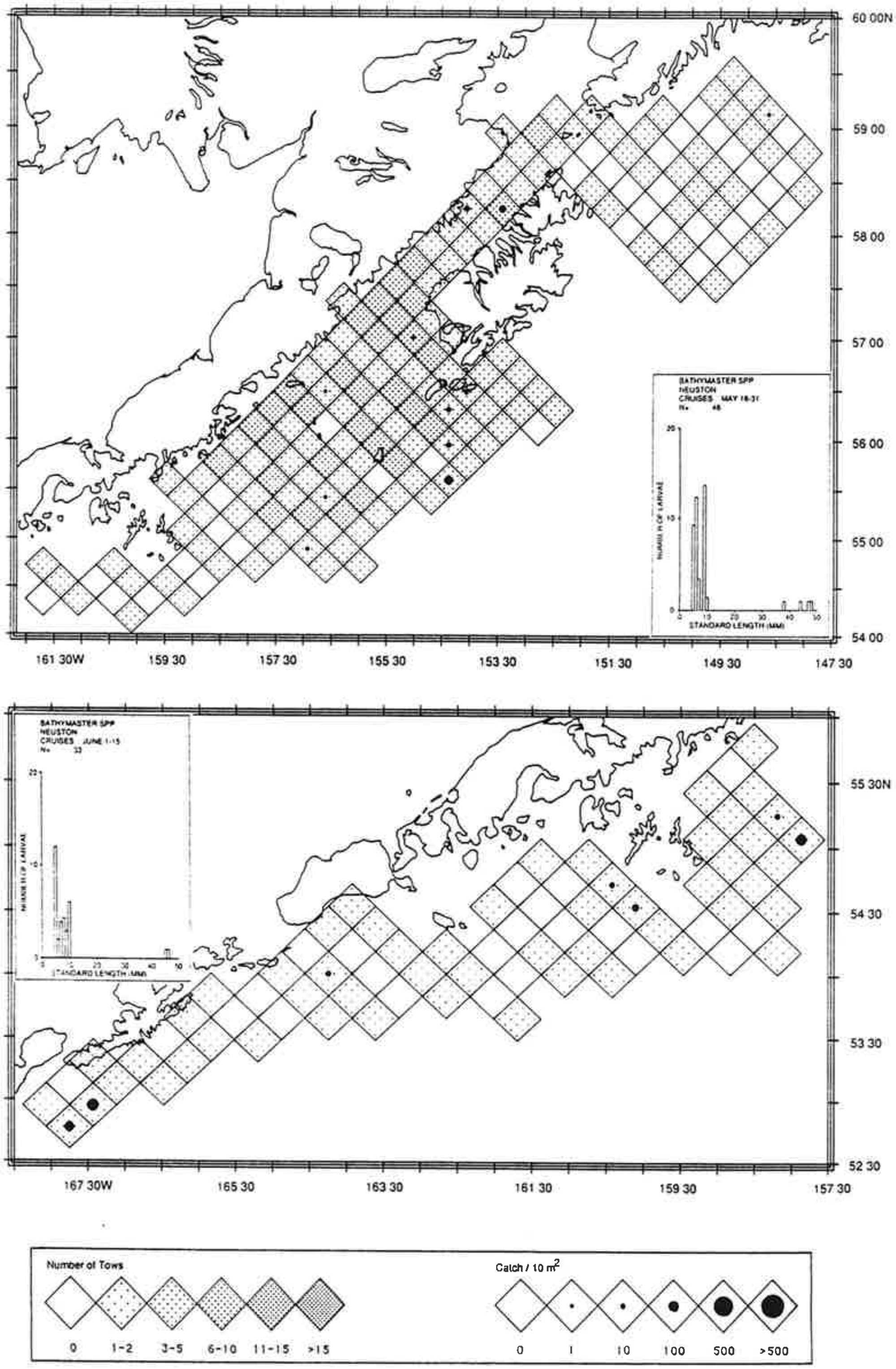
Appendix Figure 51.--Distribution of Bathymaster spp. larvae in bongo tows, A. Apr. 16-30, B. May 1-15 (catch/10 m^2=P^2/2.5281, where P=percentage of width of sector taken up by dot, for catches >500/10 m^2, P=42.8%).



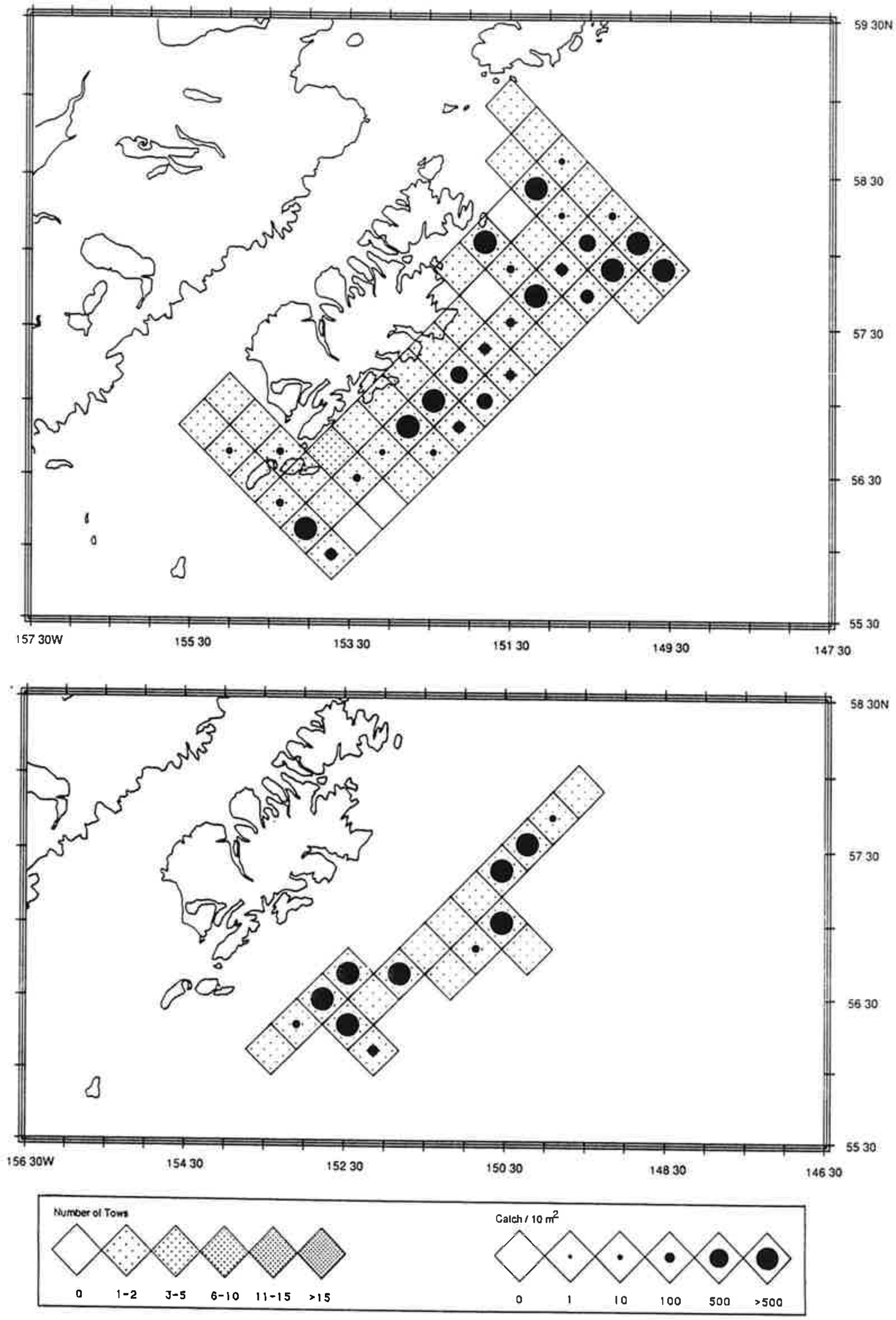
Appendix Figure 52.--Distribution of Bathymaster spp. larvae in bongo tows, A. May 16-31, B. June 1-15 (catch/10 m^2=P^2/2.5281, where P=percentage of width of sector taken up by dot, for catches >500/10 m^2, P=42.8%).



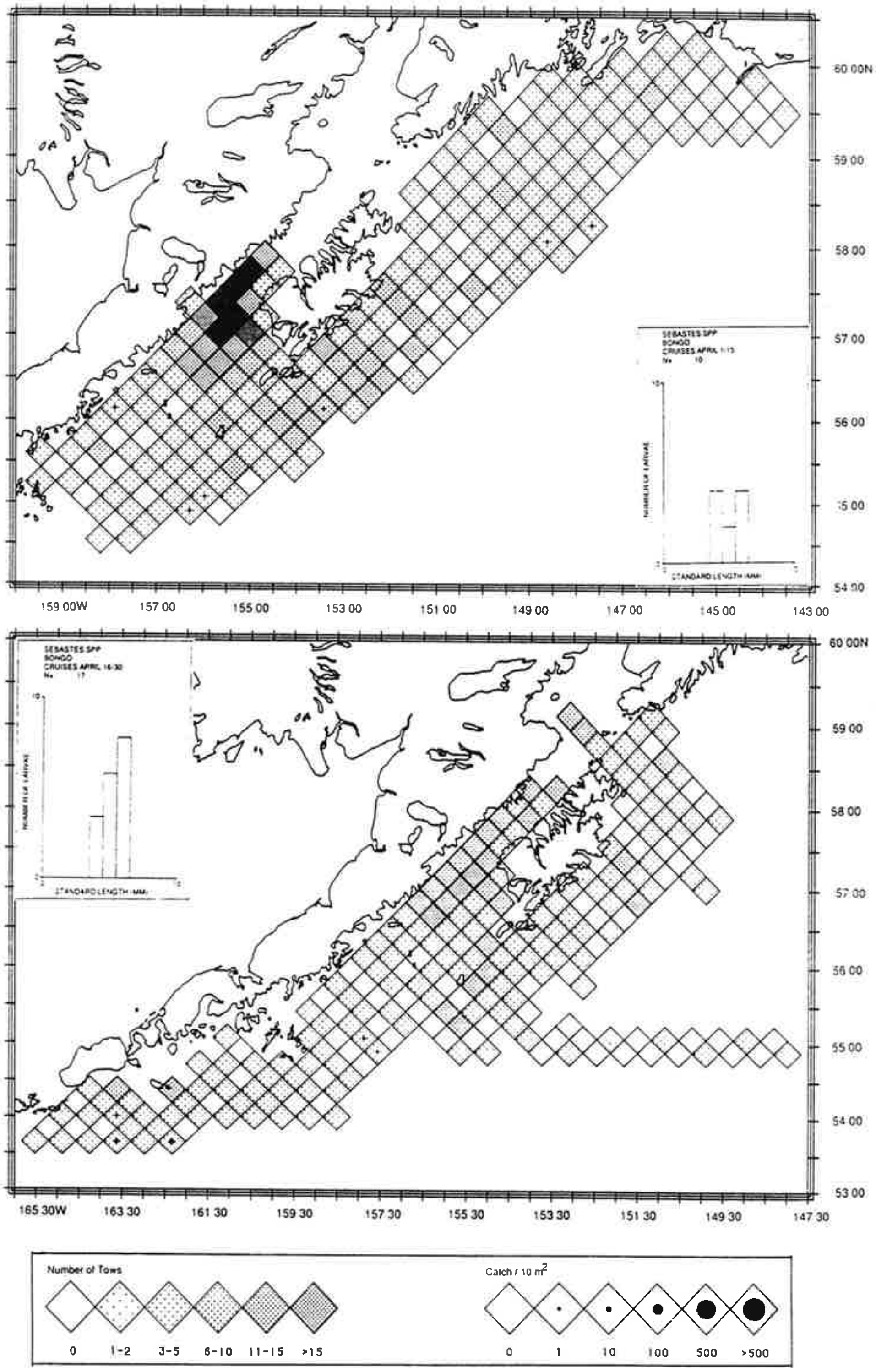
Appendix Figure 53.--Distribution of Bathymaster spp. larvae in bongo tows, A. June 16-30, B. July 1-15 (catch/10 $m^2=P^2/2.5281$, where P=percentage of width of sector taken up by dot, for catches >500/10 m^2, P=42.8%).



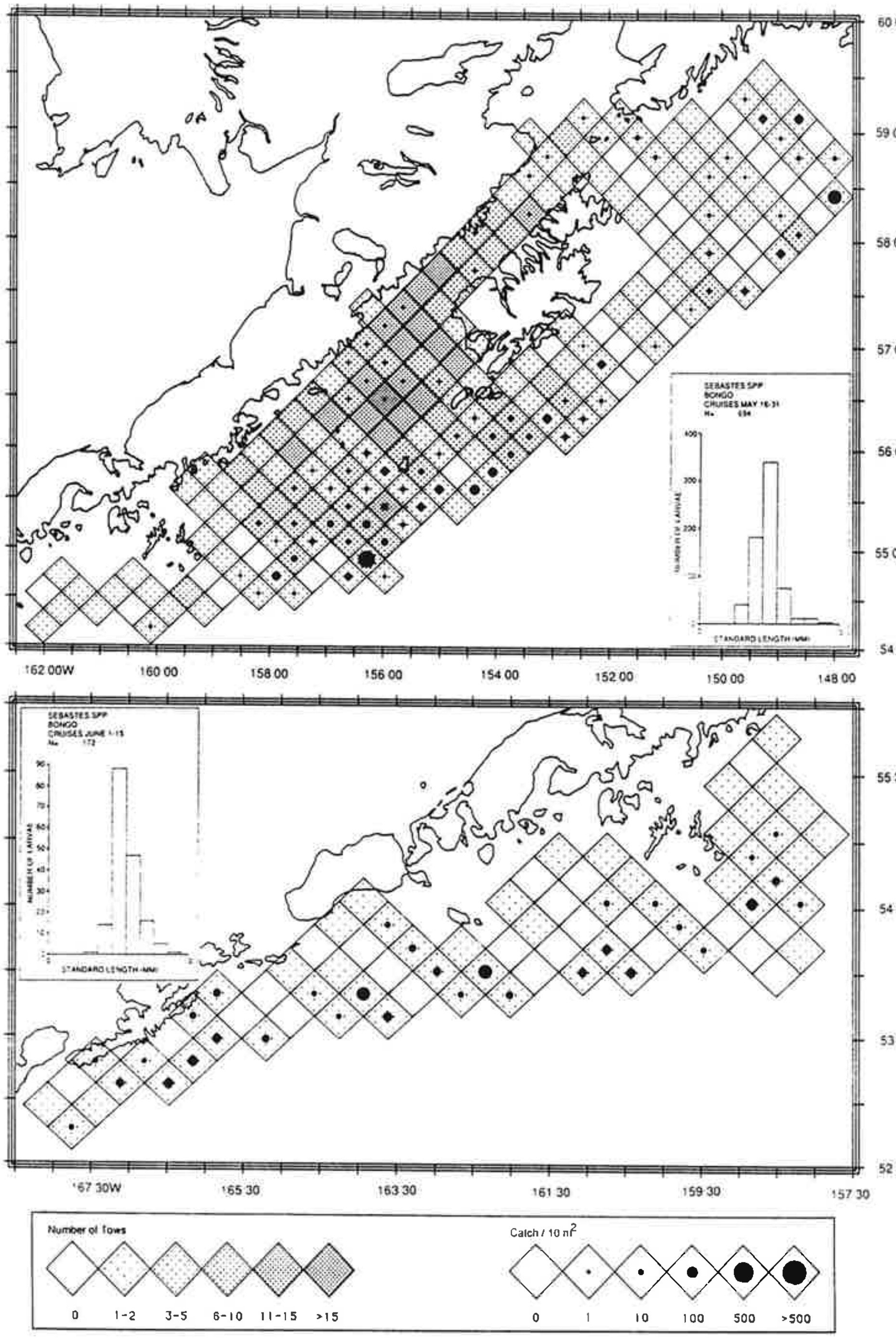
Appendix Figure 54.--Distribution of Bathymaster spp. larvae in neuston tows, A. May 16-31, B. June 1-15 (catch/10 $m^2 = P^2/2.5281$, where P=percentage of width of sector taken up by dot, for catches >500/10 m^2, P=42.8%).



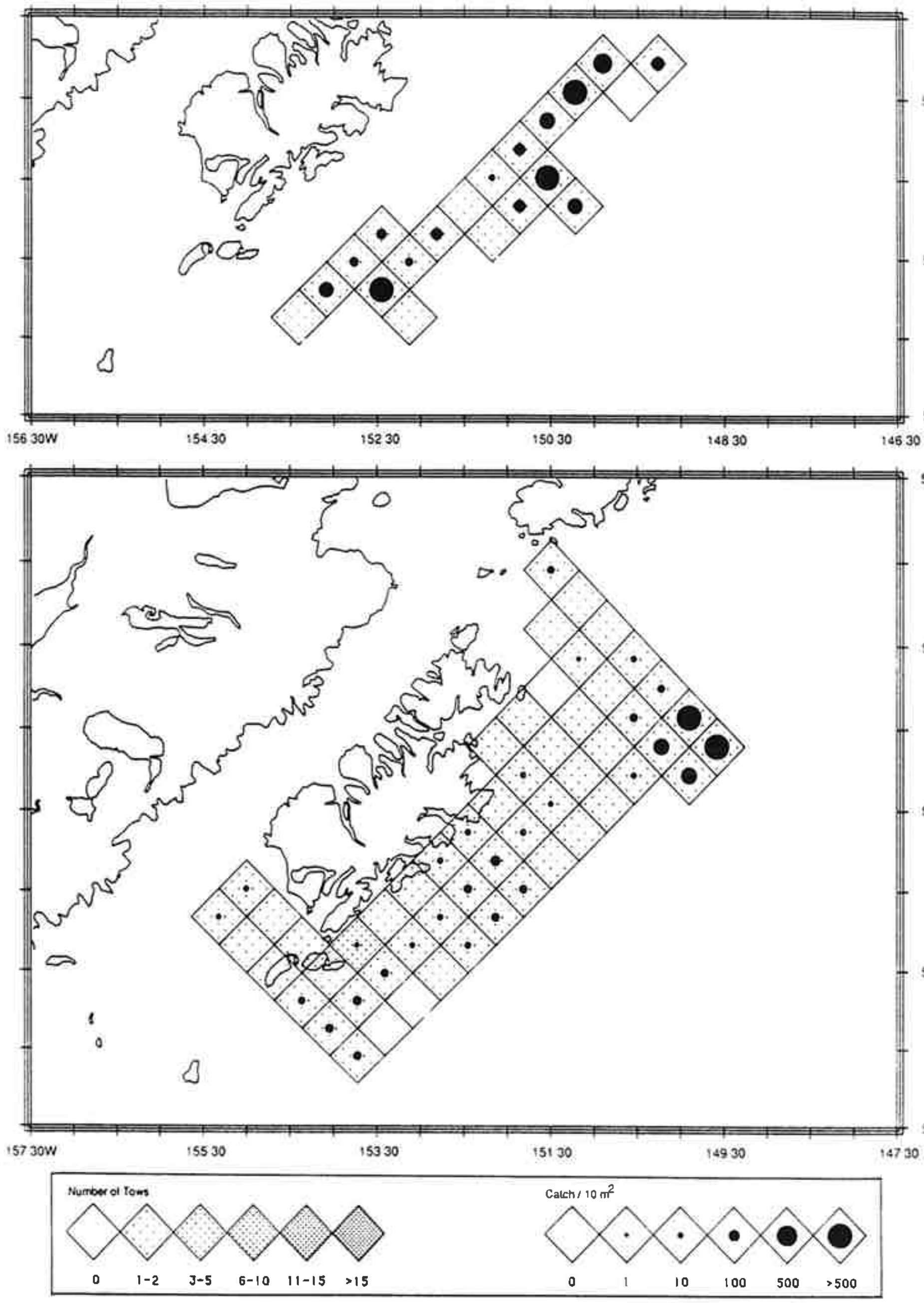
Appendix Figure 55.--Distribution of <u>Bathymaster</u> spp. larvae in neuston tows, A. June 16-30, B. July 1-15 (catch/10 m^2=P^2/2.5281, where P=percentage of width of sector taken up by dot, for catches >500/10 m^2, P=42.8%).



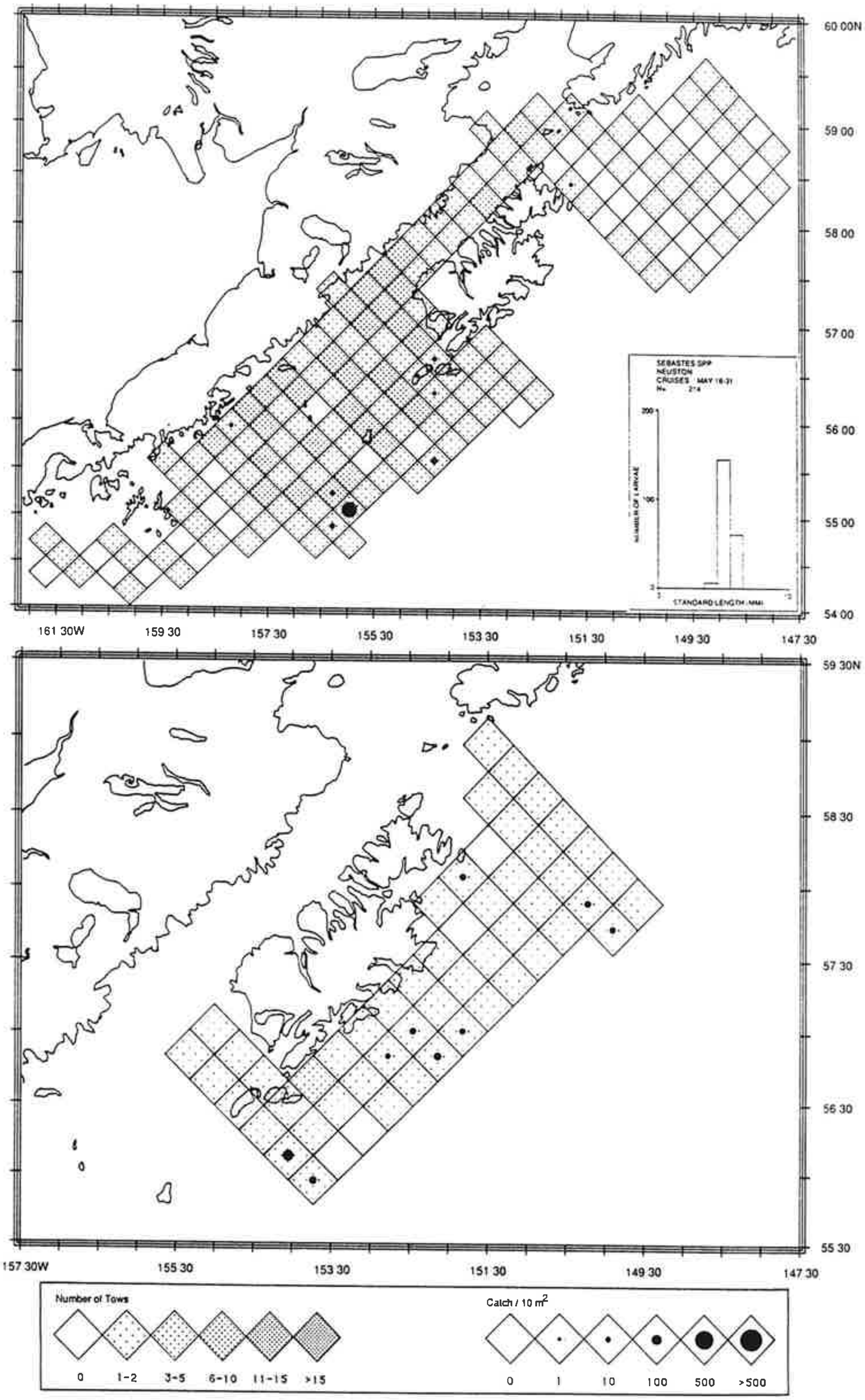
Appendix Figure 56.--Distribution of Sebastes spp. larvae in bongo tows, A. Apr. 1-15, B. Apr. 16-30 (catch/10 m^2=P^2/2.5281, where P=percentage of width of sector taken up by dot, for catches >500/10 m^2, P=42.8%).



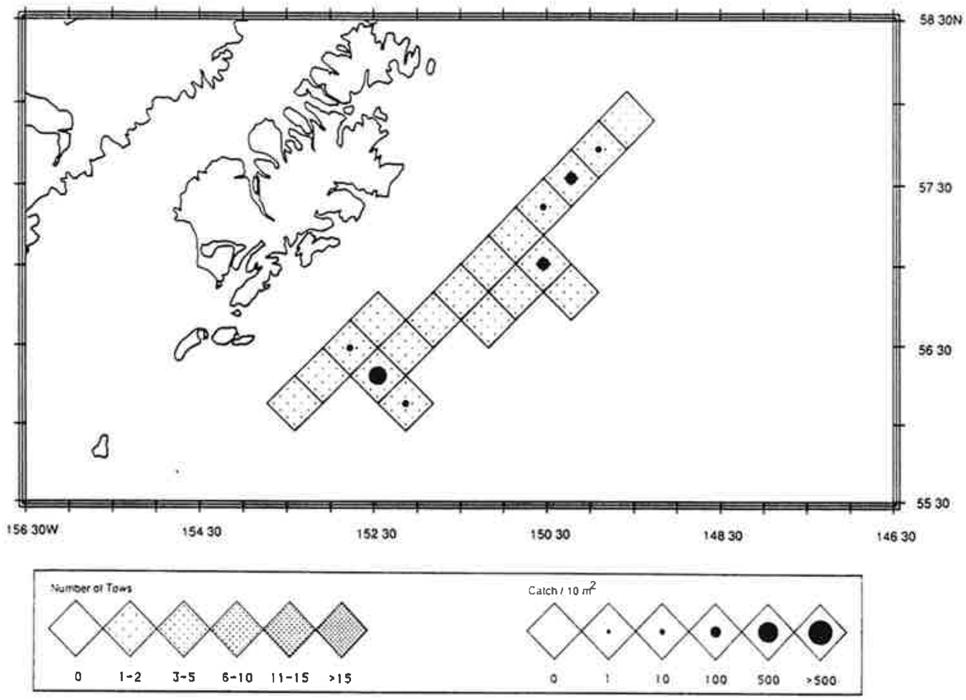
Appendix Figure 57.--Distribution of <u>Sebastes</u> spp. larvae in bongo tows, A. May 16-31, B. June 1-15 (catch/10 $m^2=P^2/2.5281$, where P=percentage of width of sector taken up by dot, for catches >500/10 m^2, P=42.8%).



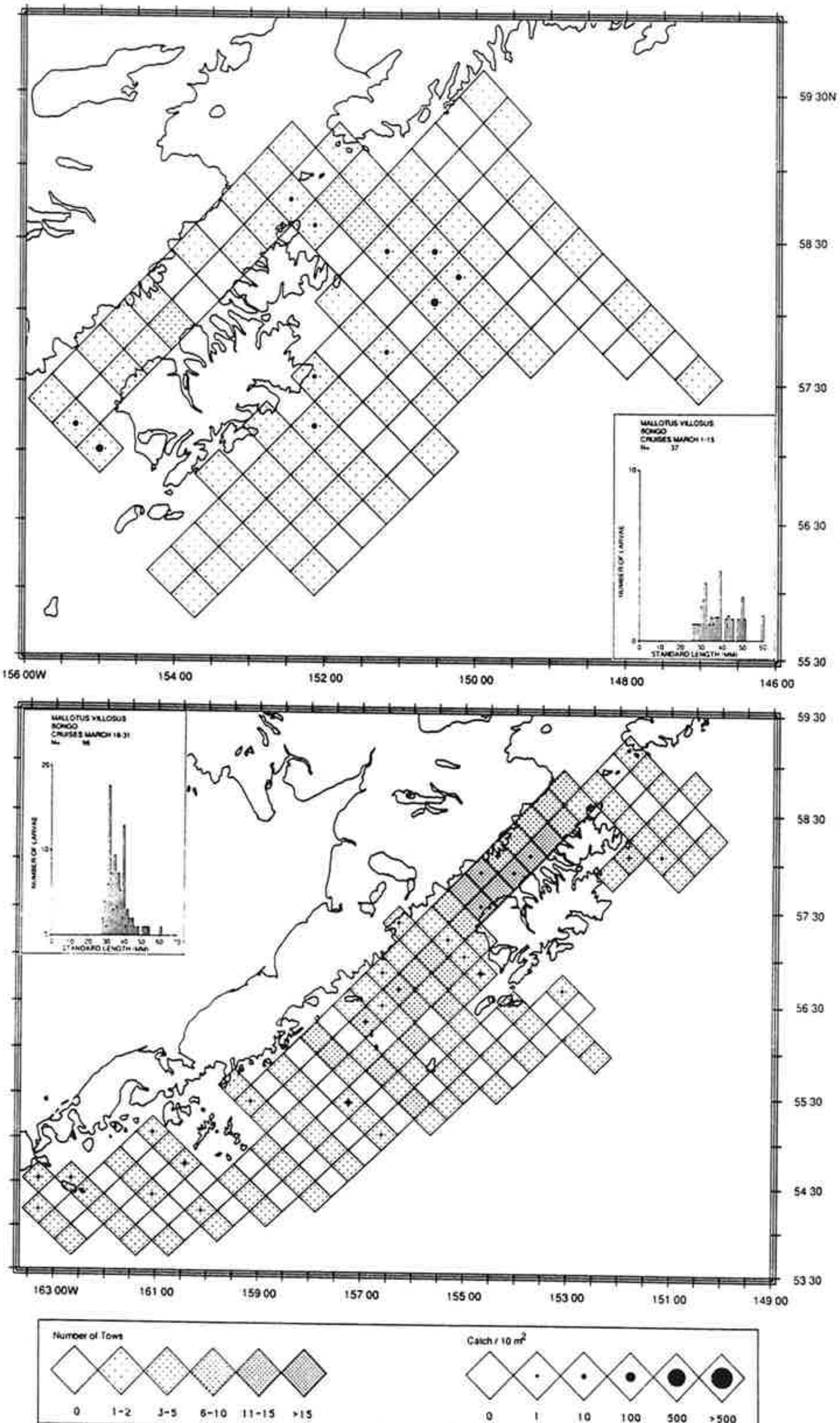
Appendix Figure 58.--Distribution of <u>Sebastes</u> spp. larvae in bongo tows, A. June 16-30, B. July 1-15 (catch/10 m^2=P^2/2.5281, where P=percentage of width of sector taken up by dot, for catches >500/10 m^2, P=42.8%).



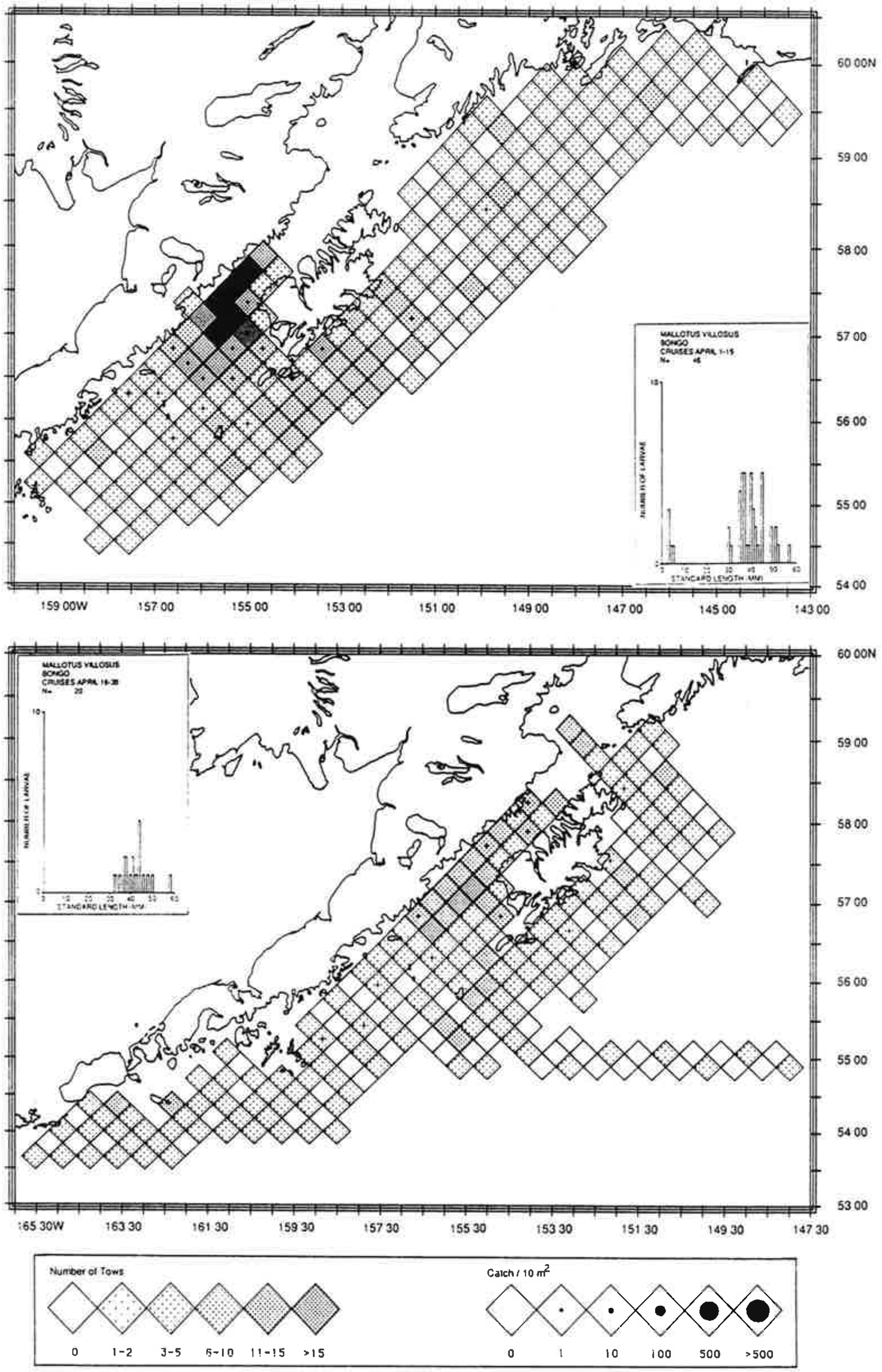
Appendix Figure 59.--Distribution of <u>Sebastes</u> spp. larvae in neuston tows, A. May 16-31, B. June 16-30 (catch/10 m^2=P^2/2.5281, where P=percentage of width of sector taken up by dot, for catches >500/10 m^2, P=42.8%).



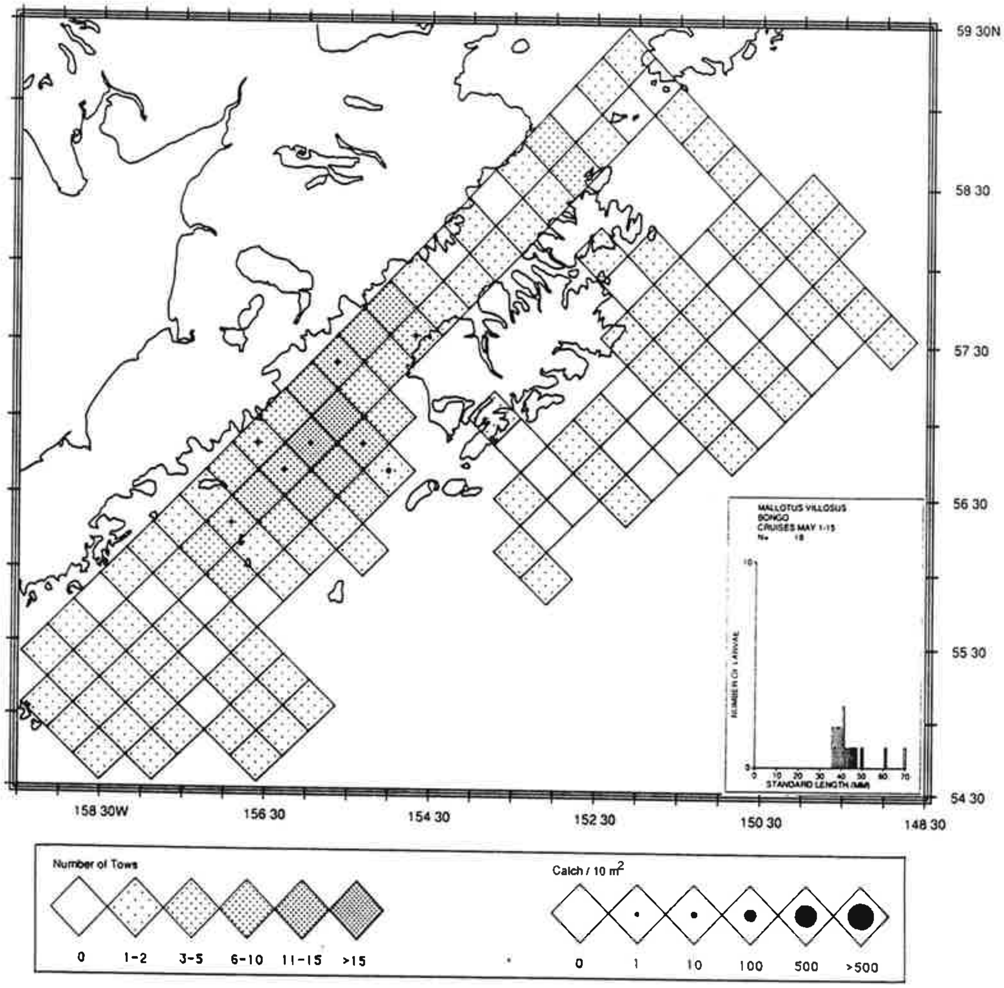
Appendix Figure 60.--Distribution of Sebastes spp. larvae in neuston tows, July 1-15 (catch/10 $m^2 = P^2/2.5281$, where P=percentage of width of sector taken up by dot, for catches >500/10 m^2, P=42.8%).



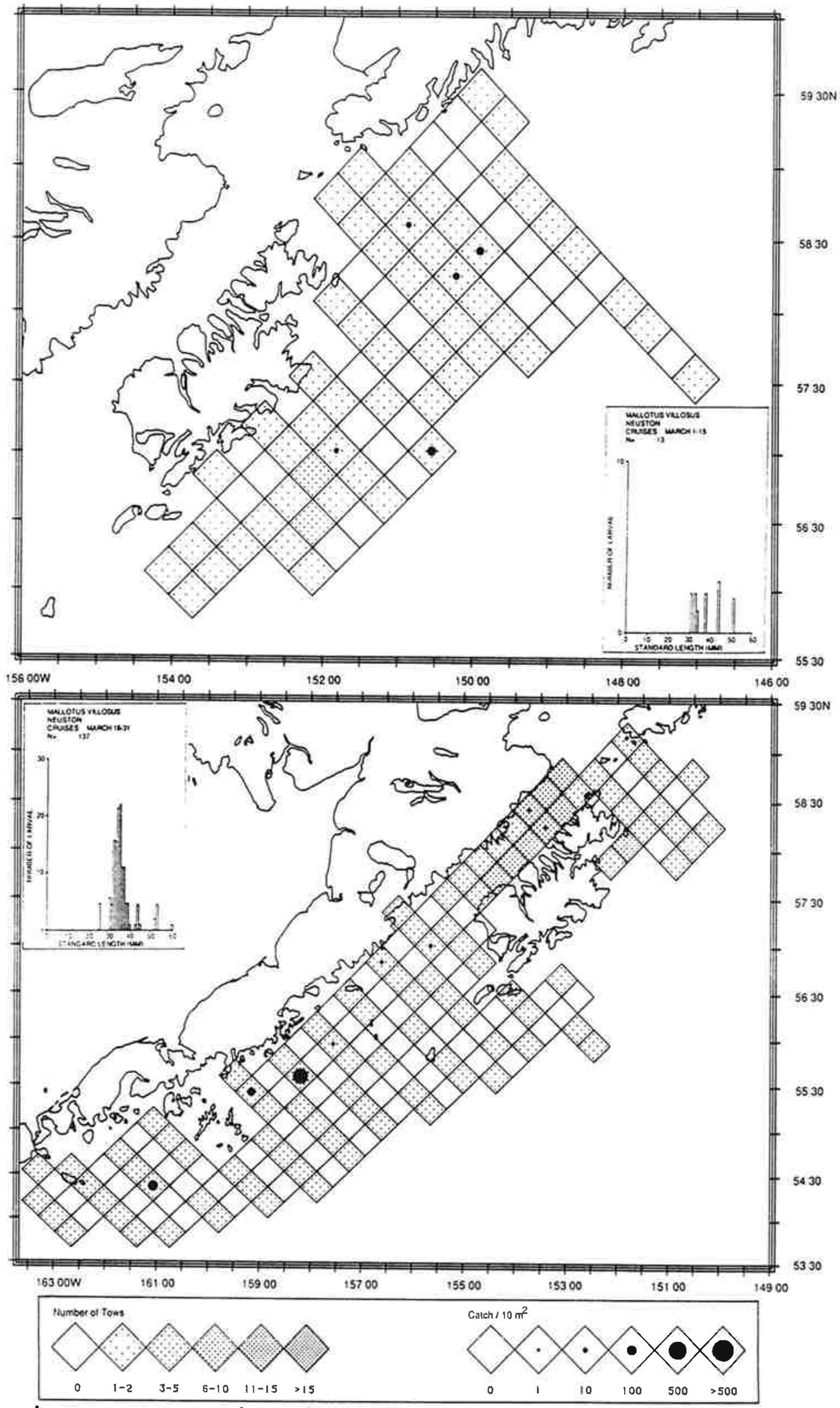
Appendix Figure 61.--Distribution of Mallotus villosus larvae in bongo tows, A. Mar. 1-15, B. Mar. 16-31 (catch/10 $m^2=P^2/2.5281$, where P=percentage of width of sector taken up by dot, for catches >500/10 m^2, P=42.8%).



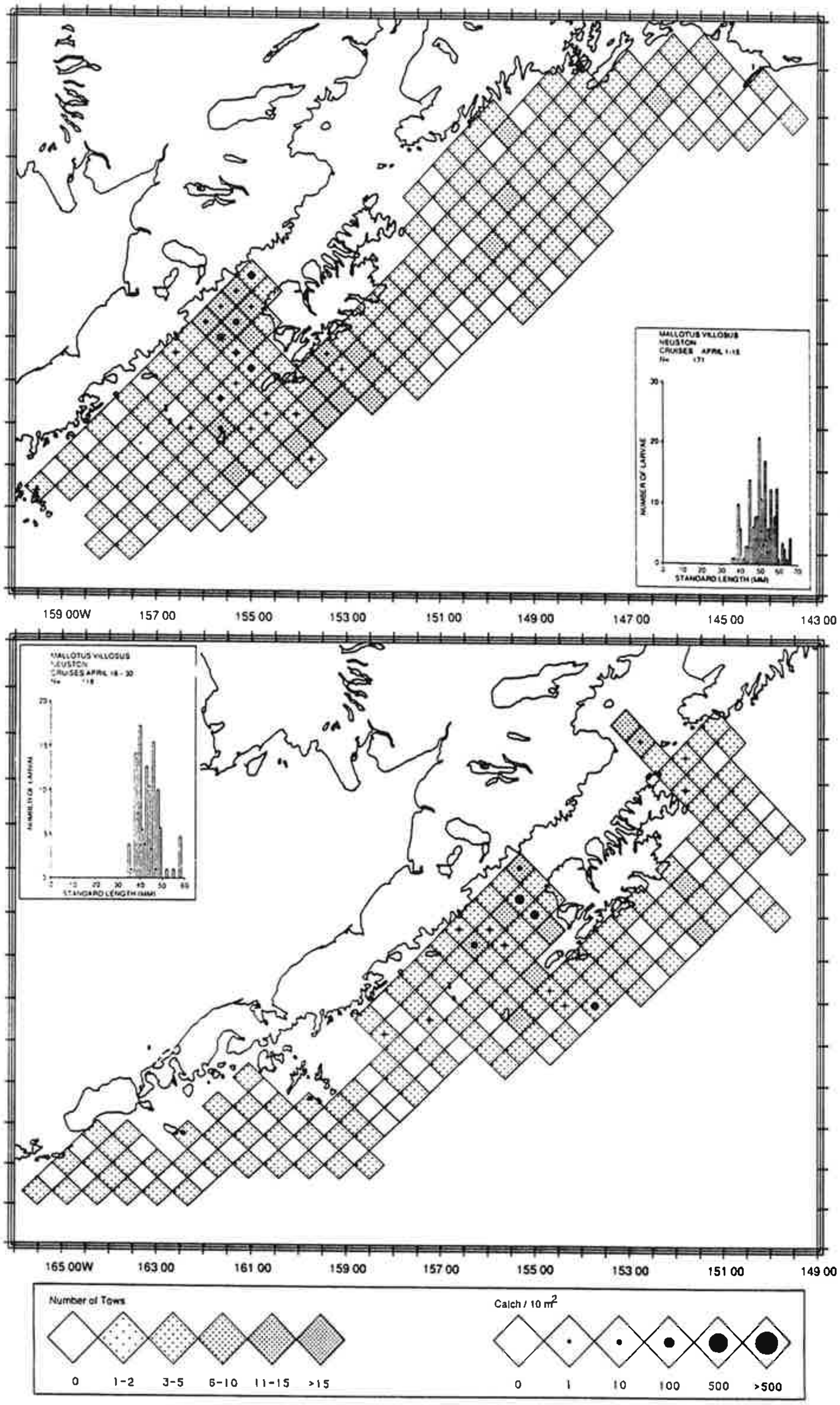
Appendix Figure 62.--Distribution of <u>Mallotus</u> <u>villosus</u> larvae in bongo tows, A. Apr. 1-15, B. Apr. 16-30 (catch/10 m^2=P^2/2.5281, where P=percentage of width of sector taken up by dot, for catches >500/10 m^2, P=42.8%).



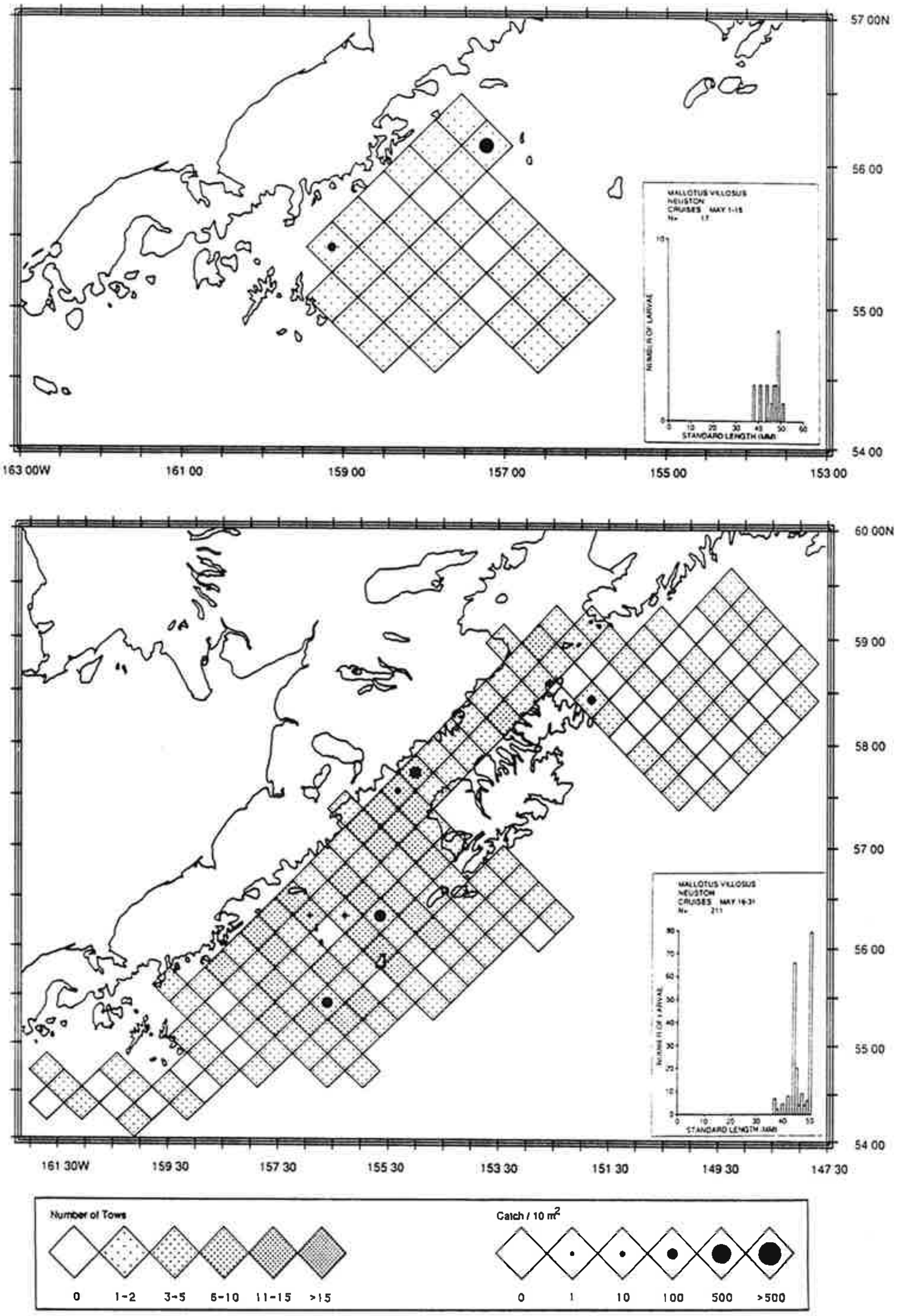
Appendix Figure 63.--Distribution of <u>Mallotus</u> <u>villosus</u> larvae in bongo tows, May 1-15 (catch/10 m^2=P^2/2.5281, where P=percentage of width of sector taken up by dot, for catches >500/10 m^2, P=42.8%).



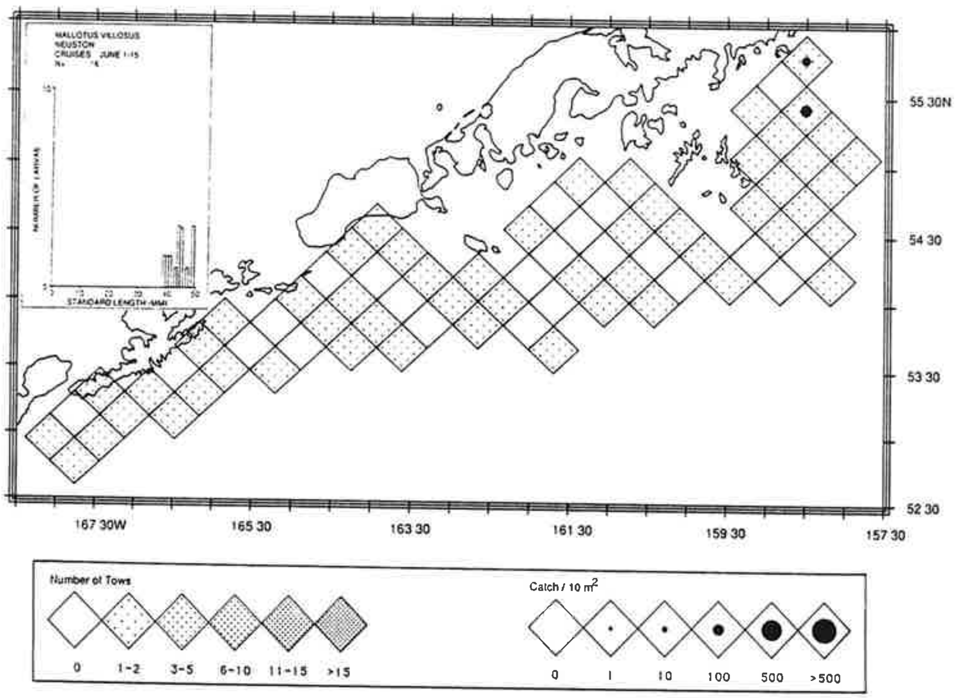
Appendix Figure 64.--Distribution of Mallotus villosus larvae in neuston tows, A. Mar. 1-15, B. Mar. 16-31 (catch/10 m^2=P^2/2.5281, where P=percentage of width of sector taken up by dot, for catches >500/10 m^2, P=42.8%).



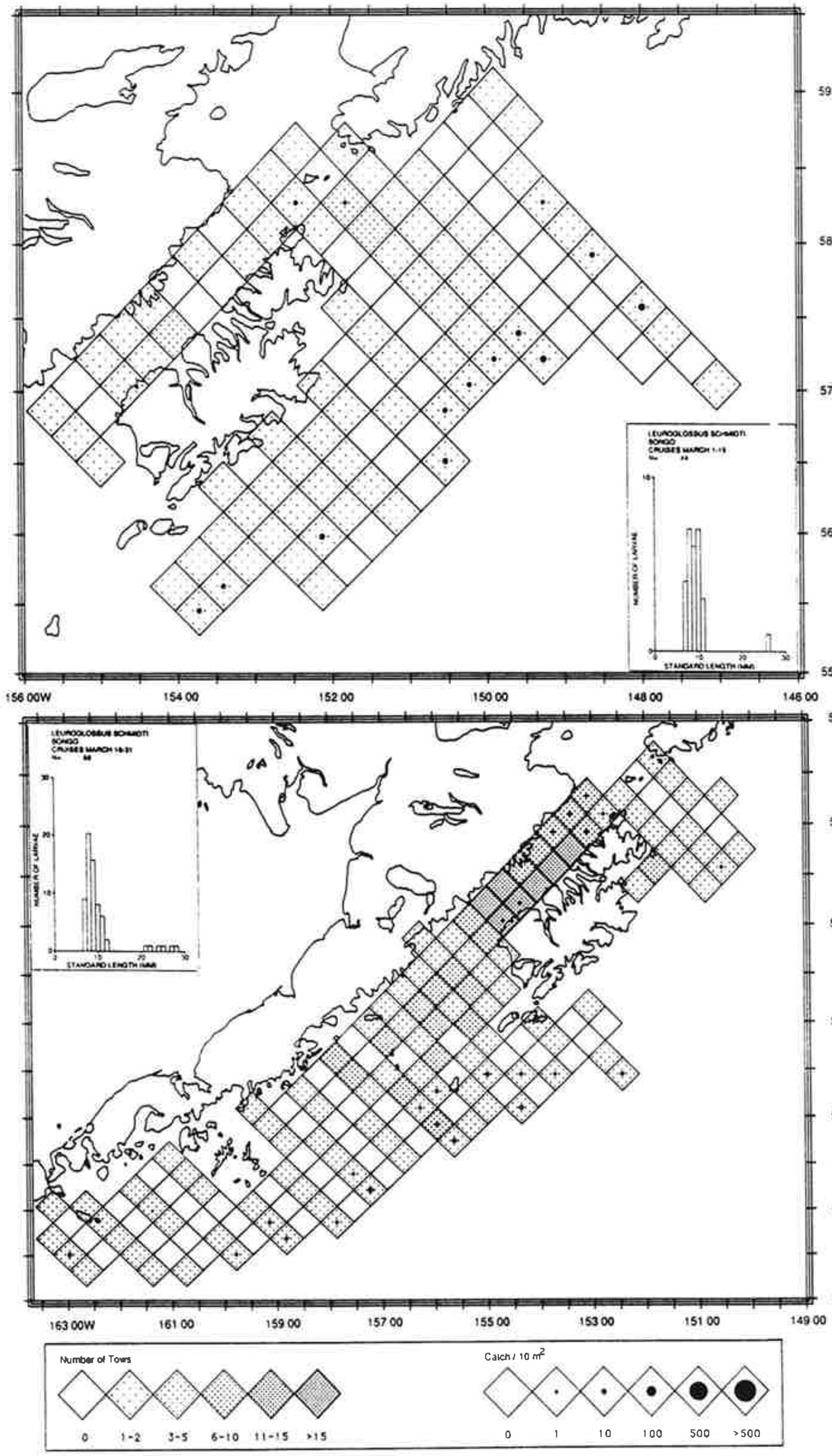
Appendix Figure 65.--Distribution of Mallotus villosus larvae in neuston tows, A. Apr. 1-15, B. Apr. 16-30 (catch/10 m^2=P^2/2.5281, where P=percentage of width of sector taken up by dot, for catches >500/10 m^2, P=42.8%).



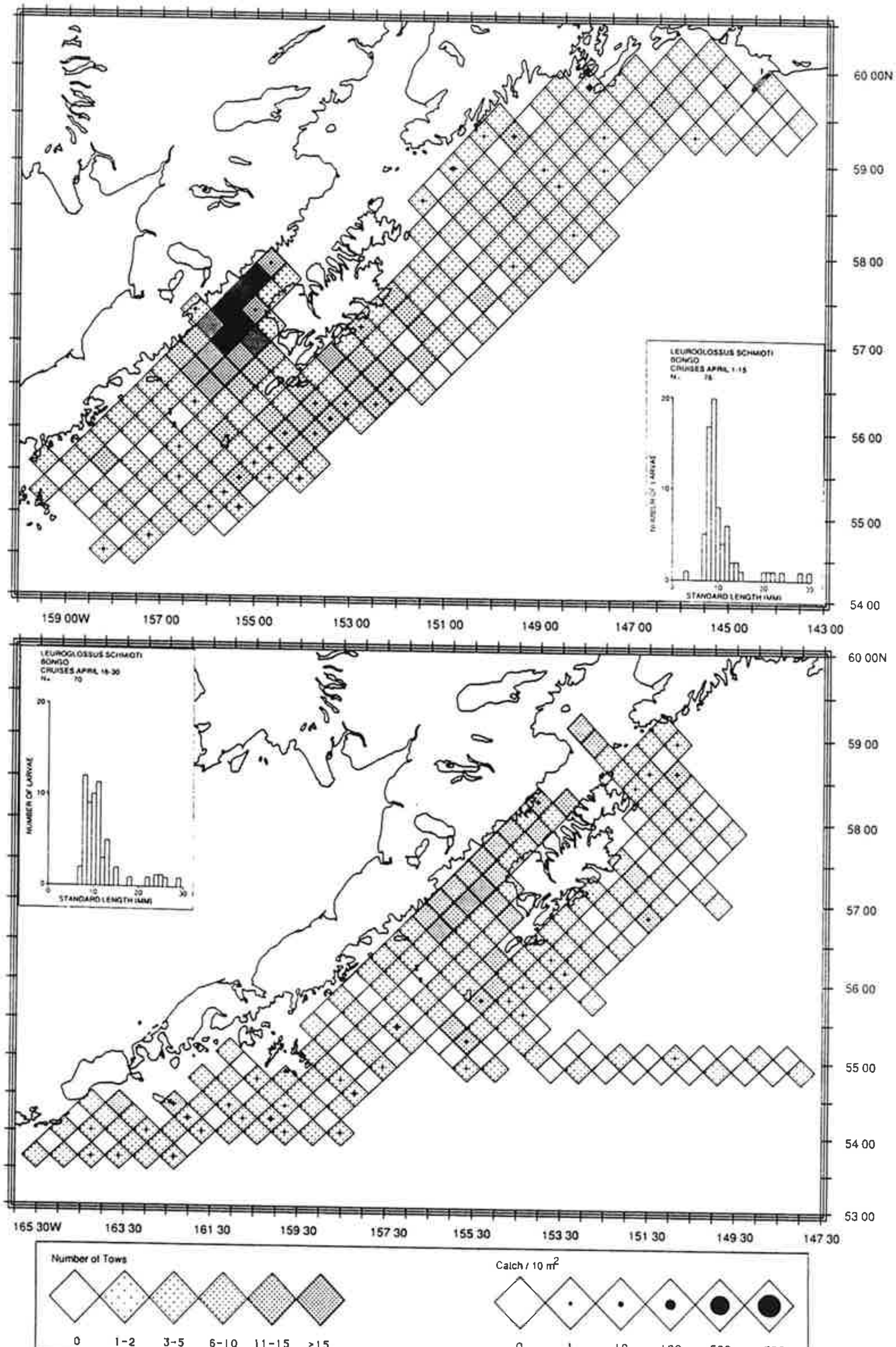
Appendix Figure 66.--Distribution of Mallotus villosus larvae in neuston tows, A. May 1-15, B. May 16-31 (catch/10 m^2=P^2/2.5281, where P=percentage of width of sector taken up by dot, for catches >500/10 m^2, P=42.8%).



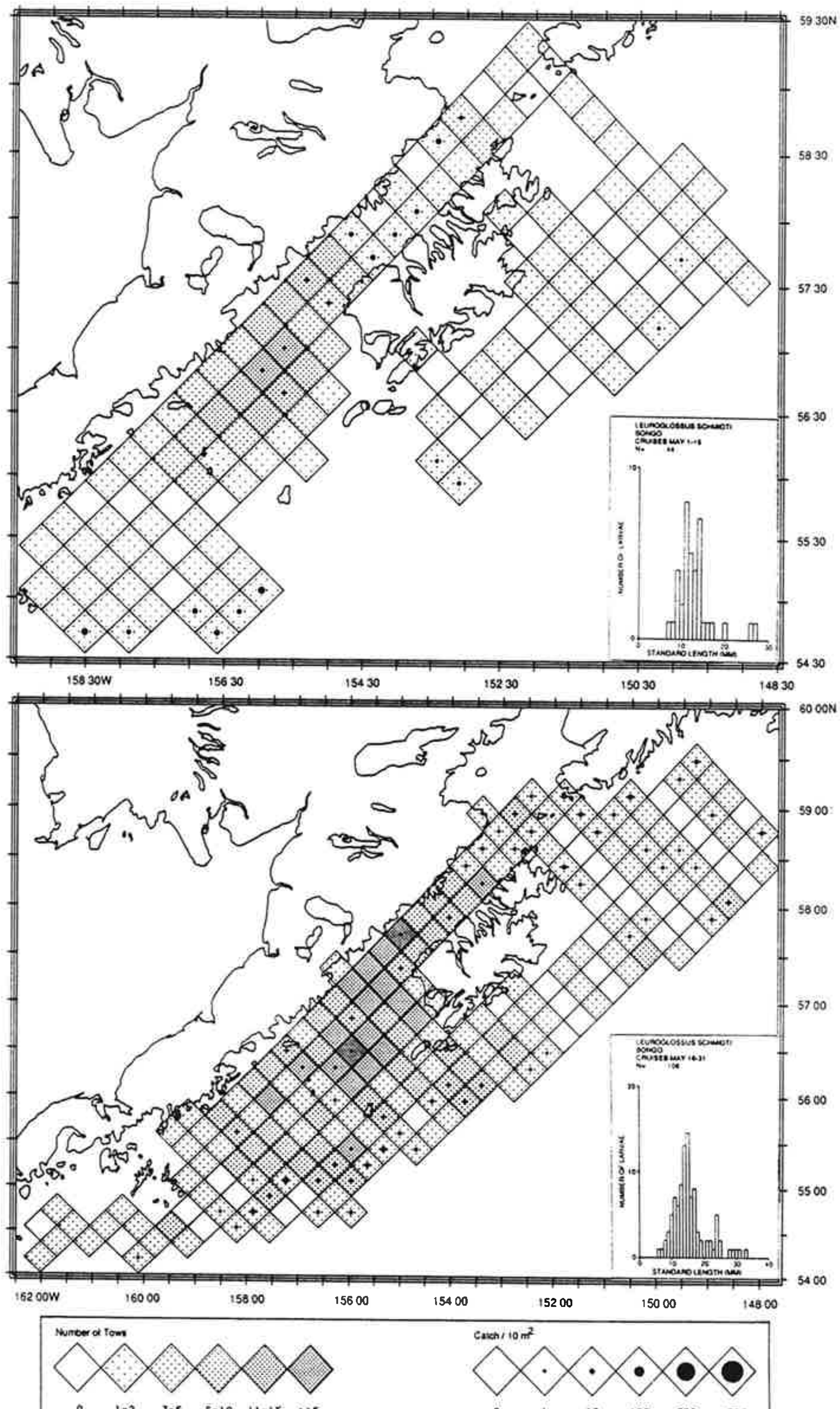
Appendix Figure 67.--Distribution of Mallotus villosus larvae in neuston tows, June 1-15 (catch/10 $m^2=P^2/2.5281$, where P=percentage of width of sector taken up by dot, for catches >500/10 m^2, P=42.8%).



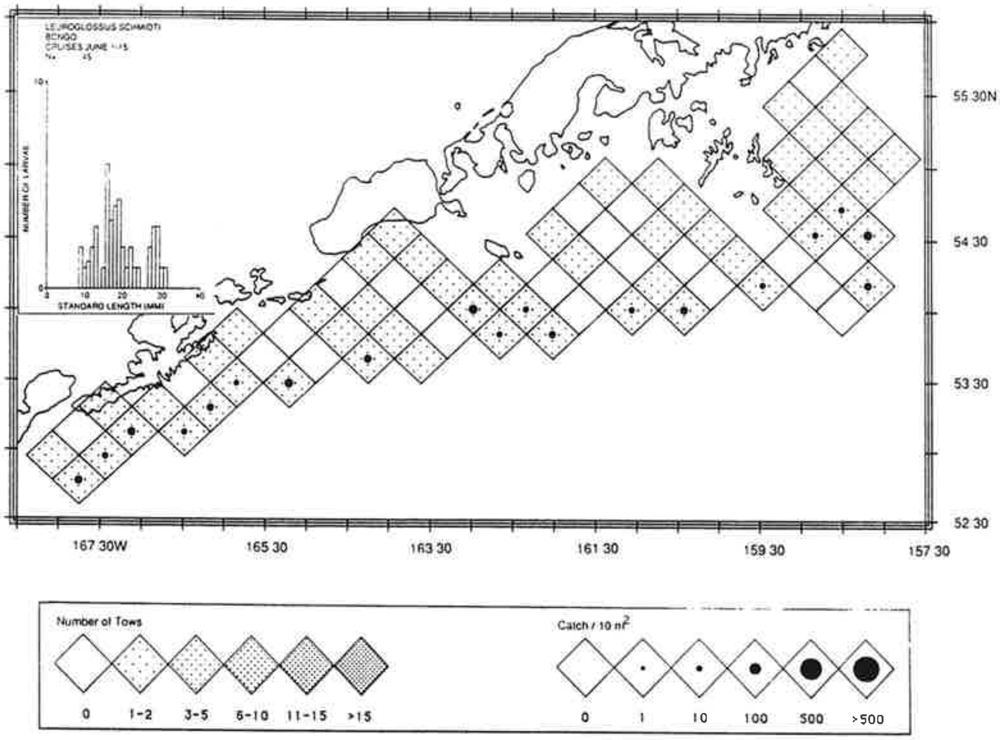
Appendix Figure 68.--Distribution of Leuroglossus schmidti larvae in bongo tows, A. Mar. 1-15, B. Mar. 16-31 (catch/10 m^2=P^2/2.5281, where P=percentage of width of sector taken up by dot, for catches >500/10 m^2, P=42.8%).



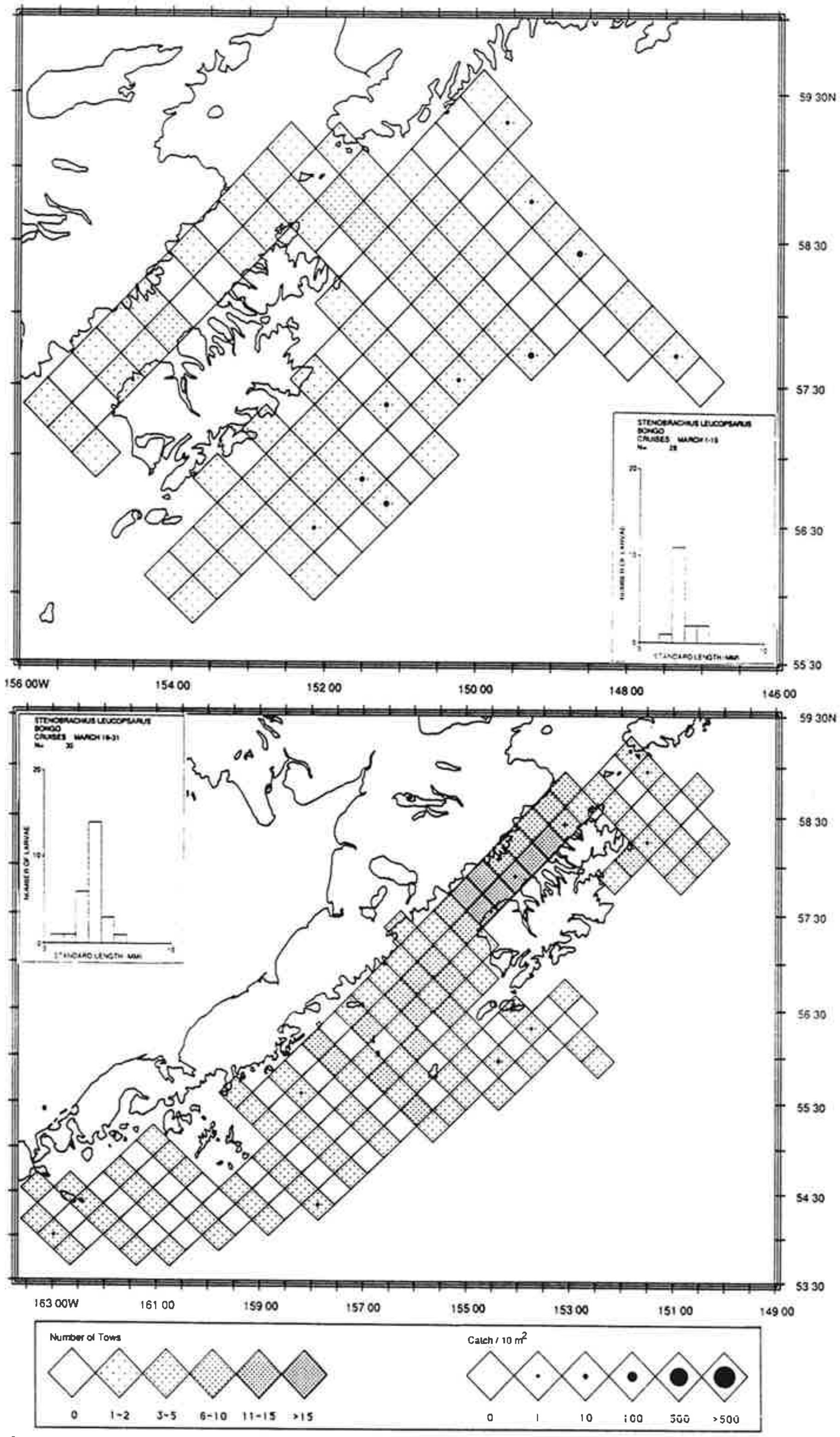
Appendix Figure 69.--Distribution of <u>Leuroglossus</u> <u>schmidti</u> larvae in bongo tows, A. Apr. 1-15, B. Apr. 16-30 (catch/10 $m^2=P^2/2.5281$, where P=percentage of width of sector taken up by dot, for catches >500/10 m^2, P=42.8%).



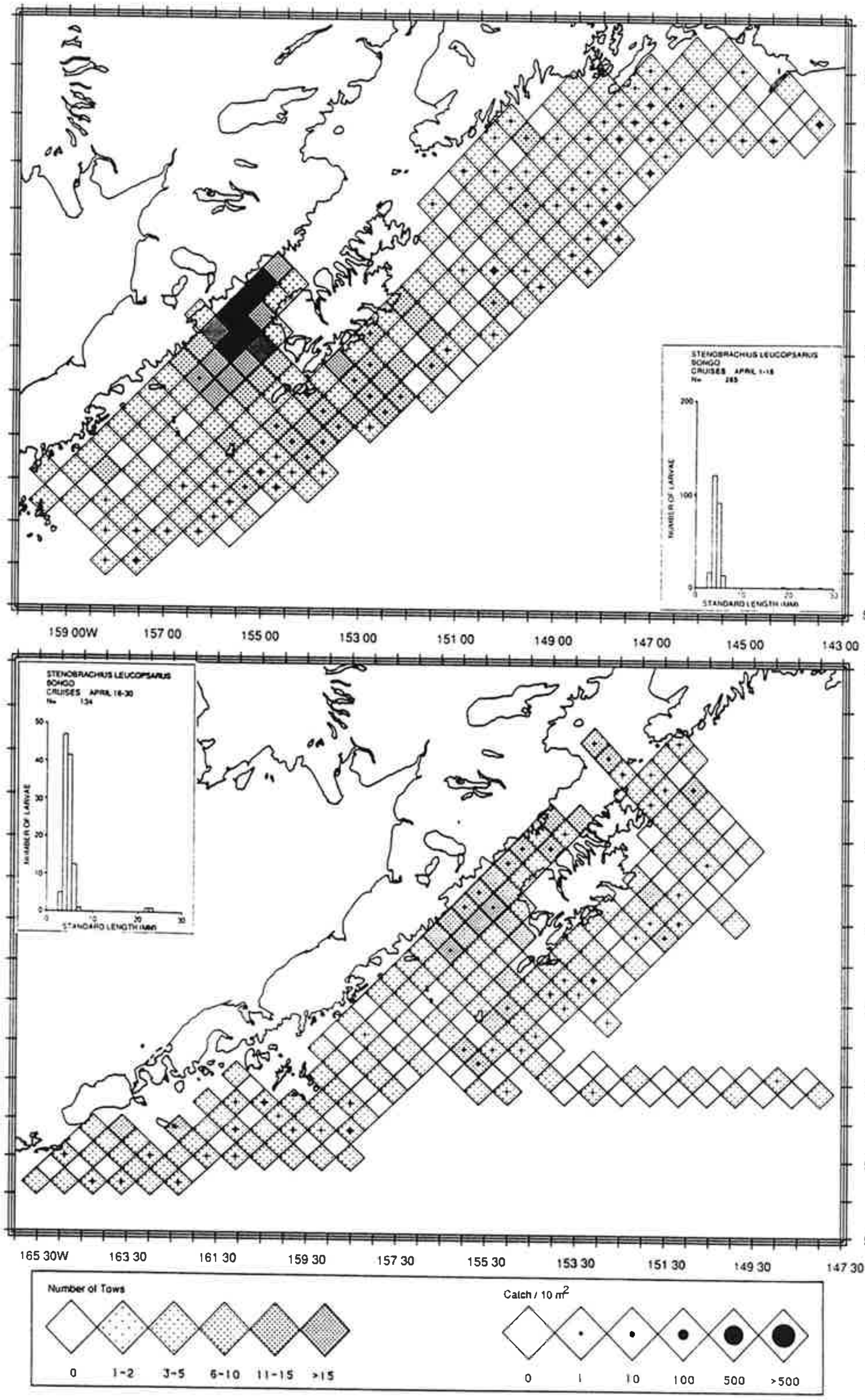
Appendix Figure 70.--Distribution of <u>Leuroglossus</u> <u>schmidti</u> larvae in bongo tows, A. May 1-15, B. May 16-31 (catch/10 $m^2=P^2/2.5281$, where P=percentage of width of sector taken up by dot, for catches >500/10 m^2, P=42.8%).



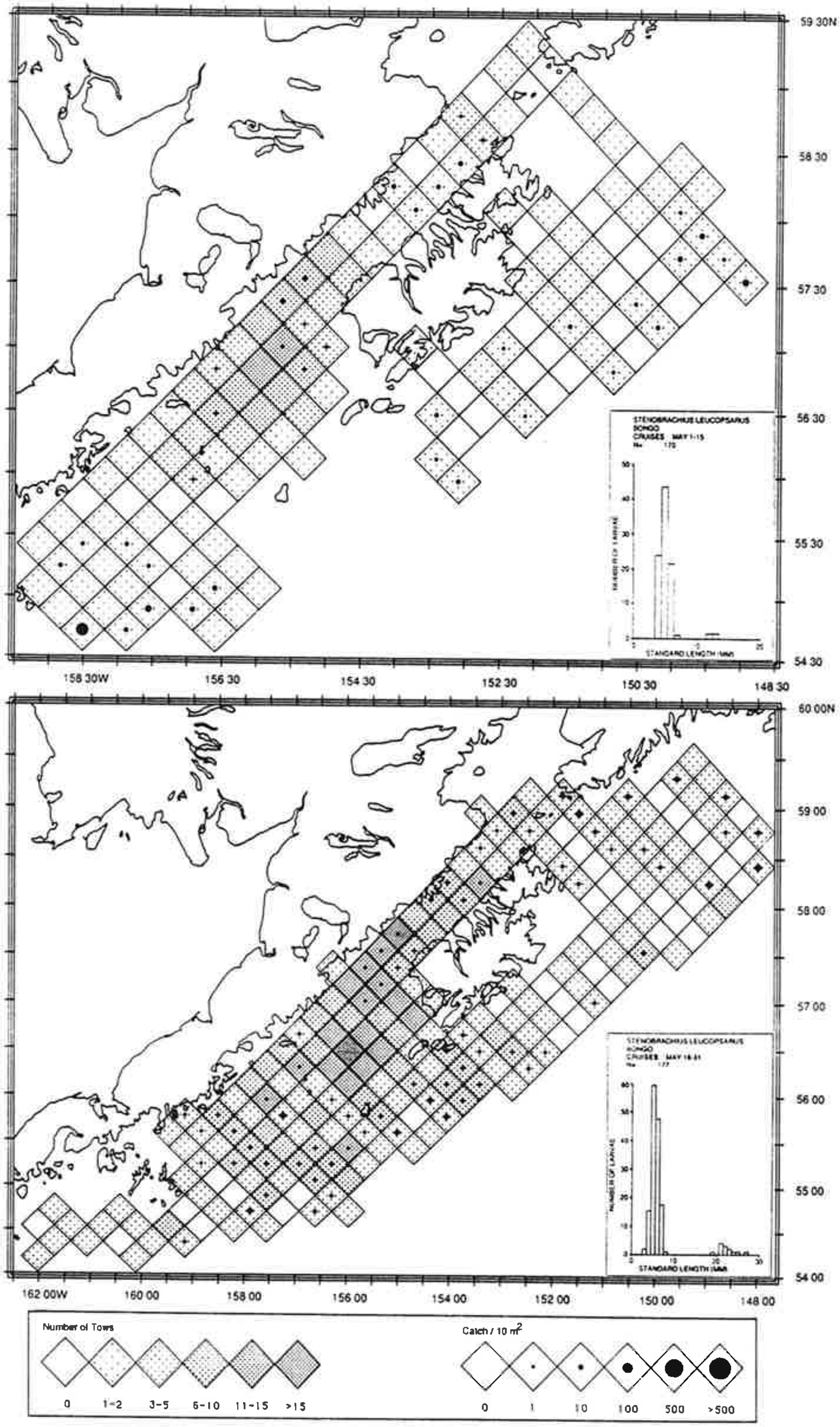
Appendix Figure 71.--Distribution of Leuroglossus schmidti larvae in bongo tows, June 1-15 (catch/10 $m^2=P^2/2.5281$, where P=percentage of width of sector taken up by dot, for catches >500/10 m^2, P=42.8%).



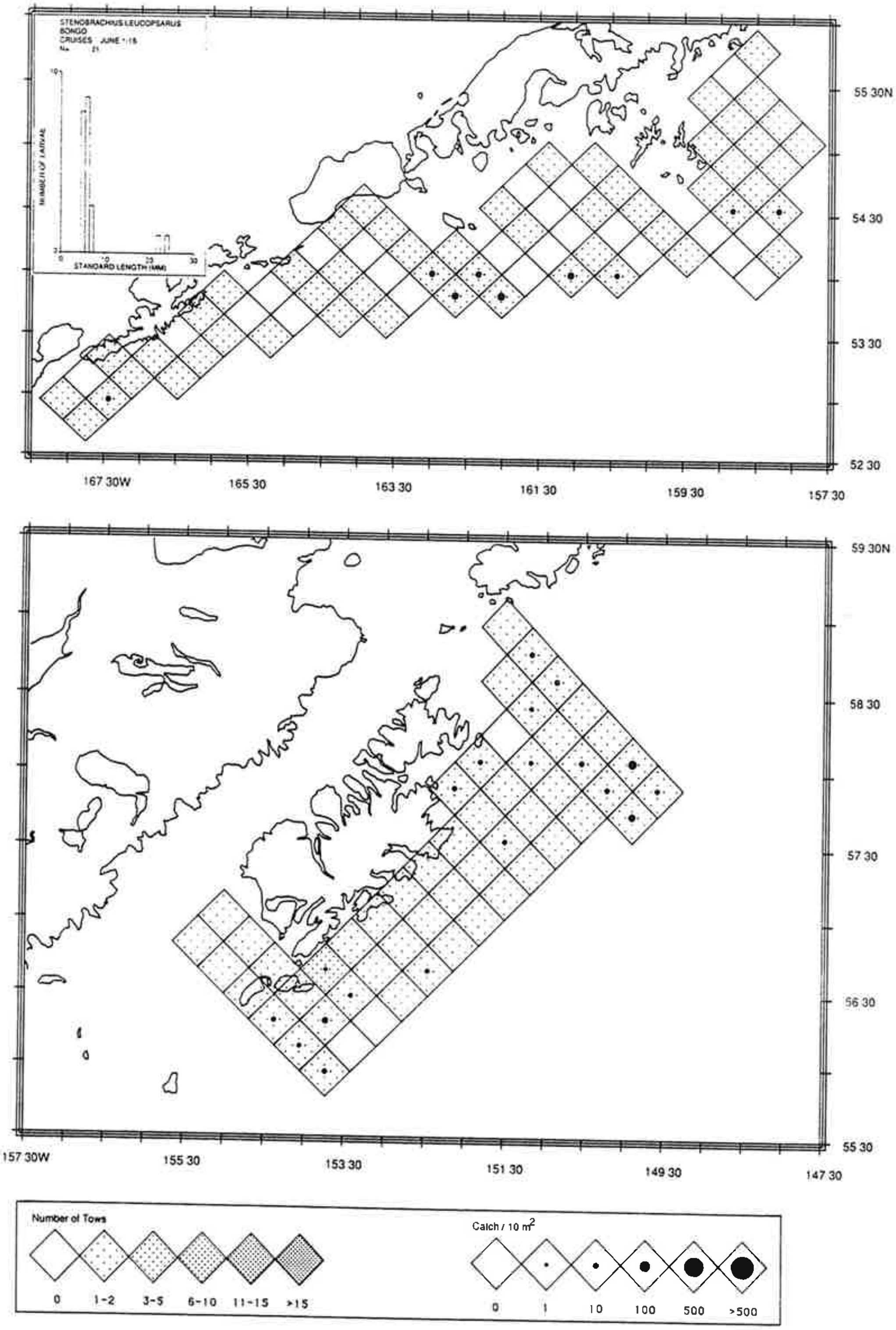
Appendix Figure 72.--Distribution of <u>Stenobrachius</u> <u>leucopsarus</u> larvae in bongo tows, A. Mar. 1-15, B. Mar. 16-31 (catch/10 $m^2=P^2/2.5281$, where P=percentage of width of sector taken up by dot, for catches >500/10 m^2, P=42.8%).



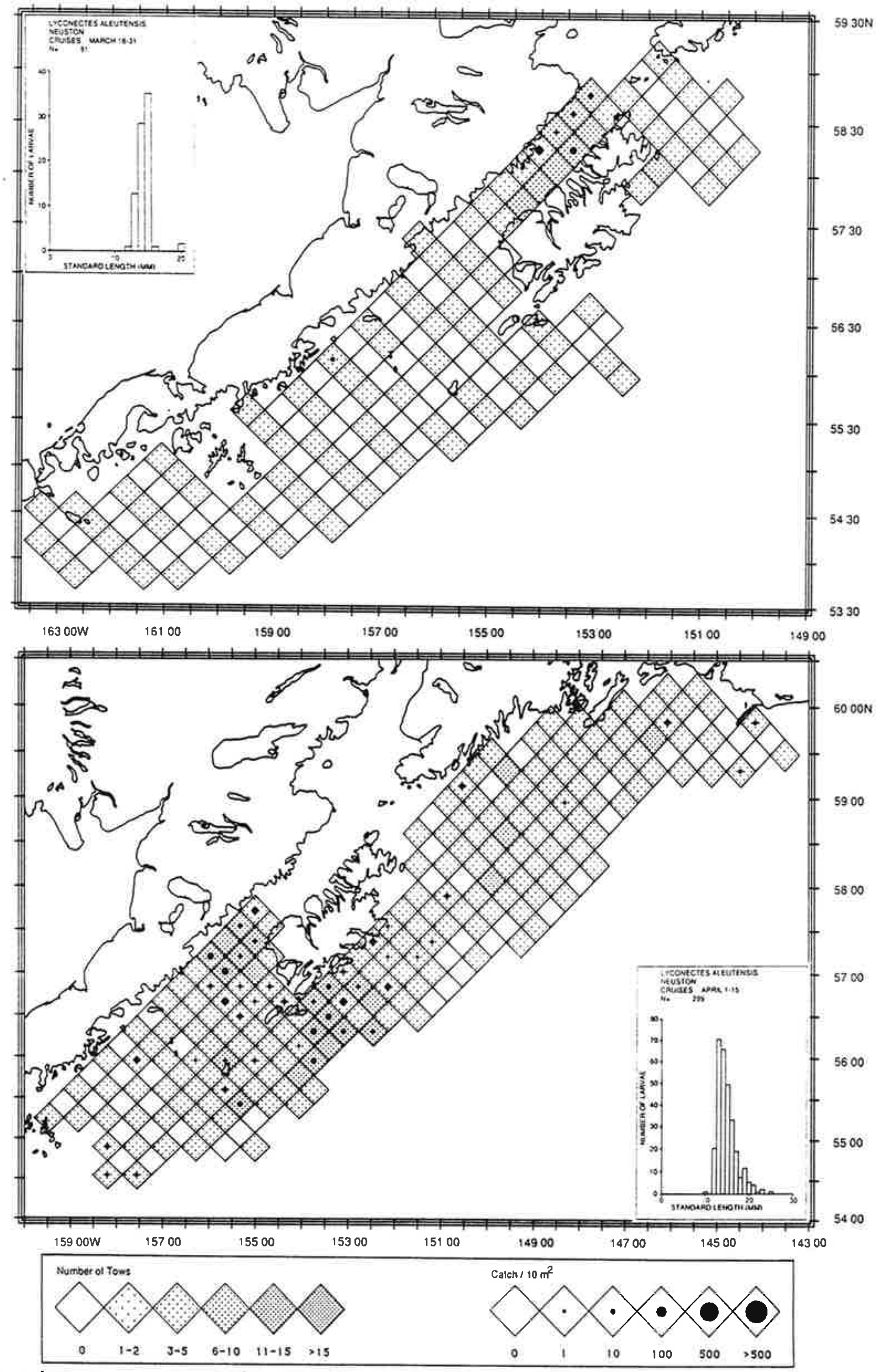
Appendix Figure 73.--Distribution of <u>Stenobrachius</u> <u>leucopsarus</u> larvae in bongo tows, A. Apr. 1-15, B. Apr. 16-30 (catch/10 m^2=P^2/2.5281, where P=percentage of width of sector taken up by dot, for catches >500/10 m^2, P=42.8%).



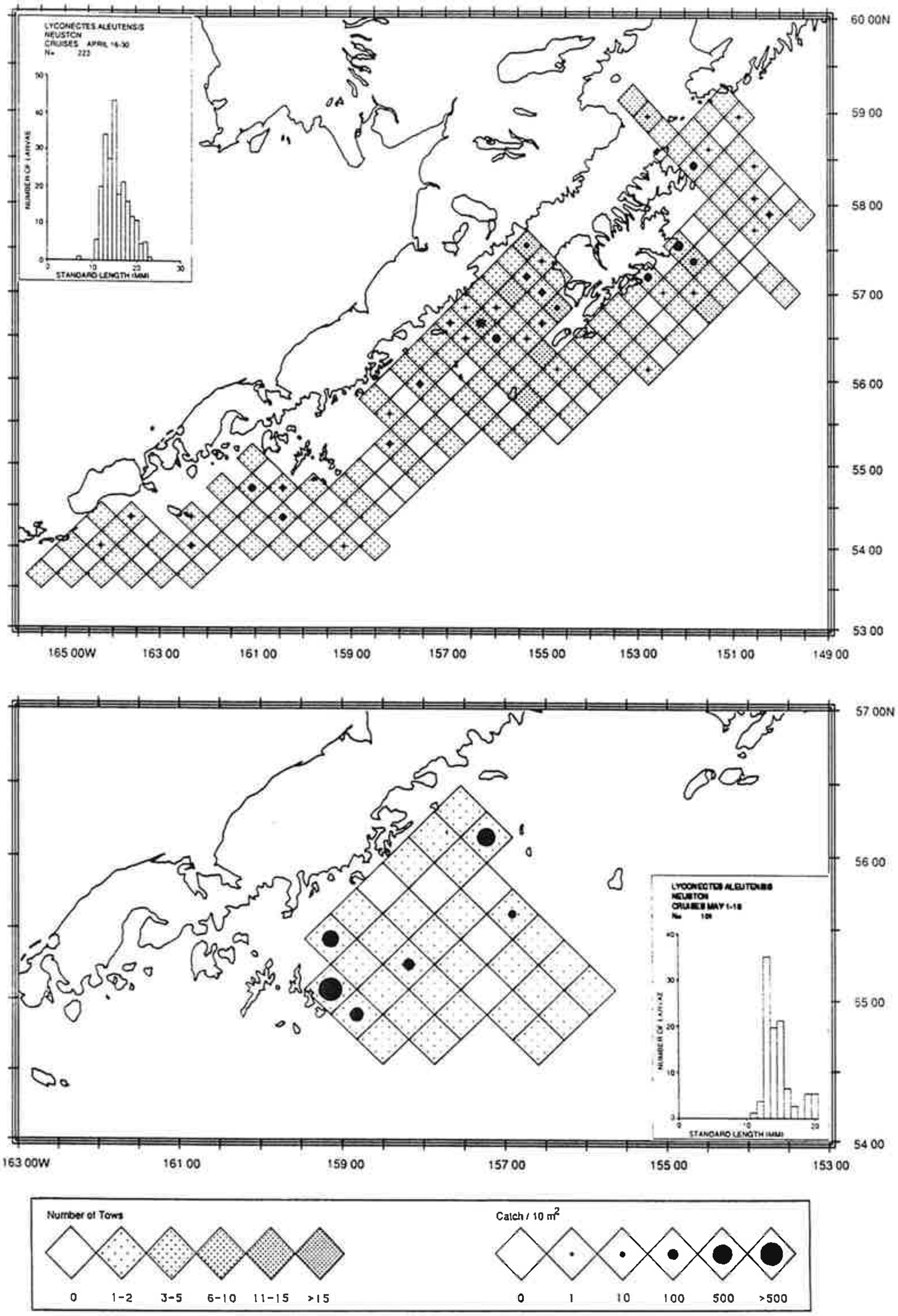
Appendix Figure 74.--Distribution of <u>Stenobrachius leucopsarus</u> larvae in bongo tows, A. May 1-15, B. May 16-31 (catch/10 m^2=P^2/2.5281, where P=percentage of width of sector taken up by dot, for catches >500/10 m^2, P=42.8%).



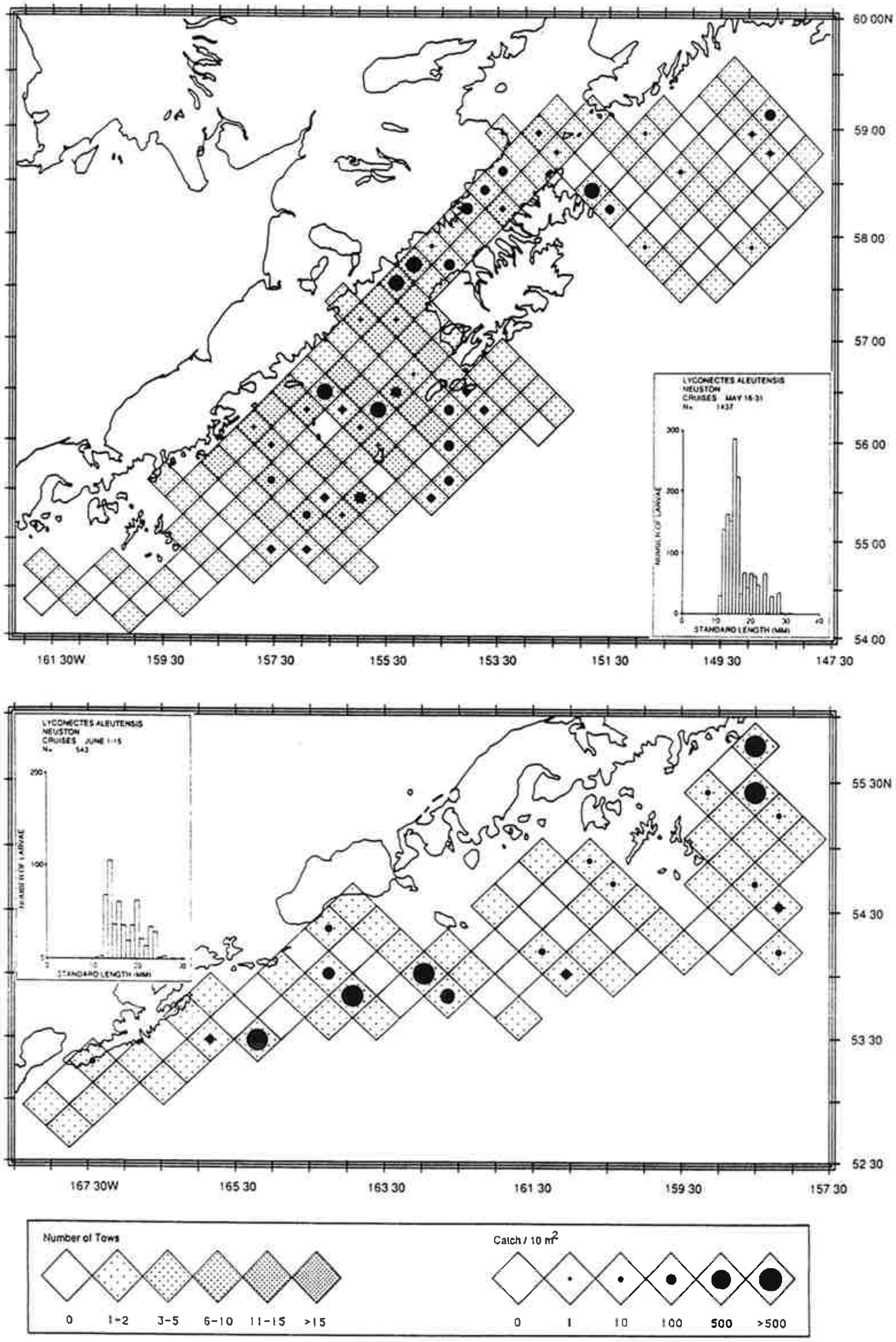
Appendix Figure 75.--Distribution of <u>Stenobrachius</u> <u>leucopsarus</u> larvae in bongo tows, A. June 1-15, B. June 16-30 (catch/10 m^2=P^2/2.5281, where P=percentage of width of sector taken up by dot, for catches >500/10 m^2, P=42.8%).



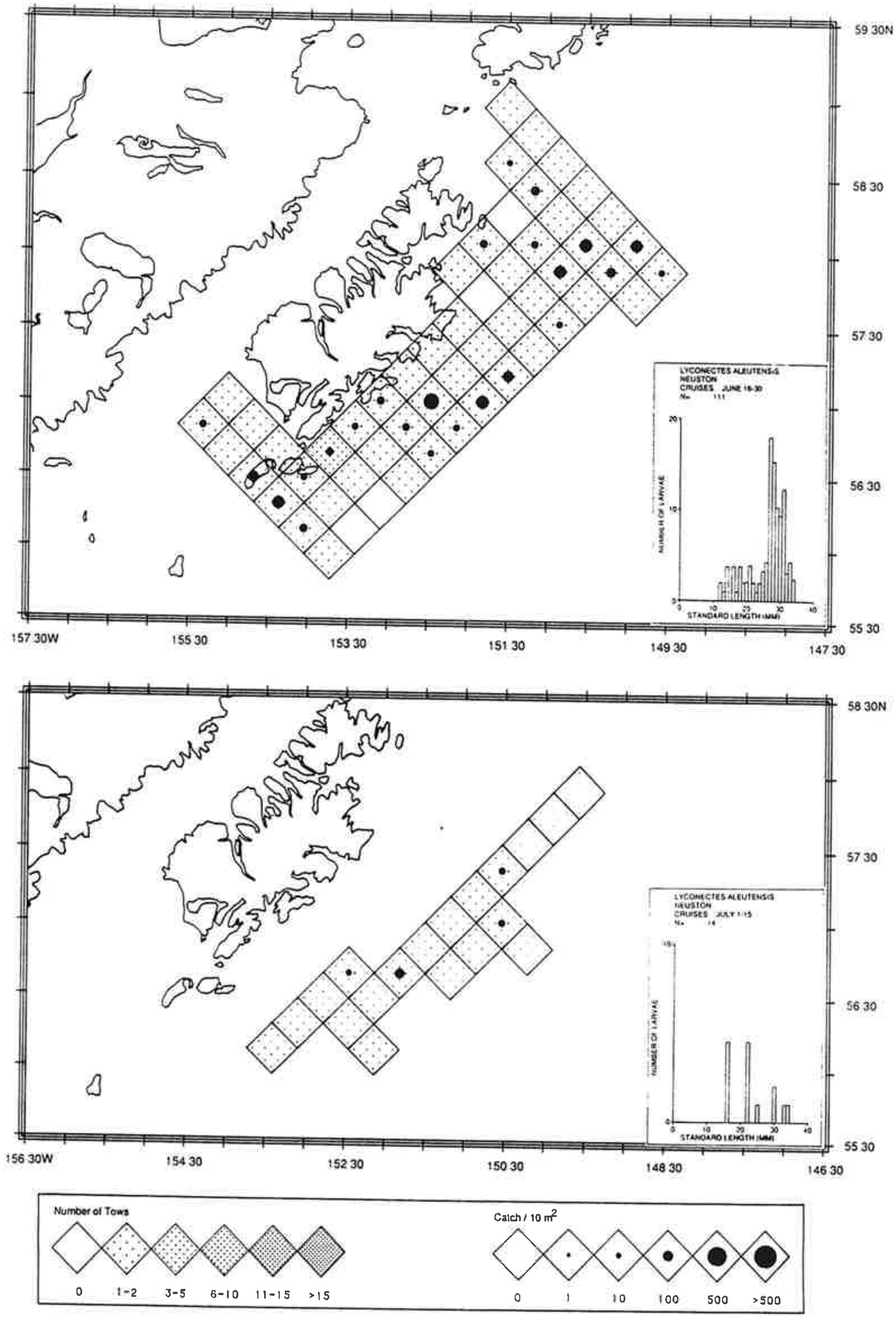
Appendix Figure 76.--Distribution of Lyconectes aleutensis larvae in neuston tows, A. Mar. 16-31, B. Apr. 1-15 (catch/10 m^2=P^2/2.5281, where P=percentage of width of sector taken up by dot, for catches >500/10 m^2, P=42.8%).



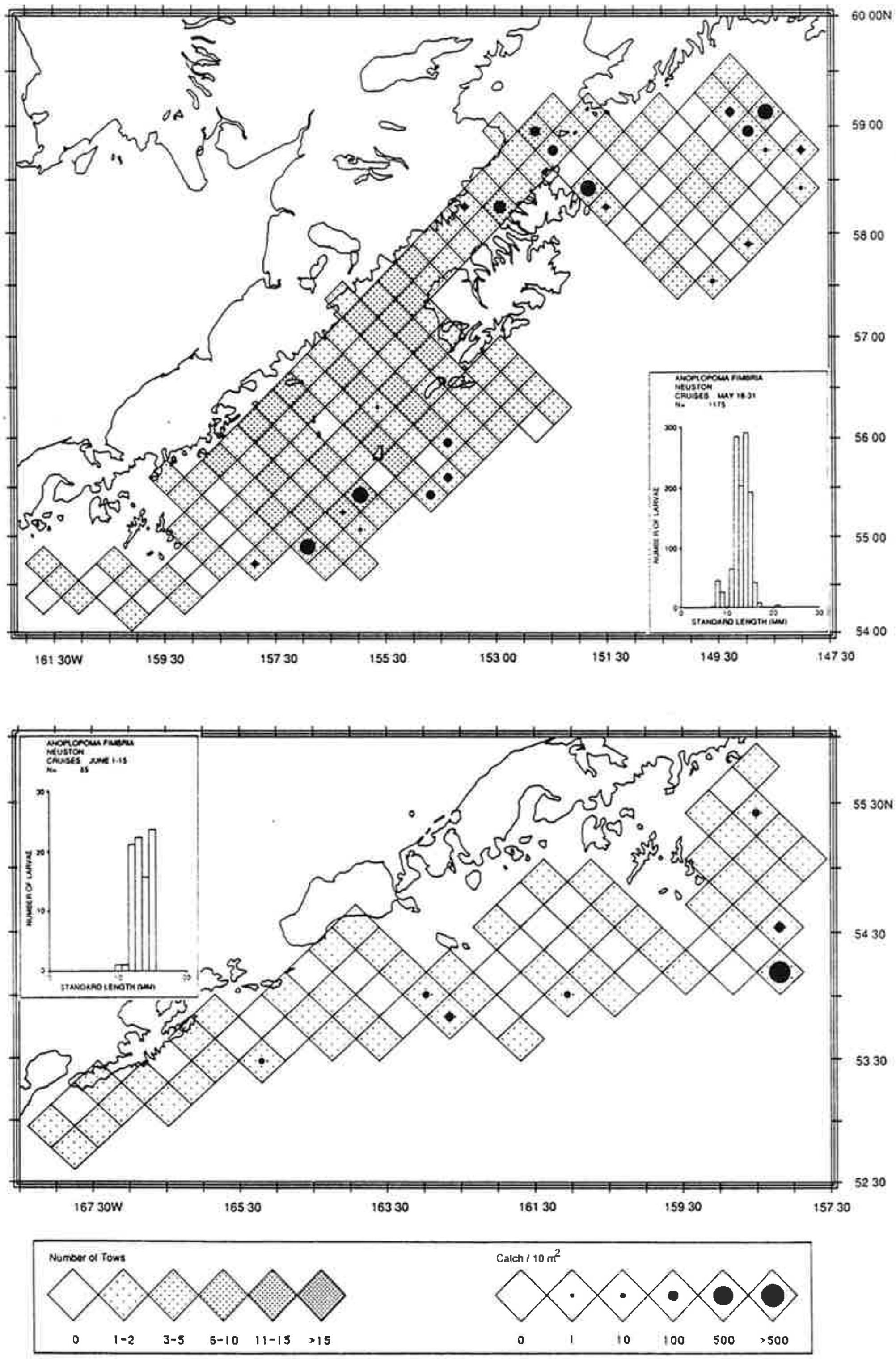
Appendix Figure 77.--Distribution of Lyconectes aleutensis larvae in neuston tows, A. Apr. 16-30, B. May 1-15 (catch/10 $m^2=P^2/2.5281$, where P=percentage of width of sector taken up by dot, for catches >500/10 m^2, P=42.8%).



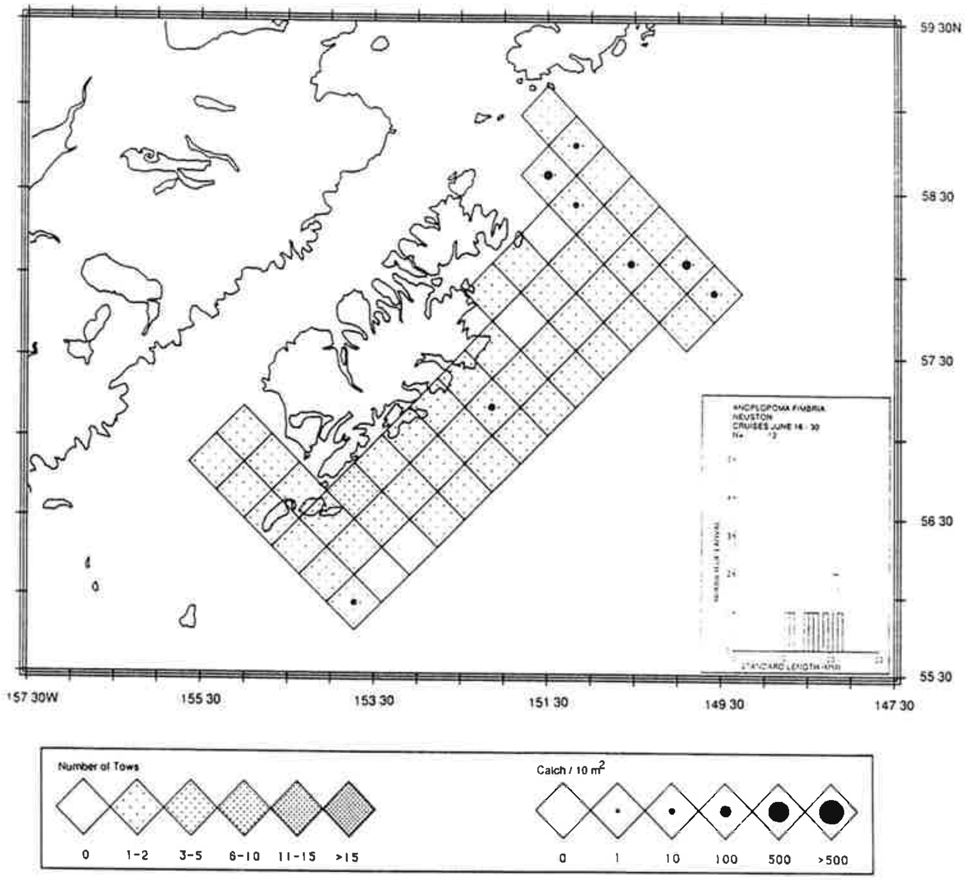
Appendix Figure 78.--Distribution of <u>Lyconectes</u> <u>aleutensis</u> larvae in neuston tows, A. May 16-31, B. June 1-15 (catch/10 m^2=P^2/2.5281, where P=percentage of width of sector taken up by dot, for catches >500/10 m^2, P=42.8%).



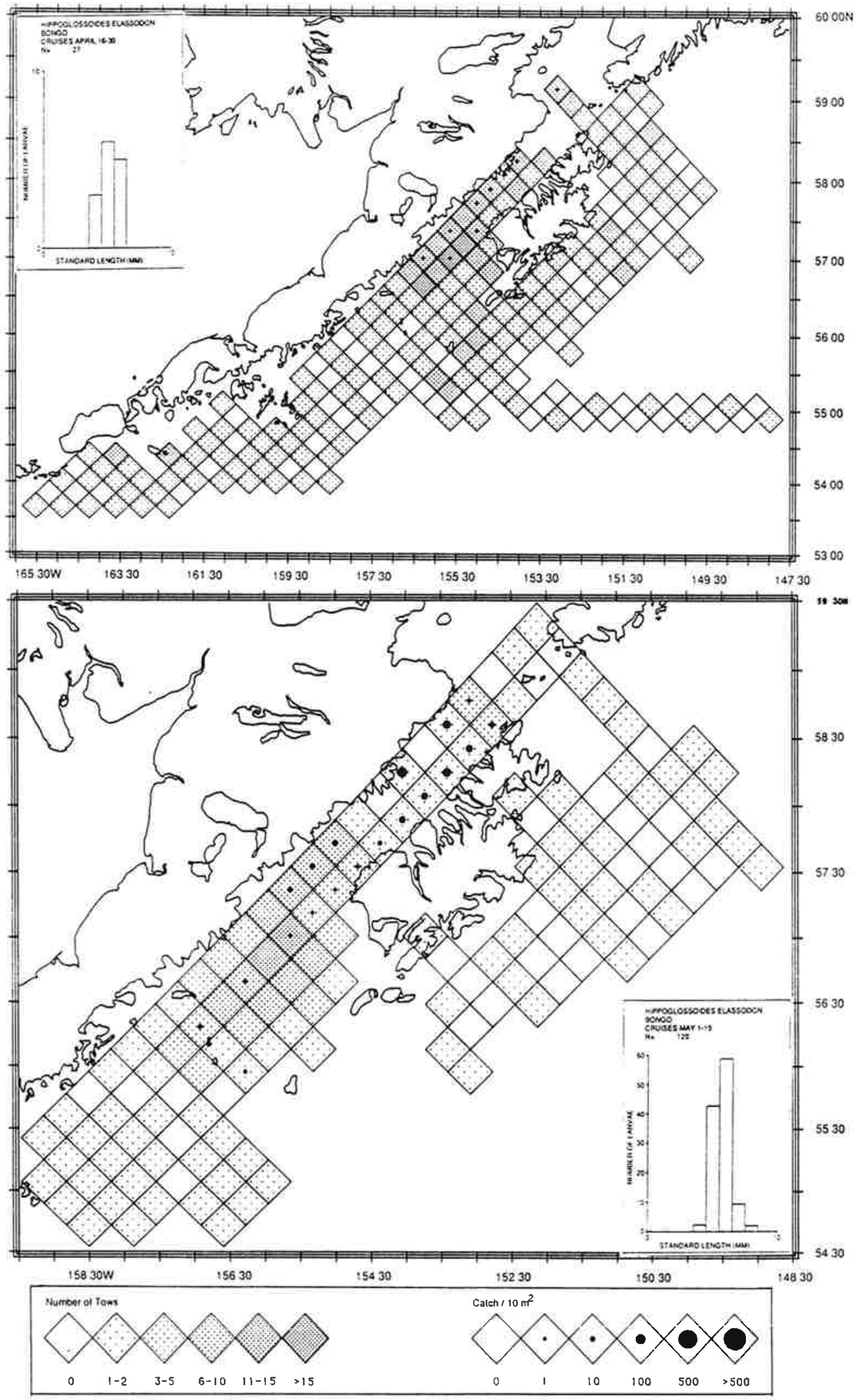
Appendix Figure 79.--Distribution of <u>Lyconectes</u> <u>aleutensis</u> larvae in neuston tows, A. June 16-30, B. July 1-15 (catch/10 m^2=P^2/2.5281, where P=percentage of width of sector taken up by dot, for catches >500/10 m^2, P=42.8%).



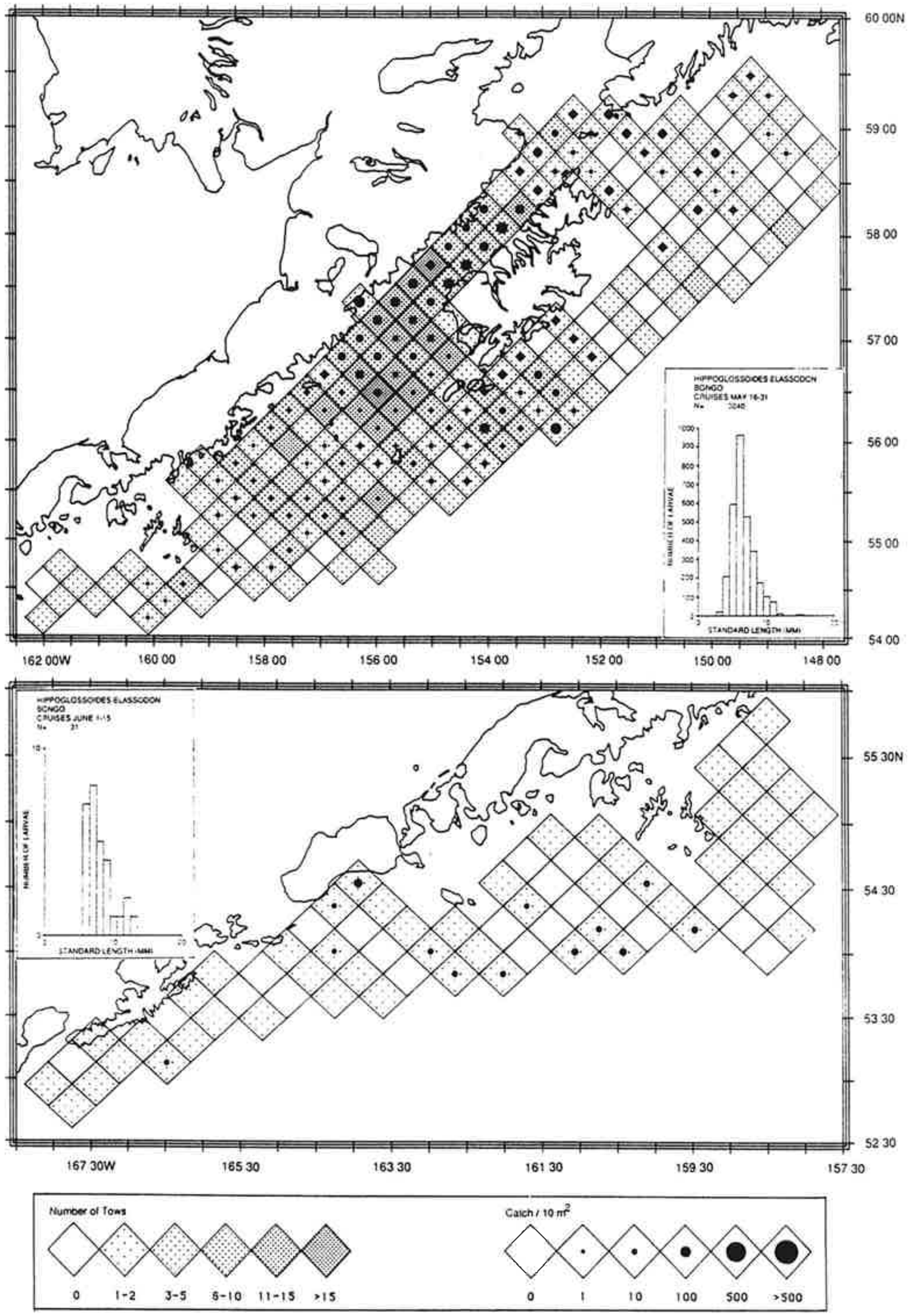
Appendix Figure 80.--Distribution of <u>Anoplopoma</u> <u>fimbria</u> larvae in neuston tows, A. May 16-31, B. June 1-15 (catch/10 m^2=P^2/2.5281, where P=percentage of width of sector taken up by dot, for catches >500/10 m^2, P=42.8%).



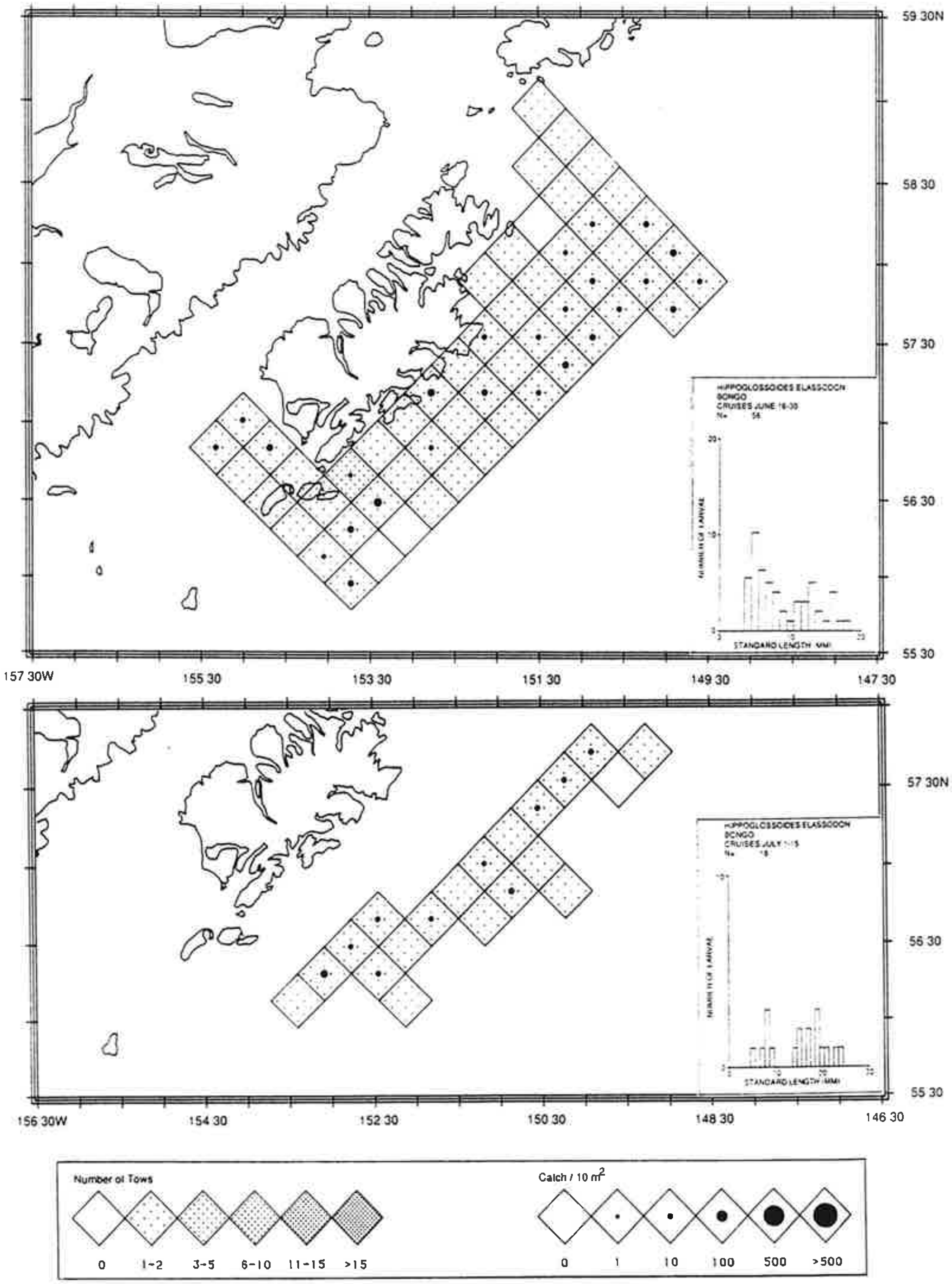
Appendix Figure 81.--Distribution of <u>Anoplopoma</u> <u>fimbria</u> larvae in neuston tows, June 16-30 (catch/10 $m^2=P^2/2.5281$, where P=percentage of width of sector taken up by dot, for catches >500/10 m^2, P=42.8%).



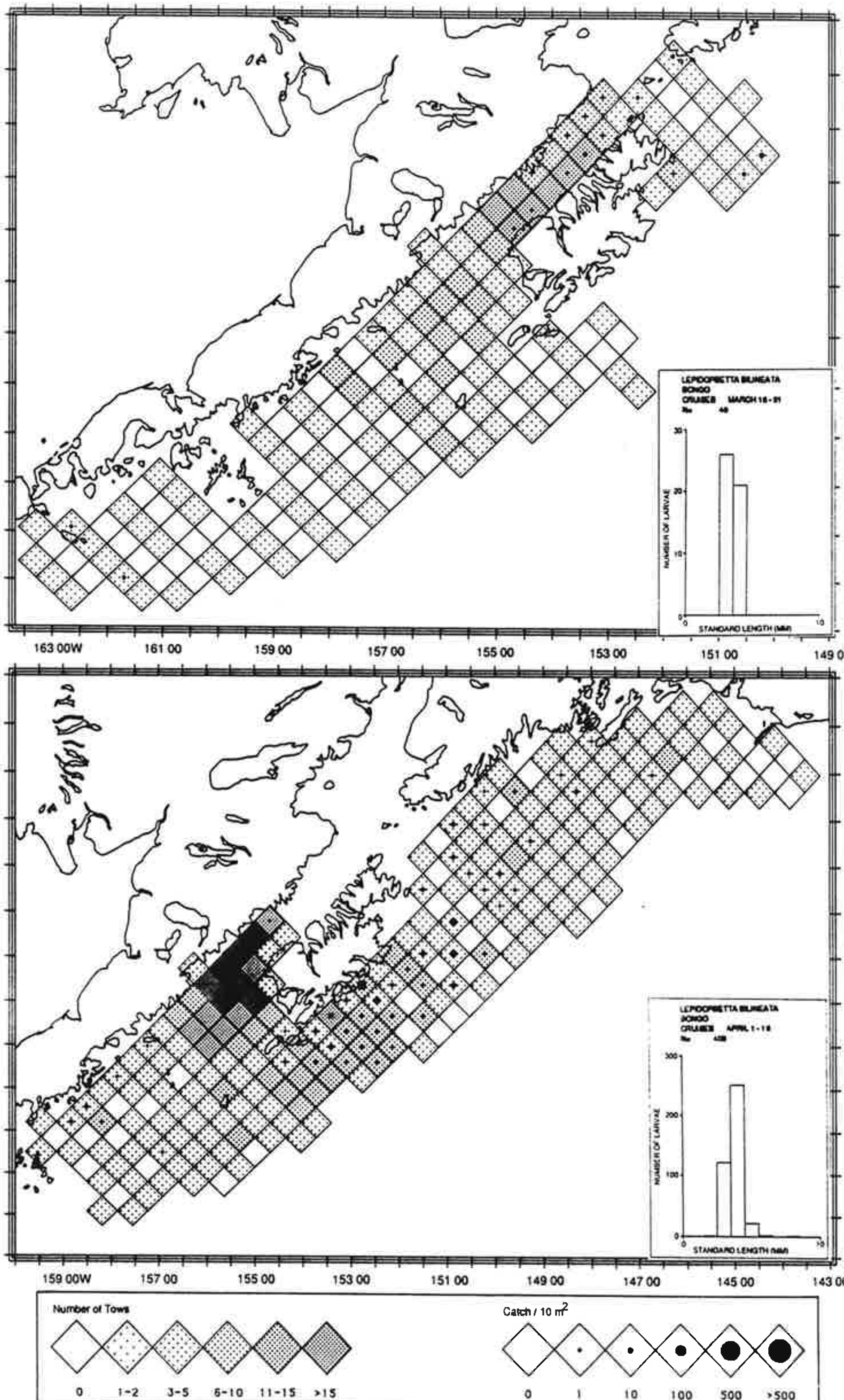
Appendix Figure 82.--Distribution of <u>Hippoglossoides</u> <u>elassodon</u> larvae in bongo tows, A. Apr. 16-30, B. May 1-15 (catch/10 m^2=P^2/2.5281, where P=percentage of width of sector taken up by dot, for catches >500/10 m^2, P=42.8%).



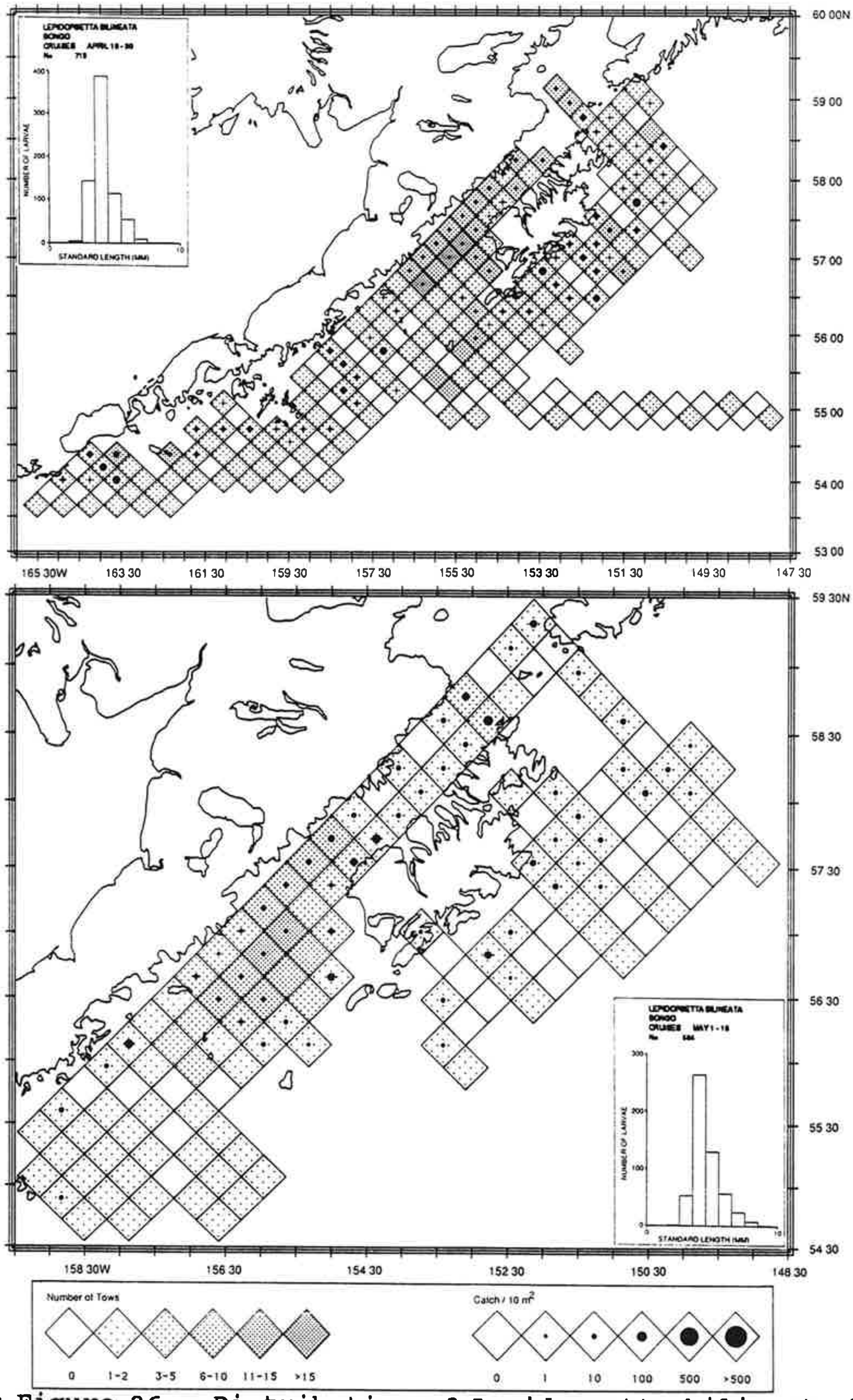
Appendix Figure 83.--Distribution of <u>Hippoglossoides</u> <u>elassodon</u> larvae in bongo tows, A. May 16-31, B. June 1-15 (catch/10 $m^2=P^2/2.5281$, where P=percentage of width of sector taken up by dot, for catches >500/10 m^2, P=42.8%).



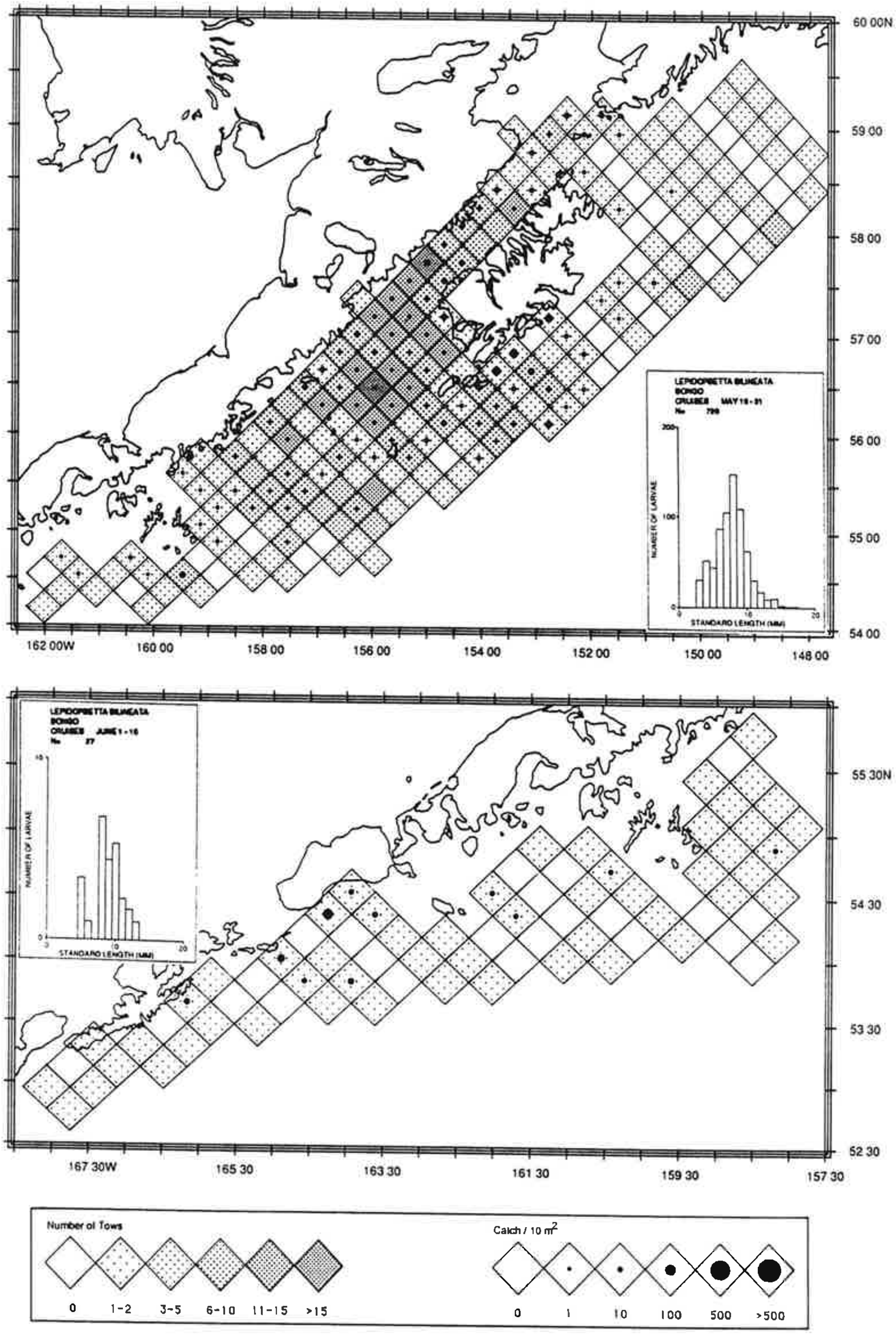
Appendix Figure 84.--Distribution of <u>Hippoglossoides</u> <u>elassodon</u> larvae in bongo tows, A. June 16-30, B. July 1-15 (catch/10 m^2=P^2/2.5281, where P=percentage of width of sector taken up by dot, for catches >500/10 m^2, P=42.8%).



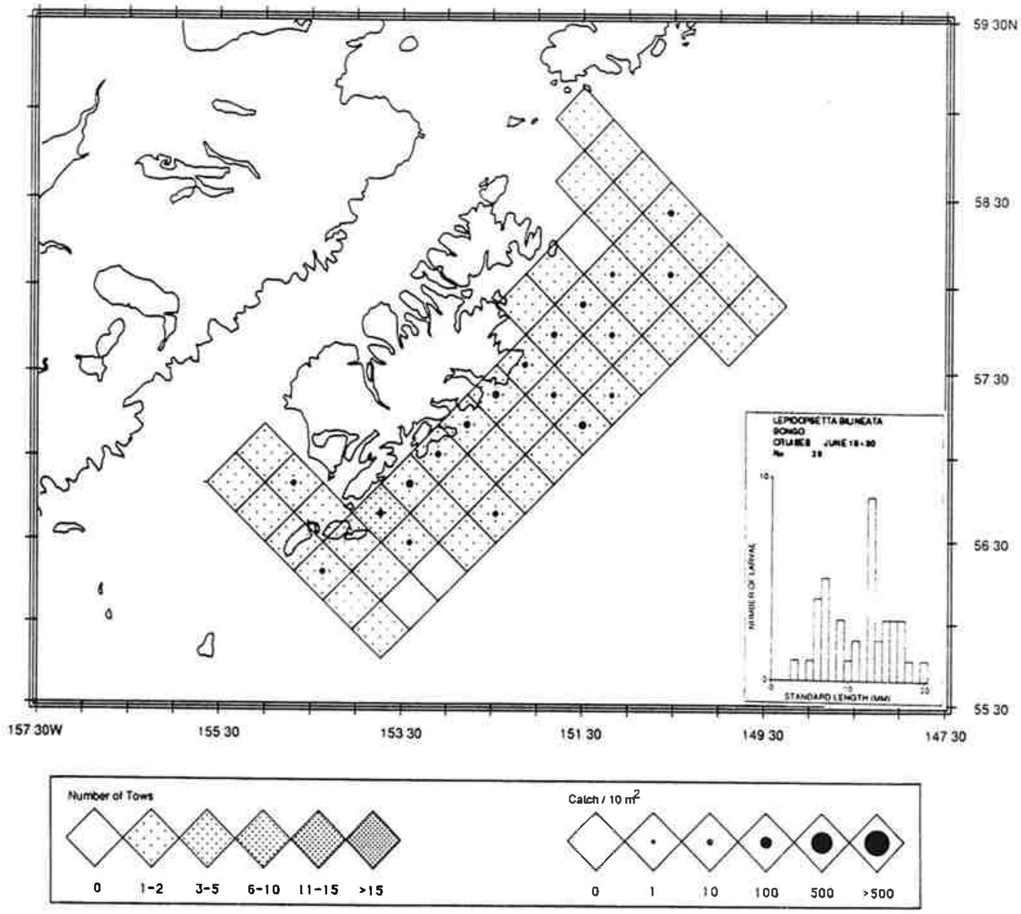
Appendix Figure 85.--Distribution of Lepidopsetta bilineata larvae in bongo tows, A. Mar. 16-31, B. Apr. 1-15 (catch/10 m^2=P^2/2.5281, where P=percentage of width of sector taken up by dot, for catches >500/10 m^2, P=42.8%).



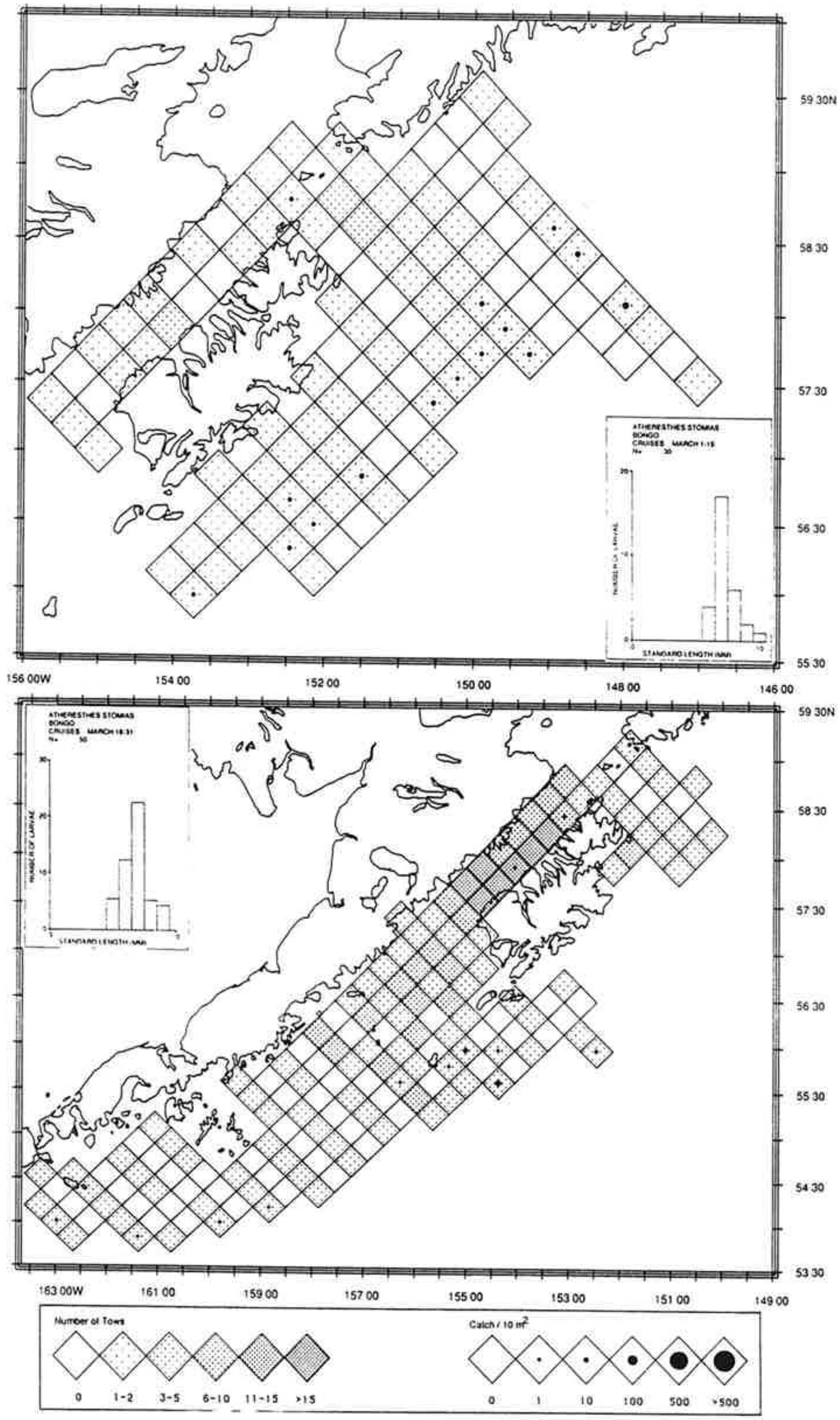
Appendix Figure 86.--Distribution of Lepidopsetta bilineata larvae in bongo tows, A. Apr. 16-30, B. May 1-15 (catch/10 $m^2=P^2/2.5281$, where P=percentage of width of sector taken up by dot, for catches >500/10 m^2, P=42.8%).



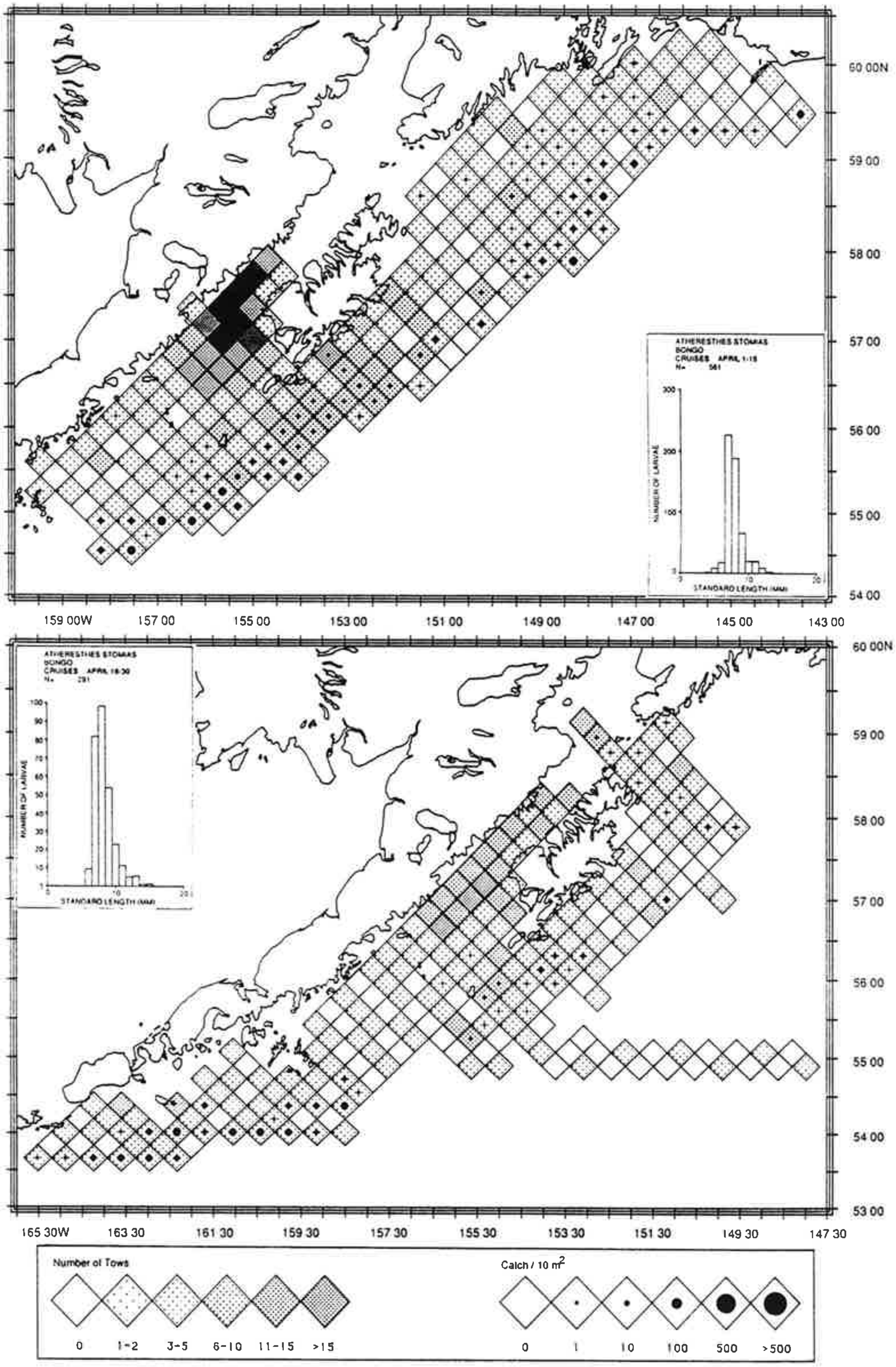
Appendix Figure 87.--Distribution of <u>Lepidopsetta</u> <u>bilineata</u> larvae in bongo tows, A. May 16-31, B. June 1-15 (catch/10 m^2=P^2/2.5281, where P=percentage of width of sector taken up by dot, for catches >500/10 m^2, P=42.8%).



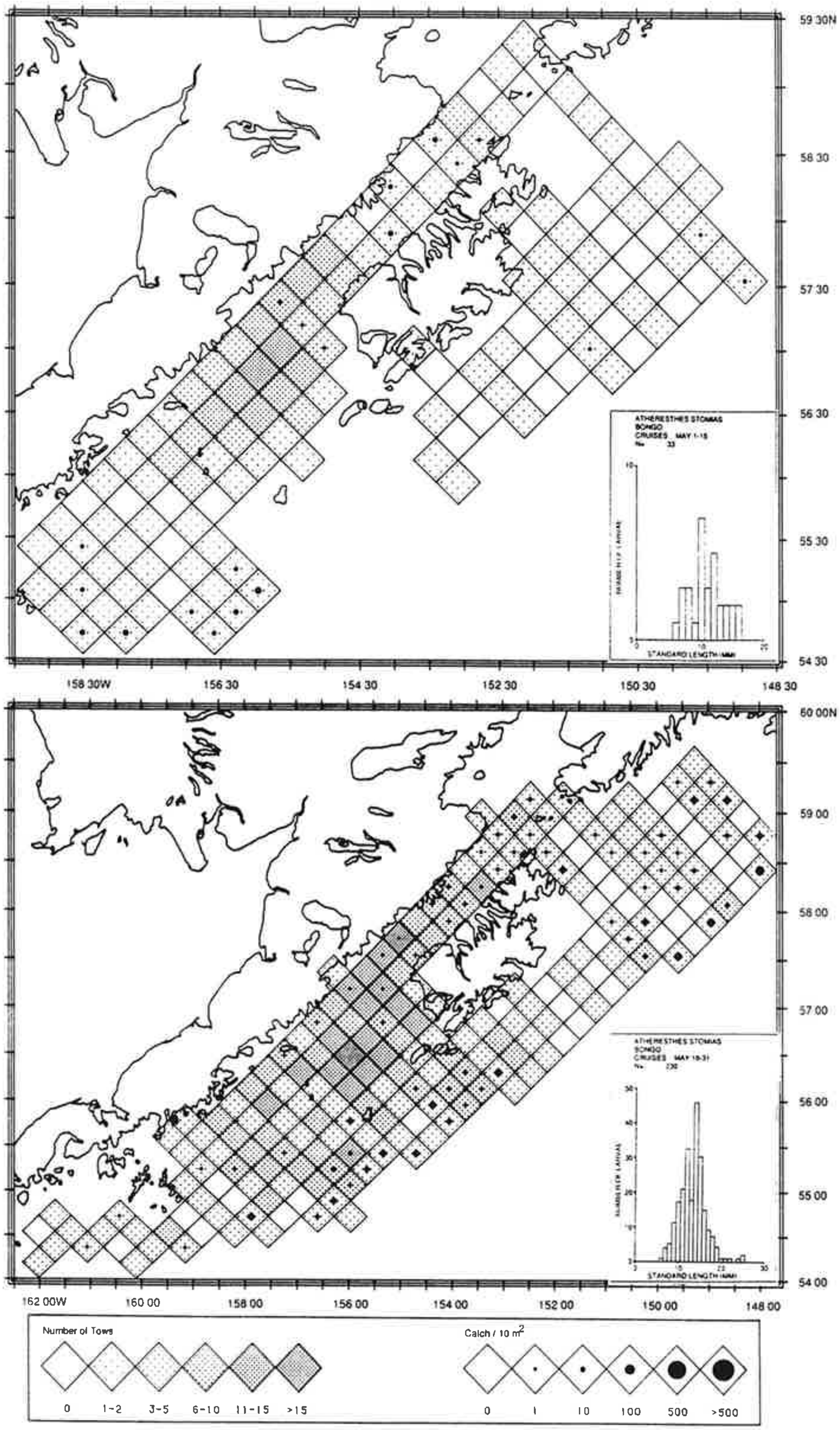
Appendix Figure 88.--Distribution of Lepidopsetta bilineata larvae in bongo tows, June 16-30 (catch/10 $m^2=P^2/2.5281$, where P=percentage of width of sector taken up by dot, for catches >500/10 m^2, P=42.8%).



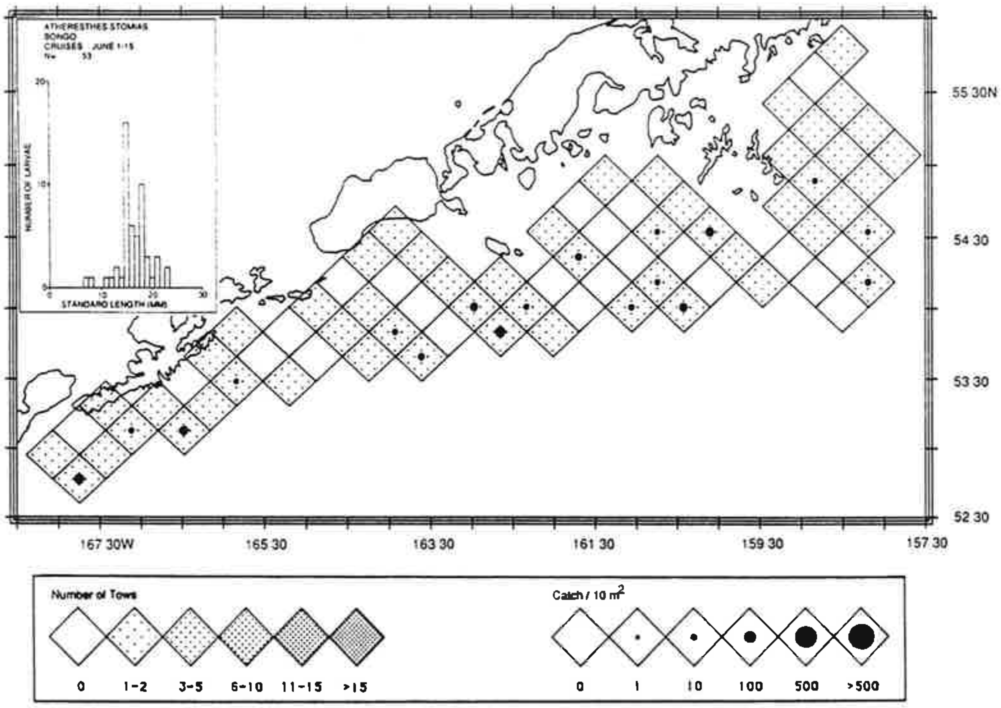
Appendix Figure 89.--Distribution of Atheresthes stomias larvae in bongo tows, A. Mar. 1-15, B. Mar. 16-31 (catch/10 m^2=P^2/2.5281, where P=percentage of width of sector taken up by dot, for catches >500/10 m^2, P=42.8%).



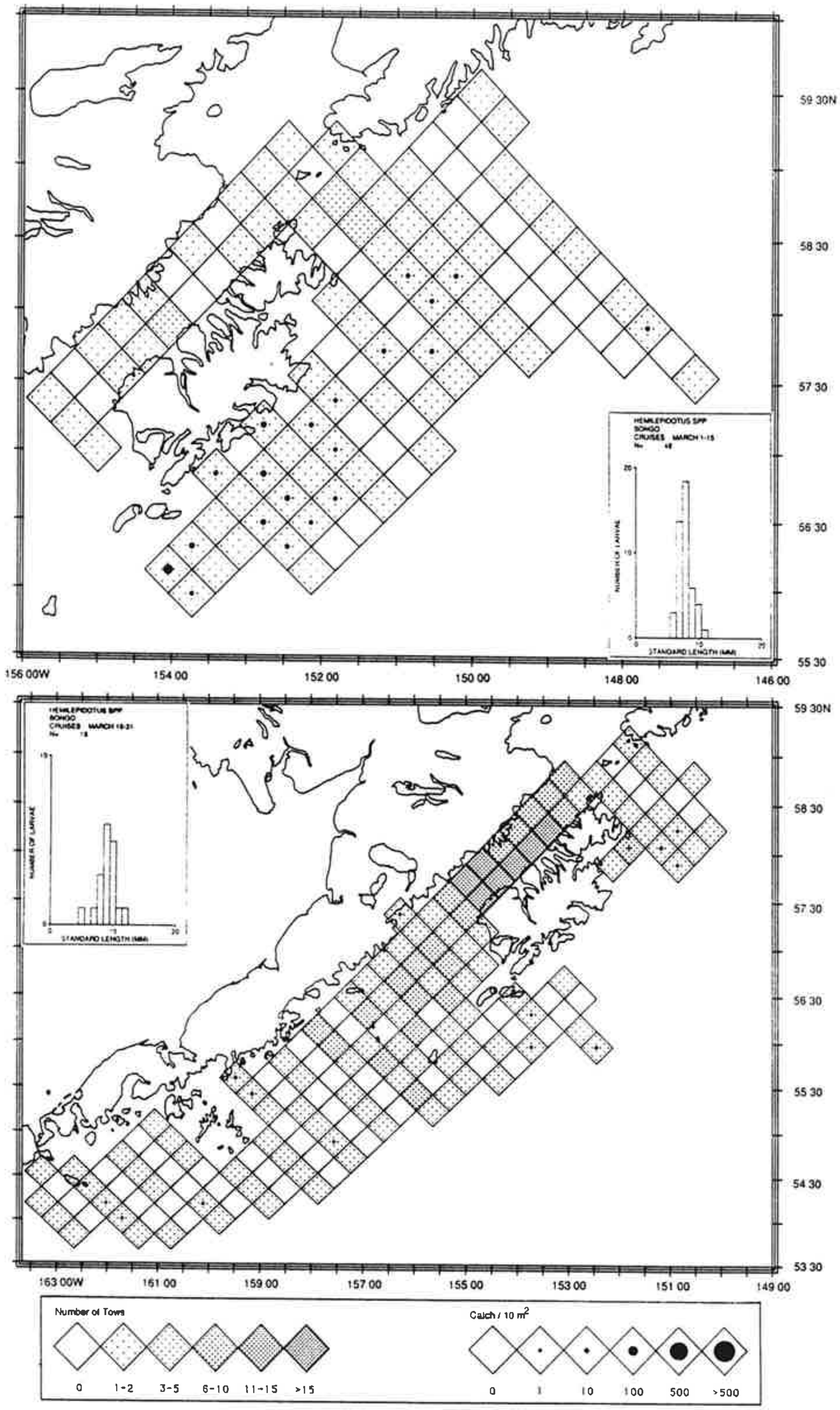
Appendix Figure 90.--Distribution of <u>Atheresthes</u> <u>stomias</u> larvae in bongo tows, A. Apr. 1-15, B. Apr. 16-30 (catch/10 $m^2 = P^2/2.5281$, where P=percentage of width of sector taken up by dot, for catches >500/10 m^2, P=42.8%).



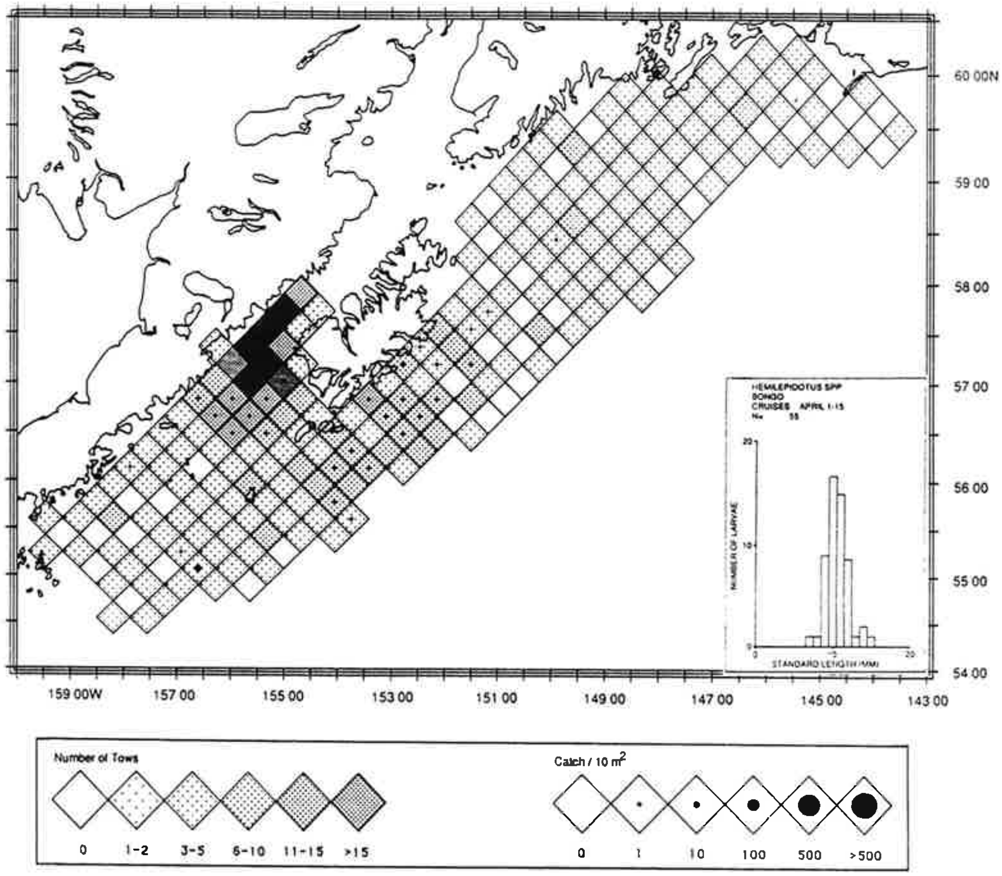
Appendix Figure 91.--Distribution of <u>Atheresthes</u> <u>stomias</u> larvae in bongo tows, A. May 1-15, B. May 16-31 (catch/10 m^2=P^2/2.5281, where P=percentage of width of sector taken up by dot, for catches >500/10 m^2, P=42.8%).



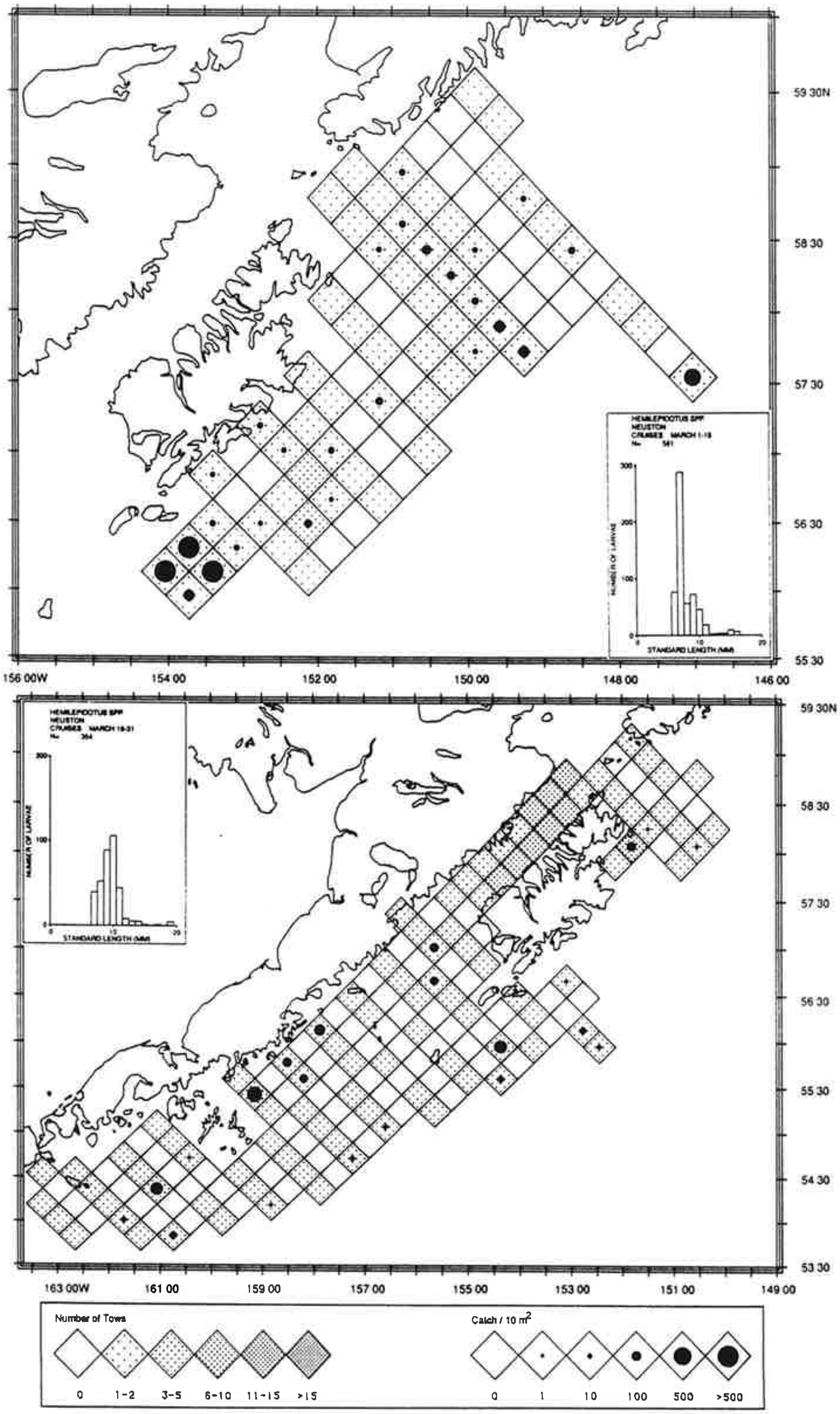
Appendix Figure 92.--Distribution of <u>Atheresthes</u> <u>stomias</u> larvae in bongo tows, June 1-15 (catch/10 $m^2=P^2/2.5281$, where P=percentage of width of sector taken up by dot, for catches >500/10 m^2, P=42.8%).



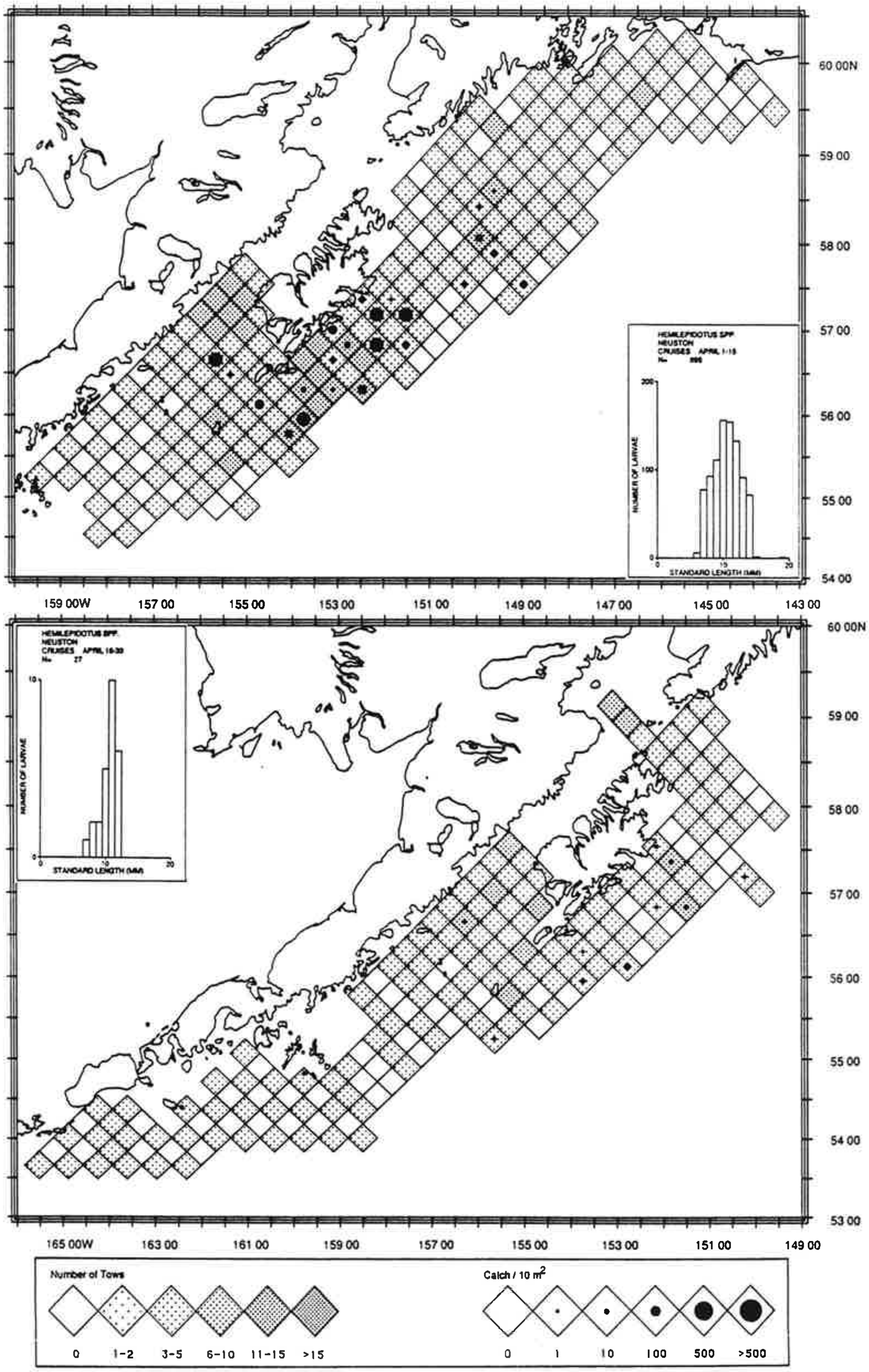
Appendix Figure 93.--Distribution of <u>Hemilepidotus</u> spp. larvae in bongo tows, A. Mar. 1-15, B. Mar. 16-31 (catch/10 $m^2 = P^2/2.5281$, where P=percentage of width of sector taken up by dot, for catches >500/10 m^2, P=42.8%).



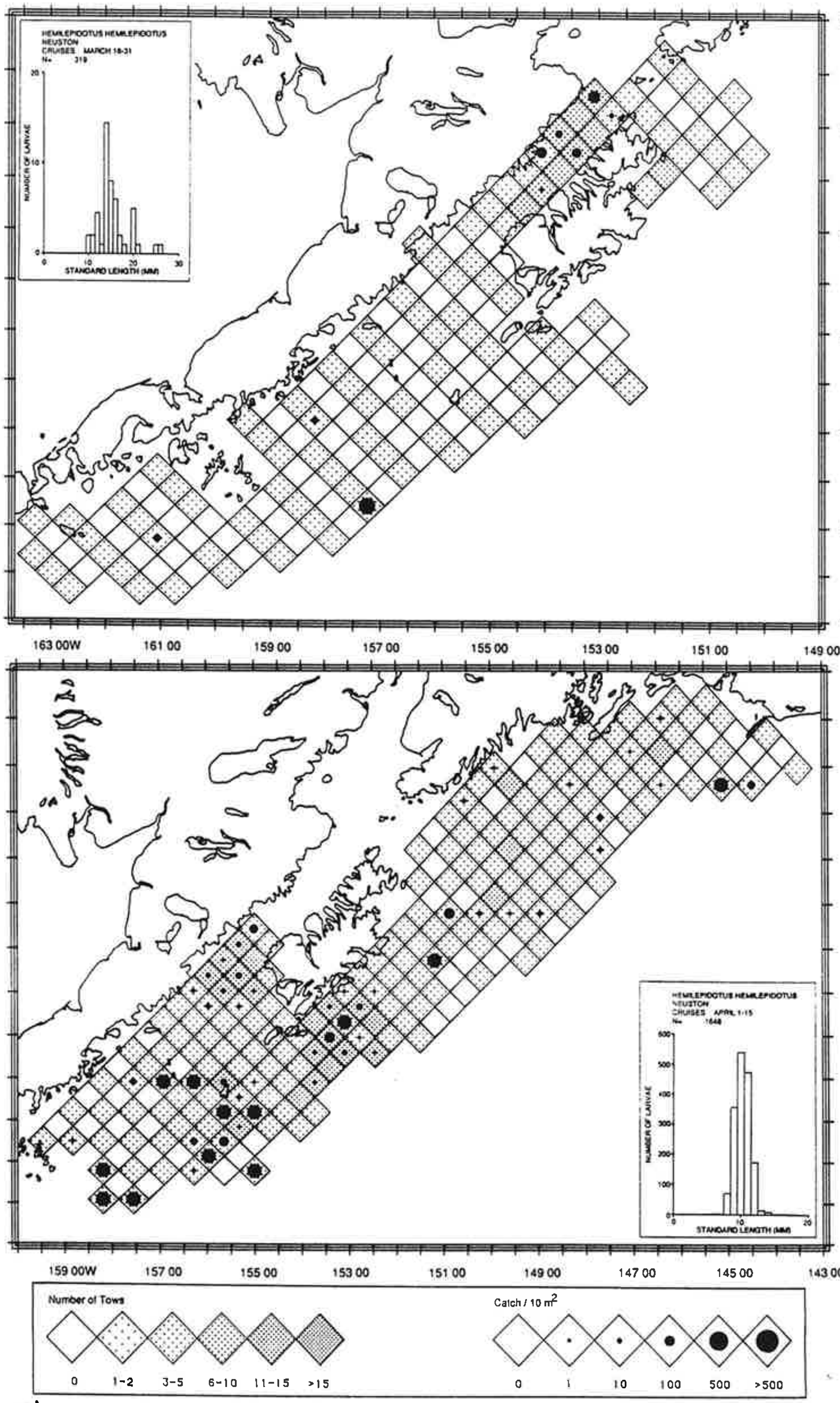
Appendix Figure 94.--Distribution of <u>Hemilepidotus</u> spp. larvae in bongo tows, Apr. 1-15 (catch/10 $m^2=P^2/2.5281$, where P=percentage of width of sector taken up by dot, for catches >500/10 m^2, P=42.8%).



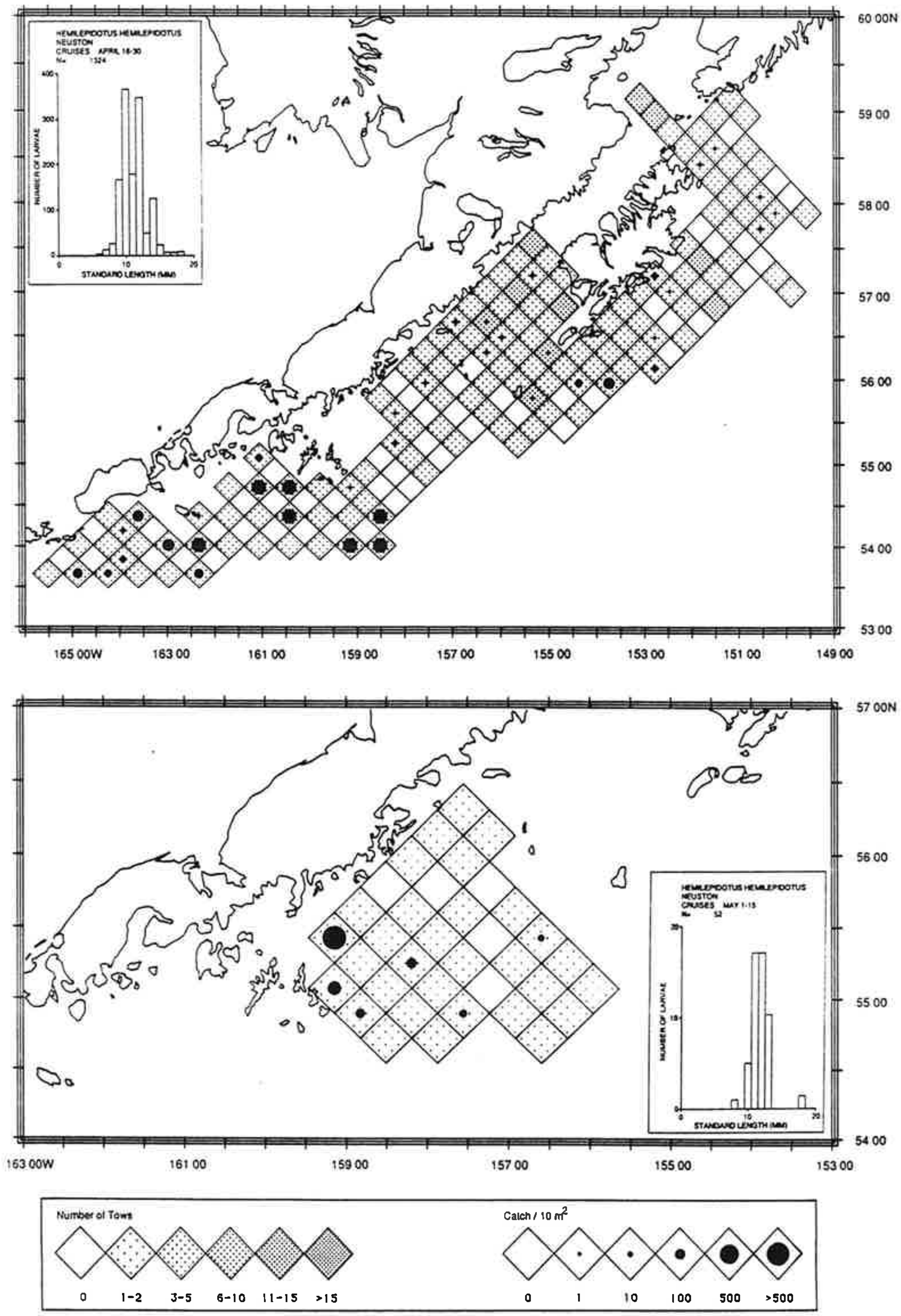
Appendix Figure 95.--Distribution of <u>Hemilepidotus</u> spp. larvae in neuston tows, A. Mar. 1-15, B. Mar. 16-31 (catch/10 m^2=P^2/2.5281, where P=percentage of width of sector taken up by dot, for catches >500/10 m^2, P=42.8%).



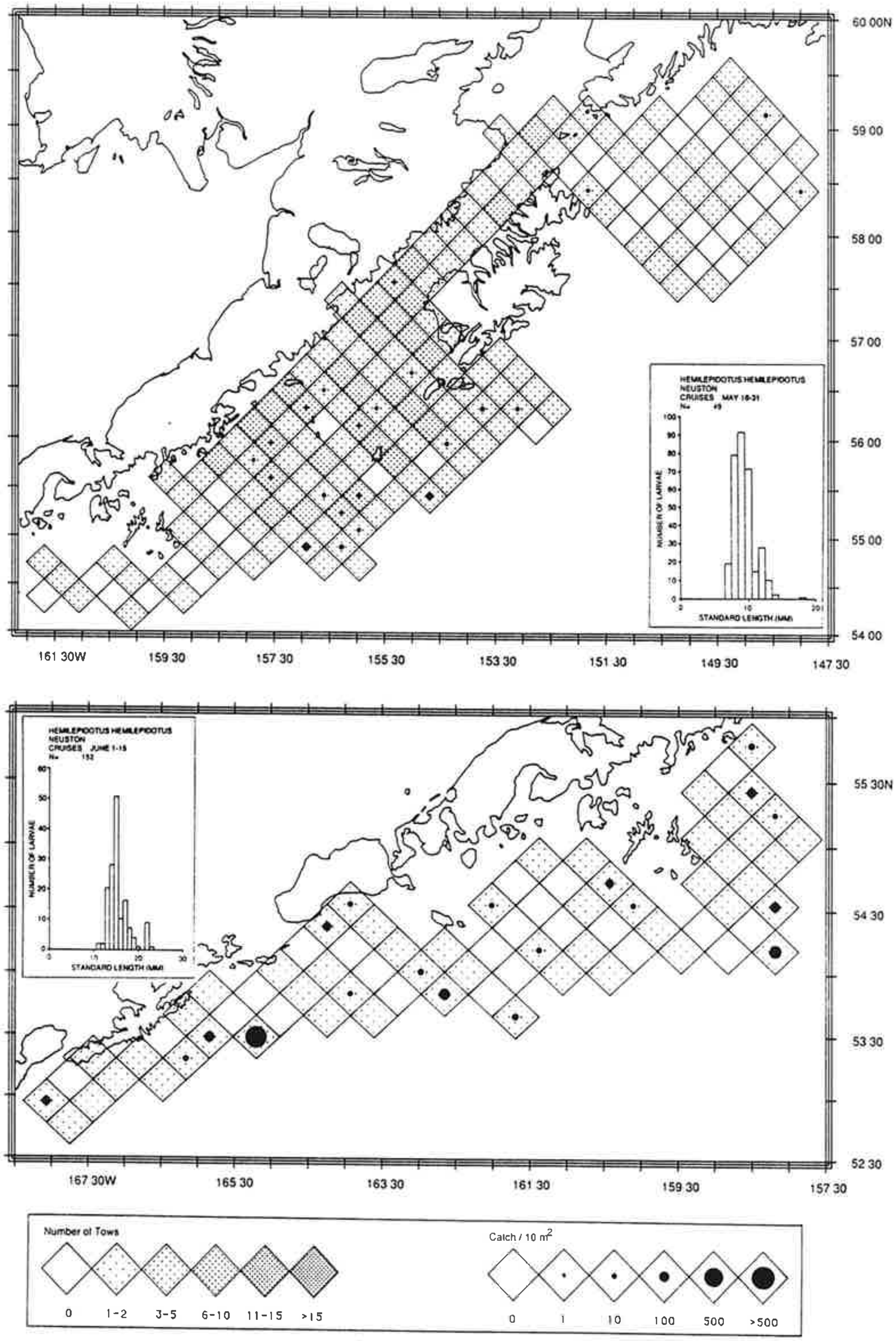
Appendix Figure 96.--Distribution of Hemilepidotus spp. larvae in neuston tows, A. Apr. 1-15, B. Apr. 16-30 (catch/10 $m^2=P^2/2.5281$, where P=percentage of width of sector taken up by dot, for catches >500/10 m^2, P=42.8%).



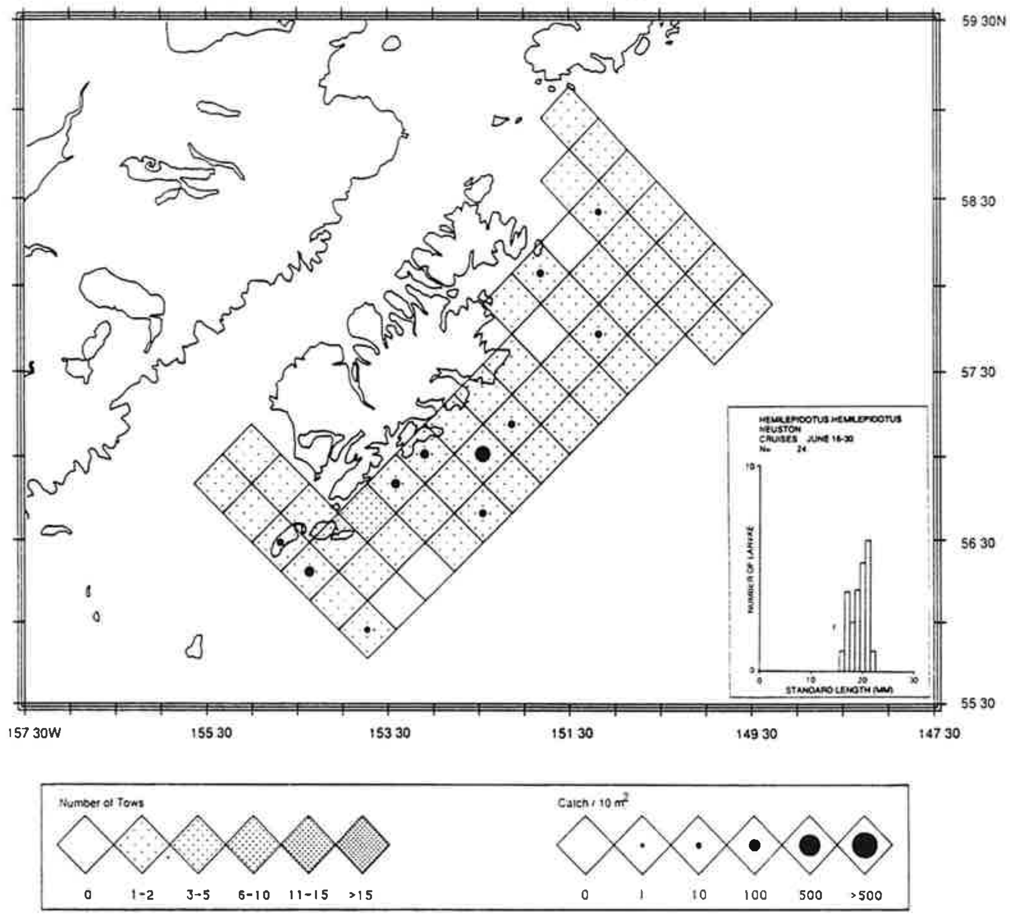
Appendix Figure 97.--Distribution of <u>Hemilepidotus</u> <u>hemilepidotus</u> larvae in neuston tows, A. Mar. 16-31, B. Apr. 1-15 (catch/10 $m^2=P^2/2.5281$, where P=percentage of width of sector taken up by dot, for catches >500/10 m^2, P=42.8%).



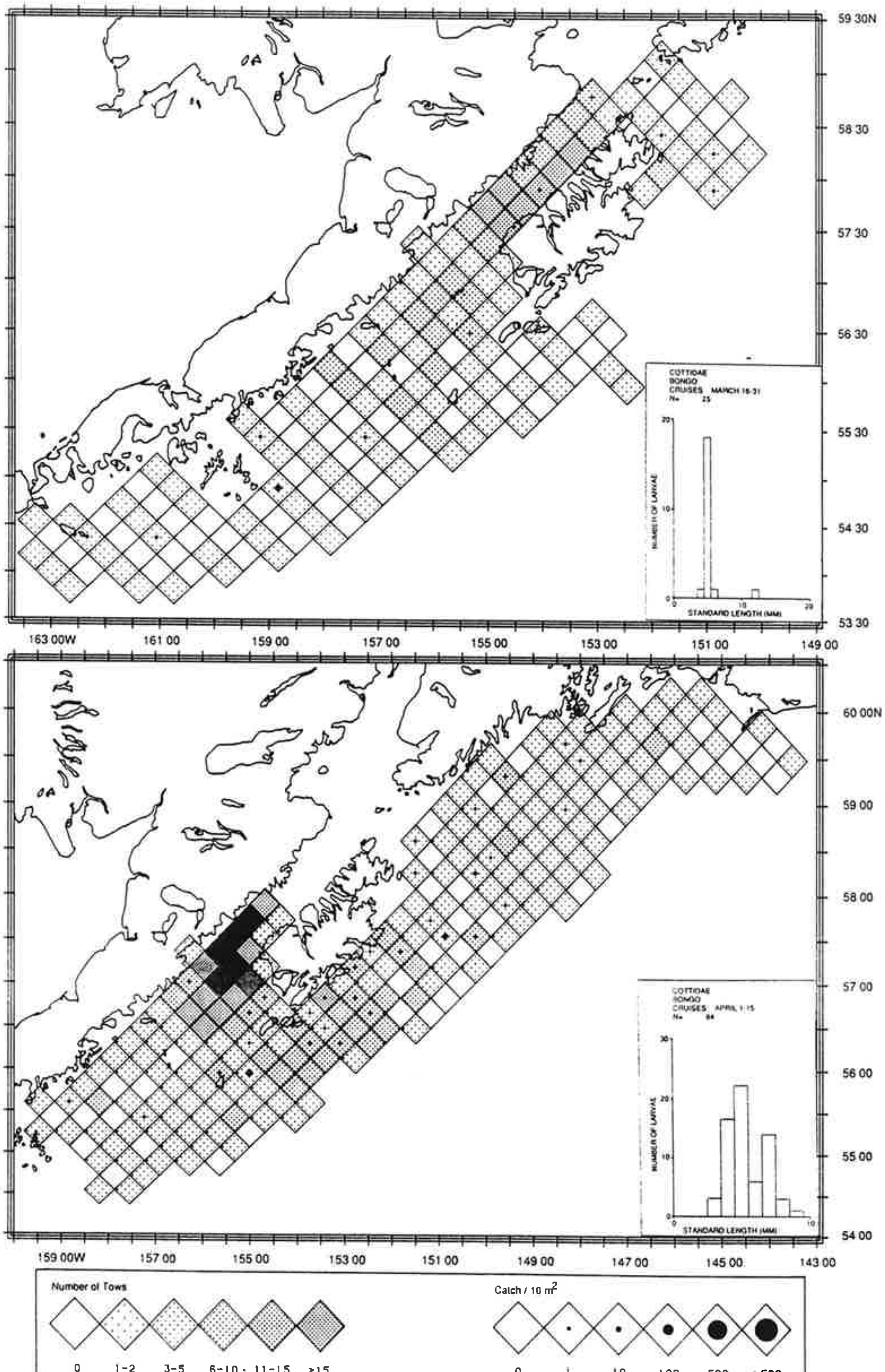
Appendix Figure 98.--Distribution of Hemilepidotus hemilepidotus larvae in neuston tows, A. Apr. 16-30, B. May 1-15 (catch/10 m^2=P^2/2.5281, where P=percentage of width of sector taken up by dot, for catches >500/10 m^2, P=42.8%).



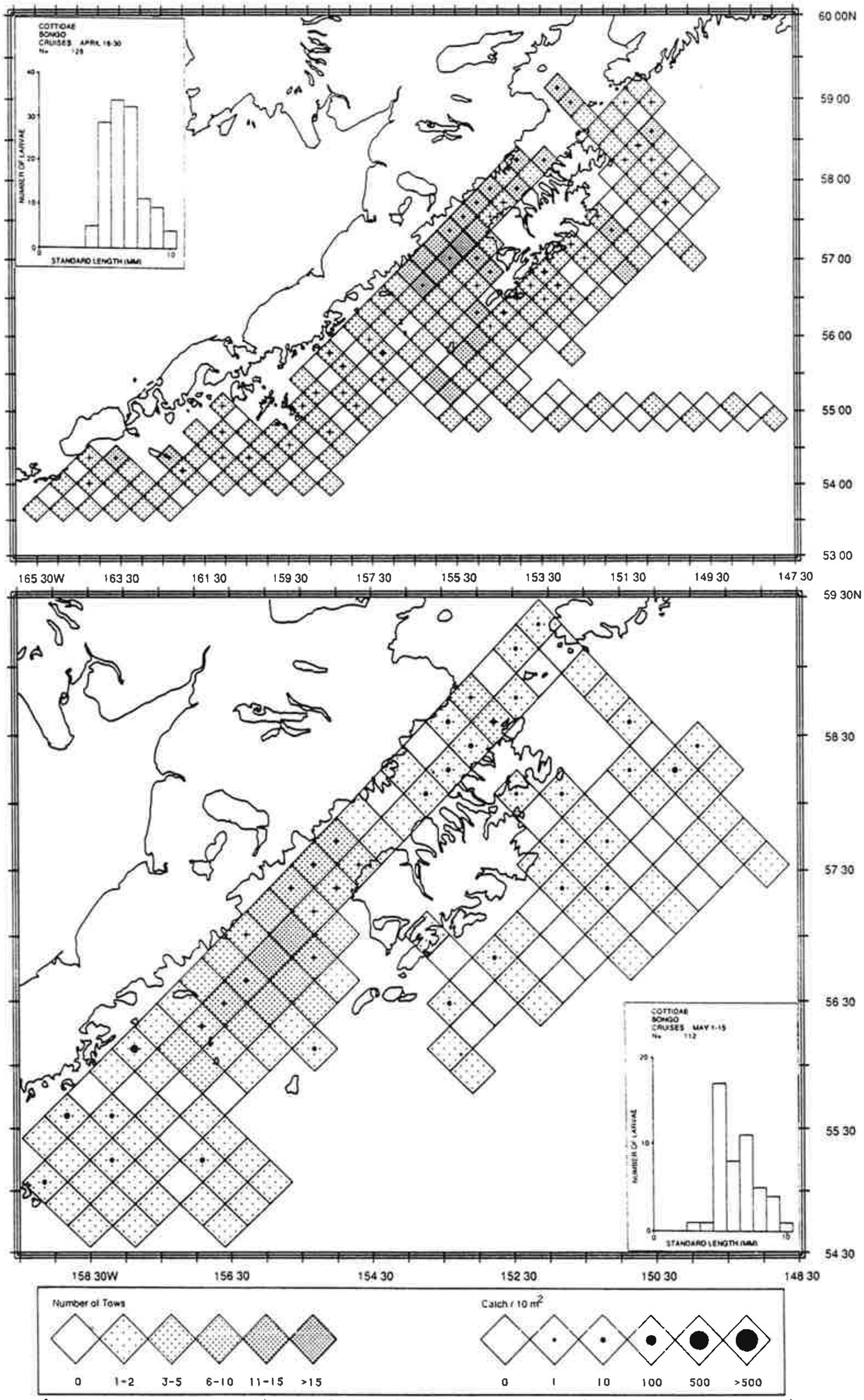
Appendix Figure 99.--Distribution of <u>Hemilepidotus</u> <u>hemilepidotus</u> larvae in neuston tows, A. May 16-31, B. June 1-15 (catch/10 m^2=P^2/2.5281, where P=percentage of width of sector taken up by dot, for catches >500/10 m^2, P=42.8%).



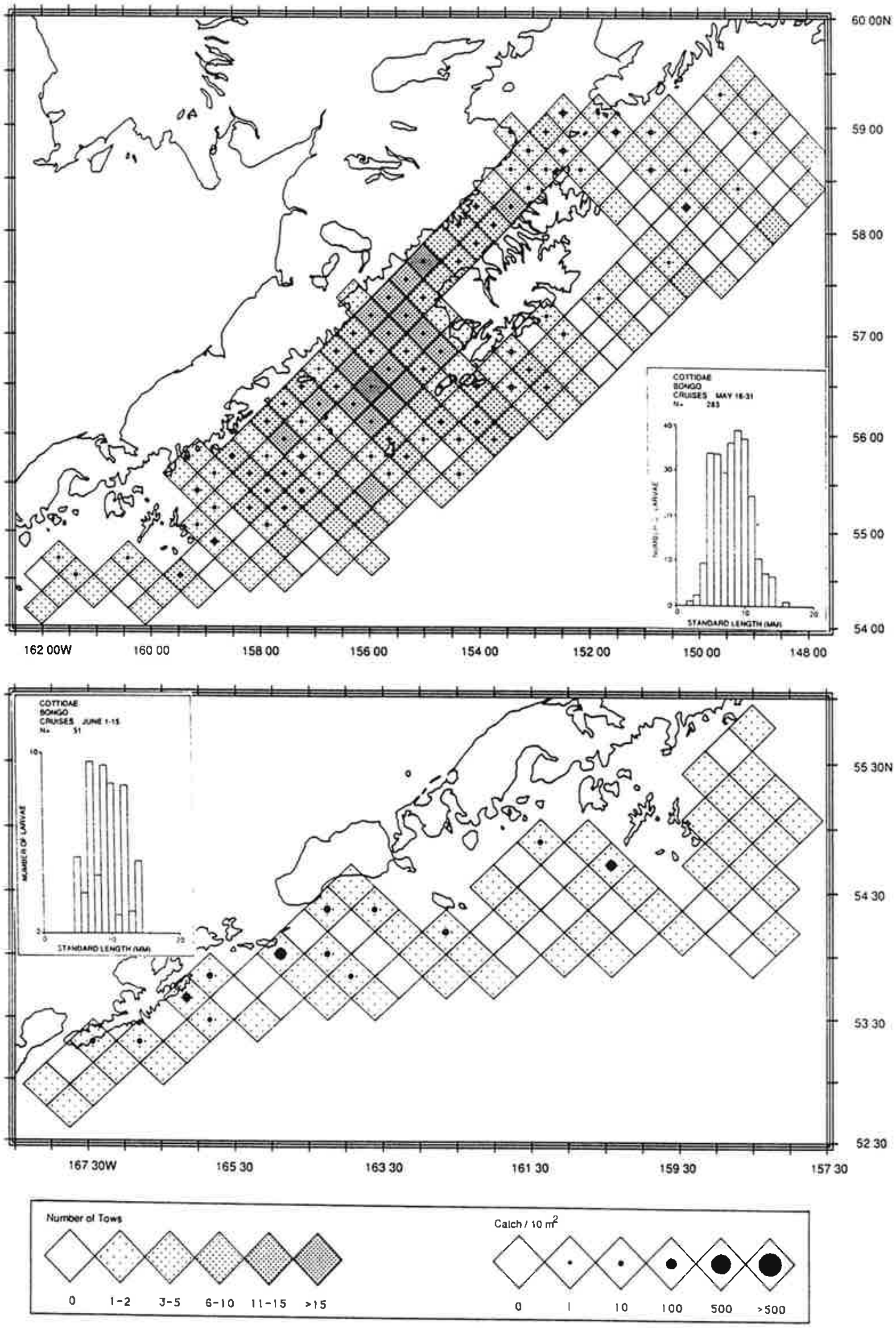
Appendix Figure 100.--Distribution of <u>Hemilepidotus hemilepidotus</u> larvae in neuston tows, June 16-30 (catch/10 $m^2 = P^2/2.5281$, where P=percentage of width of sector taken up by dot, for catches >500/10 m^2, P=42.8%).



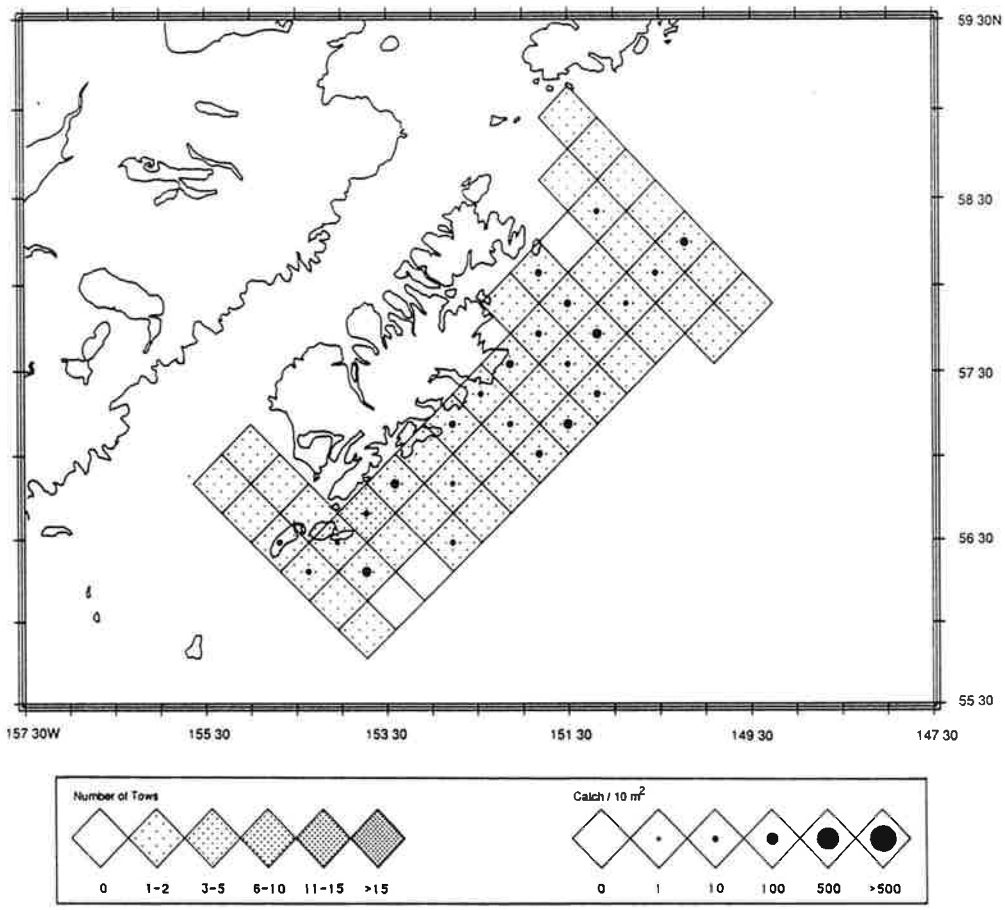
Appendix Figure 101.--Distribution of Cottidae larvae in bongo tows, A. Mar. 16-31, B. Apr. 1-15 (catch/10 $m^2 = P^2/2.5281$, where P=percentage of width of sector taken up by dot, for catches >500/10 m^2, P=42.8%).



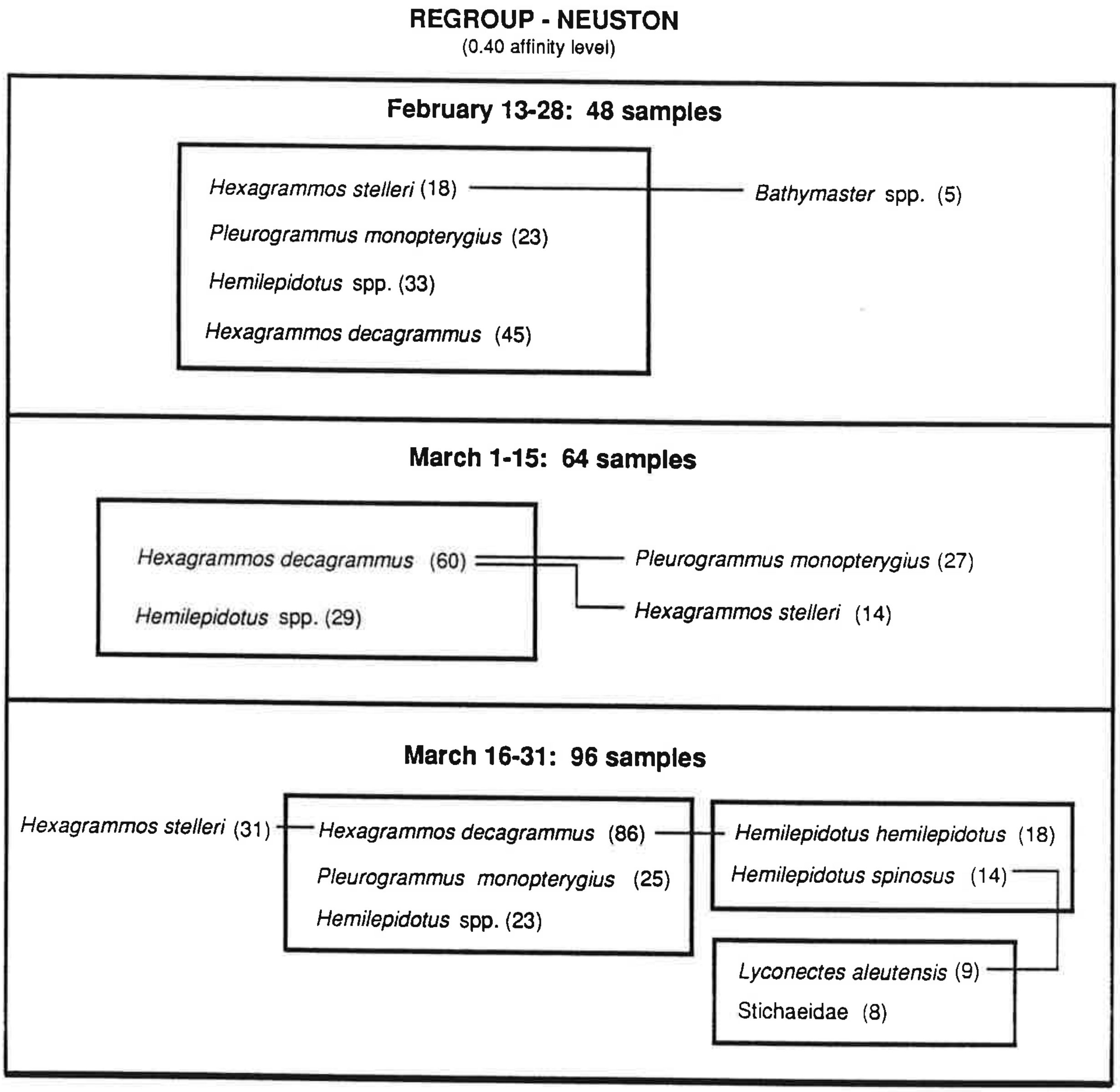
Appendix Figure 102.--Distribution of Cottidae larvae in bongo tow, A. Apr. 16-30, B. May 1-15 (catch/10 $m^2=P^2/2.5281$, where P=percentage of width of sector taken up by dot, for catches >500/10 m^2, P=42.8%).



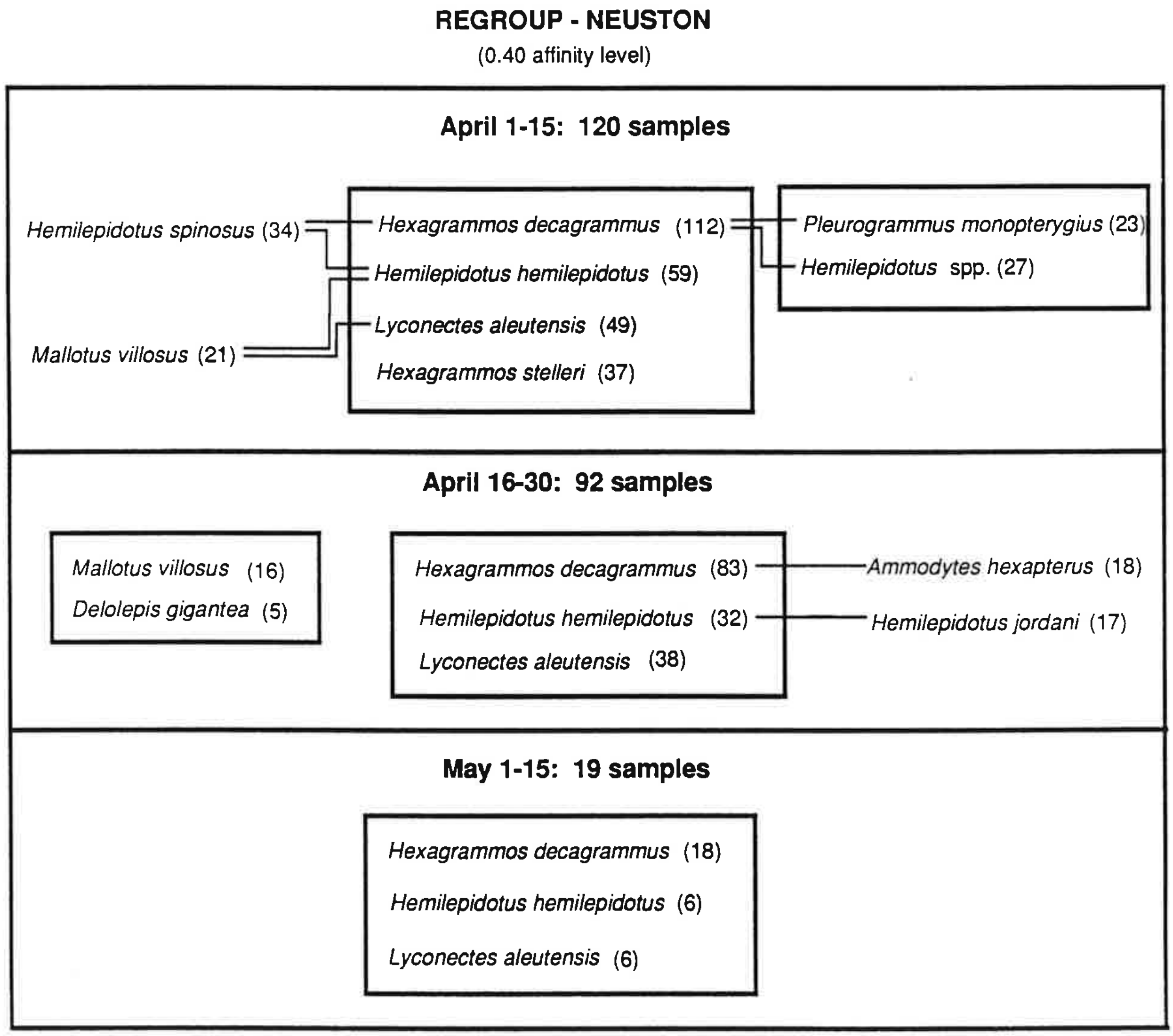
Appendix Figure 103.--Distribution of Cottidae larvae in bongo tows, A. May 16-31, B. June 1-15 (catch/10 $m^2=P^2/2.5281$, where P=percentage of width of sector taken up by dot, for catches >500/10 m^2, P=42.8%).



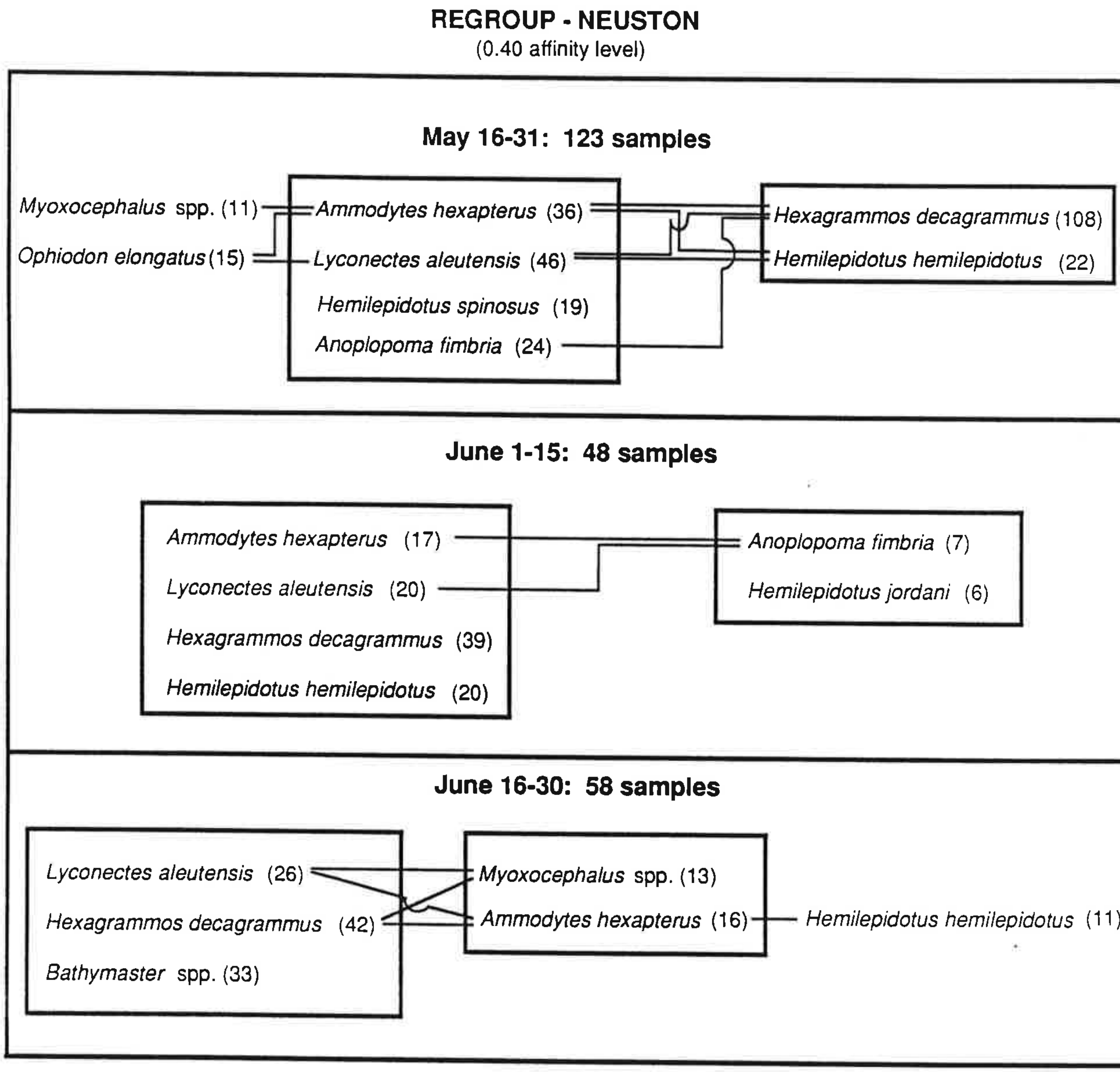
Appendix Figure 104.--Distribution of Cottidae larvae in bongo tows, June 16-30 (catch/10 m^2=P^2/2.5281, where P=percentage of width of sector taken up by dot, for catches >500/10 m^2, P=42.8%).



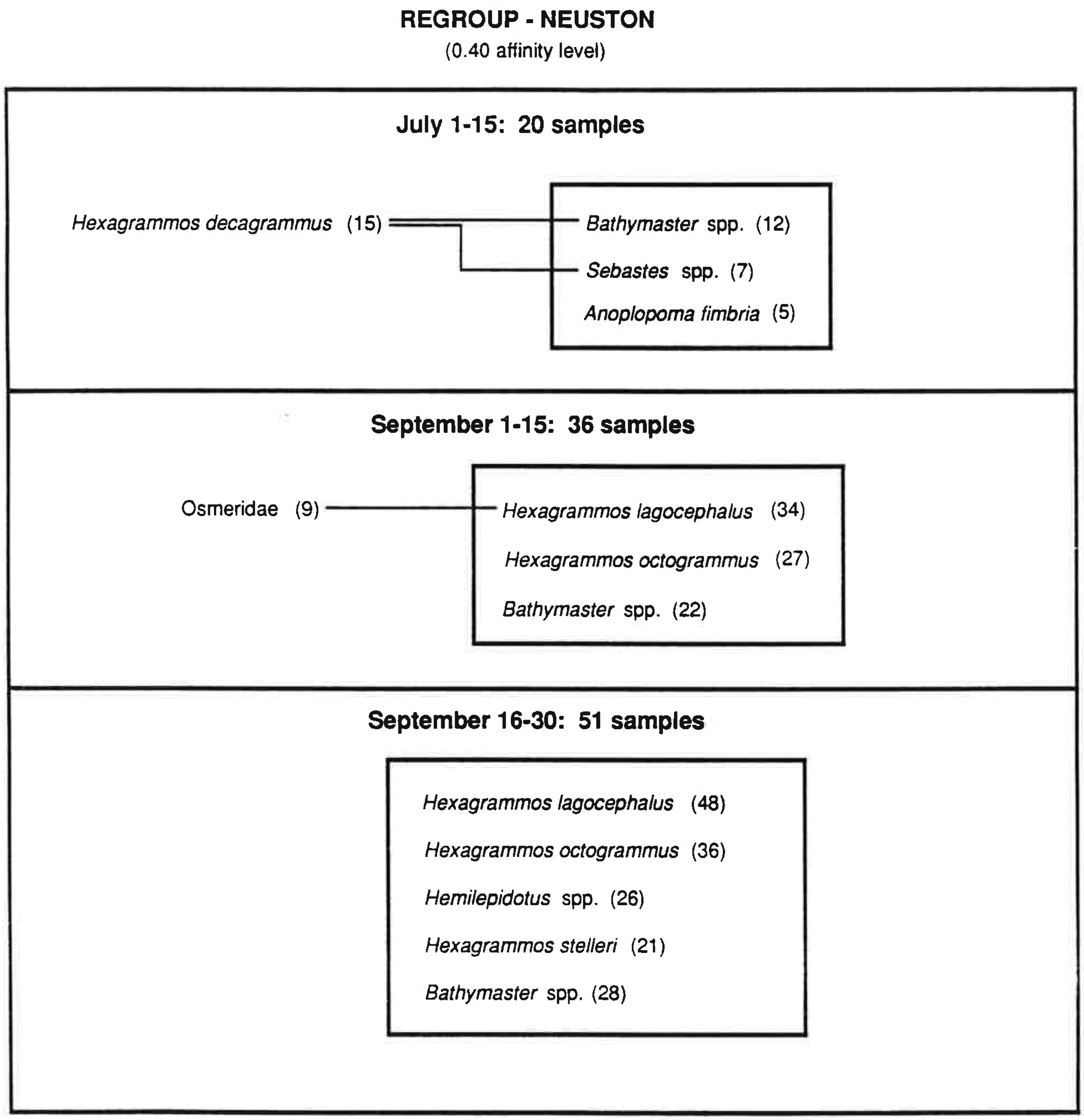
Appendix Figure 105.--Results of recurrent group analysis of neuston catches by date window, A. Feb. 13-28, B. Mar. 1-15, C. Mar. 16-31. Boxes enclose members of recurrent groups. Lines connect taxa with affinities outside their groups. Numbers of occurrences are in parentheses.



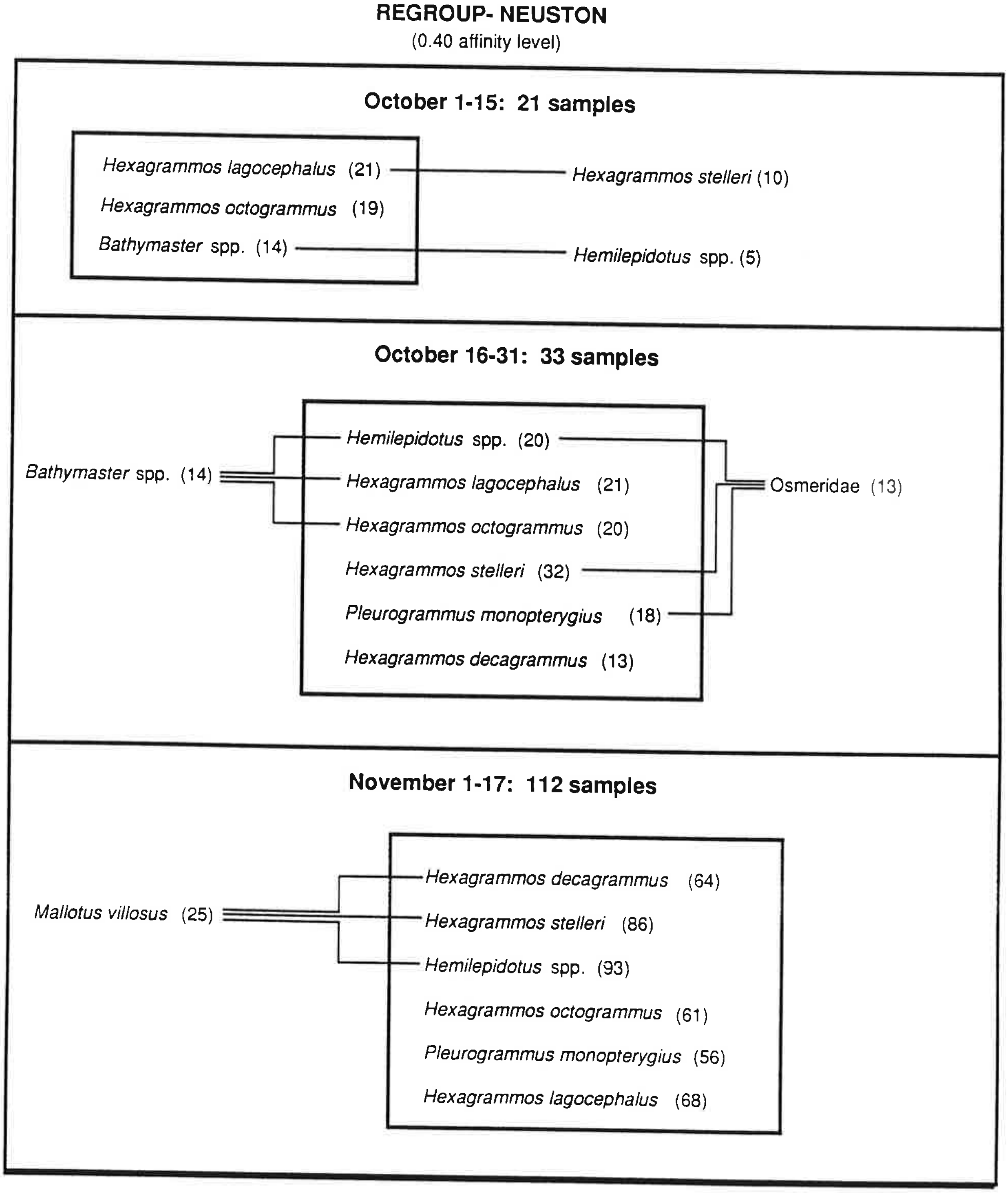
Appendix Figure 106.--Results of recurrent group analysis of neuston catches by date window, A. Apr. 1-15, B. Apr. 16-30, C. May 1-15. Boxes enclose members of recurrent groups. Lines connect taxa with affinities outside their groups. Numbers of occurrences are in parentheses.



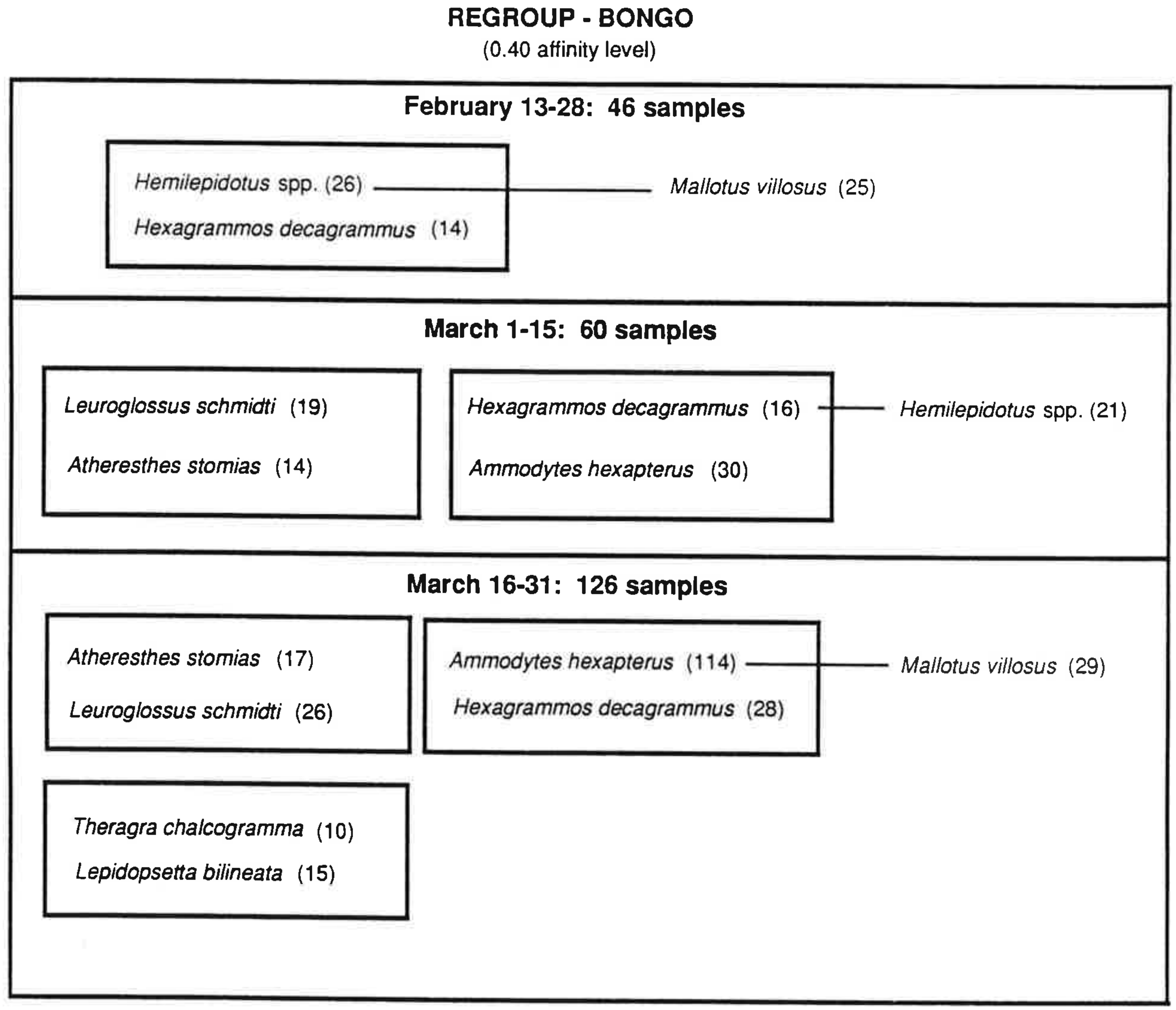
Appendix Figure 107.--Results of recurrent group analysis of neuston catches by date window, A. May 16-31, B. June 1-15, C. June 16-30. Boxes enclose members of recurrent groups. Lines connect taxa with affinities outside their groups. Numbers of occurrences are in parentheses.



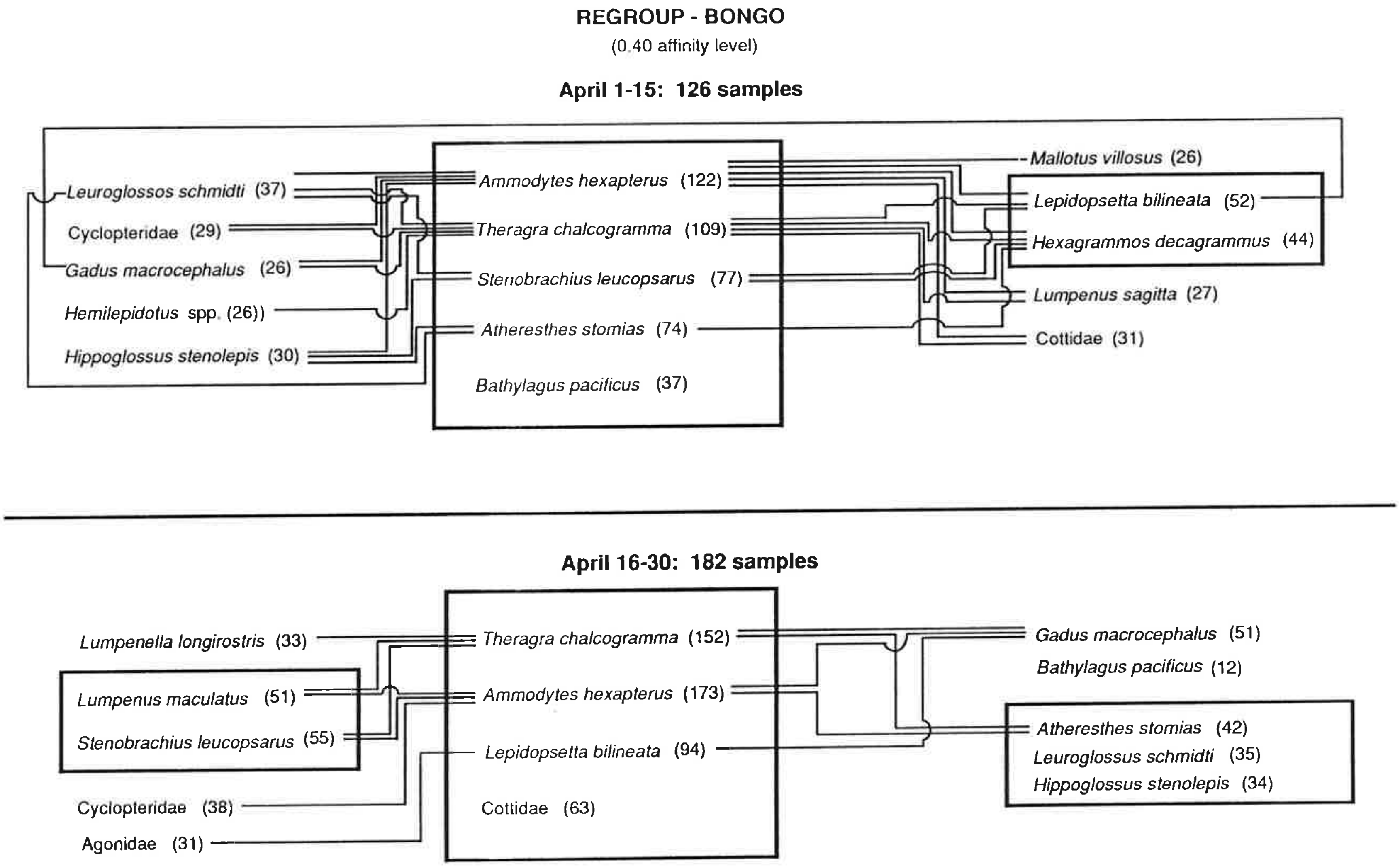
Appendix Figure 108.--Results of recurrent group analysis of neuston catches by date window, A. July 1-15, B. Sept. 1-15, C. Sept. 16-30. Boxes enclose members of recurrent groups. Lines connect taxa with affinities outside their groups. Numbers of occurrences are in parentheses.



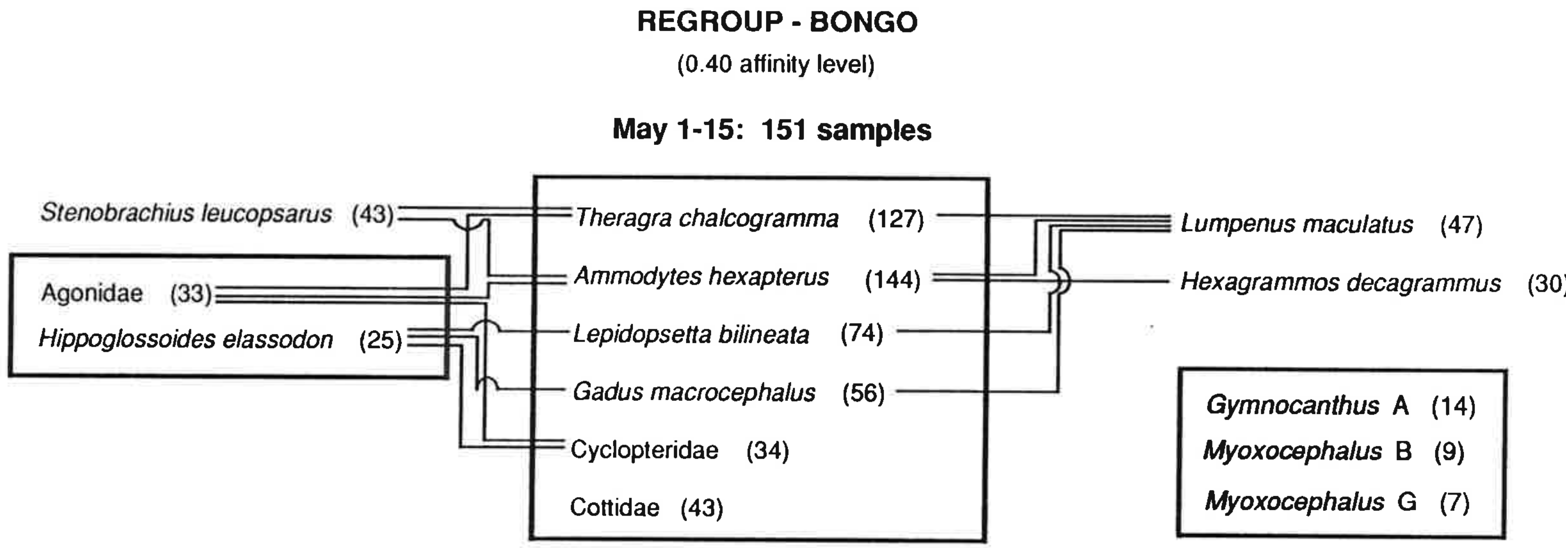
Appendix Figure 109.--Results of recurrent group analysis of neuston catches by date window, A. Oct. 1-15, B. Oct. 16-31, C. Nov. 1-17. Boxes enclose members of recurrent groups. Lines connect taxa with affinities outside their groups. Numbers of occurrences are in parentheses.



Appendix Figure 110.--Results of recurrent group analysis of bongo catches by date window, A. Feb. 13-28, B. Mar. 1-15, C. Mar. 16-31. Boxes enclose members of recurrent groups. Lines connect taxa with affinities outside their groups. Numbers of occurrences are in parentheses.



Appendix Figure 111.--Results of recurrent group analysis of bongo catches by date window, A. Apr. 1-15, B. Apr. 16-30. Boxes enclose members of recurrent groups. Lines connect taxa with affinities outside their groups. Numbers of occurrences are in parentheses.

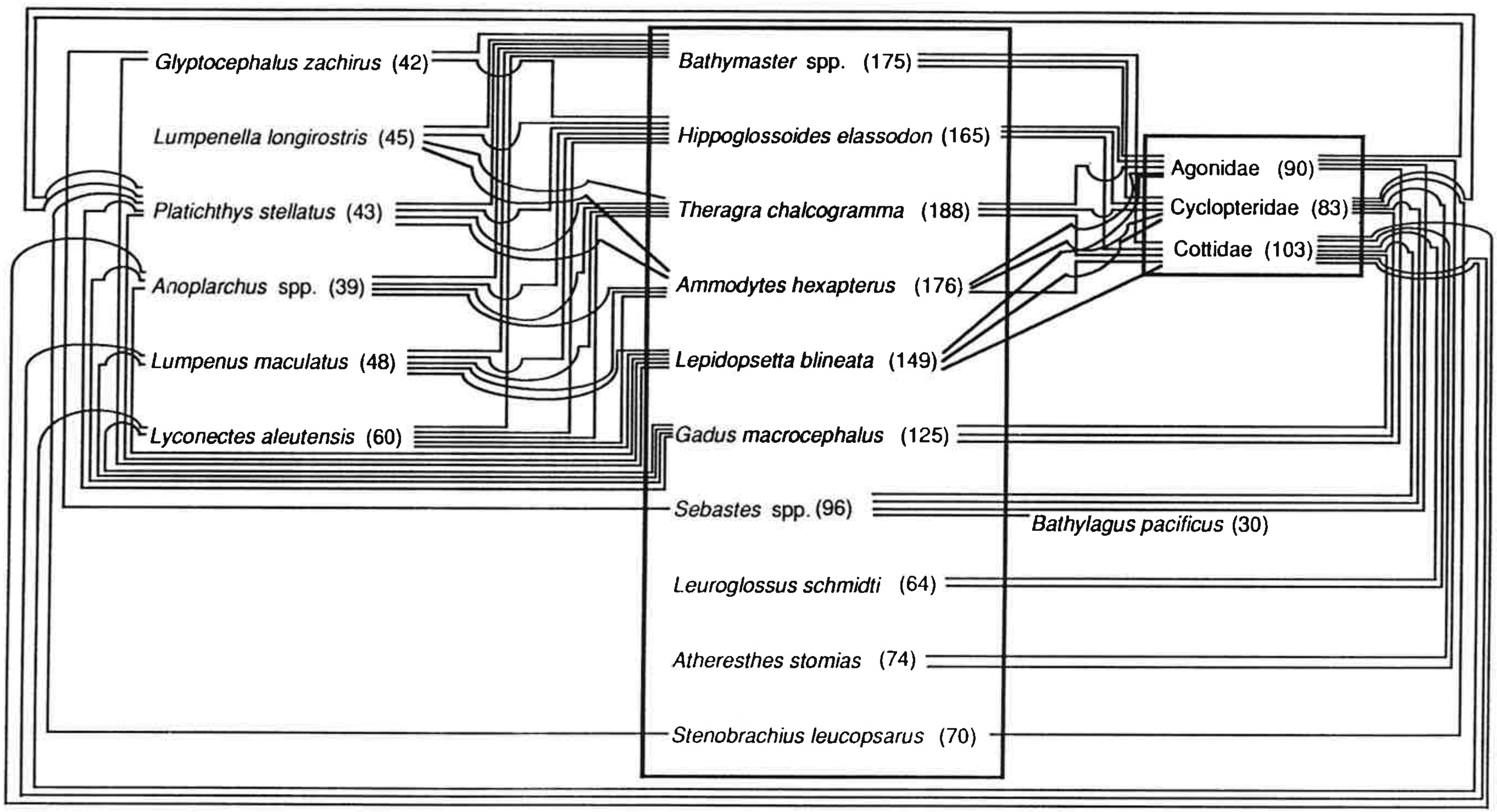


Appendix Figure 112.--Results of recurrent group analysis of bongo catches by date window, May 1-15. Boxes enclose members of recurrent groups. Lines connect taxa with affinities outside their groups. Numbers of occurrences are in parentheses.

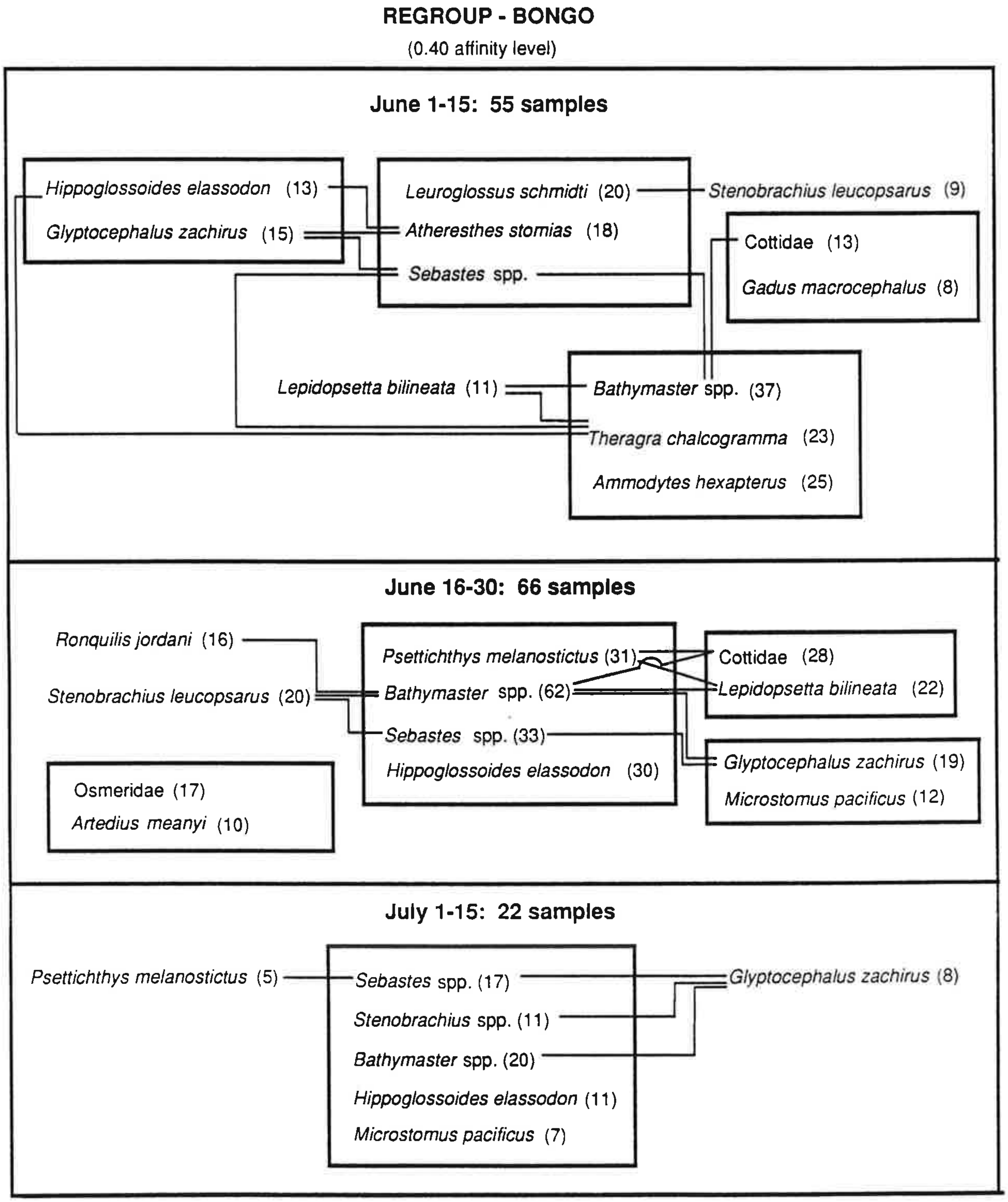
REGROUP - BONGO

(0.40 affinity level)

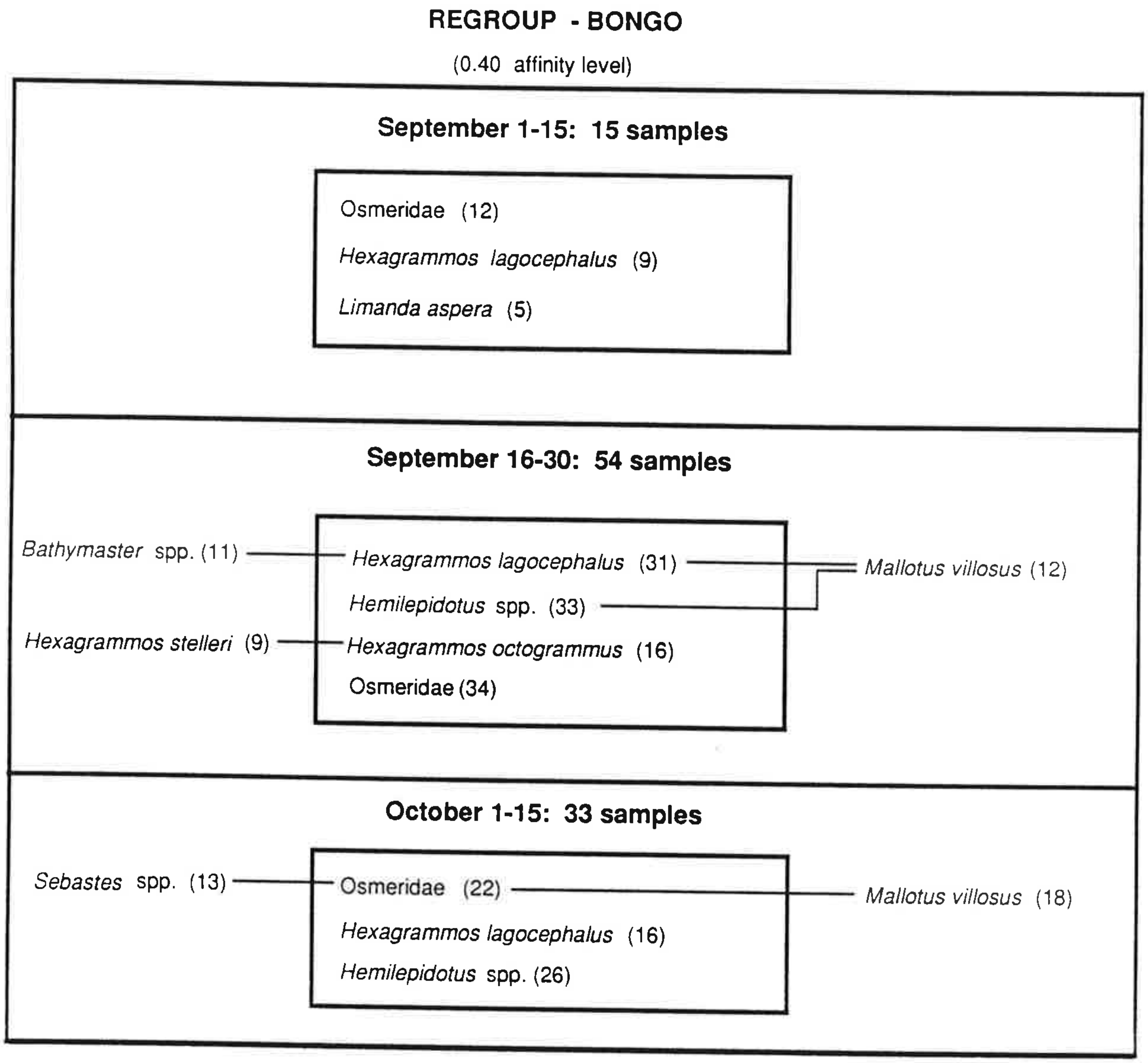
May 16-31: 207 samples



Appendix Figure 113.--Results of recurrent group analysis of bongo catches by date window, May 16-31. Boxes enclose members of recurrent groups. Lines connect taxa with affinities outside their groups. Numbers of occurrences are in parentheses.



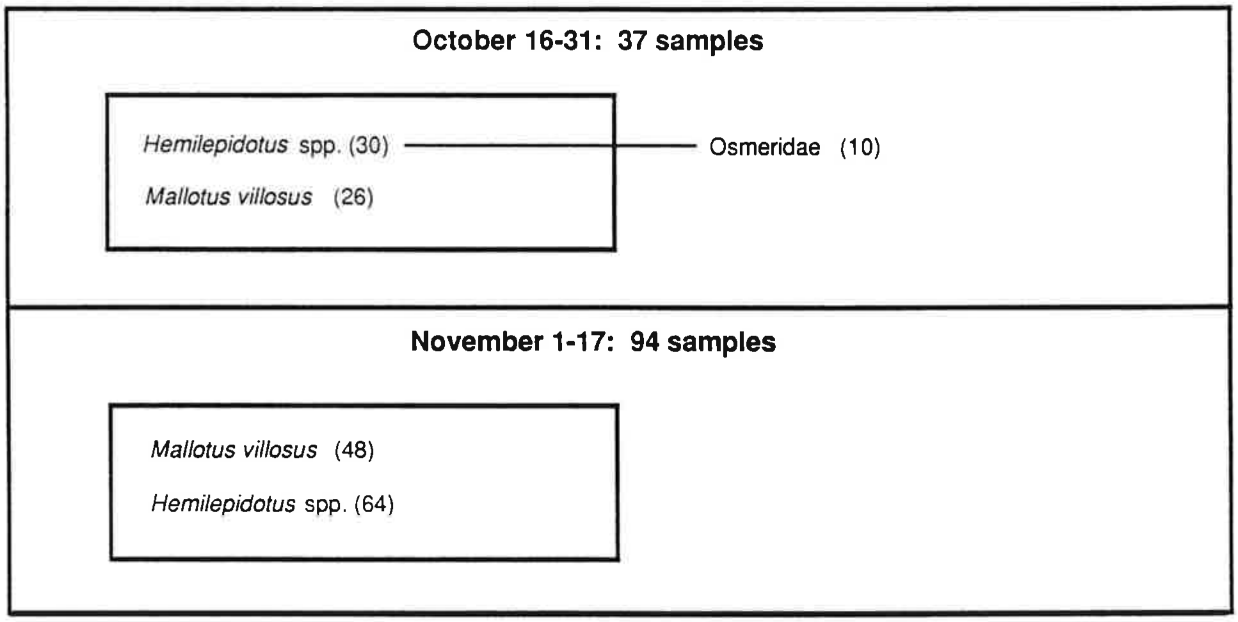
Appendix Figure 114.--Results of recurrent group analysis of bongo catches by date window, A. June 1-15, B. June 16-30, C. July 1-15. Boxes enclose members of recurrent groups. Lines connect taxa with affinities outside their groups. Numbers of occurrences are in parentheses.



Appendix Figure 115.--Results of recurrent group analysis of bongo catches by date window, A. Sept. 1-15, B. Sept. 16-30, C. Oct. 1-15. Boxes enclose members of recurrent groups. Lines connect taxa with affinities outside their groups. Numbers of occurrences are in parentheses.

REGROUP - BONGO

0.40 affinity level



Appendix Figure 116.--Results of recurrent group analysis of bongo catches by date window, A. Oct. 16-31, B. Nov. 1-17. Boxes enclose members of recurrent groups. Lines connect taxa with affinities outside their groups. Numbers of occurrences are in parentheses.