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midwater trawls, tuna longline sets, and aerial sightings**

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Introduction

This is the second in a series of atlases describing the spatial distribution of a wide range of New Zealand marine fish species produced as the first step towards analysing fish community structure in the New Zealand region. These atlases contain distribution maps that greatly extend our knowledge of the range of most species and we hope that they will provide a valuable reference document.

The first atlas (Anderson *et al.* 1998) provided geographical and depth distribution maps for species encountered in research bottom trawls over 35 years. It included 236 species, 26 species groups, and 8 families, and covered most areas around New Zealand and its offshore islands from 4–1700 m depth.

This second atlas provides distribution maps for “off-the-bottom” fish and squid species sampled by midwater trawl, tuna longline, and aerial sightings. These distributions were determined from four different data sources: the Ministry of Fisheries research trawl and scientific observer databases for midwater trawl distributions, the Ministry of Fisheries tuna longline observer database for tuna longline distributions, and the Ministry of Fisheries aerial sightings database for the aerial sightings distributions. The data were patchy in both areal and seasonal coverage, so the resulting distributions are a more reliable indication of where fish occur rather than where they do not. The distributions are presented in three sections, by method. A total of 112 species groups (90 species, 17 genera, and 5 families) are included. For midwater trawl caught species, depth distributions are presented as well as the maps of geographical distribution.

Databases

Midwater trawl

The Ministry of Fisheries research trawl survey database (*trawl*) (Mackay 1998) contained 908 midwater tows with 5852 occurrences of 317 species and species groups in February 1999 when relevant data were copied from it. These records span 20 years. All records of midwater trawls were included, regardless of their depth off the bottom.

The Ministry of Fisheries Scientific Observer Programme database (*obs*) (Mackay 1995) contained 2874 midwater tows with 19 881 occurrences of 184 species and species groups from 1990 on in October 1998 when relevant data were copied from it. Because of possible confusion over trawl gear identification (99 gear codes exist for midwater and bottom trawls), we included only those tows which were at least 20 m off the bottom at the start and finish of the tow, and for which the headline height was at least 20 m.

The resulting midwater trawl dataset contained 3782 station records and 25 733 occurrences. Spatial coverage is more patchy than for the bottom trawl data used for the first atlas. This is because of the fishery-specific nature of the scientific observer data, and the more targeted use of research midwater trawls, mainly for acoustic target identification work on orange roughy, oreo, and hoki surveys as well as some juvenile surveys for orange roughy, rock lobster *phyllosoma*, and squid.

A variety of midwater nets have been used for both commercial and research tows, with various headline heights, codend mesh sizes, and towing speeds. We make no attempt in this atlas to identify any differences in distribution that may be due to such factors.

Distribution maps were produced for the 90 species or species groups (70 species, 17 genera and 5 families) that occurred in more than 20 tows.

Tuna longline

The tuna longline database (*l_line*) (Mackay & Kalish 1995) contains information collected by scientific observers aboard tuna longline vessels. It covers 104 trips by foreign licensed, foreign chartered, and domestic longline vessels in the New Zealand Exclusive Economic Zone (EEZ) between June 1987 and June 1998. One observer, who completed five voyages, did not fully record the catch, so those trips were deleted, leaving a total of 99 trips, 2604 longline sets, and 6.9 million hooks.

Observations on more than 207 000 specimens, including 70 species of fishes and a few invertebrates, were recorded. Most species were rarely observed, and only 29 species (27 species, 2 species pairs) had more than 20 observations. Distribution maps for these species are presented here.

Aerial sightings

The aerial sightings database (*aer_sight*) (Taylor 1995, Taylor, in press) contains abundance information for a range of surface schooling species. Aerial sightings data are collected by pilots flying aircraft in support of purse-seine vessels. Their main role is to locate fish schools of a particular size and species composition, according to current market demands, and to assist the vessels in capturing them. The pilots record the location of all schools seen, and estimate species composition, school size, and the number of schools in a “sighting”.

The database contains information for 53 817 sightings of 96 species and species combinations, from 30 387 flights since 1976. The species include marine fish, marine mammals, and some crustaceans. Coverage is limited to the main areas of flying effort in the Bay of Plenty and northeast coast of the North Island and the north of the South Island, from Golden and Tasman Bays to Kaikoura (*see* distribution of flying effort in aerial sightings section). The data provide a good time series for the seven main purse-seine species—skipjack tuna (*Katsuwonus pelamis*), trevally (*Pseudocaranx dentex*), blue mackerel (*Scomber australasicus*), jack mackerel (*Trachurus declivis*, *T. murphyi*, *T. novaezelandiae*), and kahawai (*Arripis trutta*), but are less extensive for other species. Distribution maps of the 16 species and species combinations (9 species, 1 genus, and 6 mixed species schools) of marine fish that were sighted more than 50 times are presented here.

Species identification

Identification of fish and squid at sea depends on the experience of the scientific staff on each voyage and the availability of reliable reference texts. Anderson *et al.* (1998) summarised the improvement in fish identification guides over the last two decades. The same sources of information were used for identification of species on commercial and research vessels. As well as in house guides and photographs, the main references used to identify fish have been Ayling & Cox (1982), Paul (1986), and Paulin *et al.* (1989). Elasmobranch identification followed Compagno (1984) and Compagno & Didier (in press), and squid identification followed Roper *et al.* (1984). Unidentified specimens were also often brought ashore for identification by Museum of New Zealand Te Papa Tongarewa (MoNZ) staff and NIWA taxonomists. Identification of some species complexes and families requires specialised knowledge not always available at sea, and on some trips identification (either at sea or from preserved samples) may give the impression of clumped distributions (e.g., some lanternfish species off the east coast of the North Island). Known identification problems are indicated on the distribution plots in explanatory footnotes.

Identification of surface schooling species for the aerial sightings database depends on the pilot's ability to recognise species composition of a school from its appearance. According to Bell (1976), species identification is based mainly on school colour and, although confusion can occur when light

is inadequate or the sea is moderate to rough, swimming and schooling behaviours usually offer enough information for positive identification. School size (in tonnes) is estimated from the density, surface area, and depth of the school (Bell 1976). Skill is developed over a period of time, with feedback provided by comparisons of the pilot's estimate with the amount landed onto the vessel (Taylor, in press).

Possible sources of error or uncertainty

Midwater trawl

Sources of uncertainty in the identification of midwater trawl species on commercial and research vessels are similar to those described for research bottom trawl species (Anderson *et al.* 1998), and have been adapted for inclusion here.

Species were sometimes misidentified or lumped into generic groups (e.g., rattails) in the early years of deeper water fishing before comprehensive identification guides were available. The main priority on commercial and research vessels was to collect data on commercially important species, and identification to species level of non-commercial bycatch species was sometimes given low priority. As detailed guides for these species became available, identification to species level became more reliable. In more recent years, some single "species" have been found to include more than one species (e.g., sprats, giant stargazer).

Some identification problems were specific to the way in which trawl survey data were collected. Computerisation of the data involved the establishment of unique, three-letter, species codes. Use of these codes without accompanying species names has made subsequent error-checking of species codes impossible. The species code system also included "generic" codes for use when the species was not or could not be identified. This has caused problems with the verification of a few records for some species where the "generic" code is the same as a species code (e.g., WAR is the code for blue warehou, but may have been used occasionally for other warehou species). Where it is obvious that such a "generic" code was used throughout a research survey for a genus rather than a species, the records for this code have been omitted. Any problems with observers using generic codes have not been addressed.

Footnotes are provided for distribution maps where we consider that unresolvable errors may still exist.

Tuna longline

Species identification by observers on tuna longline vessels has improved through time, as they have gained experience and as cryptic species have been identified in the catches. The number of fish recorded as "unidentified" has declined, as has the number of fish incorrectly recorded under other names. Records of uncommon species were checked for accuracy where possible by examining photographs taken by observers. Species reported by only one observer were treated as unidentified unless they could be verified by photographs. The most important identification problems affecting the distribution plots presented here were as follows.

- Porbeagle and mako sharks were not adequately distinguished by all observers before 1993, so distribution plots for those two species include records from 1993 onwards.
- The lancetfish species *Alepisaurus ferox* and *A. brevirostris* have only recently been distinguished by observers, so the two species have been combined on one plot.
- Juvenile hapuku, *Polyprion oxygeneios*, and bass, *P. americanus*, are difficult to distinguish, so they have been combined on one plot.

Aerial sightings

Species identification by spotter pilots is probably accurate, which is to be expected, given that their credibility in the industry depends on it. This also applies to estimates of school size (the importance of which is discussed below), but only for those species targeted by the purse-seine fleet. For the non-targeted species whose distributions are presented here, baitfish, blue maomao (*Scorpius violaceus*), kingfish (*Seriola lalandi*), pilchard (*Sardinops neopilchardus*), and snapper (*Pagrus auratus*), estimates are likely to be less accurate because there can be no feedback from the vessel. Without regular landings, pilots cannot tune their methods of estimation for these species.

For the same reason the species composition of “baitfish” schools is mostly unknown. A full species list of New Zealand baitfish includes juveniles of blue mackerel, jack mackerel, kahawai, and koheru (*Decapterus koheru*), as well as all life history stages of anchovy (*Engraulis australis*), pilchard, piper (*Hyporhamphus ihi*), saury (*Scomberesox saurus*), slender sprat (*Sprattus antipodum*), stout sprat (*Sprattus muelleri*), and yellow-eyed mullet (*Aldrichetta forsteri*), but it is unknown which of these are observed by fish-spotter pilots. Sightings that were recorded as pilchard are not included in the “baitfish” distribution and have been used to produce a separate distribution map.

Mixed schools are frequently sighted, and a number of mixed distributions are presented here, but the relative proportions of the constituent species are not recorded. Mixed schools are defined here according to their species composition. Their presence seems to vary seasonally in a way that is specific to their species composition (Taylor, unpublished data), and they may persist over some period of time. They are important in that they represent large total tonnages.

Each species can potentially mix with a range of other species. For mixed schools of kahawai and jack mackerel, a distribution map is presented of the sightings of this combination because it satisfied the selection criterion of more than 50 sightings. No other mixed school combinations satisfy the selection criterion on their own. Instead, sightings of all mixed combinations for a particular species are aggregated, and where the aggregate meets the selection criterion, the sightings are plotted as the distribution of mixed schools for that species. Because they contain more than one, and up to four species (e.g., schools have been recorded that contain blue mackerel, jack mackerel, kahawai, and trevally), some mixed school sightings are included in more than one distribution (e.g., sightings of the kahawai-trevally combination are included in mixed school distributions of both kahawai and trevally).

The following species occur in mixed school distributions in addition to the species that gives the group its name.

- Blue mackerel mixed schools may contain “baitfish”, jack mackerel, skipjack tuna, and trevally.
- Blue maomao mixed schools may contain kahawai, pink maomao (*Caprodon longimanus*), and trevally.
- Jack mackerel mixed schools may contain albacore (*Thunnus alalunga*), “baitfish”, barracouta (*Thyrsites atun*), blue mackerel, skipjack tuna, and trevally.
- Kahawai mixed schools may contain albacore, “baitfish”, barracouta, blue mackerel, blue maomao, jack mackerel, koheru, pink maomao, skipjack tuna, snapper, trevally, and warehou (species unknown).
- Trevally mixed schools may contain blue mackerel, blue maomao, jack mackerel, kahawai, kingfish, koheru, pink maomao, and snapper.

Jack mackerel (*Trachurus* spp.) species cannot all be distinguished from the air. Schools of *T. murphyi* have a characteristic red-brown colour, but *T. declivis* and *T. novaezelandiae* schools cannot be distinguished. Therefore, all three species have most often been recorded as the aggregate “jack mackerel” (presented here as *Trachurus* spp.). Distribution of *T. murphyi* is based on the records of the principal pilot in the Bay of Plenty who has separated *T. murphyi* since September 1992.

Species distribution

Geographical distributions and depth distributions are presented for midwater trawl species. Reliable depth data were not available for tuna longline and surface schooling species.

Midwater trawl

For the research trawl data, the start and finish positions of each tow were recorded with various degrees of accuracy. Position fixing methods included Global Positioning System (GPS), satellite navigation, radar, and dead reckoning. Seabed depth, depth of the headline, and headline height were recorded for all tows. Where possible, average net depth was calculated as the mean of the minimum and maximum net depths or mean of the start and finish net depths (Appendix 1). Average bottom depth was calculated as the mean of the start and finish bottom depths (Appendix 1). If averages could not be calculated, any one of the available observations was used to represent depth.

Tuna longline

The two main areas fished by tuna longliners are the eastern North Island and the western South Island. Observers do not record the exact location of each hook, either at setting or retrieval. Instead, they record the vessel's location by GPS when line hauling begins, and then at approximately 1 hour intervals. Full recovery of a longline containing more than 3000 hooks may take 12 hours. The approximate location of each hook at the time of recovery has been estimated by interpolation between the hourly locations.

Depth information is not routinely available on tuna longline vessels because most sets are made near the surface over deep water, and the echo-sounders frequently are unable to register the seabed. However, most hooks are set within 250 m of the surface over depths that exceed 1000 m.

Aerial sightings

Before 1998 all sightings were indexed to a numbered grid of half-degree squares. Pilots recorded the area where sightings occurred by either indicating the area on a map and grid incorporated into the data collection form, or recording estimates of distance and a directional bearing to known landmarks. During 1998 the pilots began recording positions of sightings using handheld GPS units.

Possible sources of error or uncertainty

Midwater trawl

Sources of uncertainty in the positions of midwater trawl species are similar to those described for bottom trawl species (Anderson *et al.* 1998).

Initial distribution maps and depth plots showed occasional outliers for which location or depth had obviously been misrecorded. These errors were corrected where possible. If the correct position and matching bottom depth could not be determined, the record was deleted.

Another possible source of error arose where the net, the fish holding bins, or the conveyors were not completely cleared of fish after a particular tow. Such fish may have been occasionally recorded in the

the catch from the next tow. Outliers which appeared to have resulted from incorrect tow allocation were omitted.

There may be some small-scale errors in tow location for early database records caused by inaccuracies of the methods used. Accuracy in recording positions has improved steadily since the start of the time series of surveys. Early surveys relied on radar and dead reckoning, but were often in shallow inshore waters where these techniques can be accurate. In the late 1970s and early 1980s, satellite navigation became available, but satellite passes were often infrequent and positions could be inaccurate by several nautical miles. The use of GPS from the late 1980s has improved position fixing to within about 100 m.

Research midwater tows tend to be seasonal in some areas; for example, winter off the west coast of the South Island for hoki and orange roughy surveys and August–September in the Sub-Antarctic for southern blue whiting surveys. Scientific observer records also show these seasonal patterns, as well as spring off the west coast of the North Island (jack mackerel), summer on the Chatham Rise (jack mackerel and hoki), and summer-autumn off the south of the South Island (squid and hoki).

Research tows may have caught some species near the bottom, but are unlikely to have caught species that are normally hard down on the bottom. As commercial trawls are occasionally fished hard down on the bottom, scientific observer records for tows above 20 m off the bottom were selected to minimise this problem.

Tuna longline

Positional errors in the tuna longline database were rare, because multiple, hourly positions were recorded during hauling, and the database had been groomed for errors previously under projects funded by the Ministry of Fisheries. Outliers were checked by comparing their locations with the start-of-set positions recorded by the observer and, if necessary, with the position of sets made by the same vessel on the previous and next days.

Observer data were distributed unevenly across months. All observer data from around South Island were collected during March–July (mostly April–June). Observer data were collected throughout the year around North Island, but most effort was in June–July. The fish distributions shown in the plots therefore reflect mainly winter conditions. Consequently, the distributions of tropical and subtropical species are likely to have a northerly bias, and the distributions of cool temperate and Sub-Antarctic species may have a southerly bias.

Aerial sightings

The frequency of positional errors in the aerial sightings database is unknown, but is assumed to be low. Errors arising from sightings being recorded in grid squares adjacent to those where the fish were actually sighted are probably more frequent than gross positional inaccuracies. Comprehensive range checks at the time that data forms are processed reduces gross recording errors and any others introduced when forms are coded. Several distributional outliers were identified and corrected in the original drafts of the maps presented here.

According to aerial sightings data, most species exhibit strong seasonality in their presence at the surface (Taylor, in press), and little flying effort during some months may result in poor representation of species that are observable only at that time. Low levels of flying effort are particularly evident on the west coast of the North Island, where there is little purse-seining due to rough sea conditions and long steaming distances to unload. Most flying occurs in this area between January and April, probably because skipjack tuna are being monitored, but there has been

considerable coverage during other months as well. Flying on the west coast of the North Island was probably extensive enough to produce reliable presence/absence distributions, but there is some variation in relative abundance compared with other areas attributable to the lower flying effort.

Presentation of data

This atlas provides fish distribution information on the 112 most frequently caught species and species groups (90 species, 17 genera, 5 families) that occur off the bottom. The maps based on each of the three methods are slightly different because of the differences in the methods of recording the data and the types of data available. Figures 1–4 show the location of total fishing effort by fishing method and recorder (for midwater tows). Features that all or most species or species group distribution maps have in common are listed below.

- The maps are arranged in alphabetical order by scientific name within each of the three sections. One common name (where it exists) is listed on each map.
- Footnotes identify issues concerning the reliability of the data presented or provide additional information.
- Distribution maps have been produced for some genera where identification to species level was impossible and for some groups above genus level where minimal identification to genus or species has been made.
- The location of total sampling effort is shown as a grey background.

Two indexes are provided: an index of common names (Index 1) and an index of family names (Index 2). Common names vary considerably among countries and among regions within a country. On the plots, we have attempted to provide the names used most often within New Zealand, especially those which appear most often in standard texts. They generally follow Paulin & Stewart (1985) and Paulin *et al.* (1989) who based their names on earlier lists (Phillips 1927, Graham 1956, Whitley 1968, Doak 1972, Ayling & Cox 1982). In the index of common names, we also list other common names used by fisheries researchers and the fishing industry. For lists of Maori fish names, see Whitley (1968) and Strickland (1990). The family names for teleosts, elasmobranchs, and squids follow Paulin *et al.* (1989), Compagno & Didier (in press), and Roper *et al.* (1984), respectively, except for a few recently updated names (C. Paulin and A. Stewart, MoNZ, pers. comm., S. O'Shea, NIWA, pers. comm.).

Midwater trawl

Each map gives the location and depth distribution of capture and the number of tows on which the species was caught. Separate symbols are used for research (closed circles) and scientific observer (open squares) data. The location of the tow represents the start position. Average capture and bottom depths were calculated and are presented as smoothed lines through values representing the proportion of all tows within each 10 m depth interval in which the species was caught. The mean depth of capture and bottom depth (weighted by the number of tows in each depth interval) and the ranges in depth are given in Appendix 1.

Tuna longline

Locations plotted on the longline maps represent the approximate hook locations at which the species was caught. Thus, each location represents one fish, and the sample size represents the total number of fish observed. For the grey background showing the distribution of longline effort, it was impractical to show the locations of the 6.9 million hooks in the database. Instead, we have plotted the location of every 500th hook, from hook 1 up to hook 4000 (most sets have less than 3000 hooks), to represent the location of the longline set.

Aerial sightings

Distributions from the aerial sightings database are presented as estimated abundance (i.e., number of schools and tonnes) rather than presence-absence plots. This has been done to express the variation between areas which is not possible in presence-absence plots because of the coarse geographical scale (half degree square) used for recording sightings.

The total flying effort in each half degree square, in hours flown since 1976, is shown in grey on all maps. The scale of this distribution differs from those for the number of schools and the number of tonnes which are presented in black and defined on the appropriate map. Definition of the effort scale is included on the first map of the aerial sightings series.

Some of the plotted circles are over the land. This is an artifact caused by centring the plotted circles in the half degree squares, and occurs where they intersect the land.

Acknowledgments

We thank the many fisheries researchers who, over the years, have taken the time to identify species and bring back new or rare specimens, and colleagues at the Museum of New Zealand Te Papa Tongarewa (MoNZ) and NIWA for formal identifications. In particular, for this second atlas, we thank Kevin Mackay (NIWA) for guidance with database construction and advice on producing data extract routines, Lynda Griggs for extracting data from the tuna longline database, and spotter pilots Red Barker, Brian Dekke, and John Reid for comments on draft distribution maps from the aerial sightings data. Special thanks to Andrew Stewart (MoNZ) and Don Robertson (NIWA) for their constructive comments when reviewing this manuscript. The Ministry of Fisheries provided access to their aerial sightings, research trawl survey, tuna longline, and scientific observer databases, and the Foundation for Research, Science and Technology funded the project.

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Total effort distributions

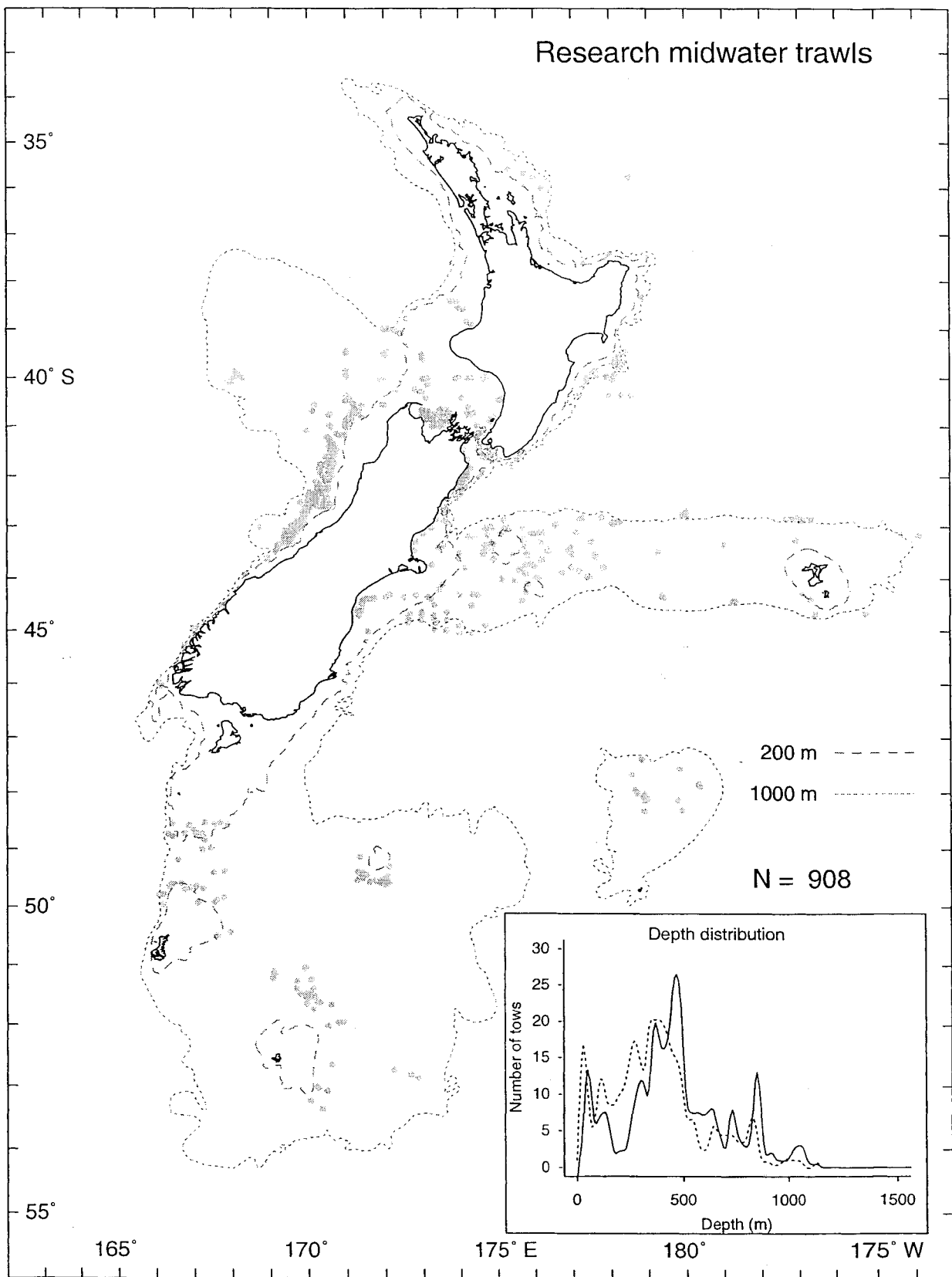


Figure 1 : Distribution of research midwater trawls. Depth distribution plot shows the depth of the seabed (continuous line) and depth of the trawl net groundrope (dashed line) by 10 m depth intervals. N is the number of tows. All positions outside the 1000 m contour are over 1000 m bottom depth, except for the northernmost station which is on a seamount at 359 m.

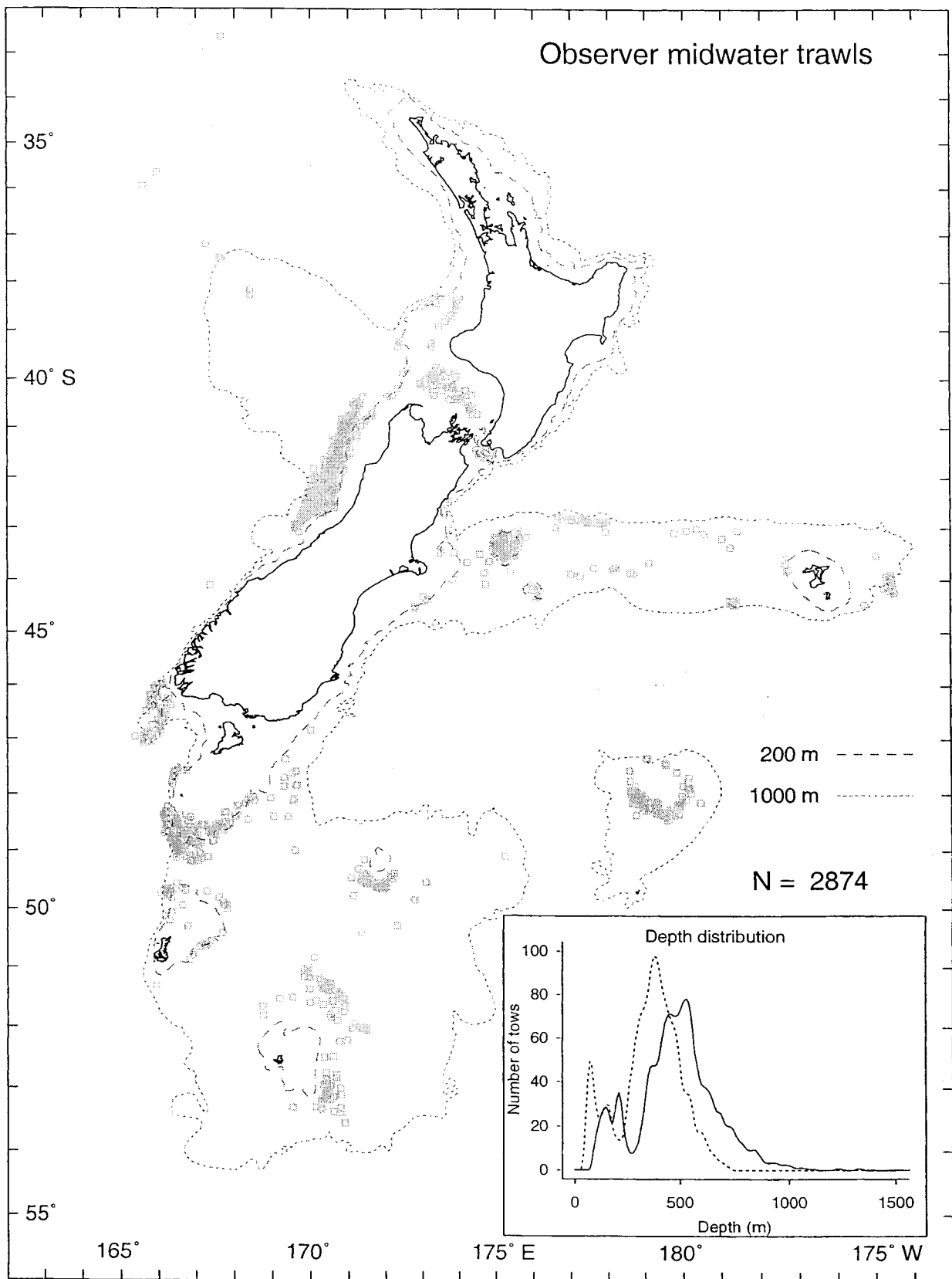


Figure 2 : Distribution of observer midwater trawls. Depth distribution plot shows the depth of the seabed (continuous line) and depth of the trawl net groundrope (dashed line) by 10 m depth intervals. N is the number of tows. All positions outside the 1000 m contour are over 1000 m bottom depth, except for the northernmost station which is on a seamount at 356 m.

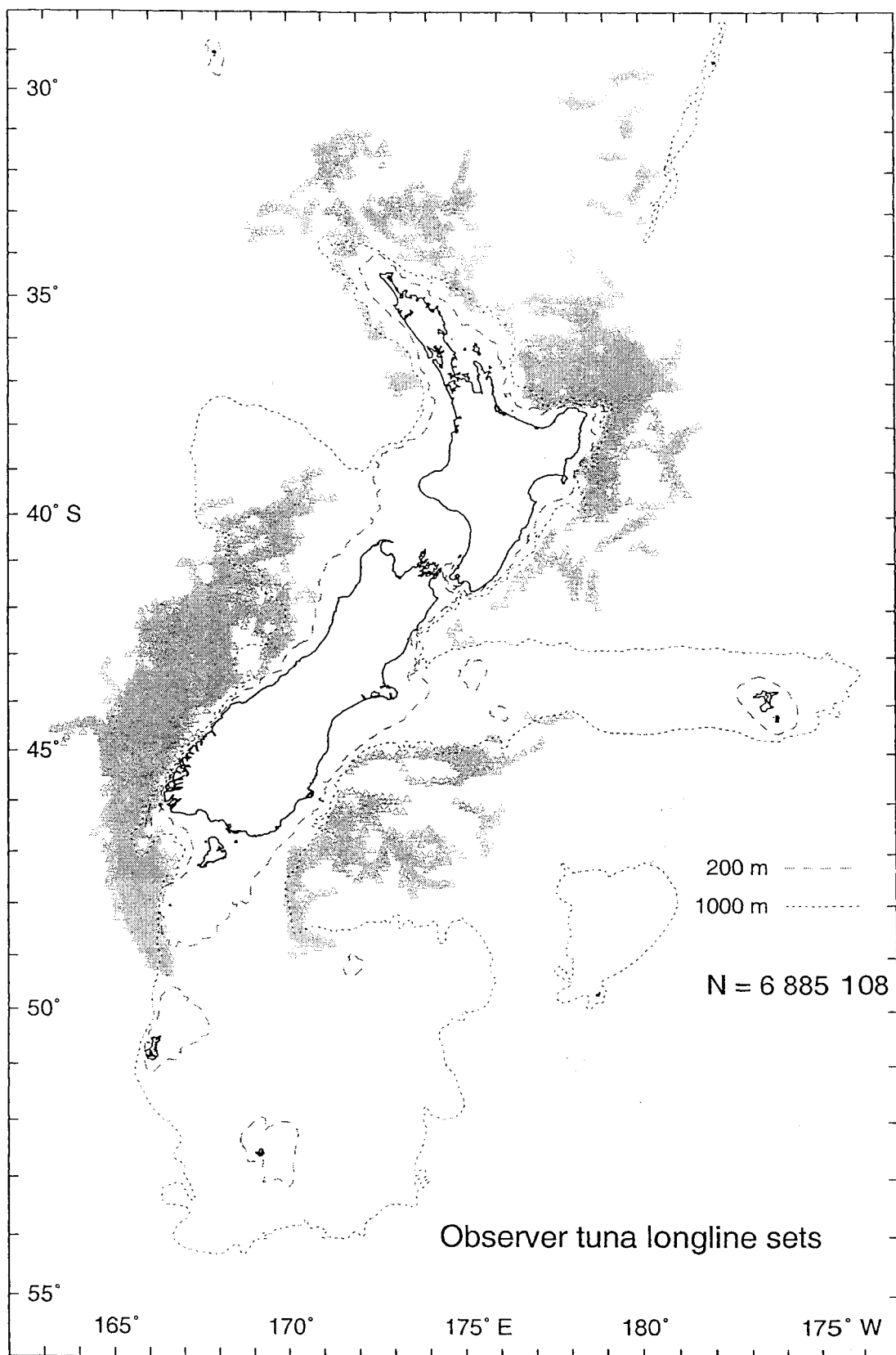


Figure 3 : Distribution of observer tuna longline sets. Only a subset of the hooks is shown for each set (the first hook plus every 500th hook thereafter). N represents the total number of hooks.

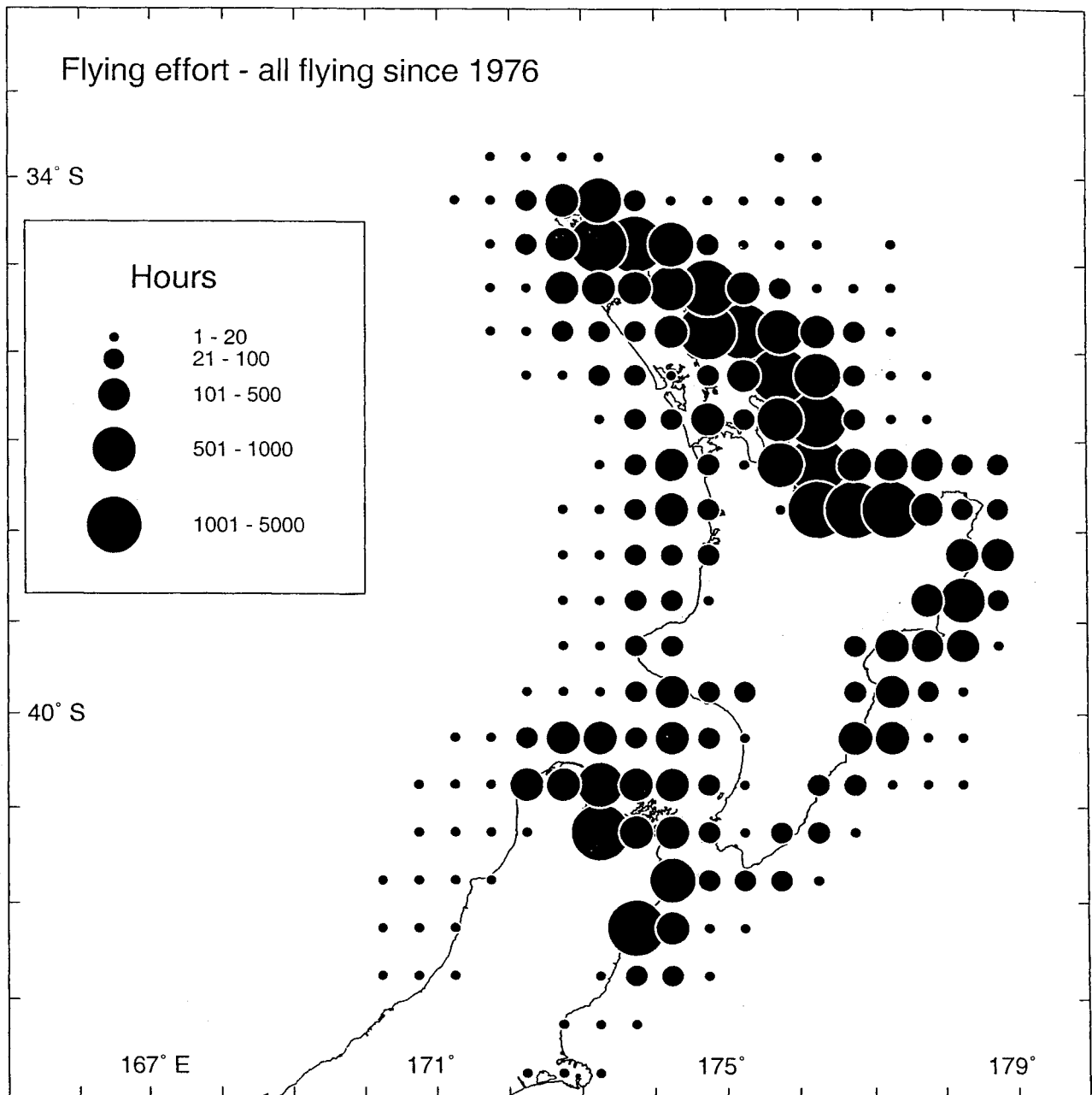
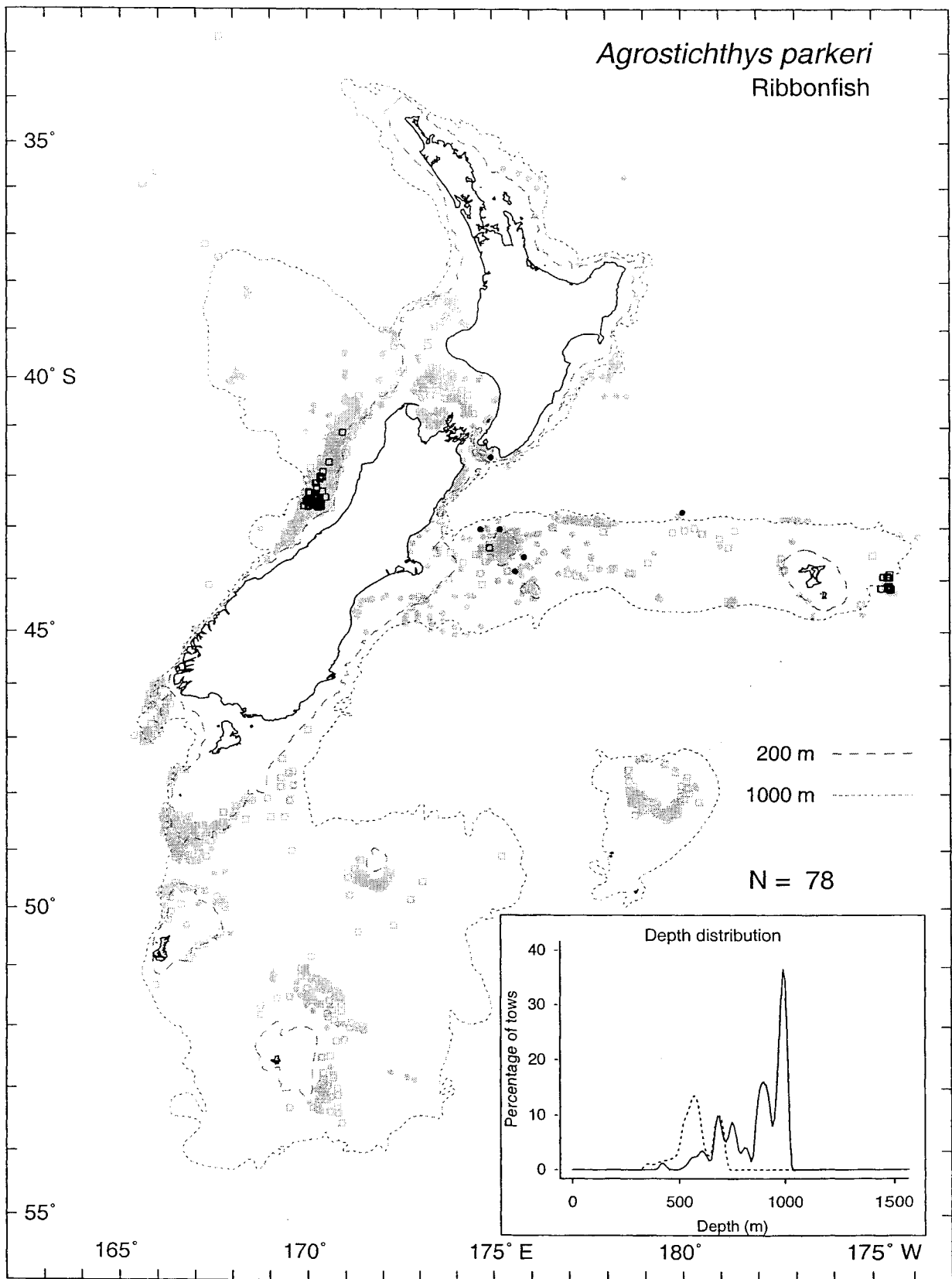


Figure 4: Distribution of aerial sightings flying effort. Circle size represents the number of hours flown by half degree square.

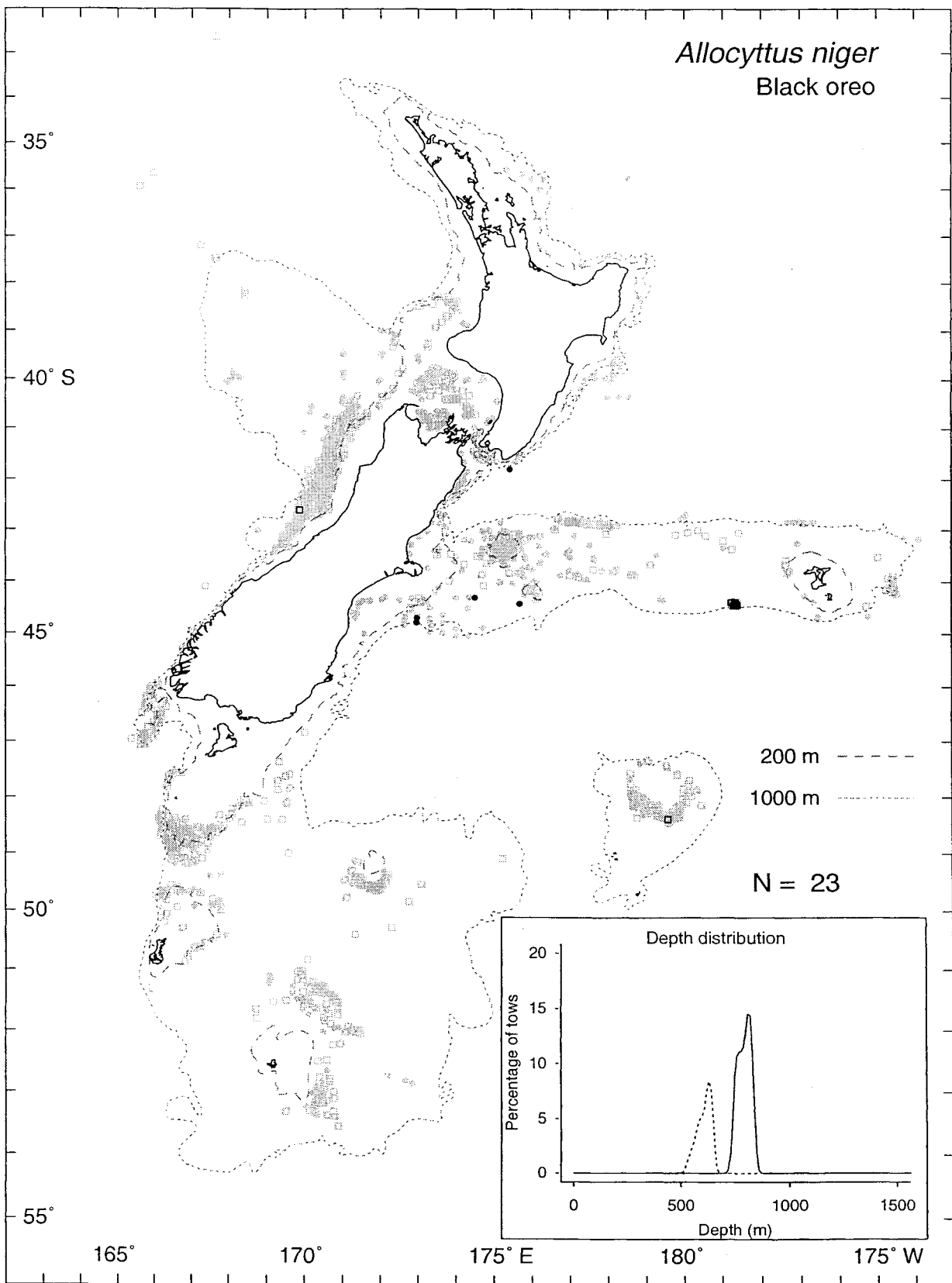
Midwater distributions

Key to symbols used in the distribution plots

•	Research midwater trawls. All tows marked in grey.
□	Observer midwater trawls. All tows marked in grey.

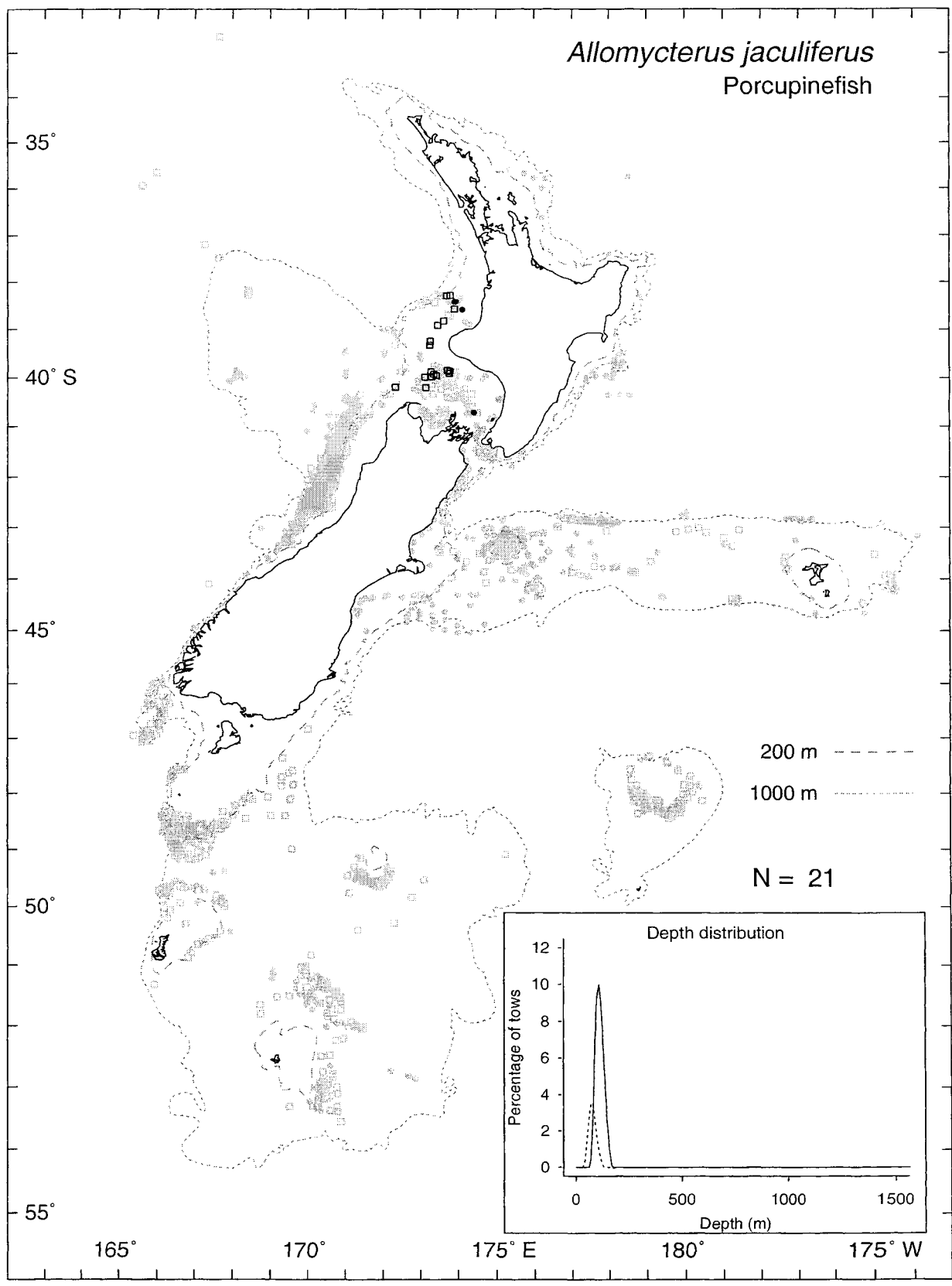


May include some *Regalecus glesne*.

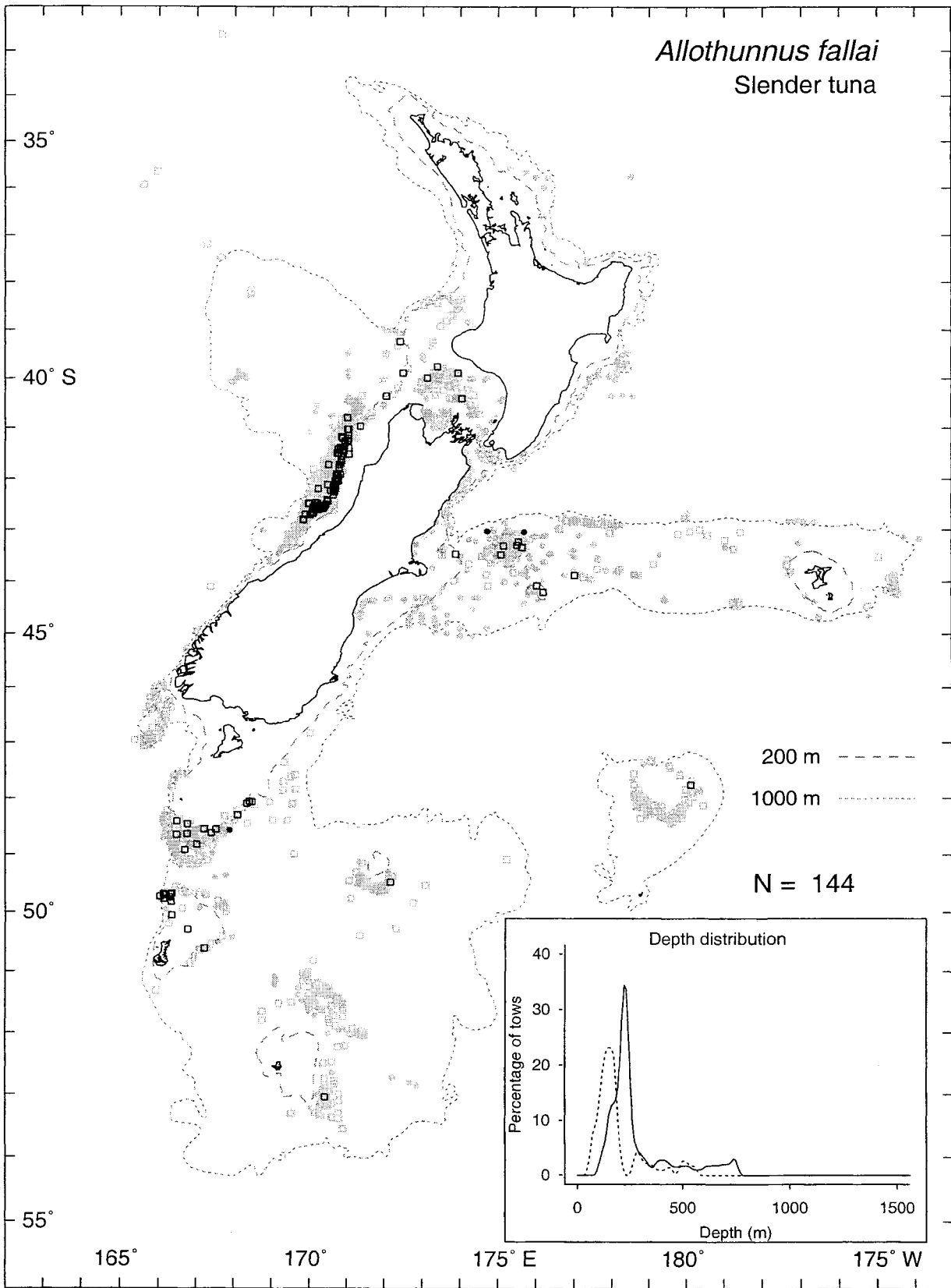


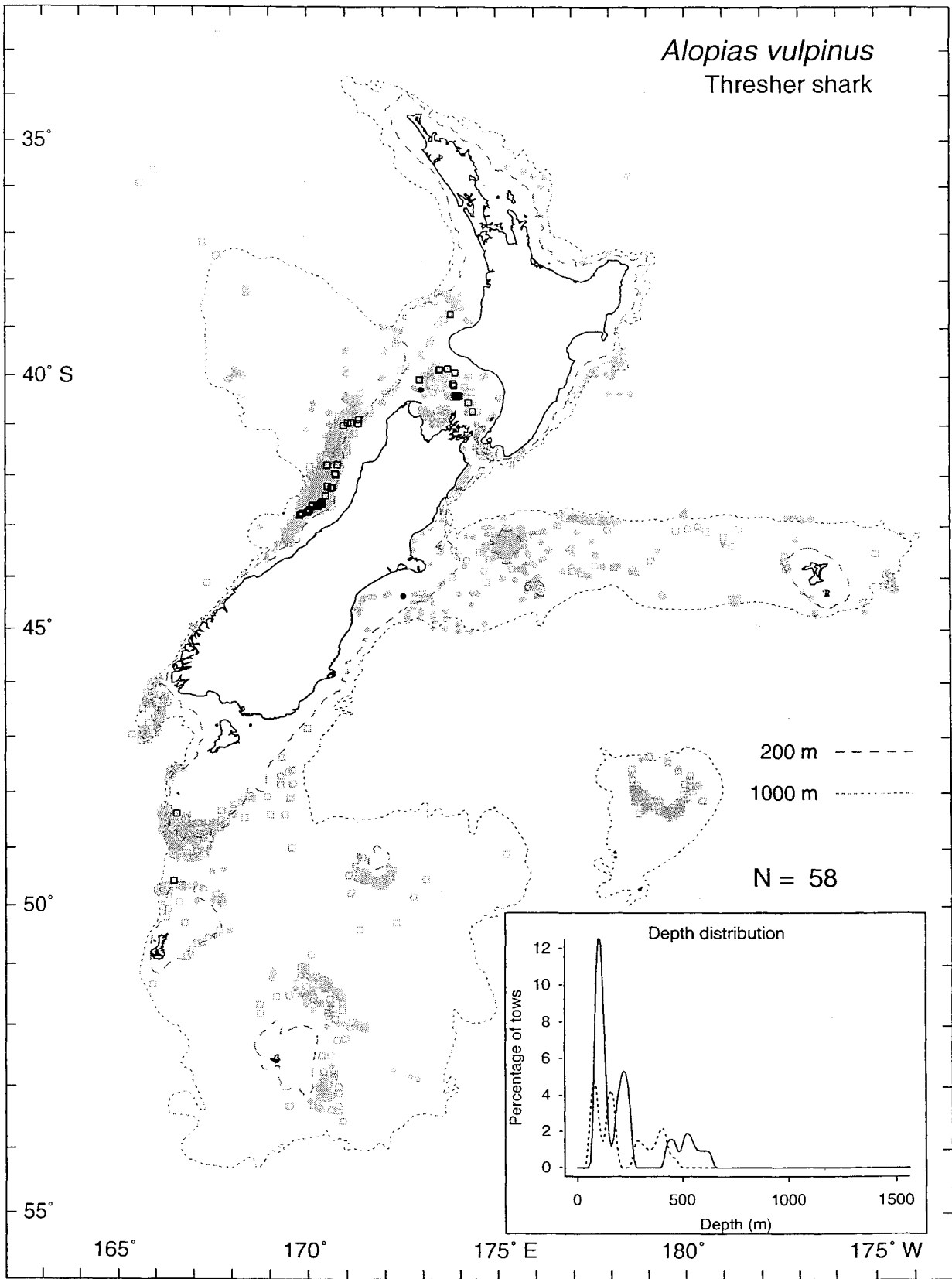
May include some *Neocyttus rhomboidalis*.

Allomycterus jaculiferus
Porcupinefish

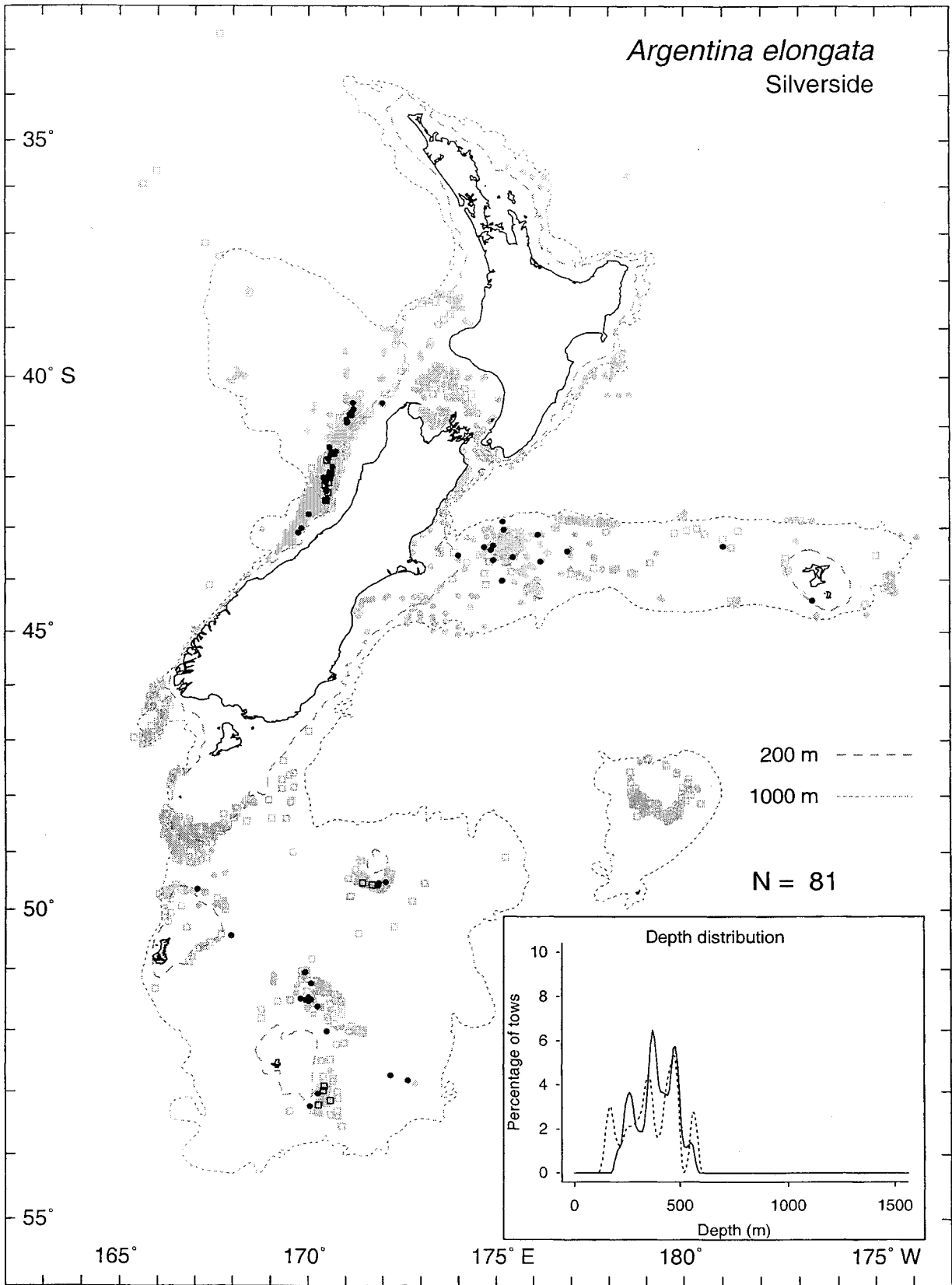


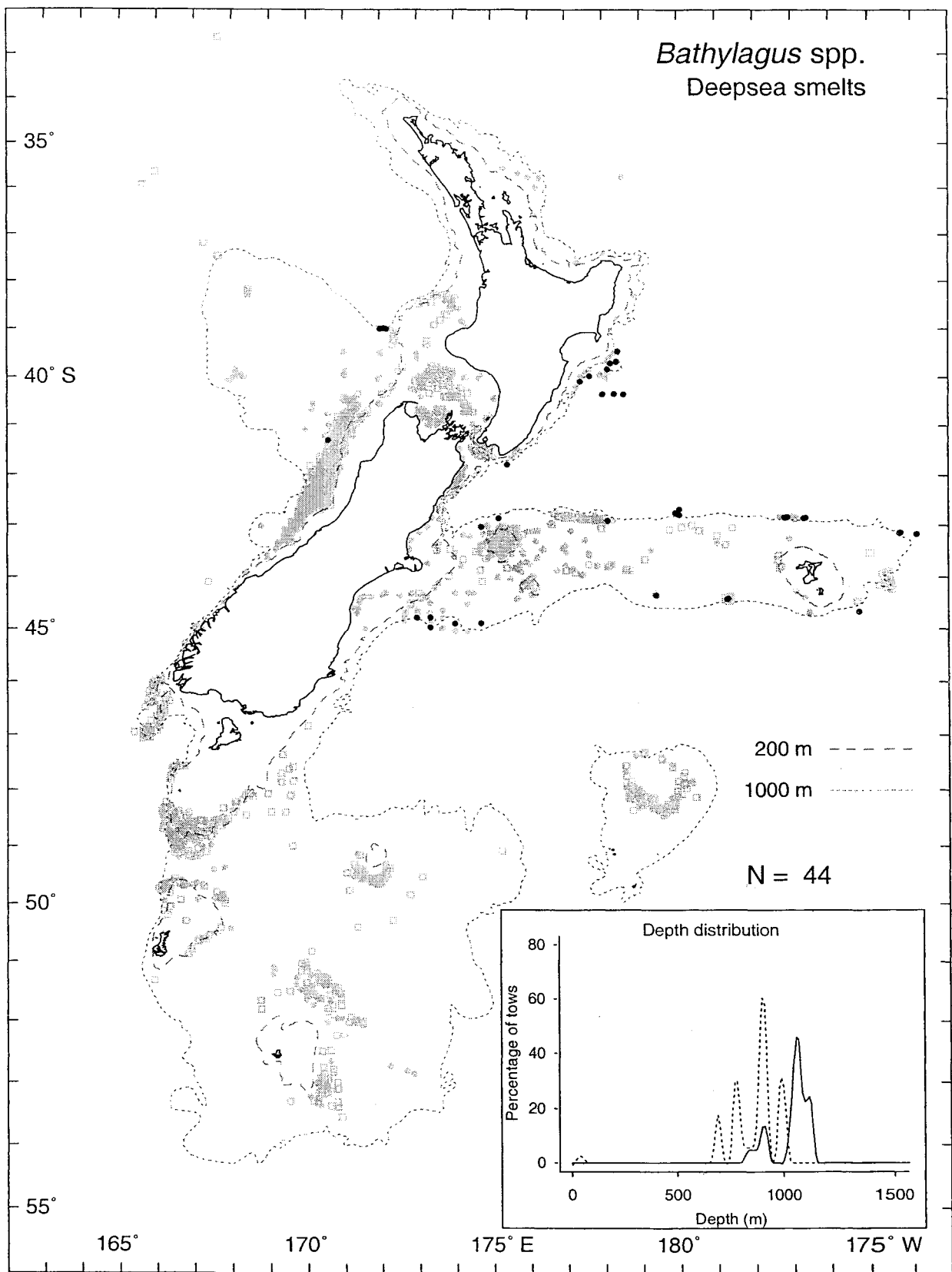
Allothunnus fallai
Slender tuna



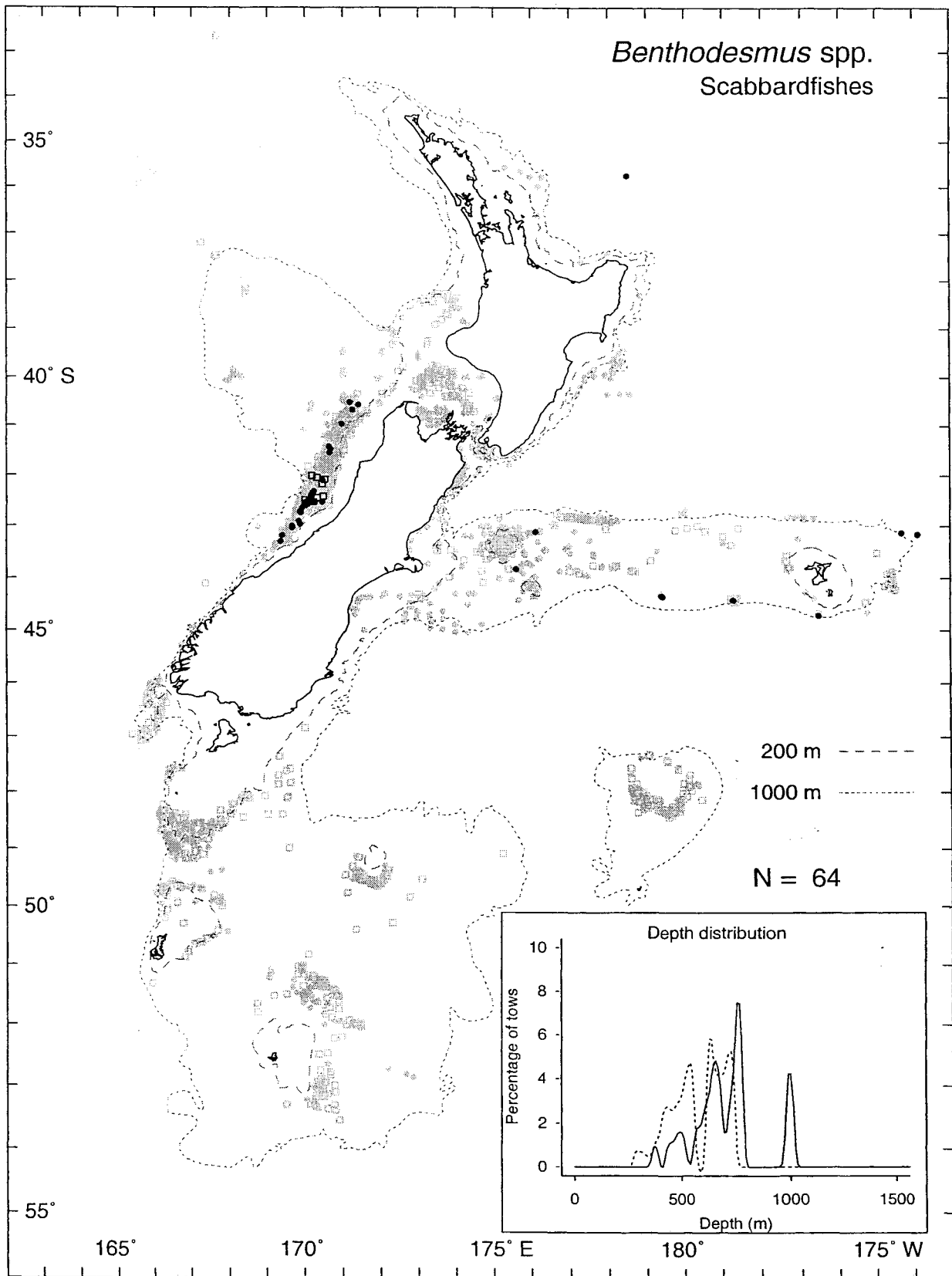


May include some *Alopias superciliosus*.

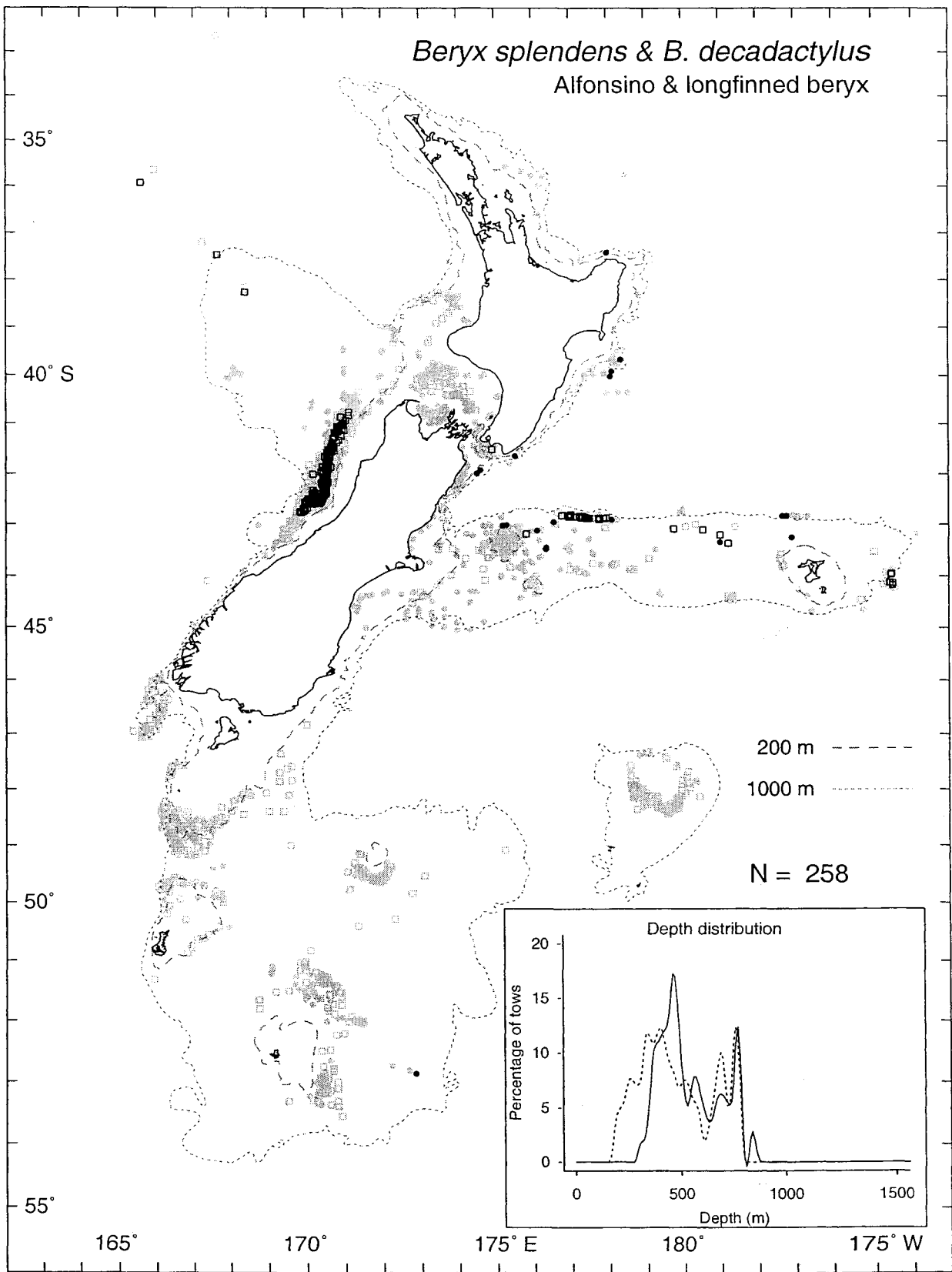




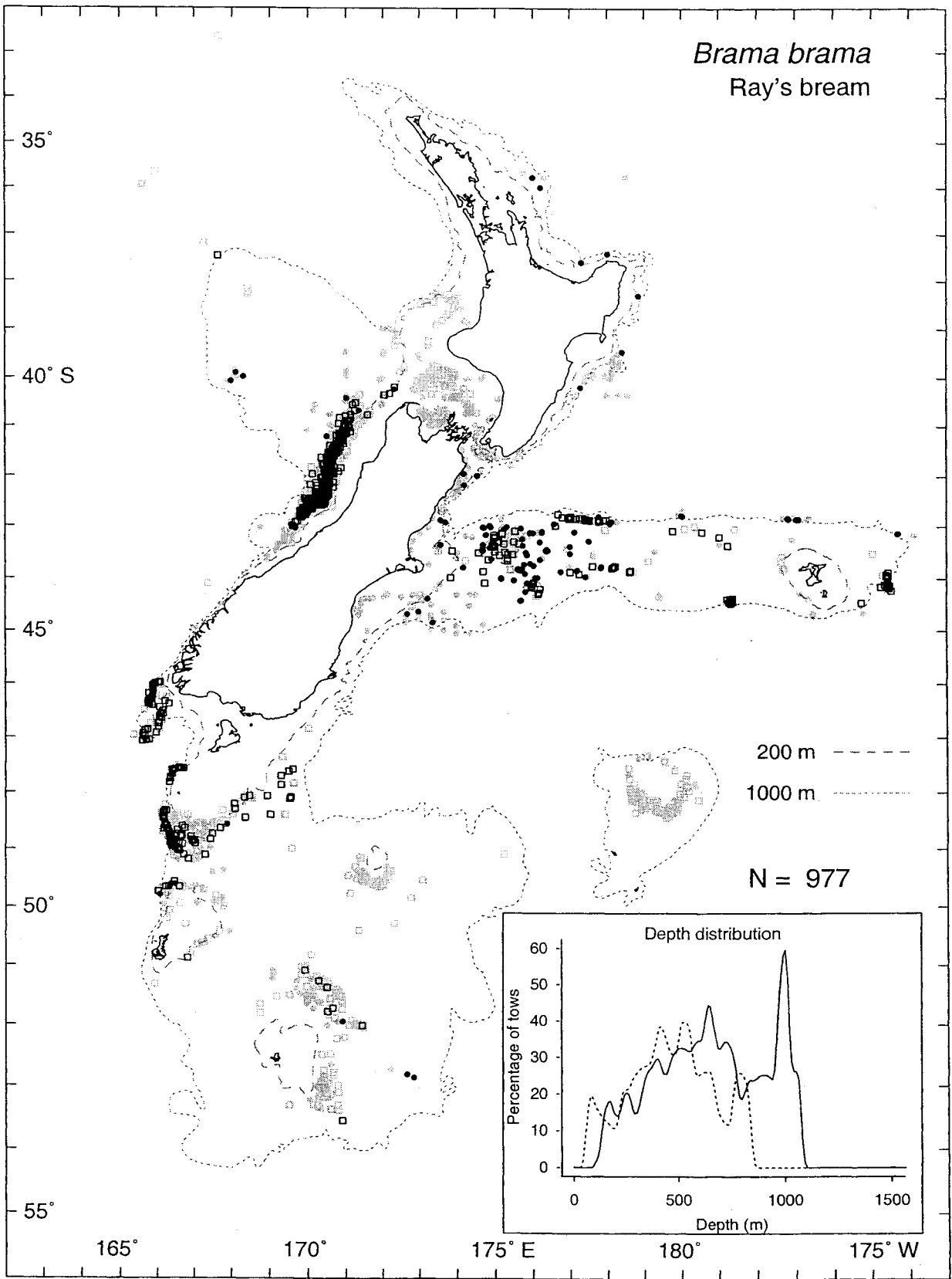
May include some *Nansenia* spp.



Includes *Benthodesmus elongatus*, *B. tenuis*, and *Benthodesmus* sp. And possibly also *Paradiplospinus gracilis*. The northern most research station outside the 1000 m contour is on a seamount in 359 m bottom depth.

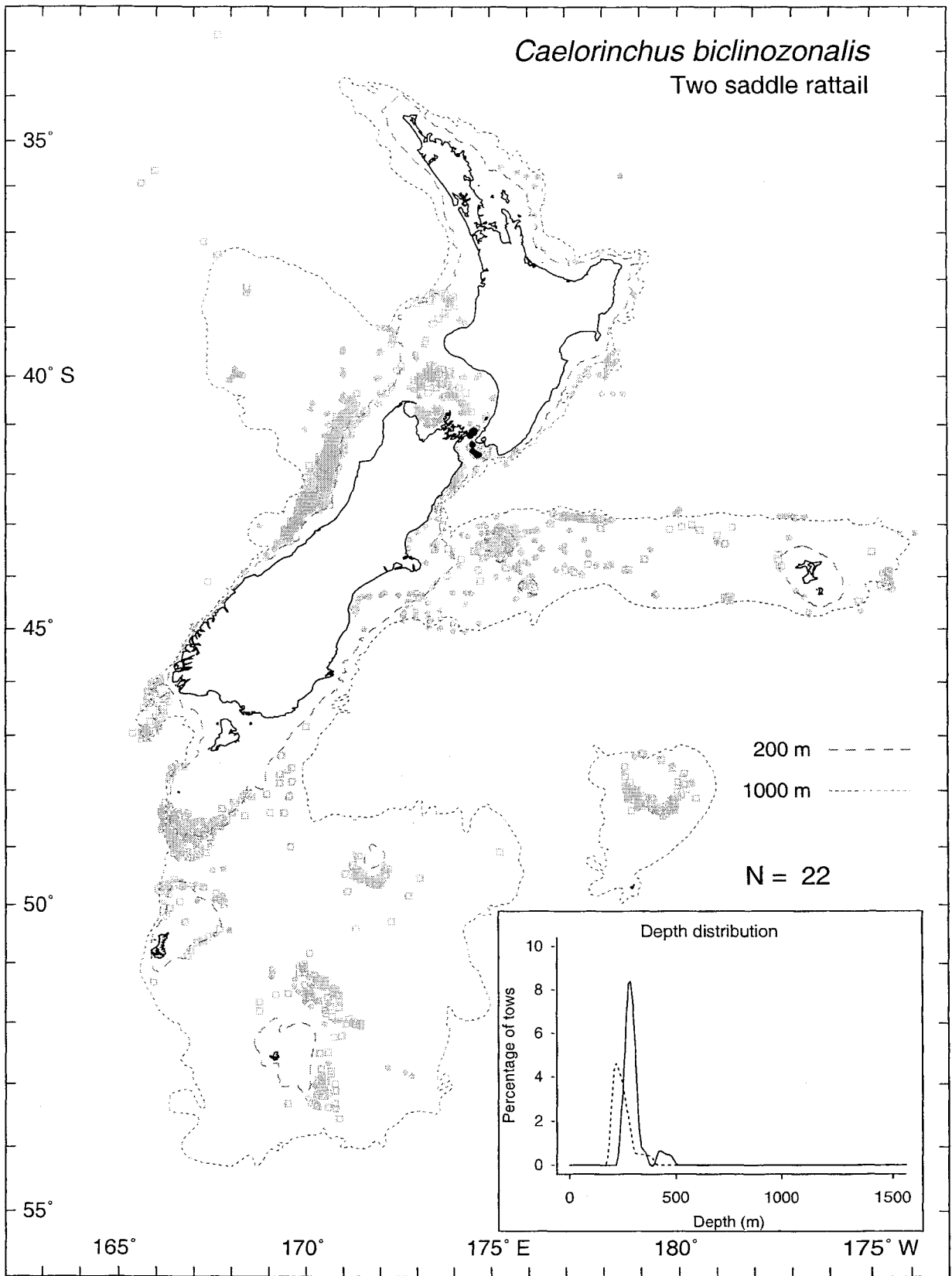


Most records will be *B. splendens*.

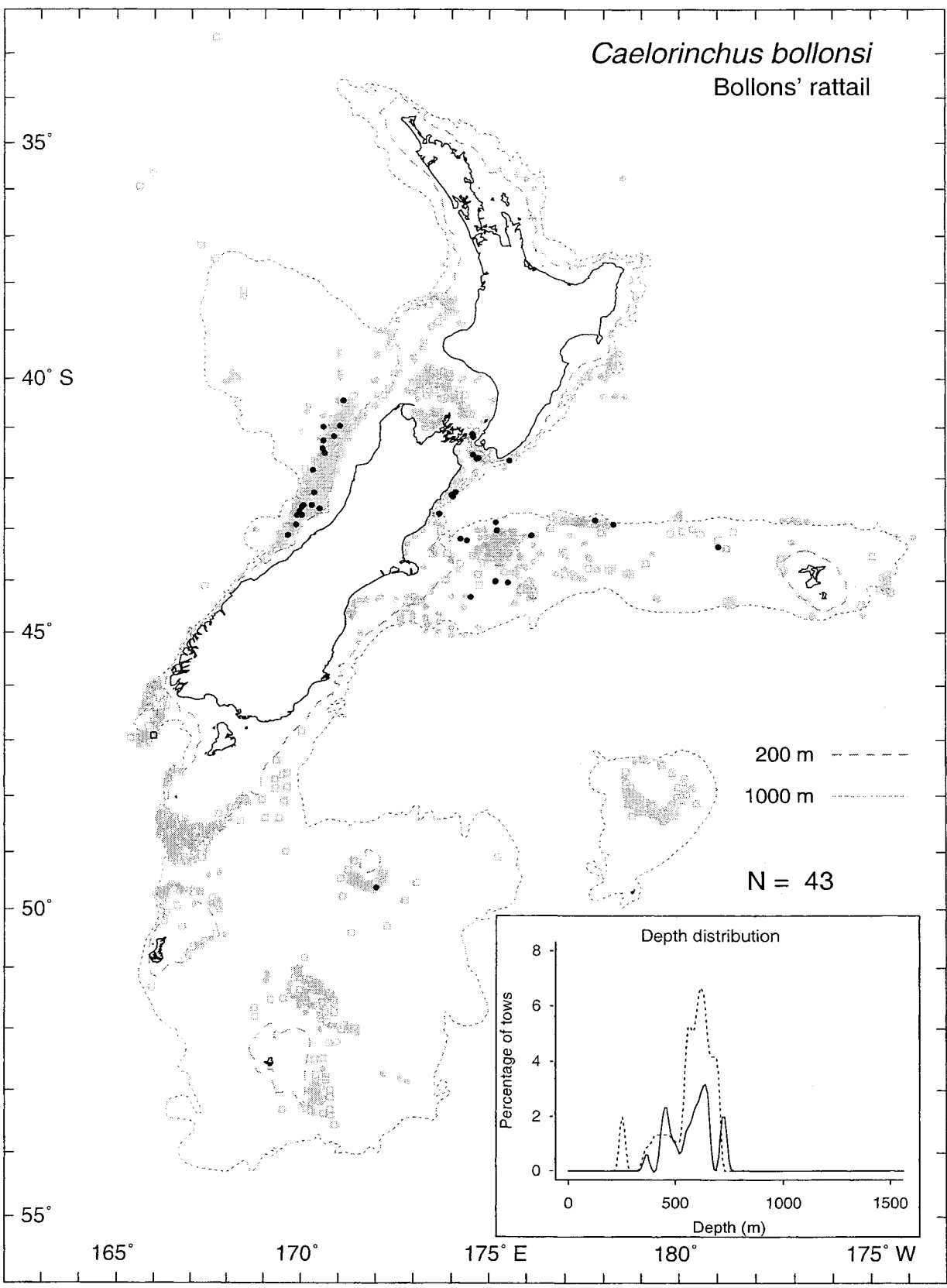


May include some *B. australis* and *Xenobrama microlepis*.

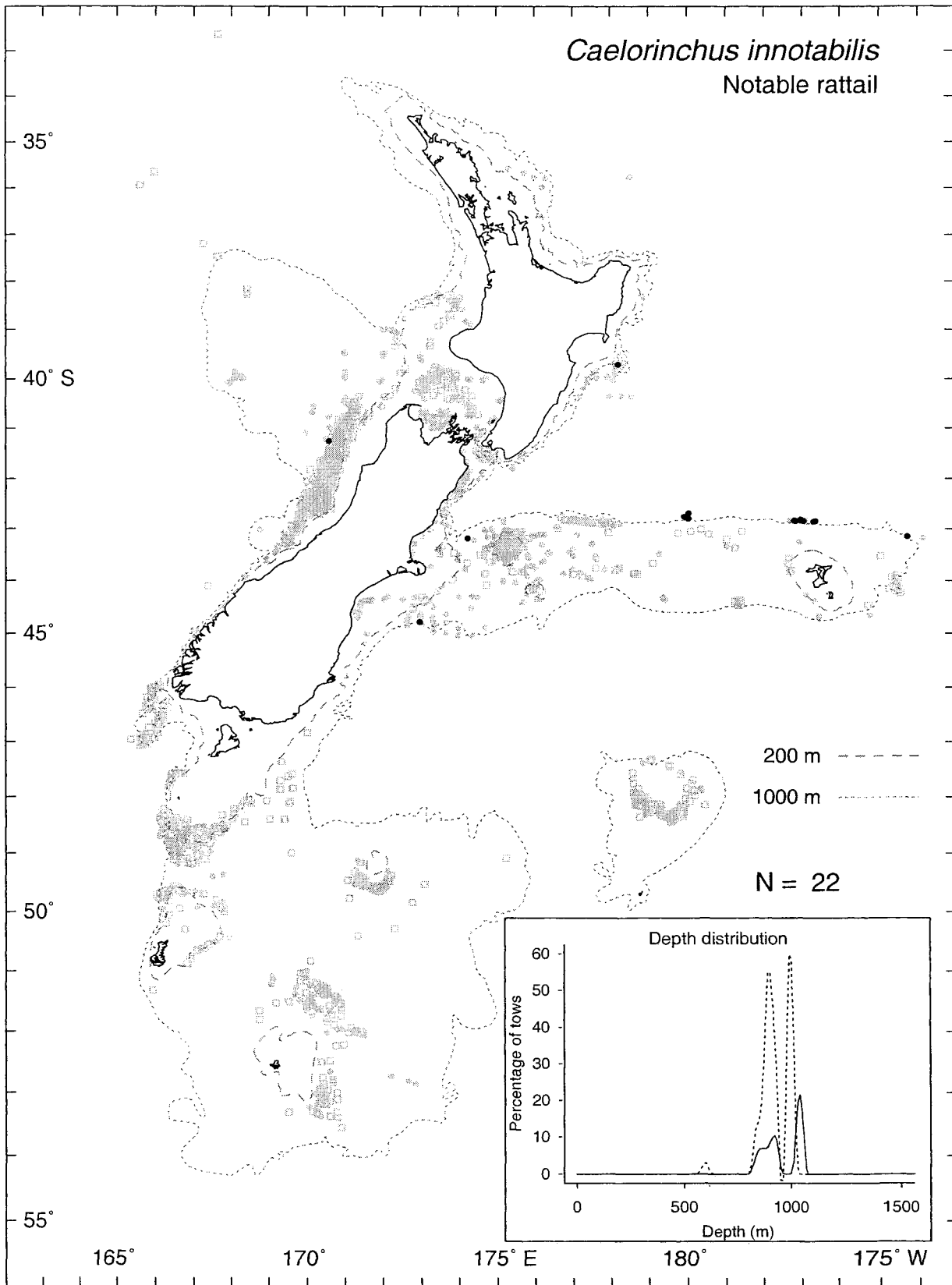
Caelorinchus biclinozonalis
Two saddle rattail



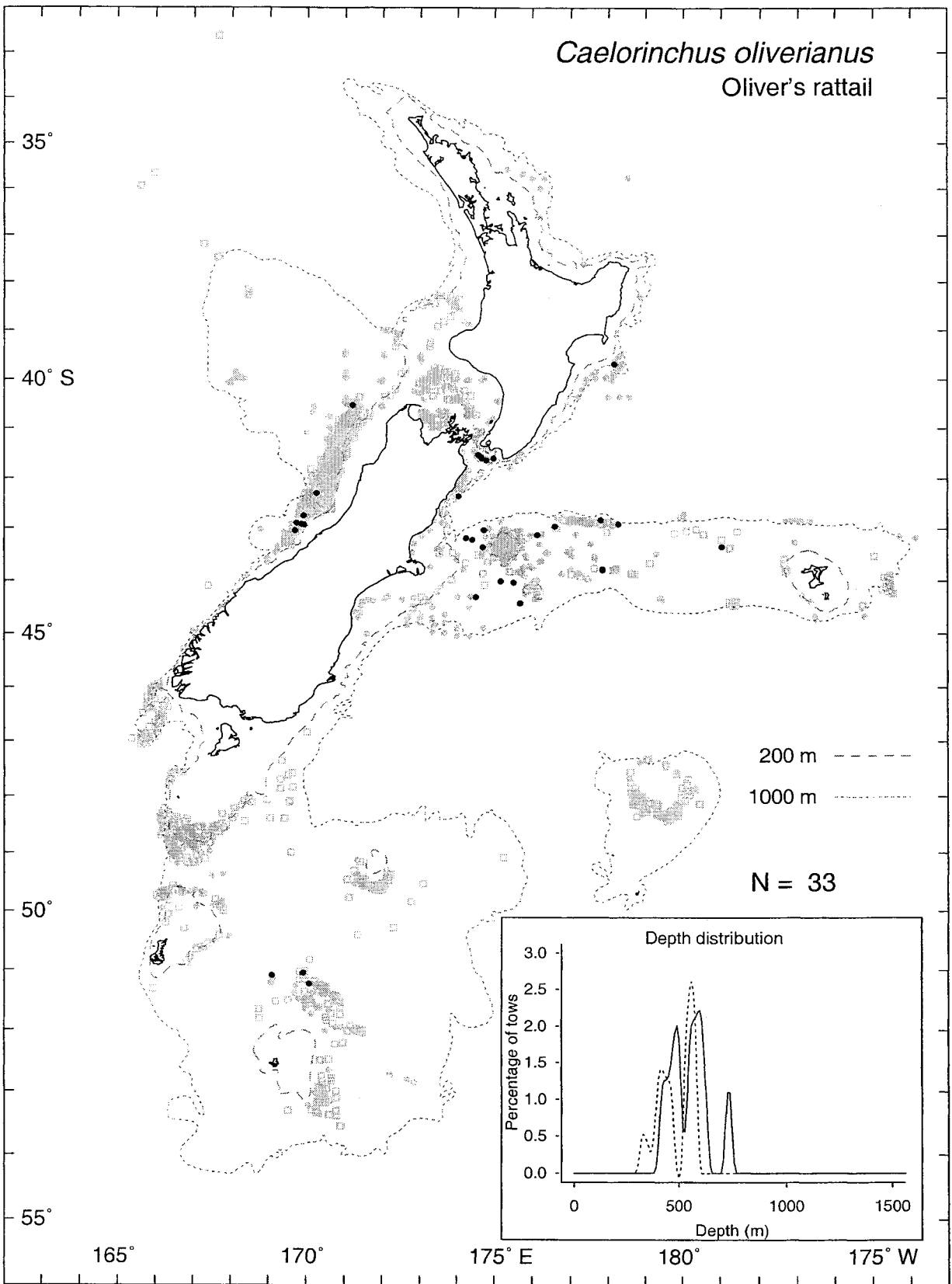
Caelorinchus bollonsi
Bollons' rattail



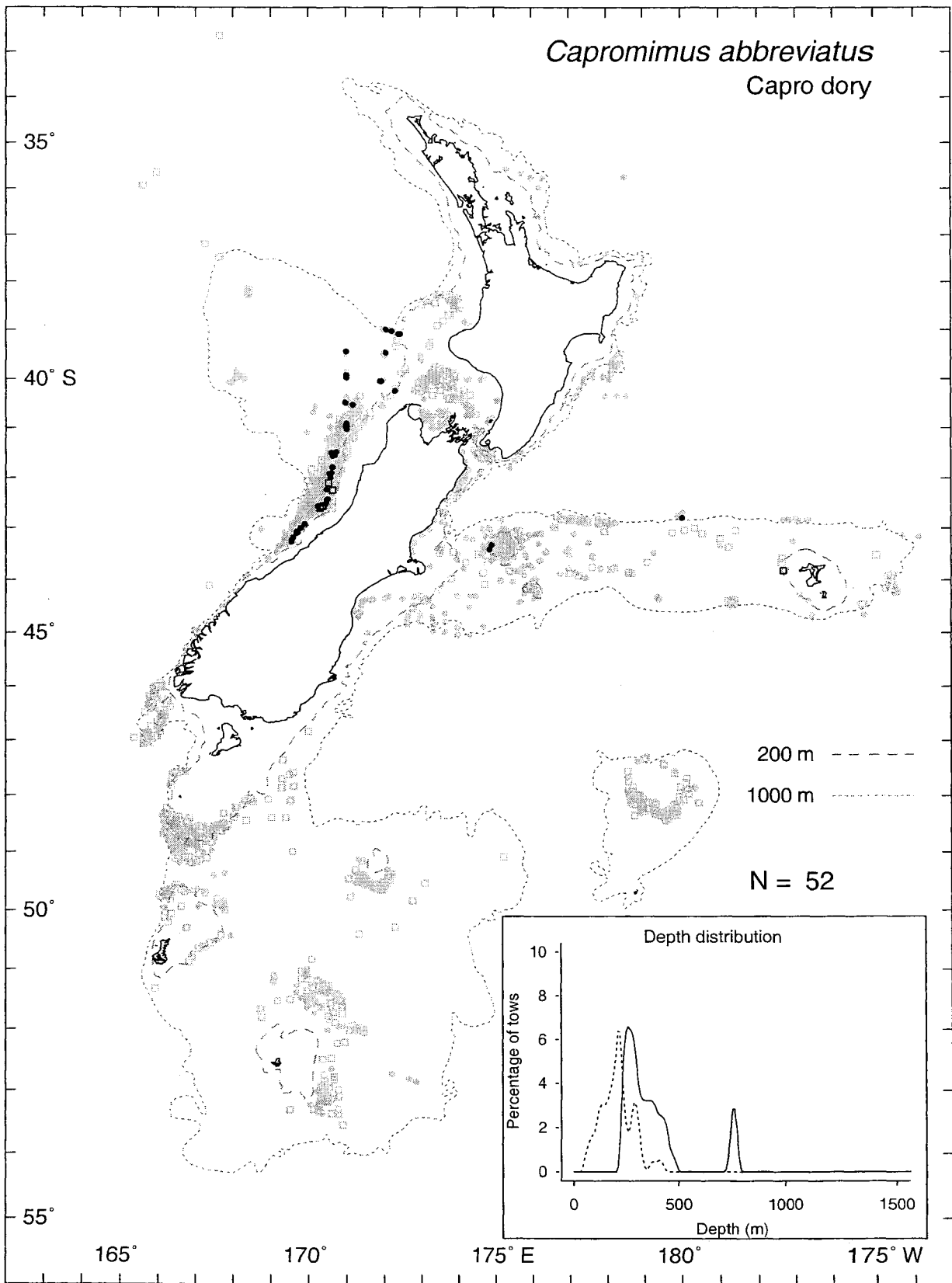
Caelorinchus innotabilis
Notable rattail

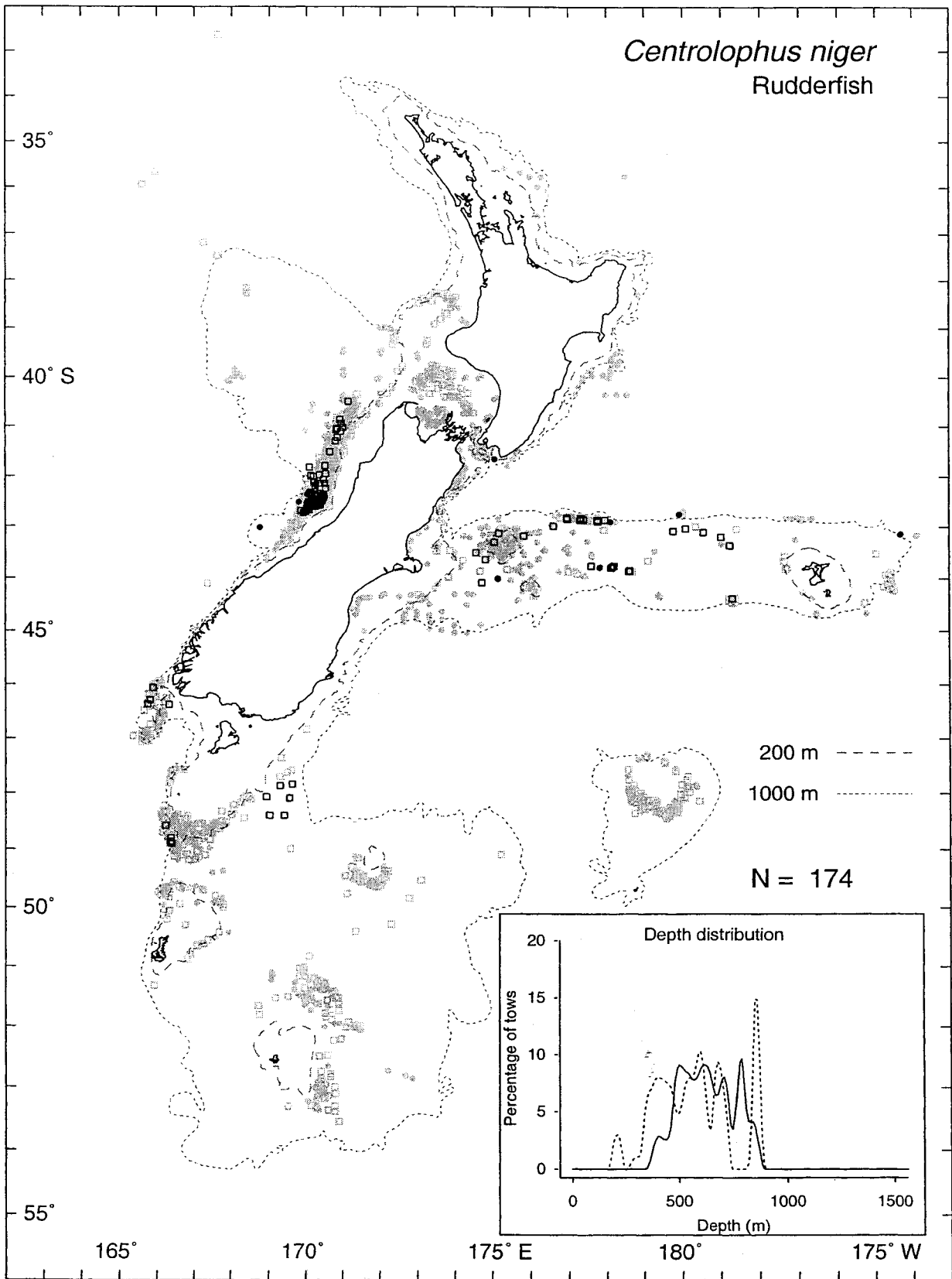


Caelorinchus oliverianus
Oliver's rattail



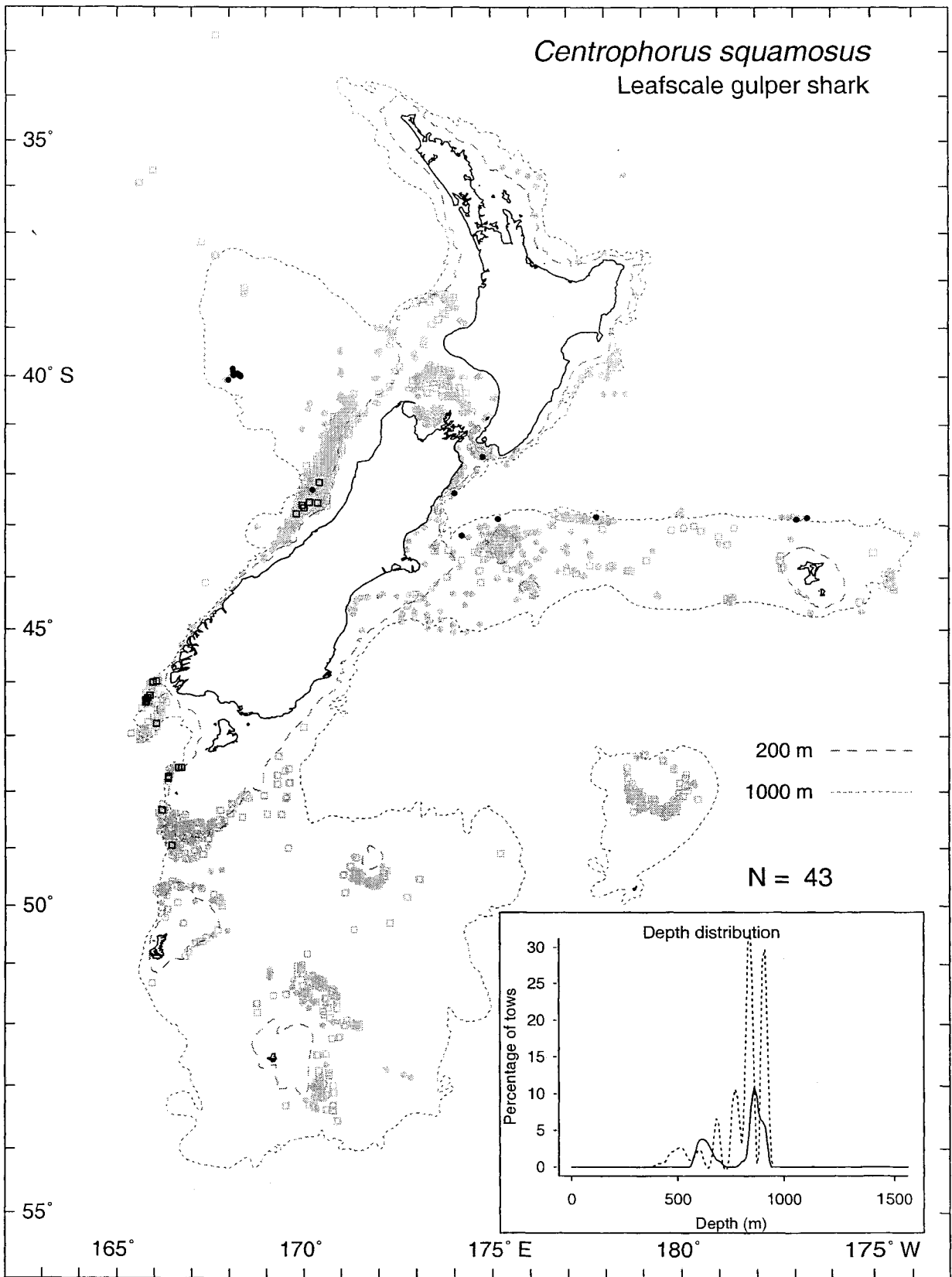
Capromimus abbreviatus
Capro dory



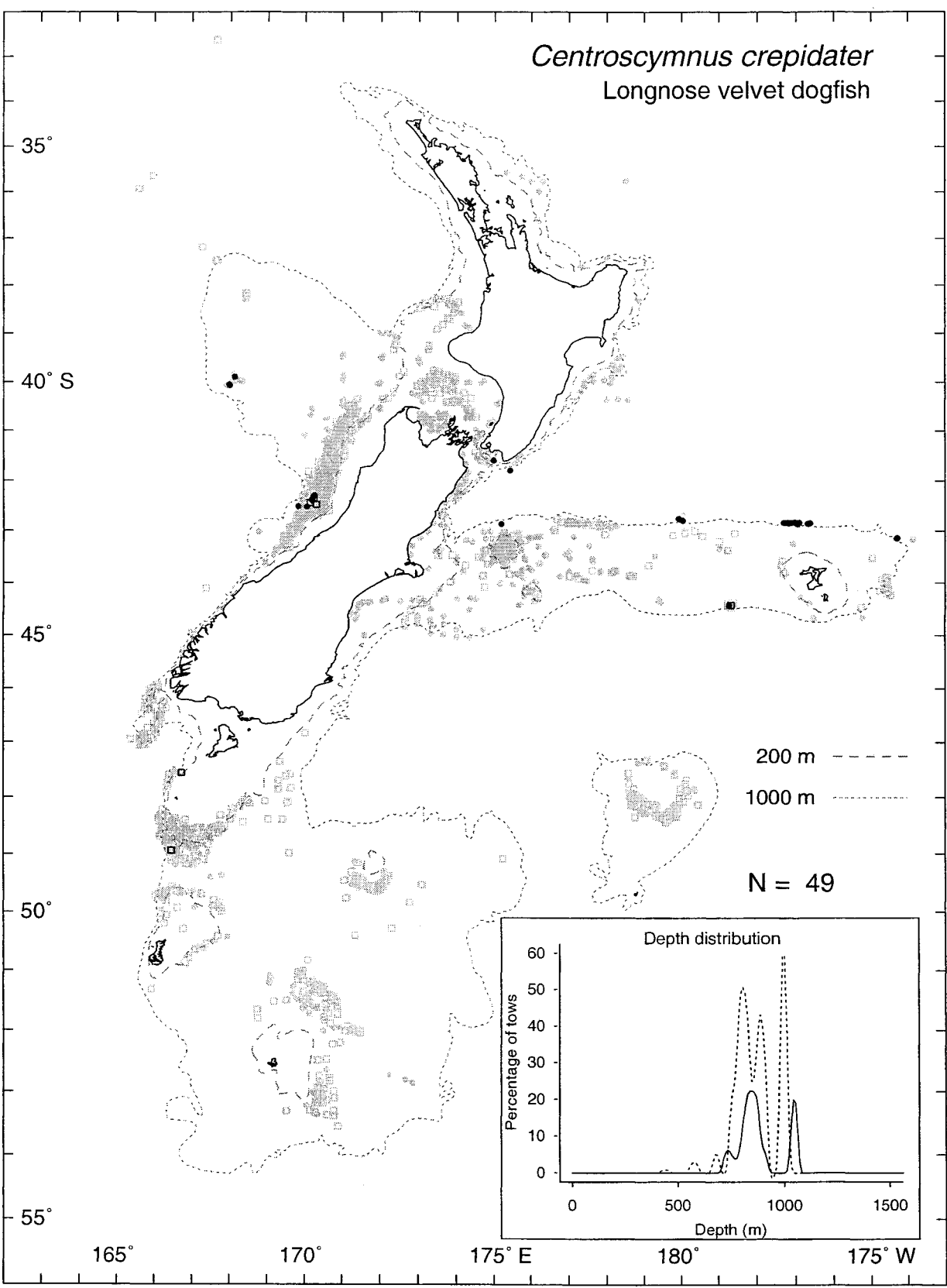


Possibly includes *Tubbia* spp.

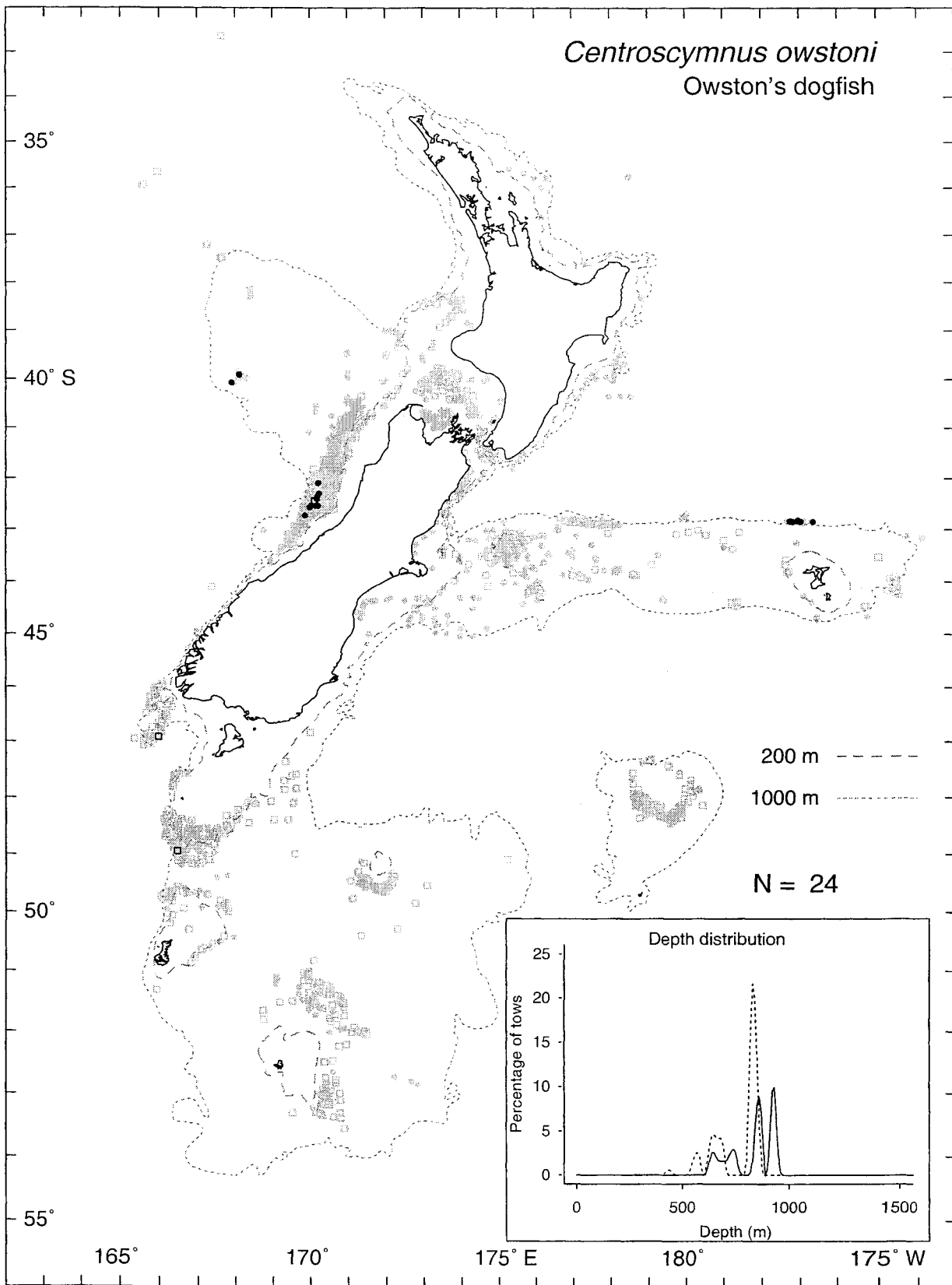
Centrophorus squamosus
Leafscale gulper shark



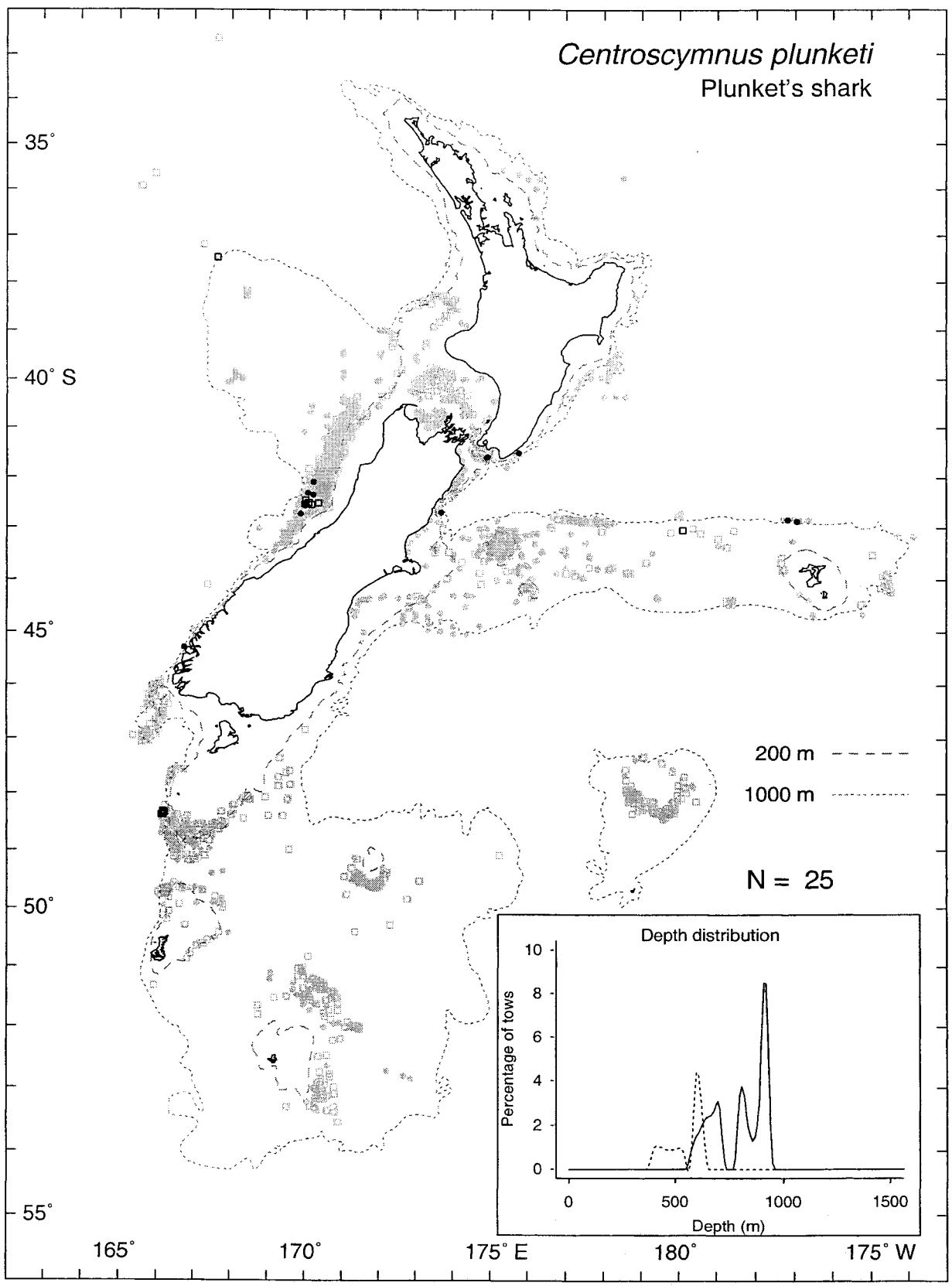
Centroscymnus crepidater
Longnose velvet dogfish



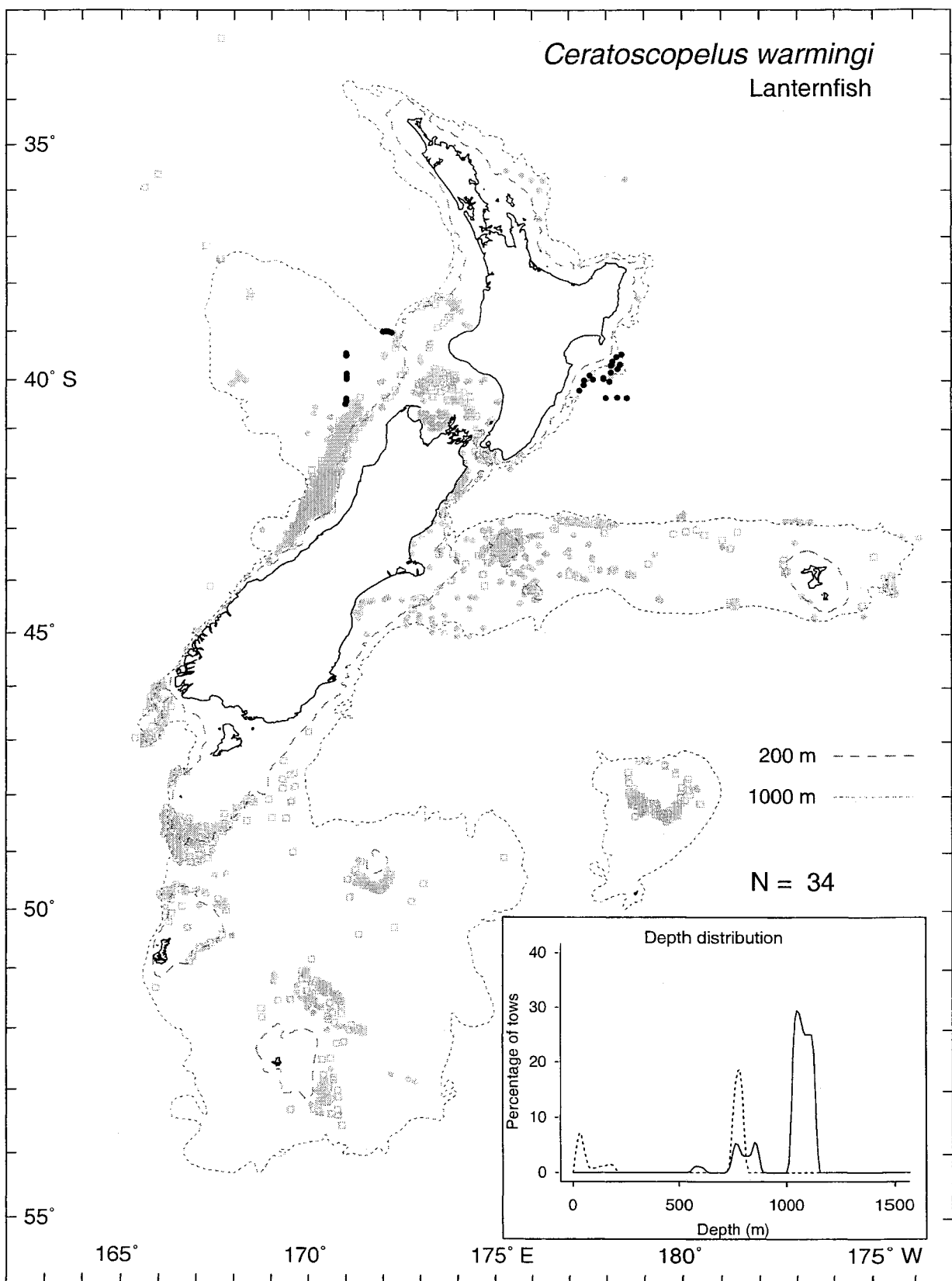
Centroscymnus owstoni
Owston's dogfish



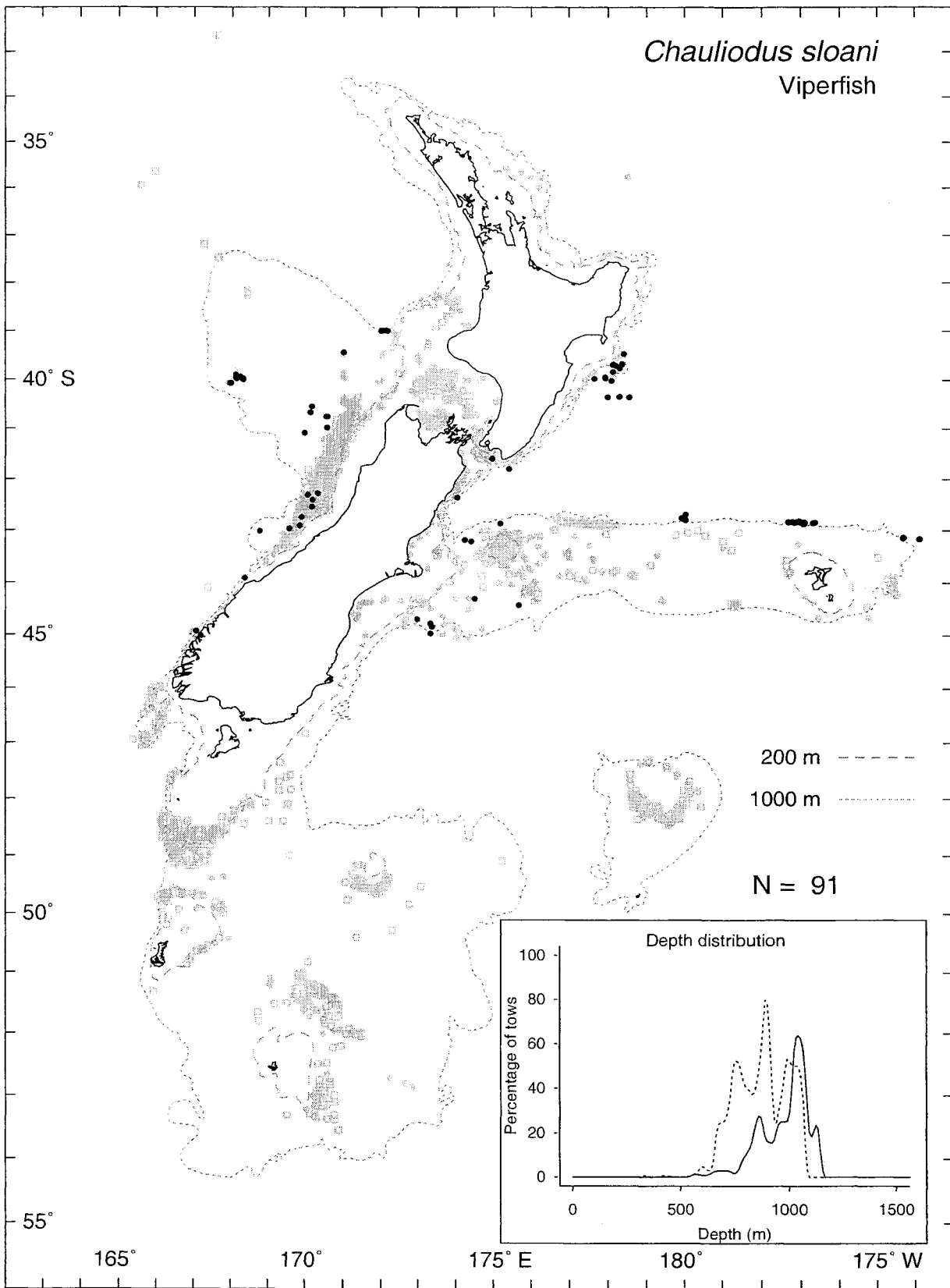
Centroscymnus plunketi
Plunket's shark

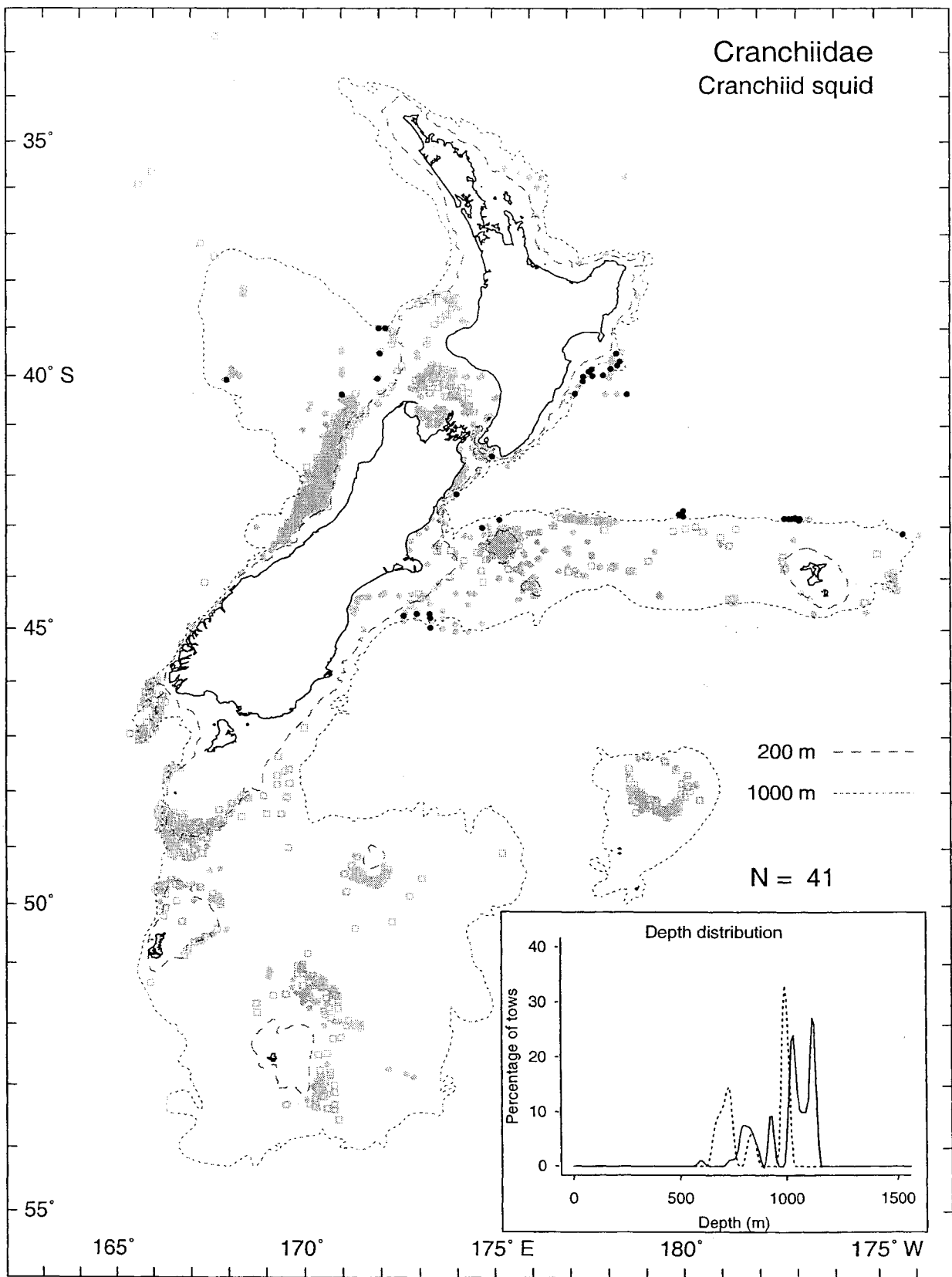


Ceratoscopelus warmingi
Lanternfish

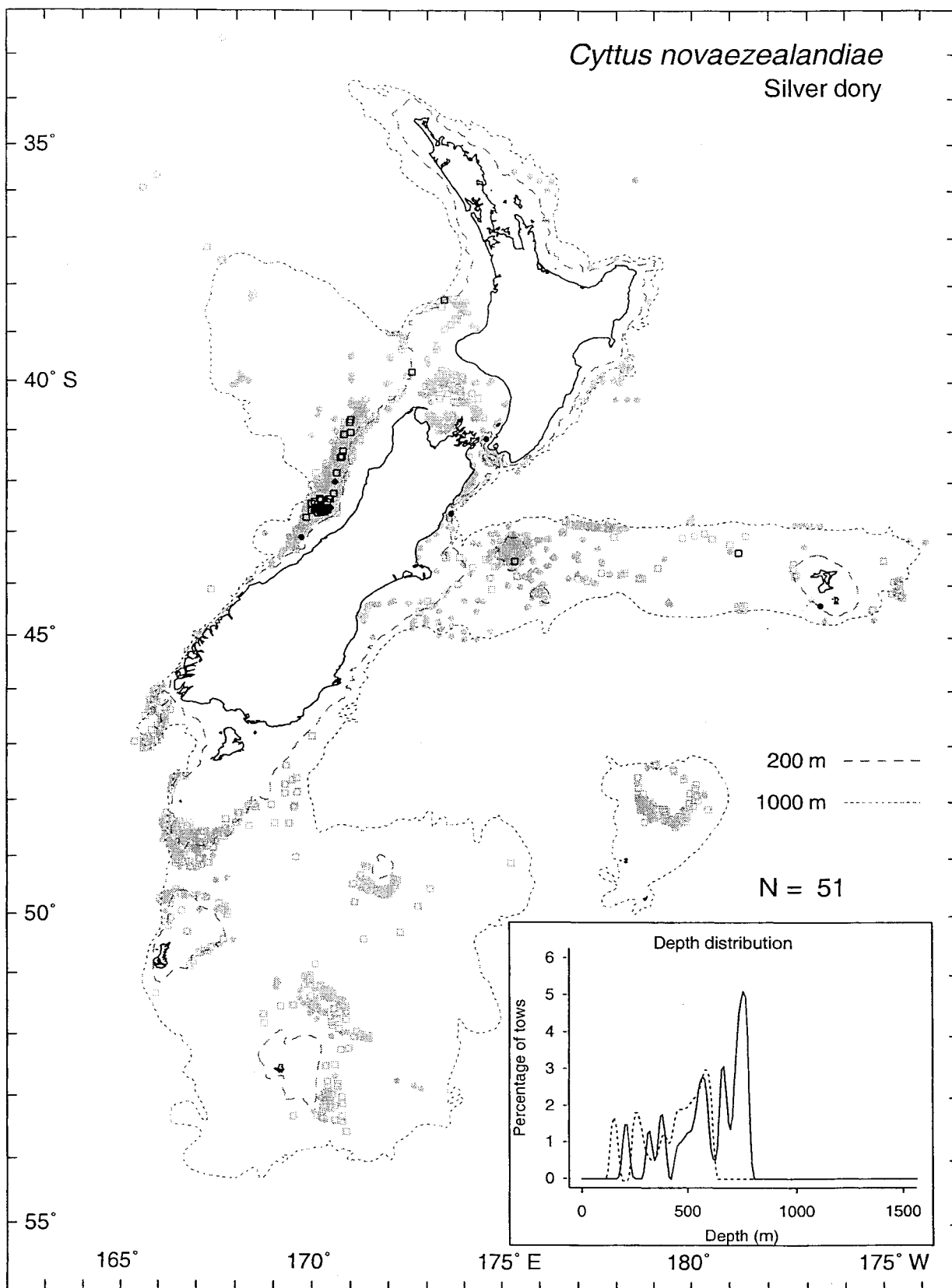


Chauliodus sloani
Viperfish

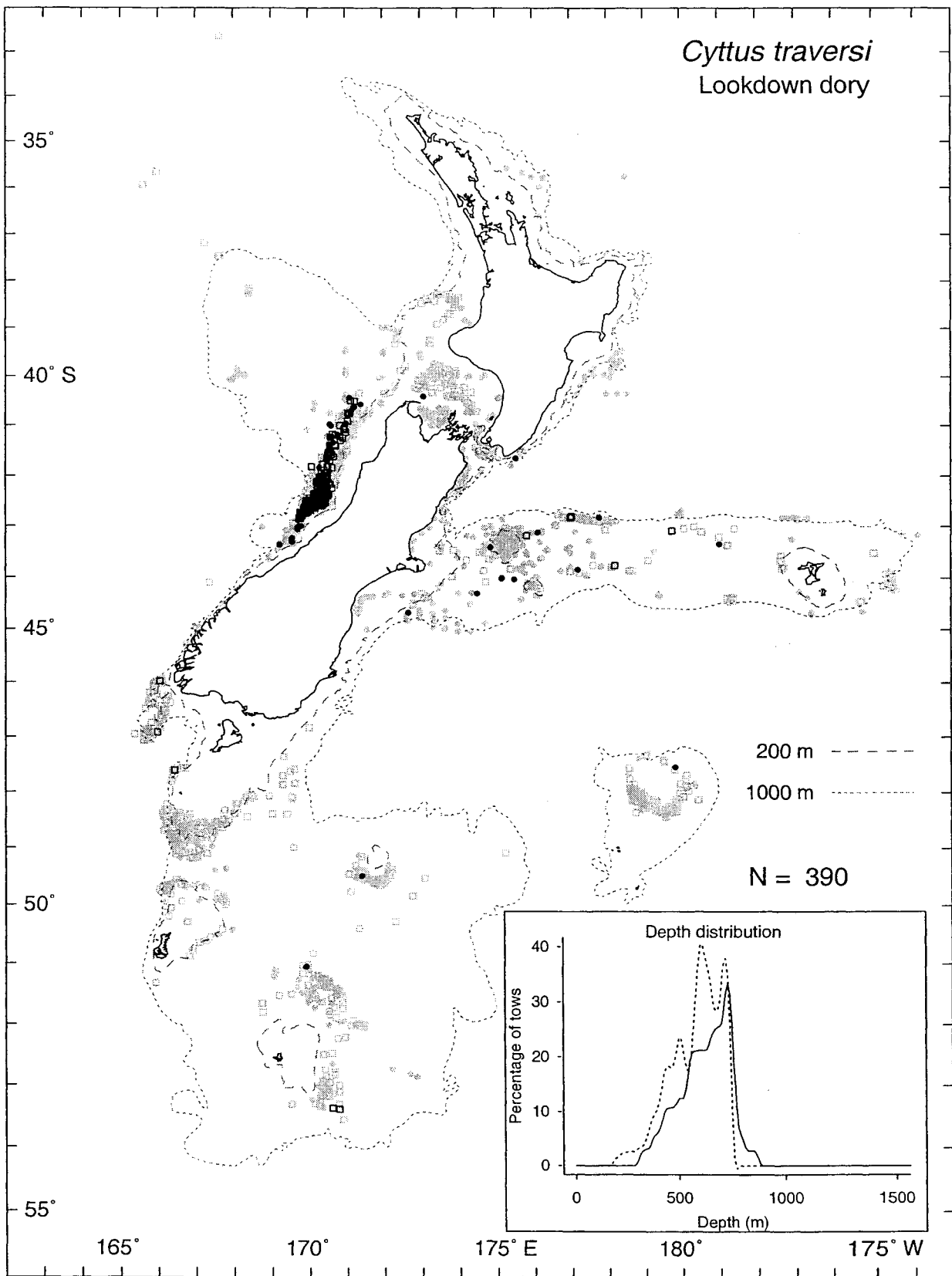




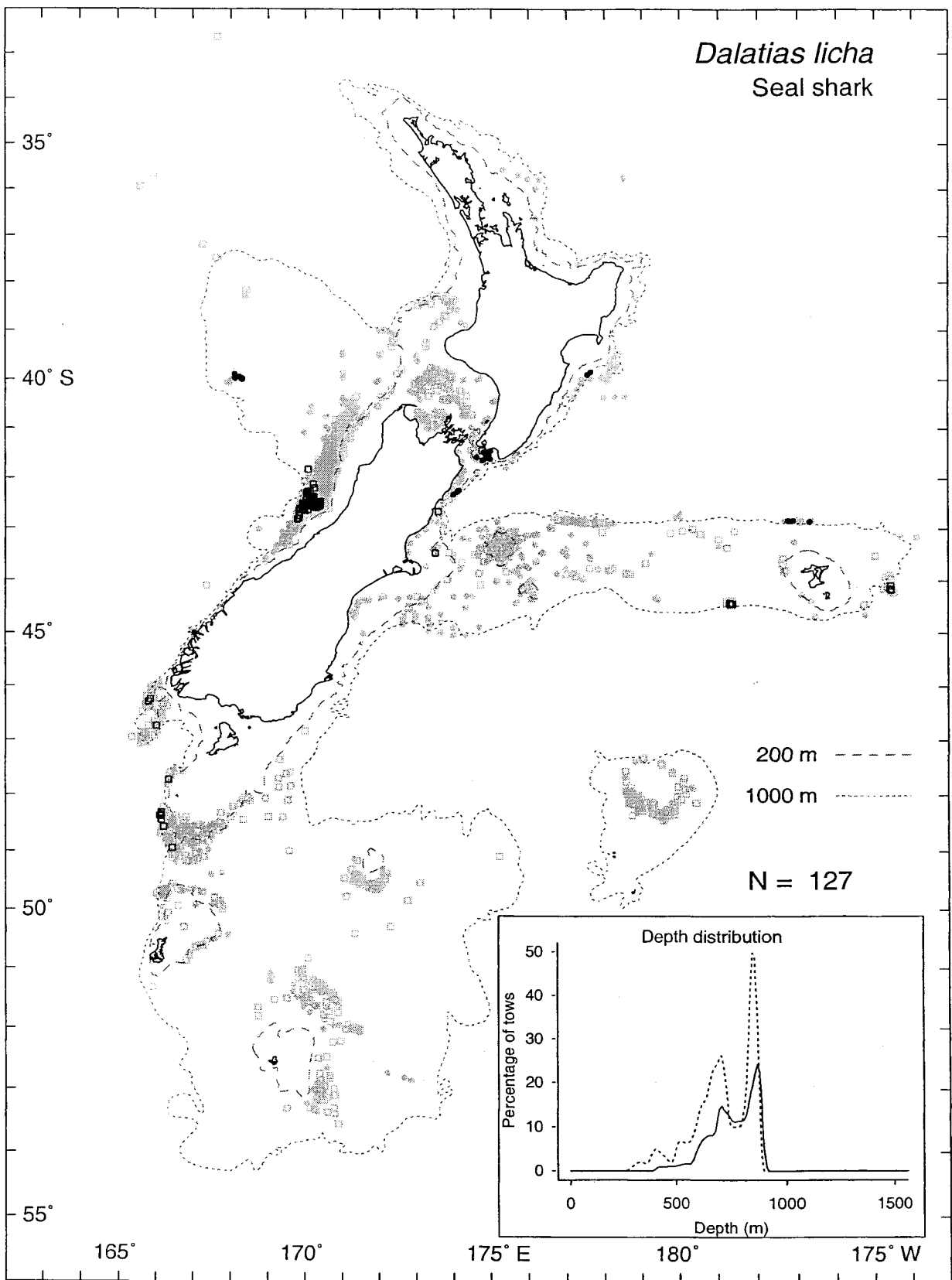
May include up to 14 species but most will be *Teuthowenia pellucida* or *Galiteuthis glacialis*.



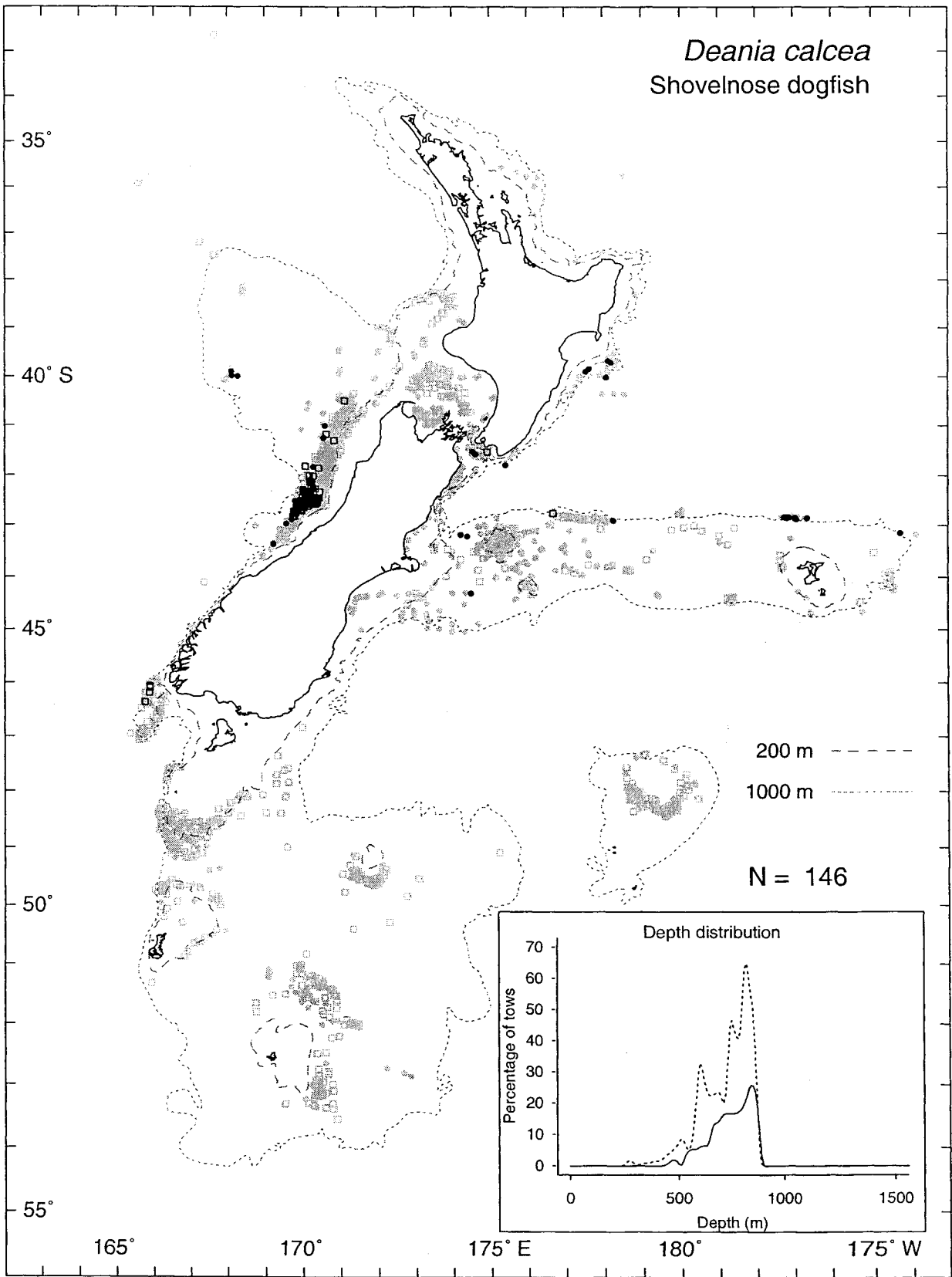
Deeper records may be *Cyttus traversi*.



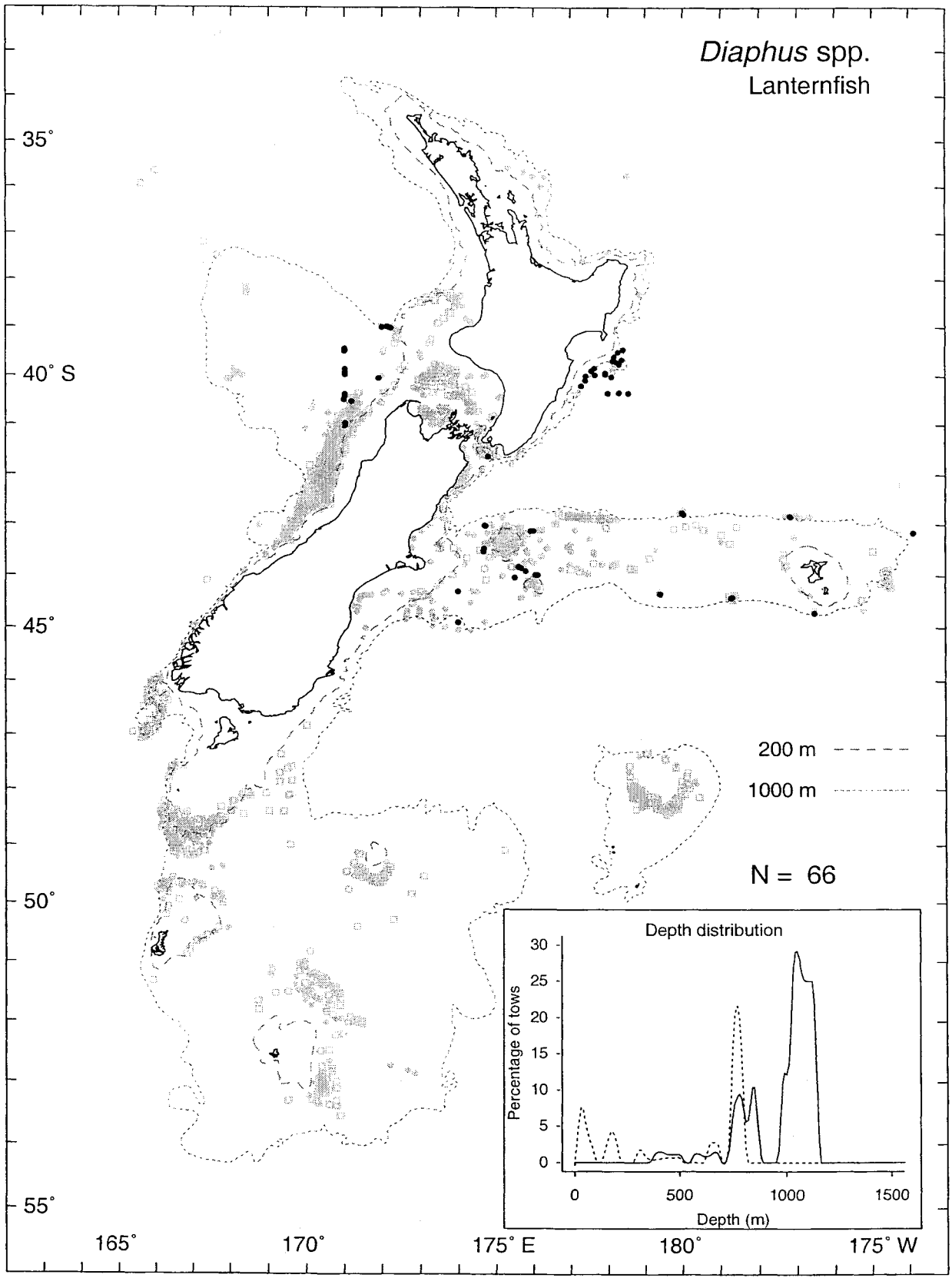
May include some *Cyttus novaezealandiae*.



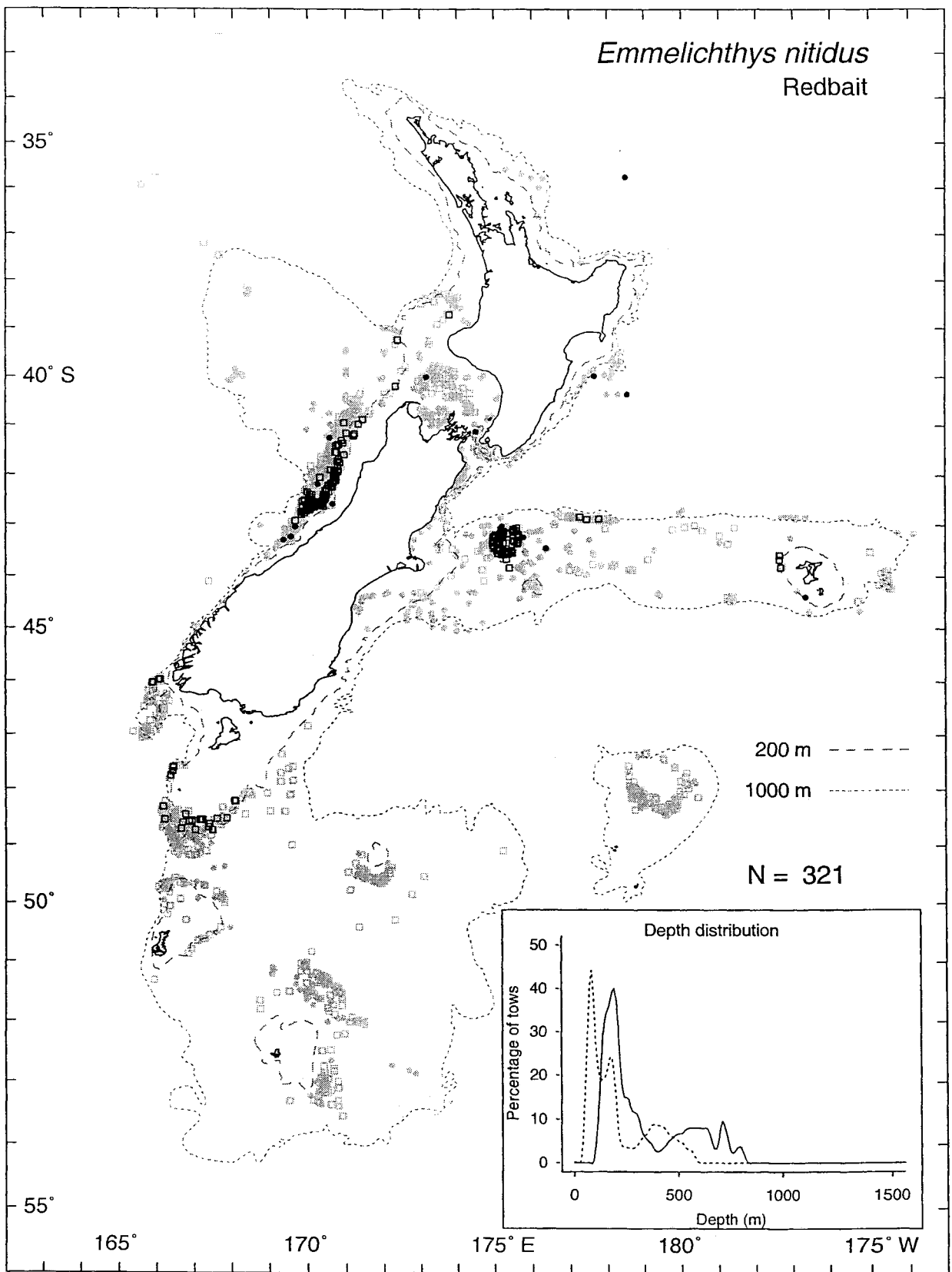
Also known by the common name black shark. Some records may represent other black shark species.



May include some *Deania quadrispinosum*.

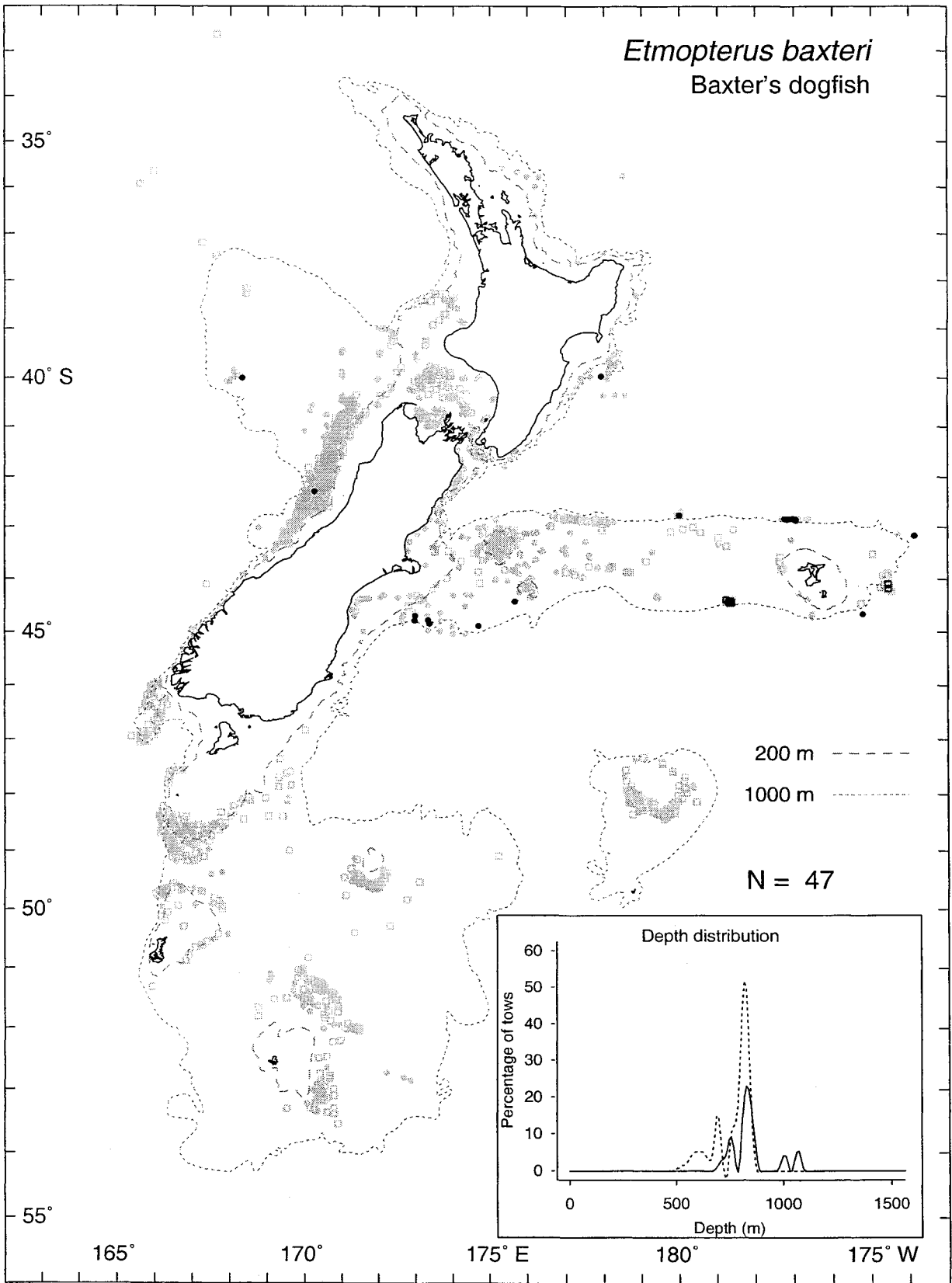


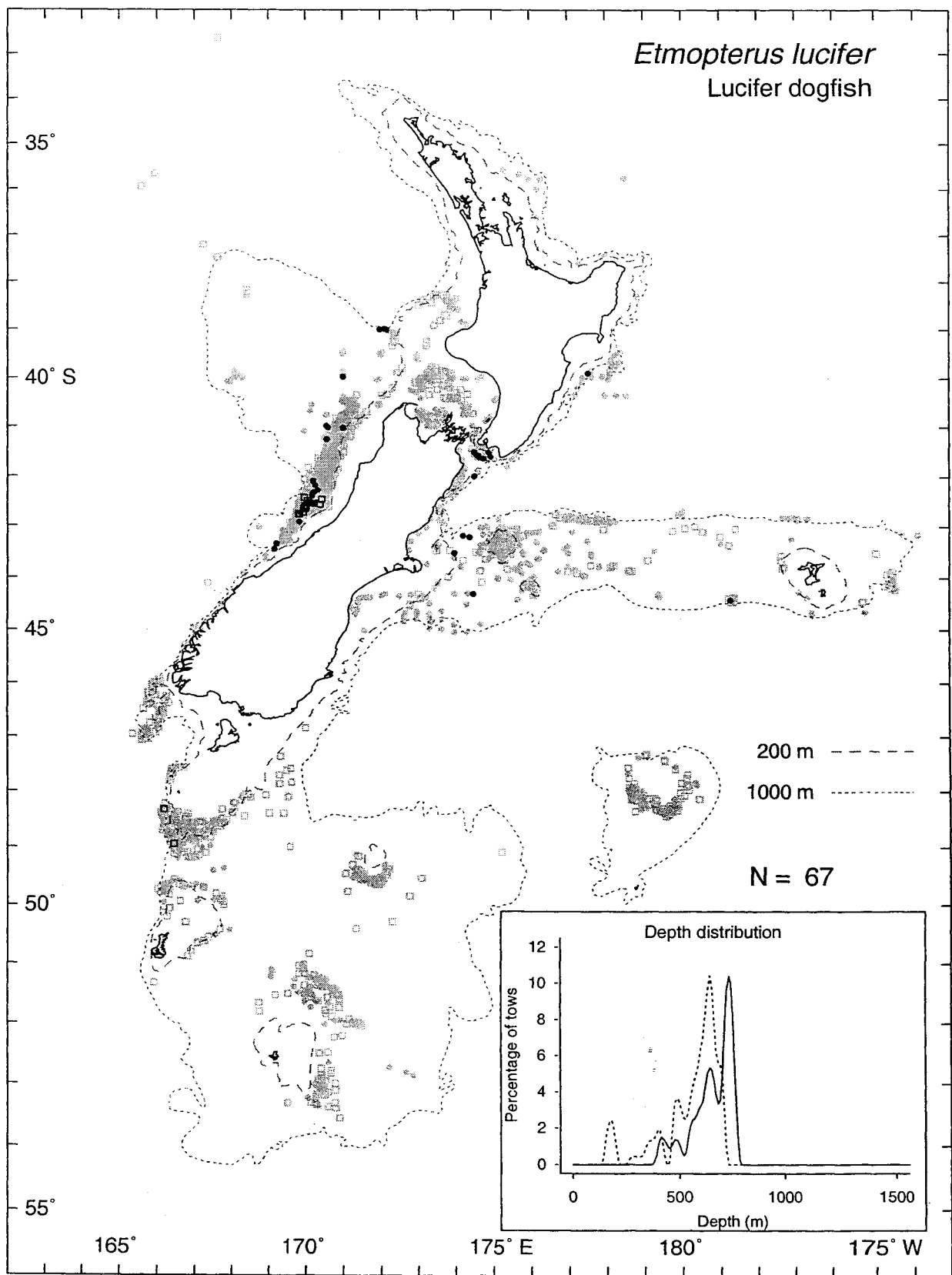
May include up to 24 species.



The northernmost research station outside the 1000 m contour is on a seamount in 365 m bottom depth.

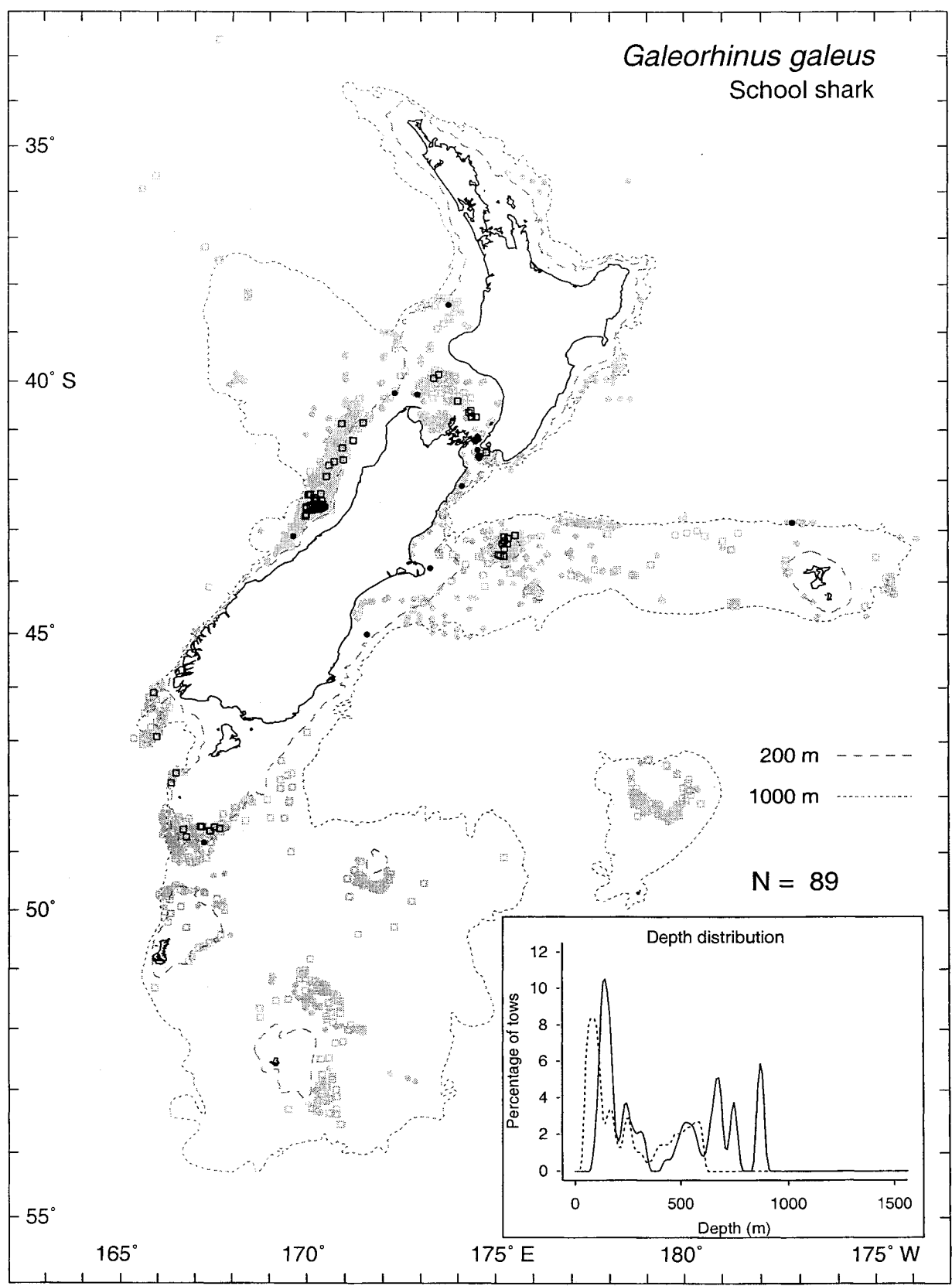
Etmopterus baxteri
Baxter's dogfish



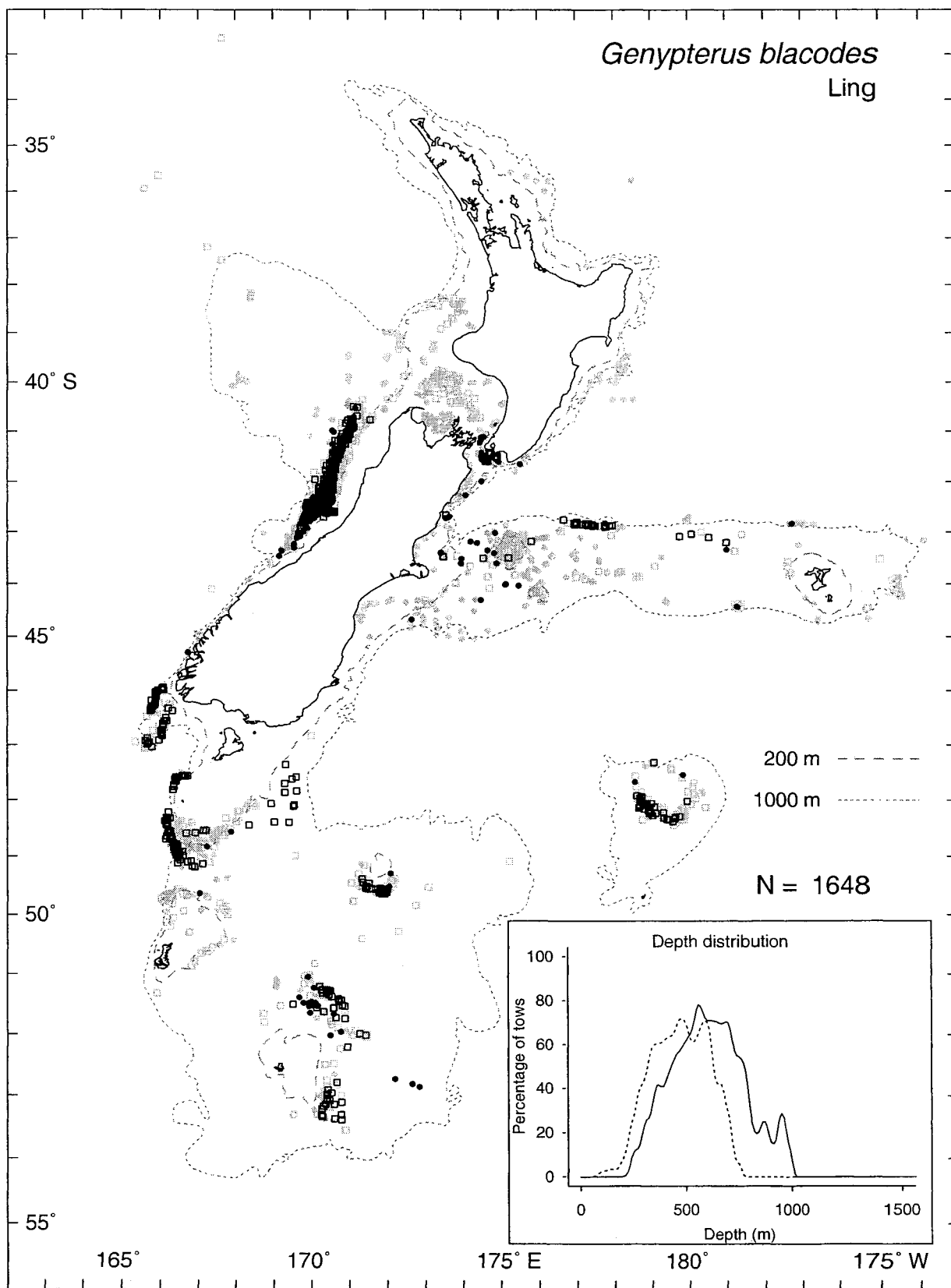


May include some *Etmopterus mollerii*.

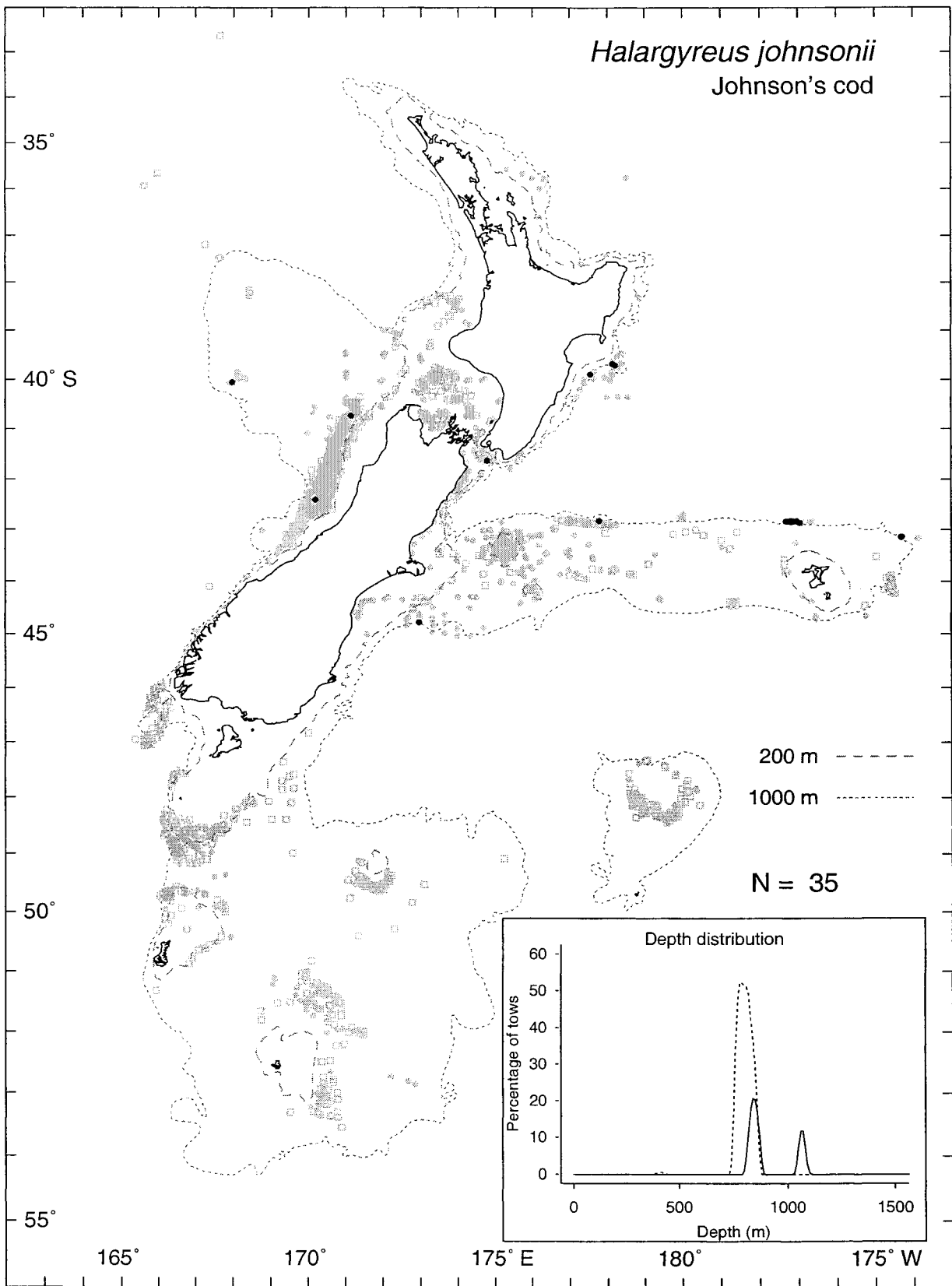
Galeorhinus galeus
School shark

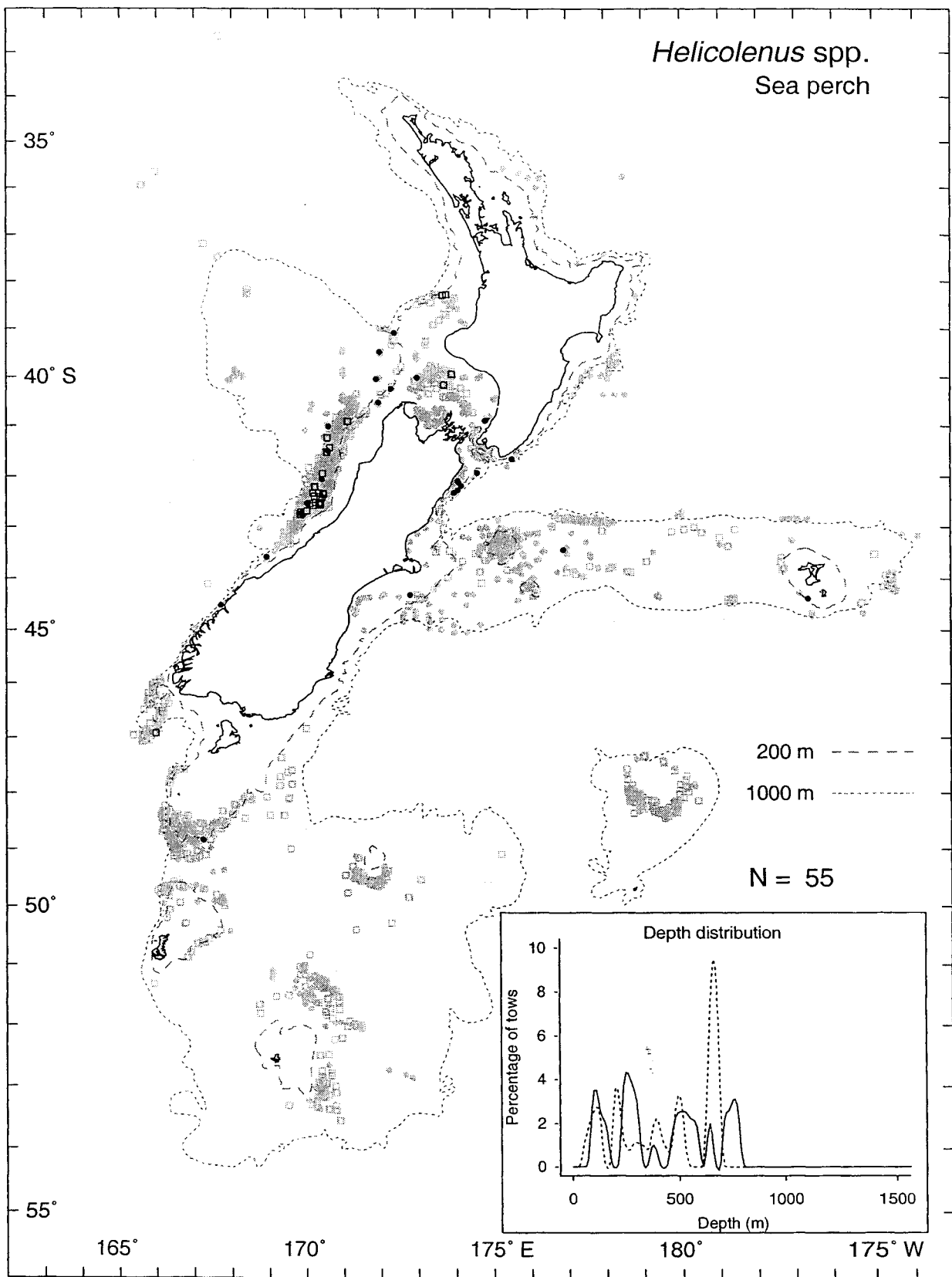


Genypterus blacodes
Ling

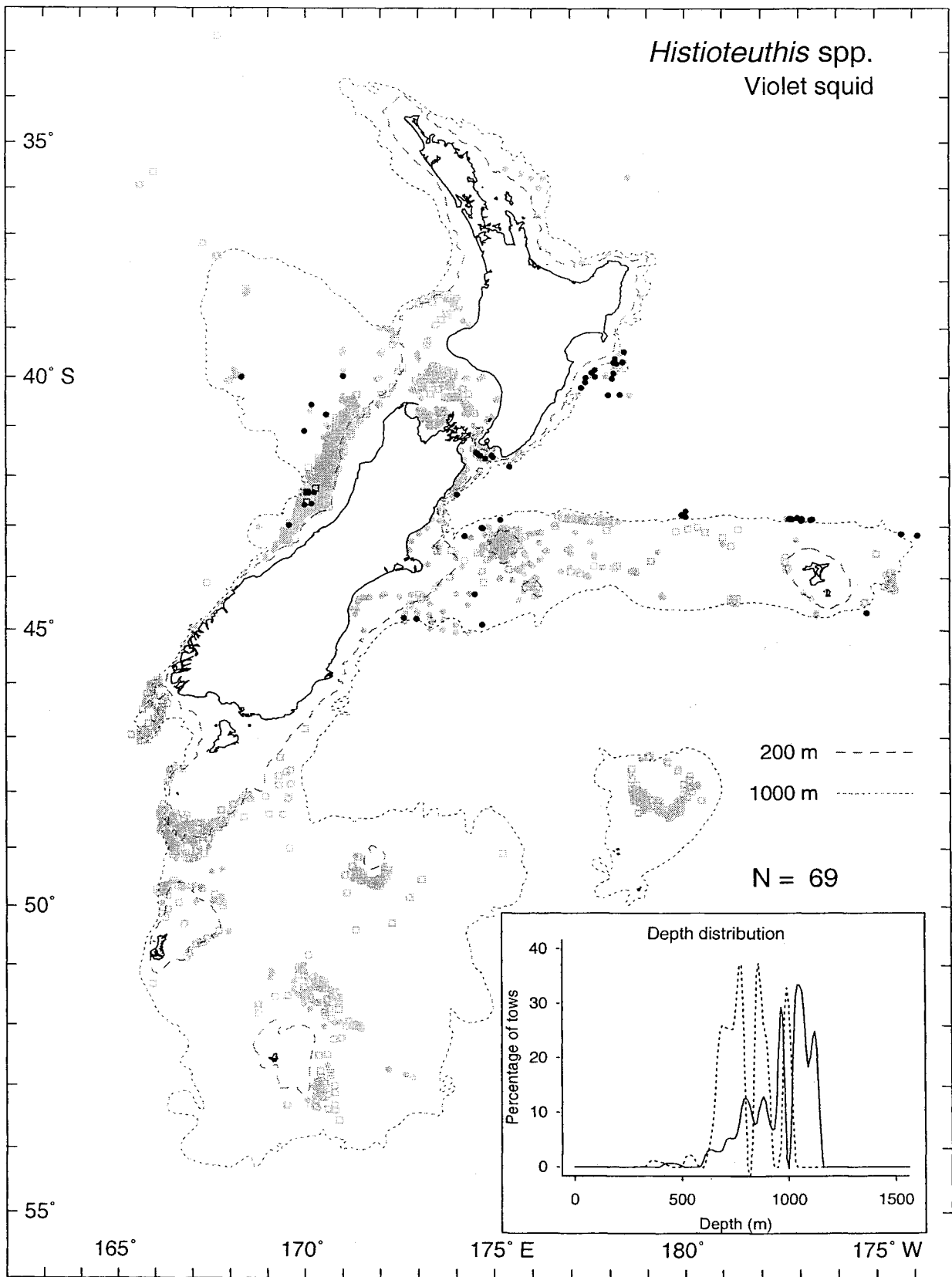


Halargyreus johnsonii
Johnson's cod



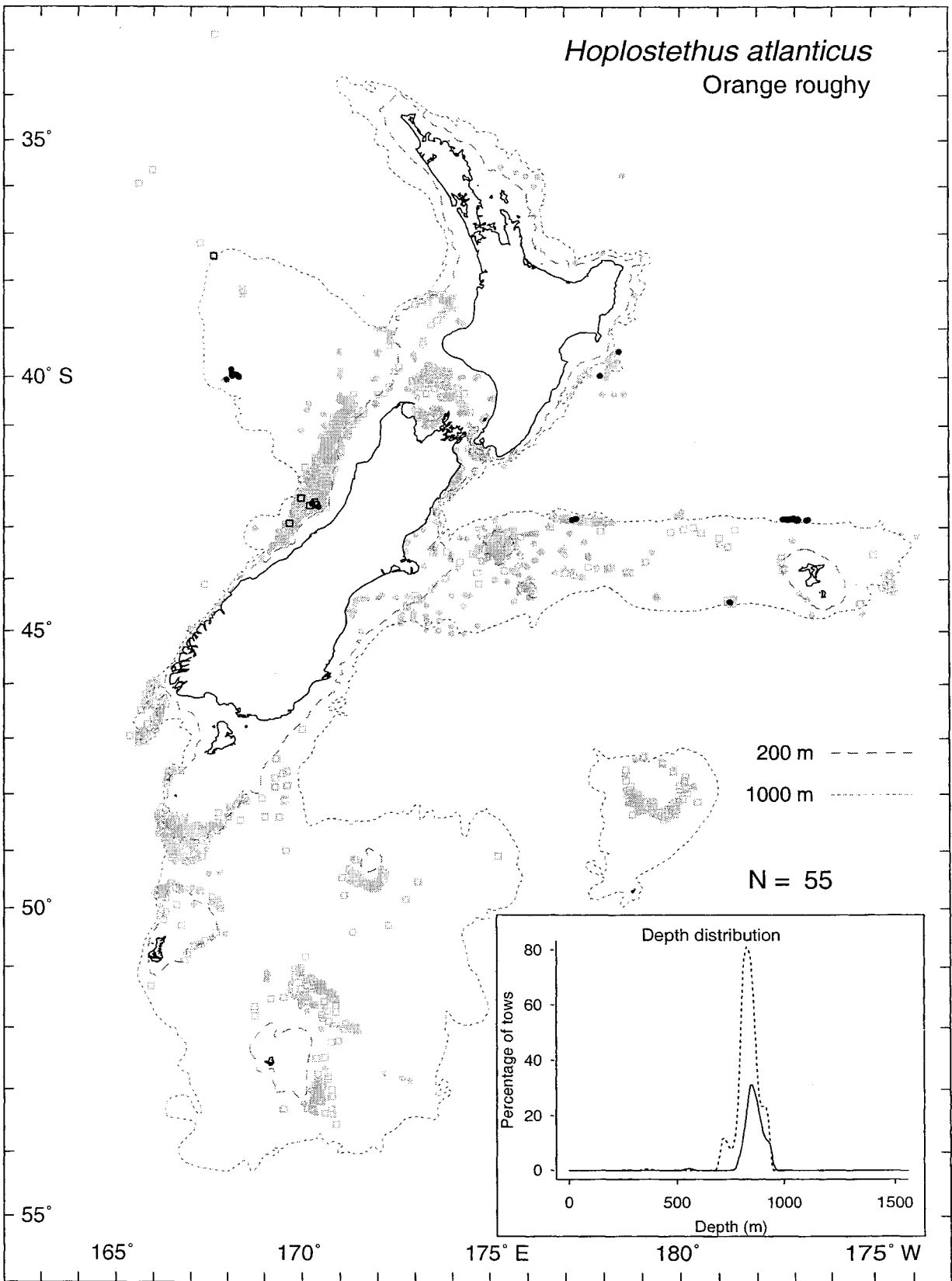


Records deeper than 800 m may include some *Trachyscorpia capensis*.

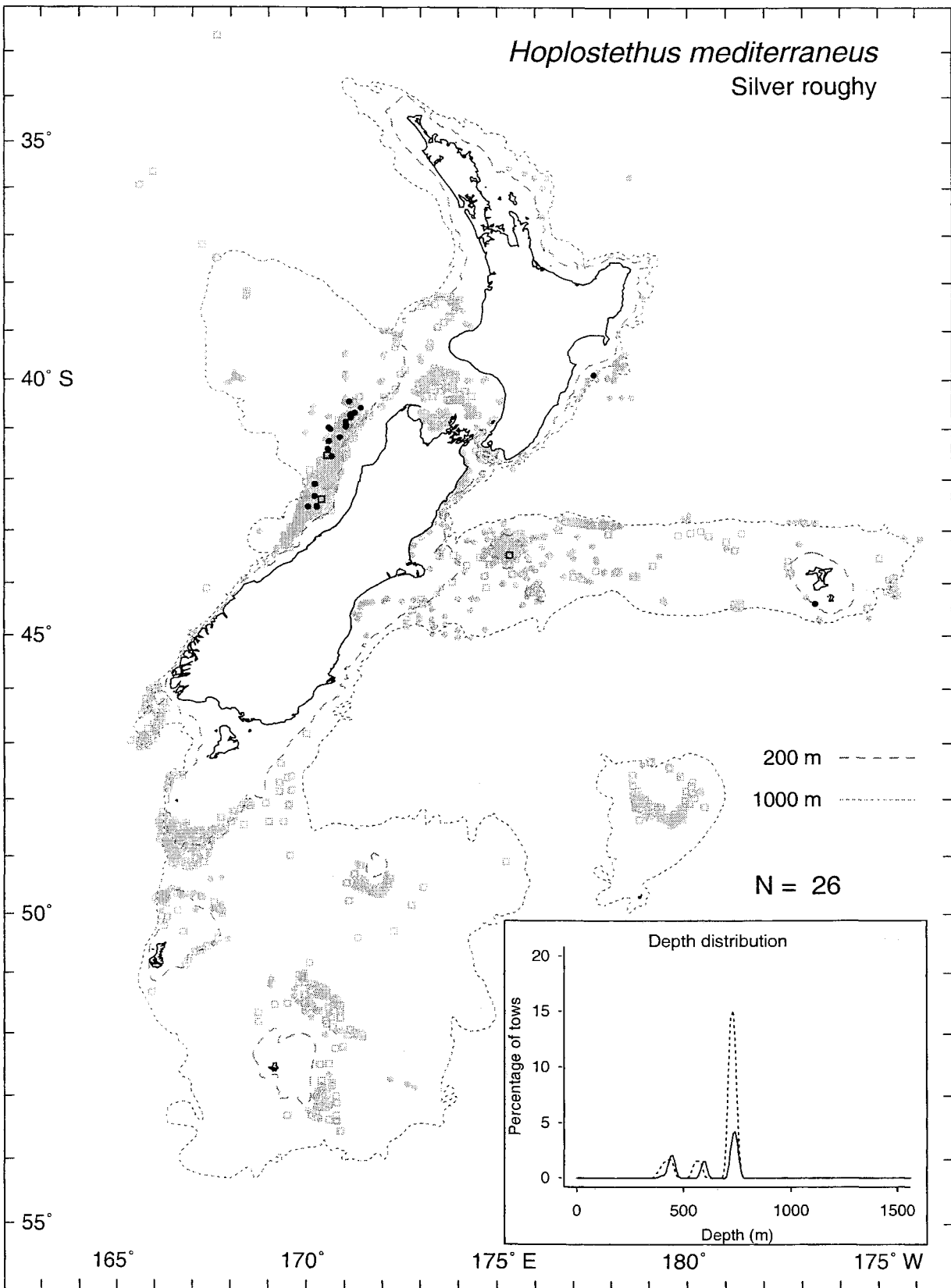


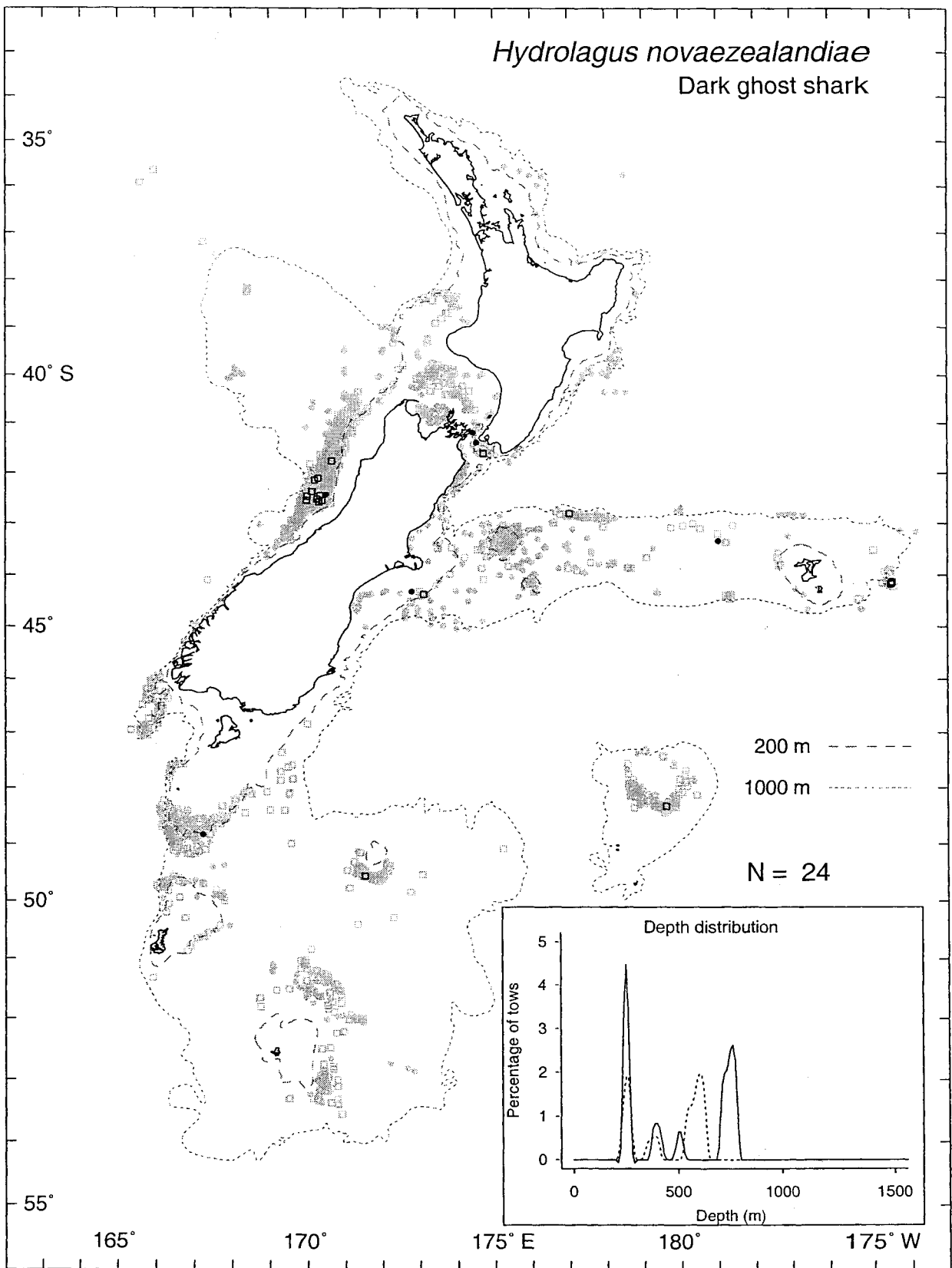
May include up to seven species.

Hoplostethus atlanticus
Orange roughy

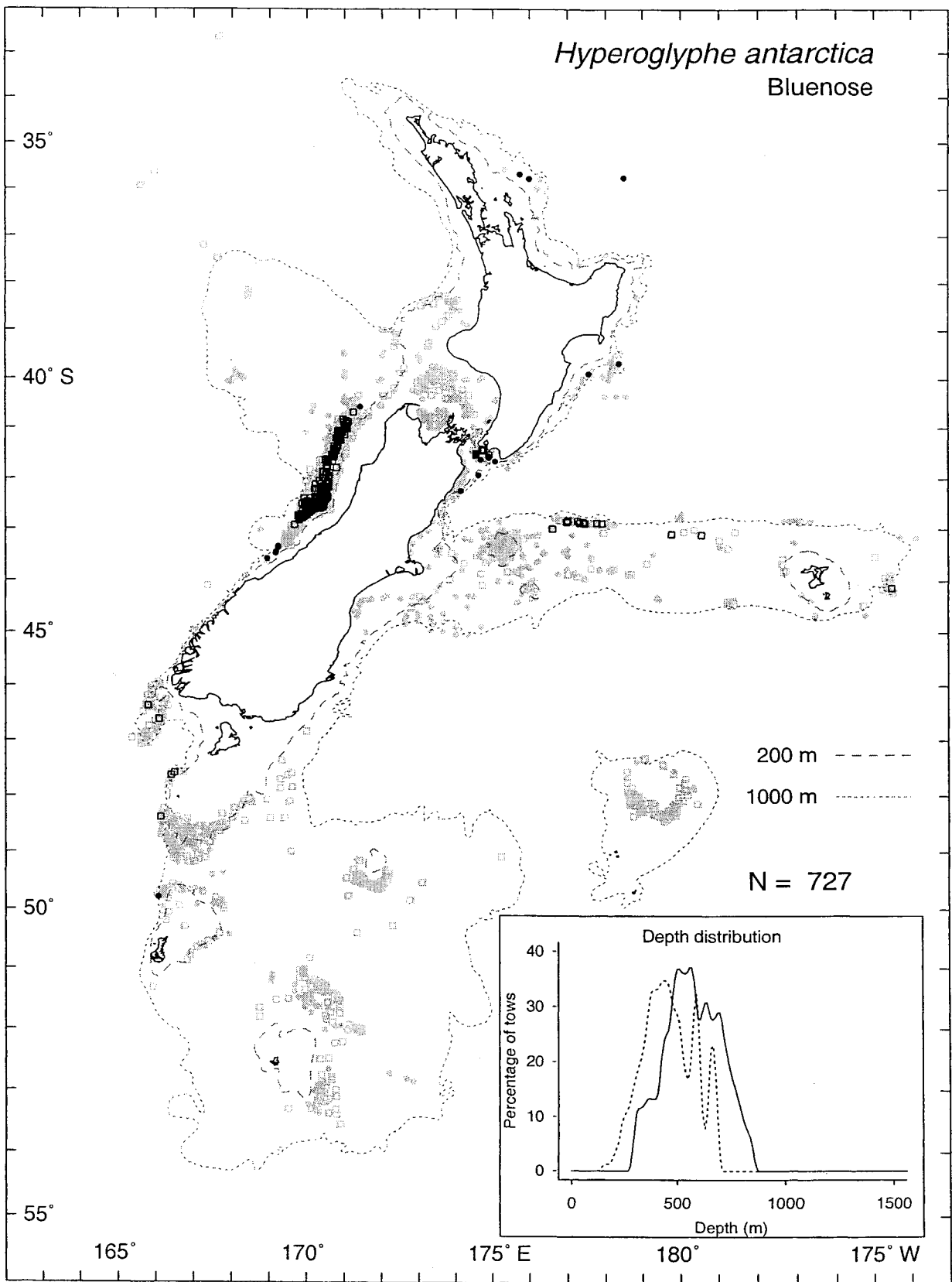


Hoplostethus mediterraneus
Silver roughy

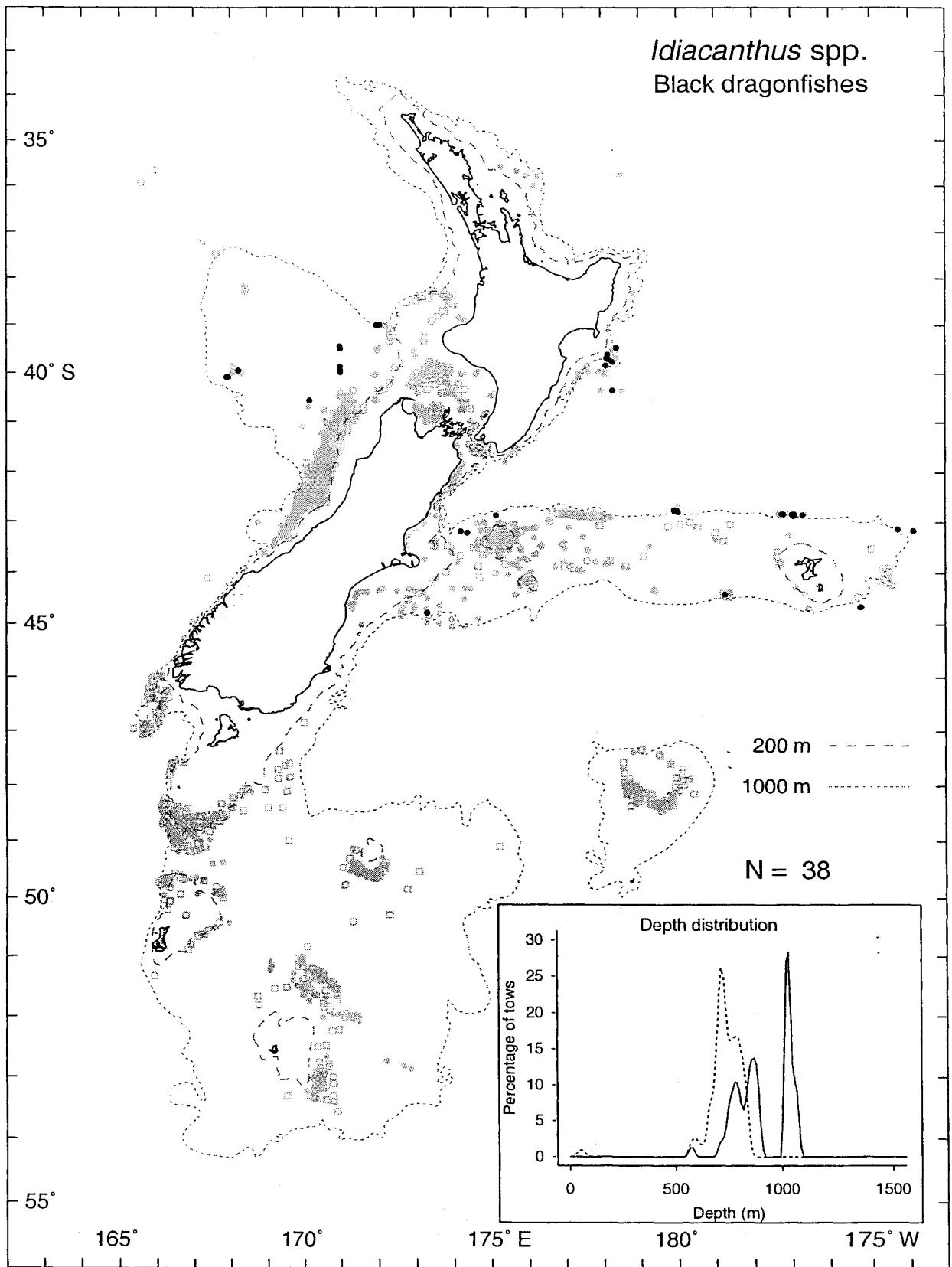




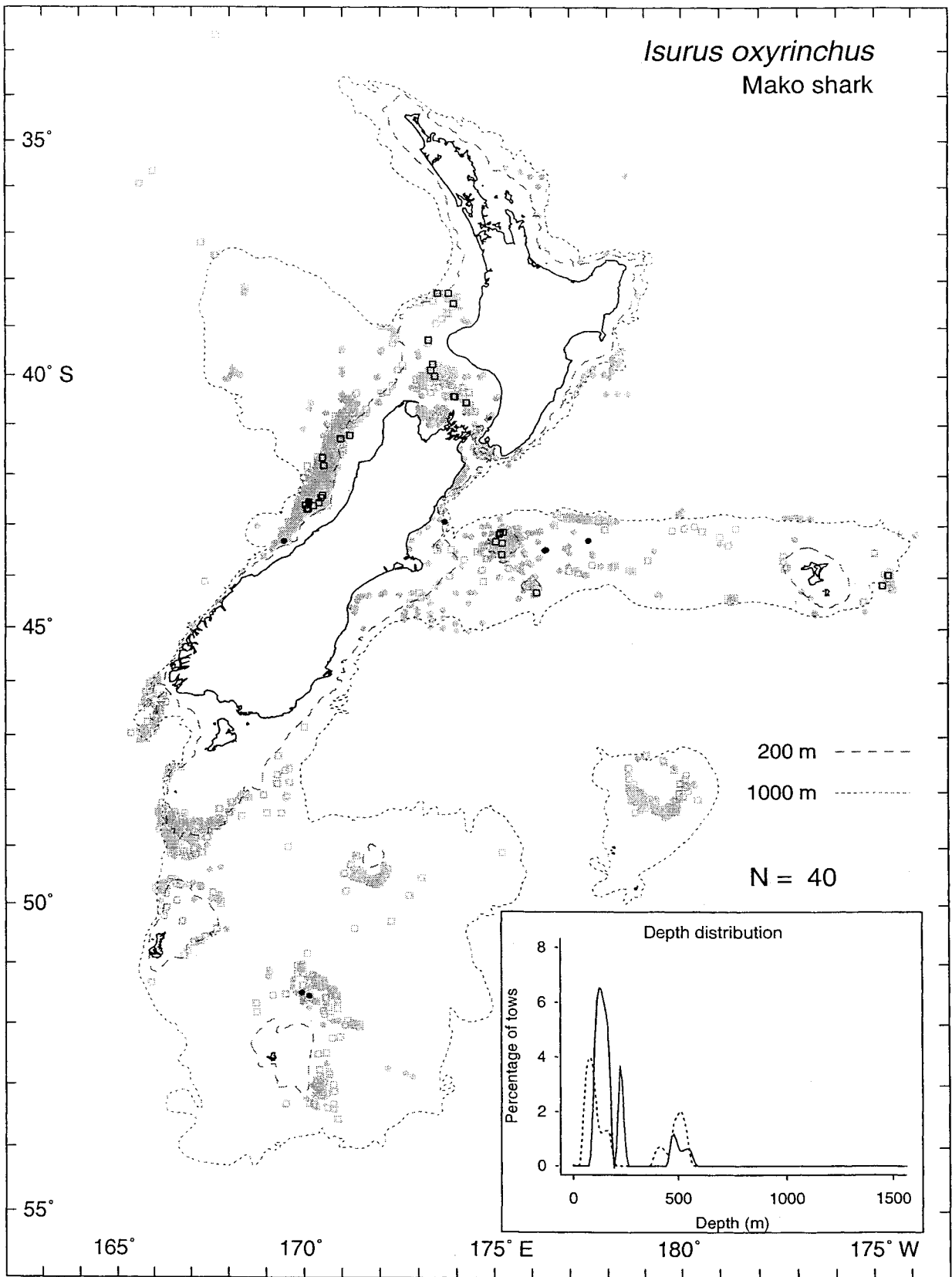
Some of the deeper records may be *Hydrolagus* sp. B2.



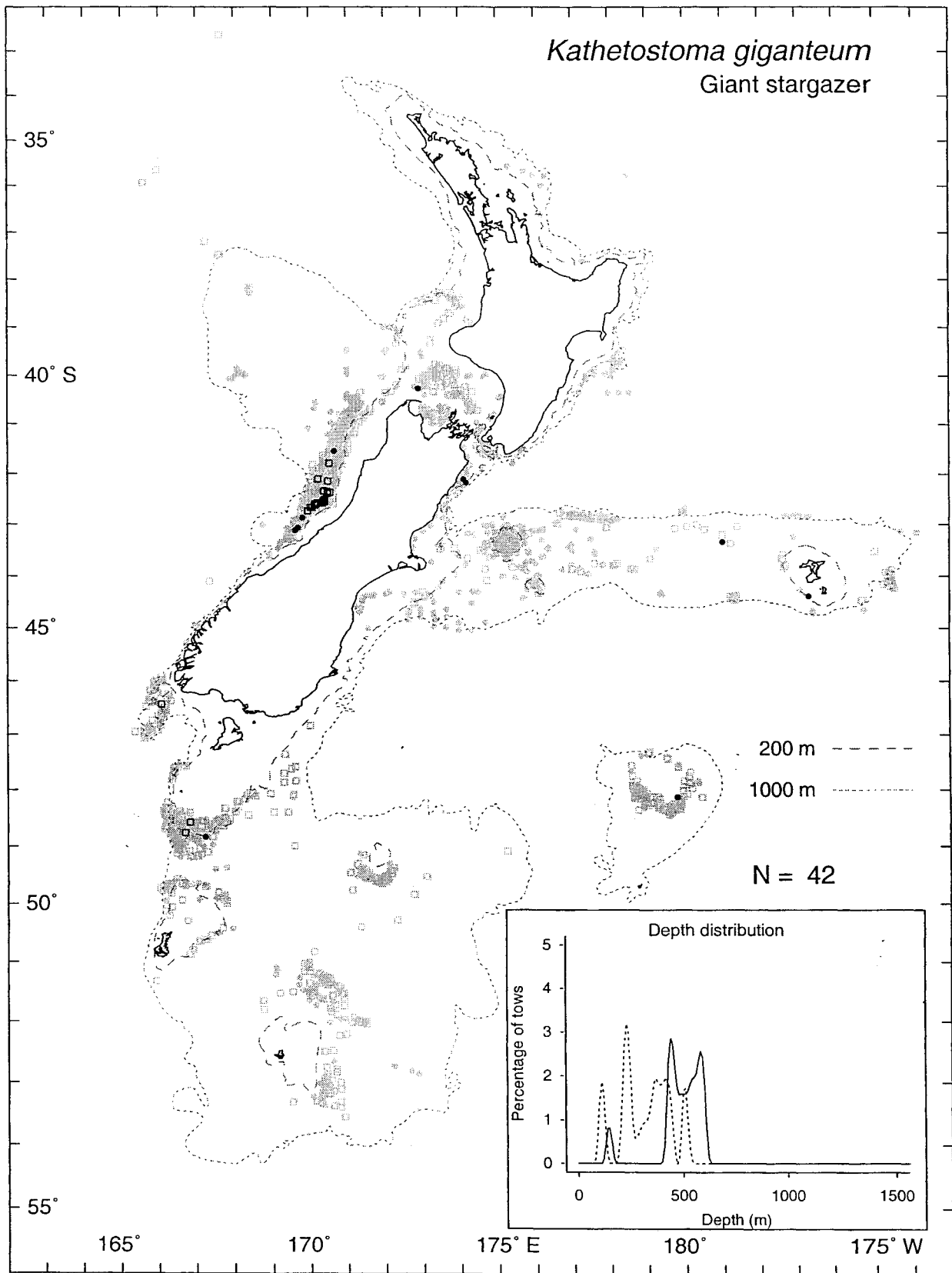
The northernmost research station outside the 1000 m contour is on a seamount in 365 m bottom depth.



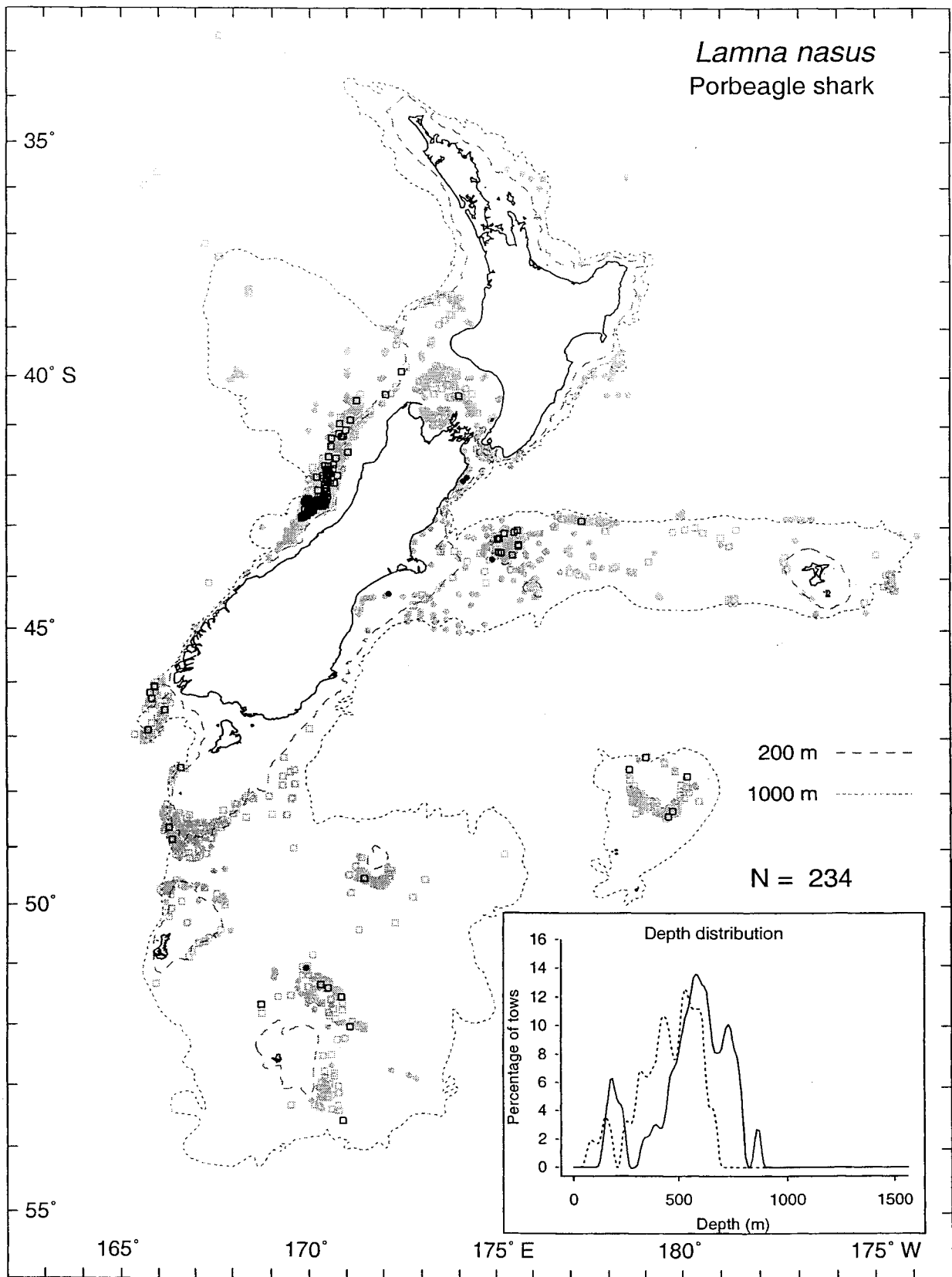
Includes two species.



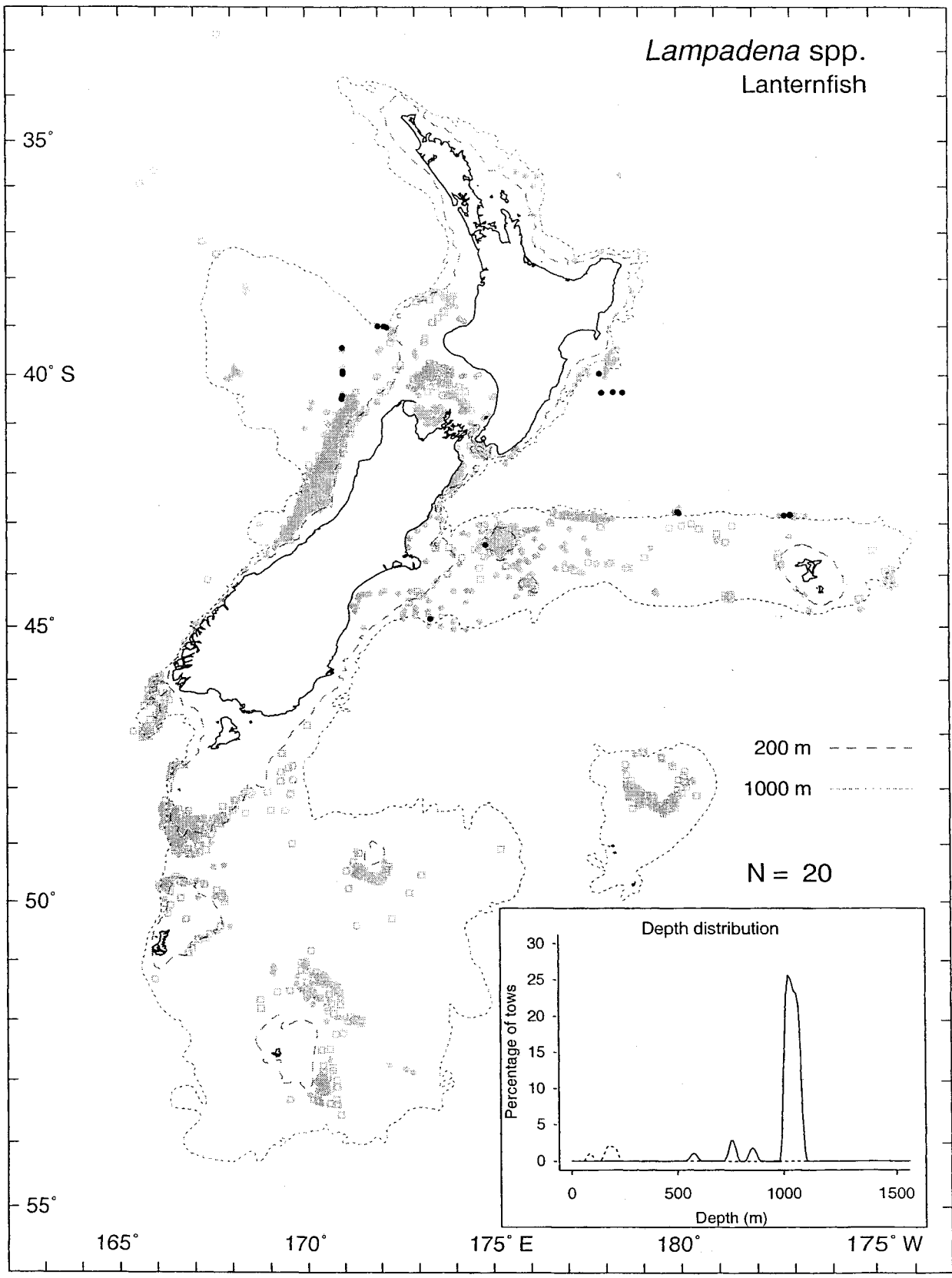
May include some *Lamna nasus*.



Some records for this species may represent other stargazer species, particularly the banded stargazer *Kathetostoma* sp., which was not recorded separately until 1986.

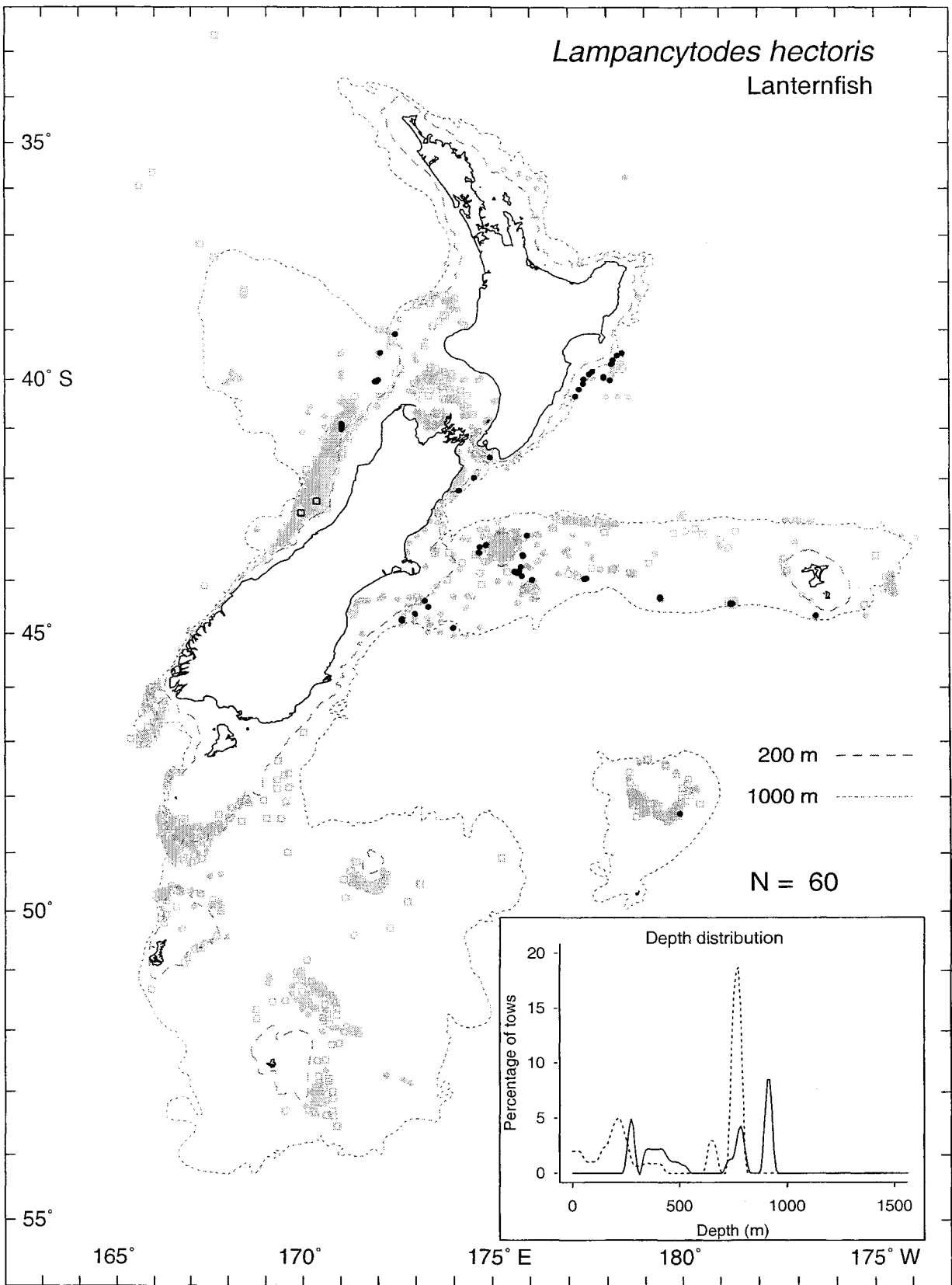


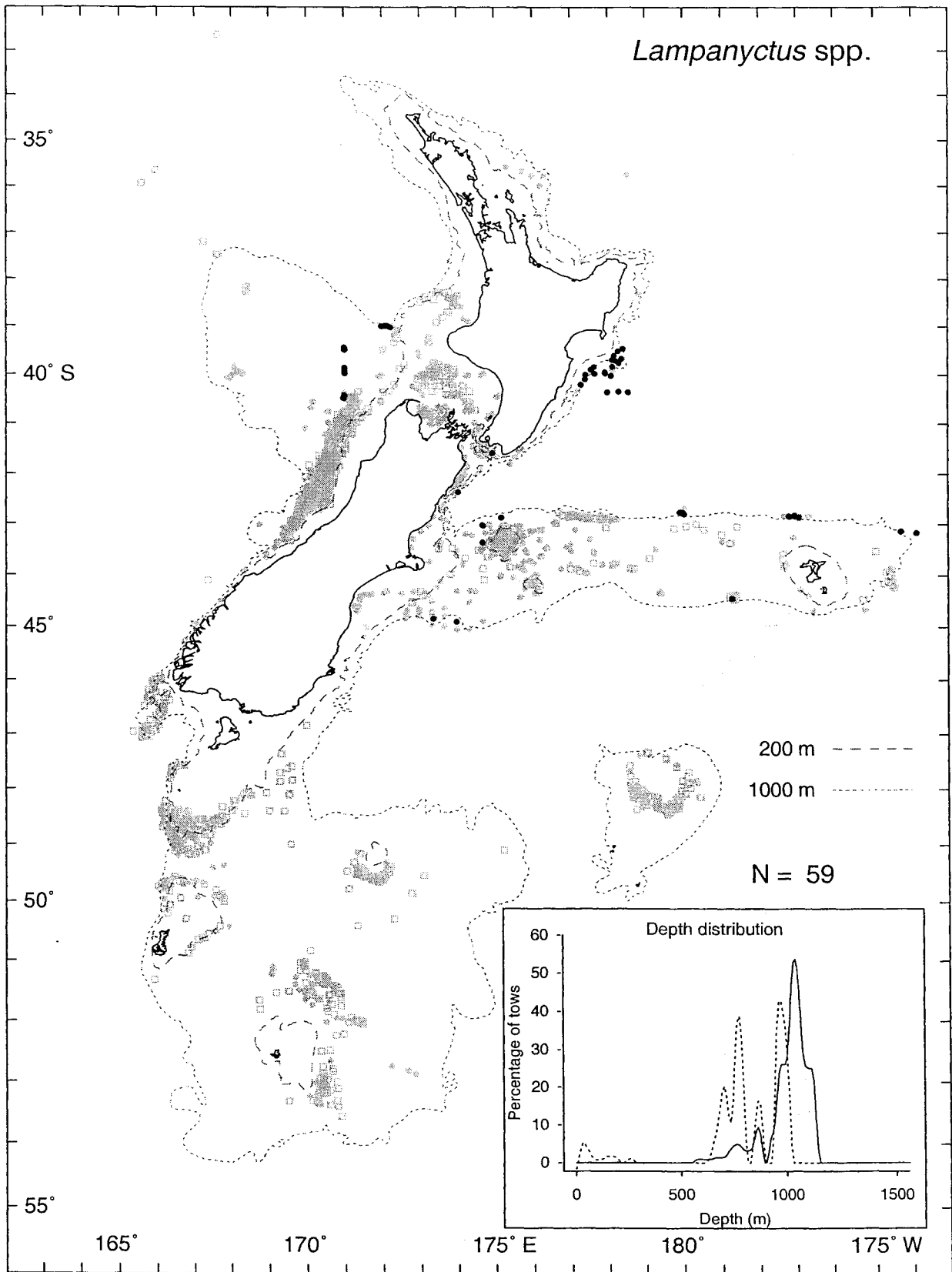
May include some *Isurus oxyrinchus*.



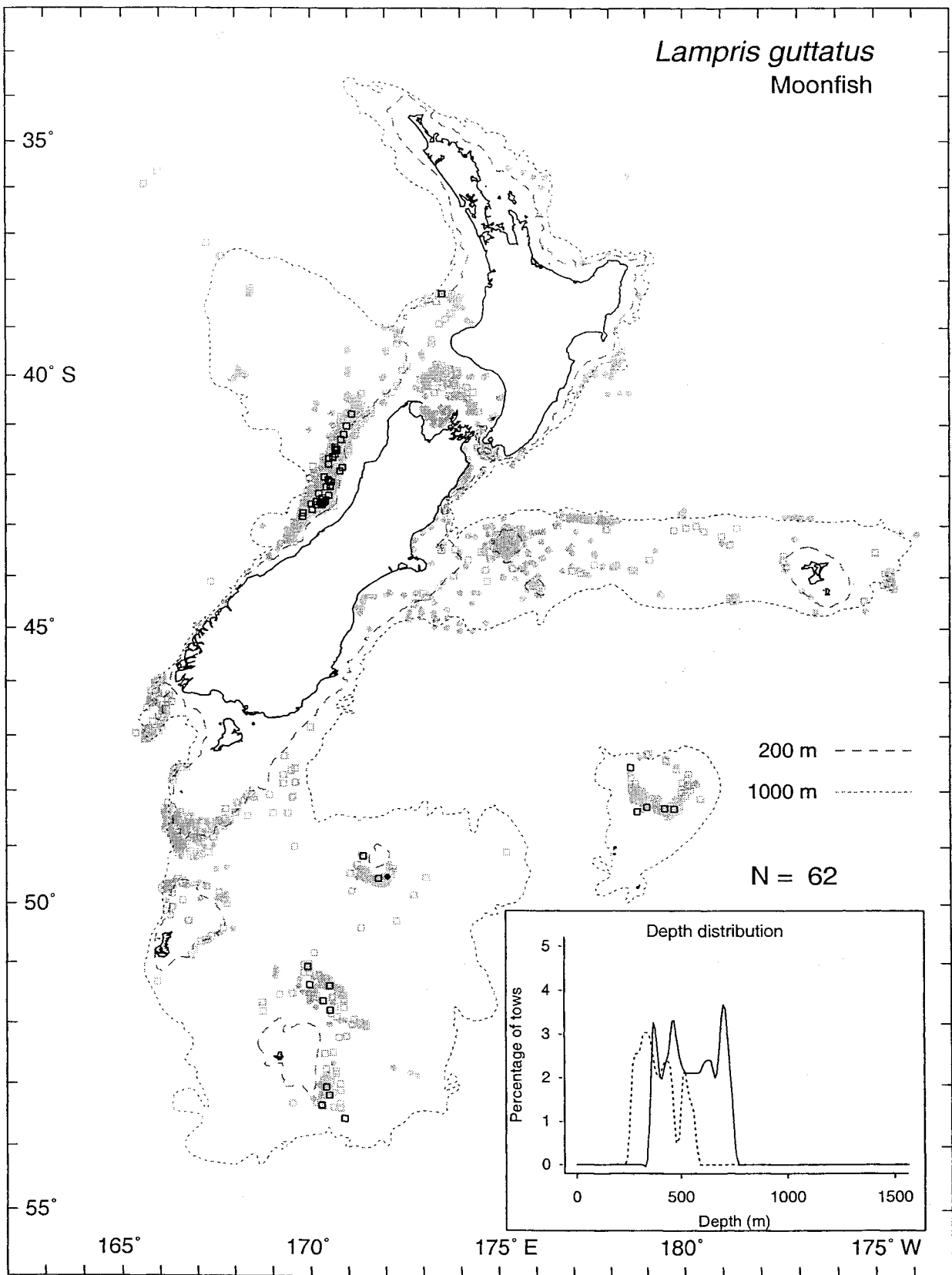
May include up to four species.

Lampanyctodes hectoris
Lanternfish

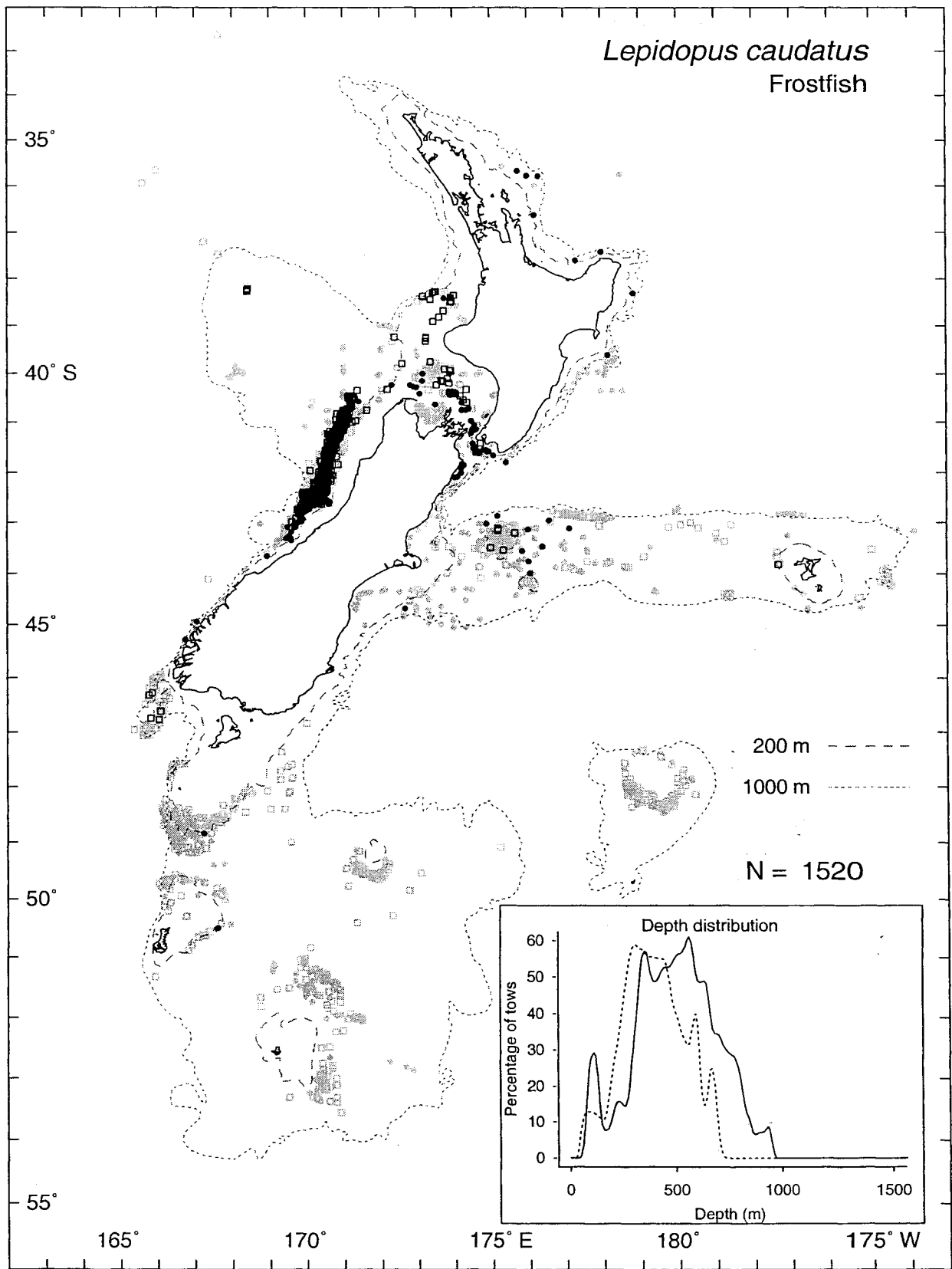




May include up to twelve species.

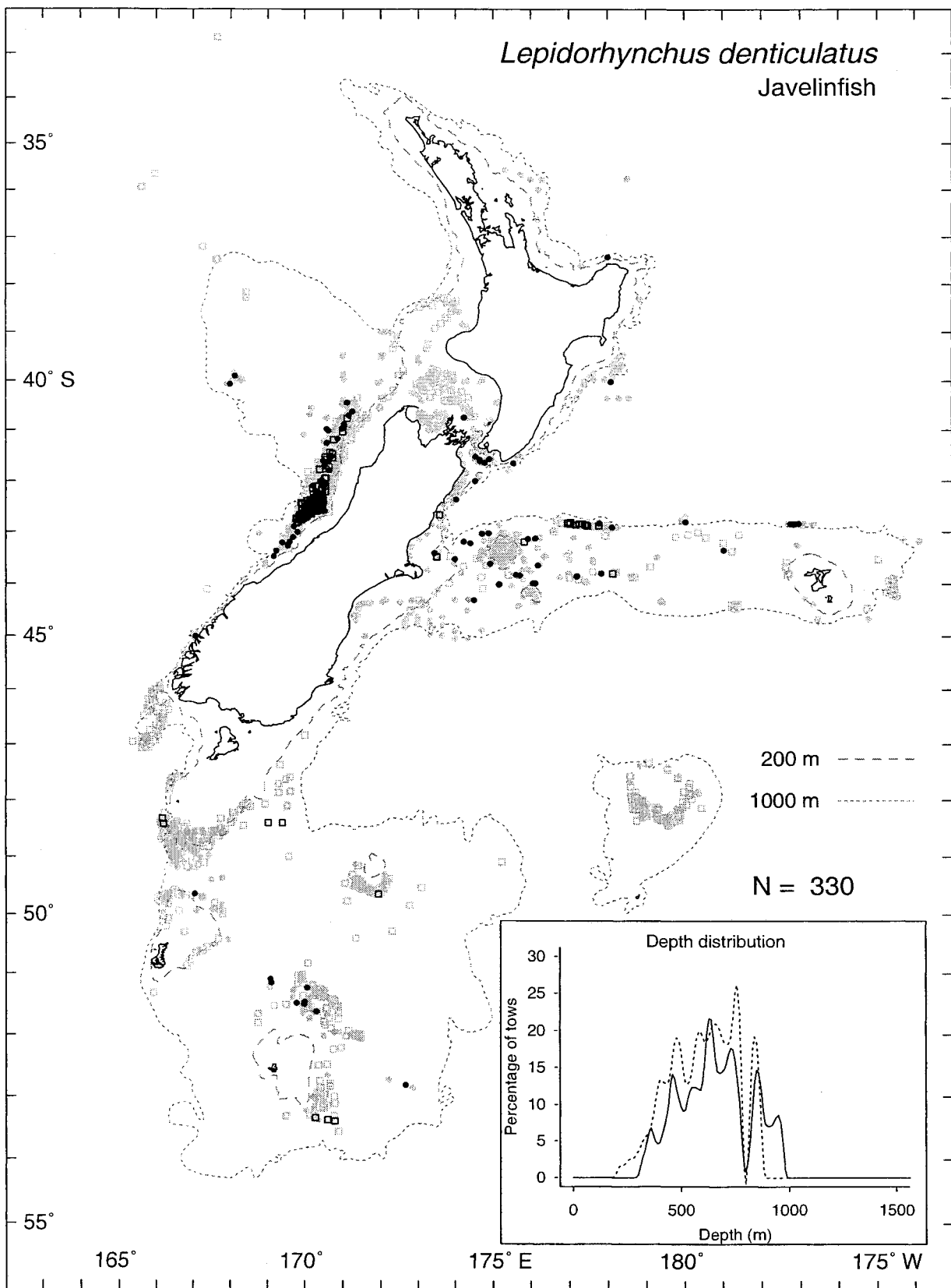


May include some *Lampris immaculatus*.

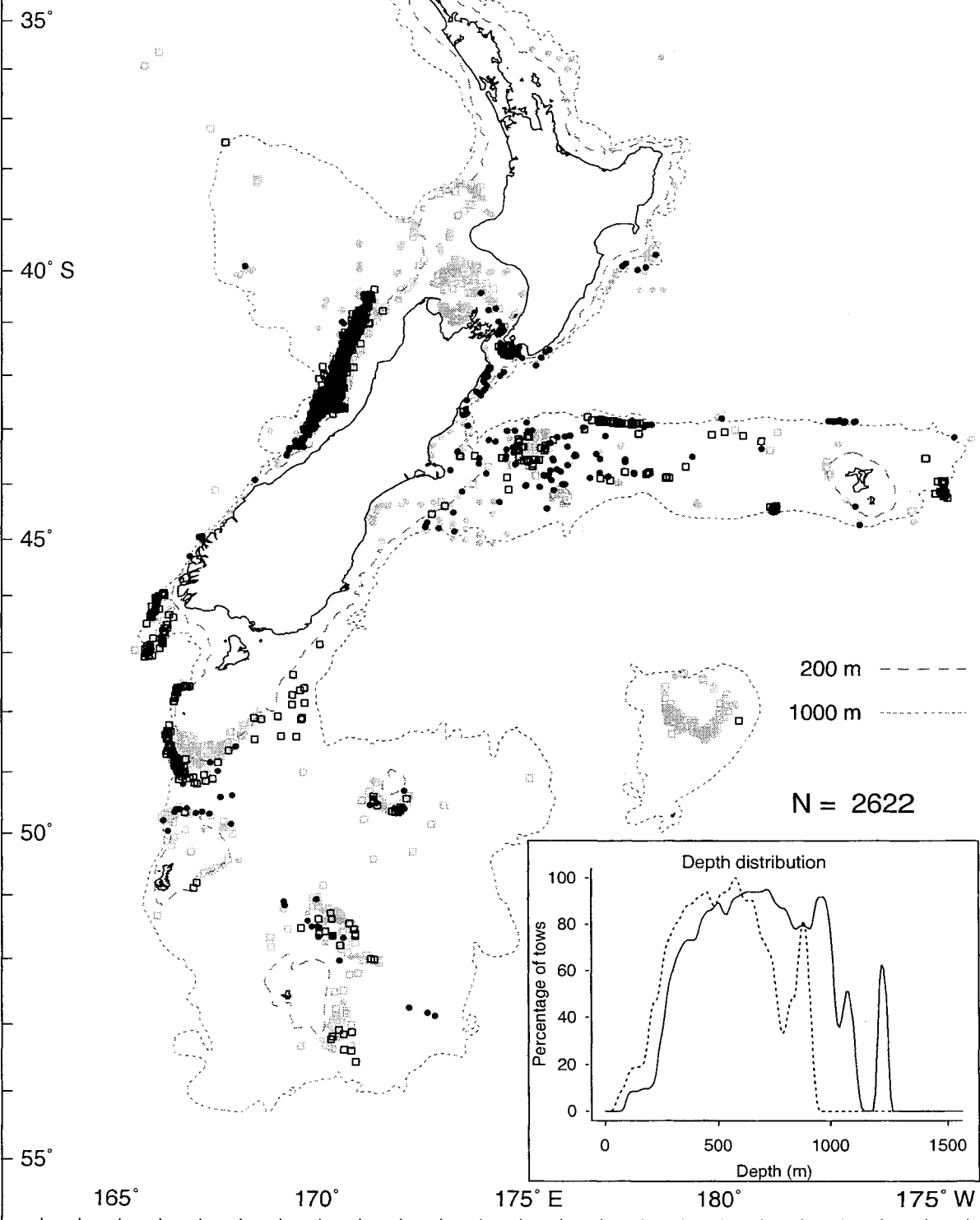


Subantarctic records may have been mis-identified and may include some *Paradiplospinus gracilis* and *Benthodesmus* spp.

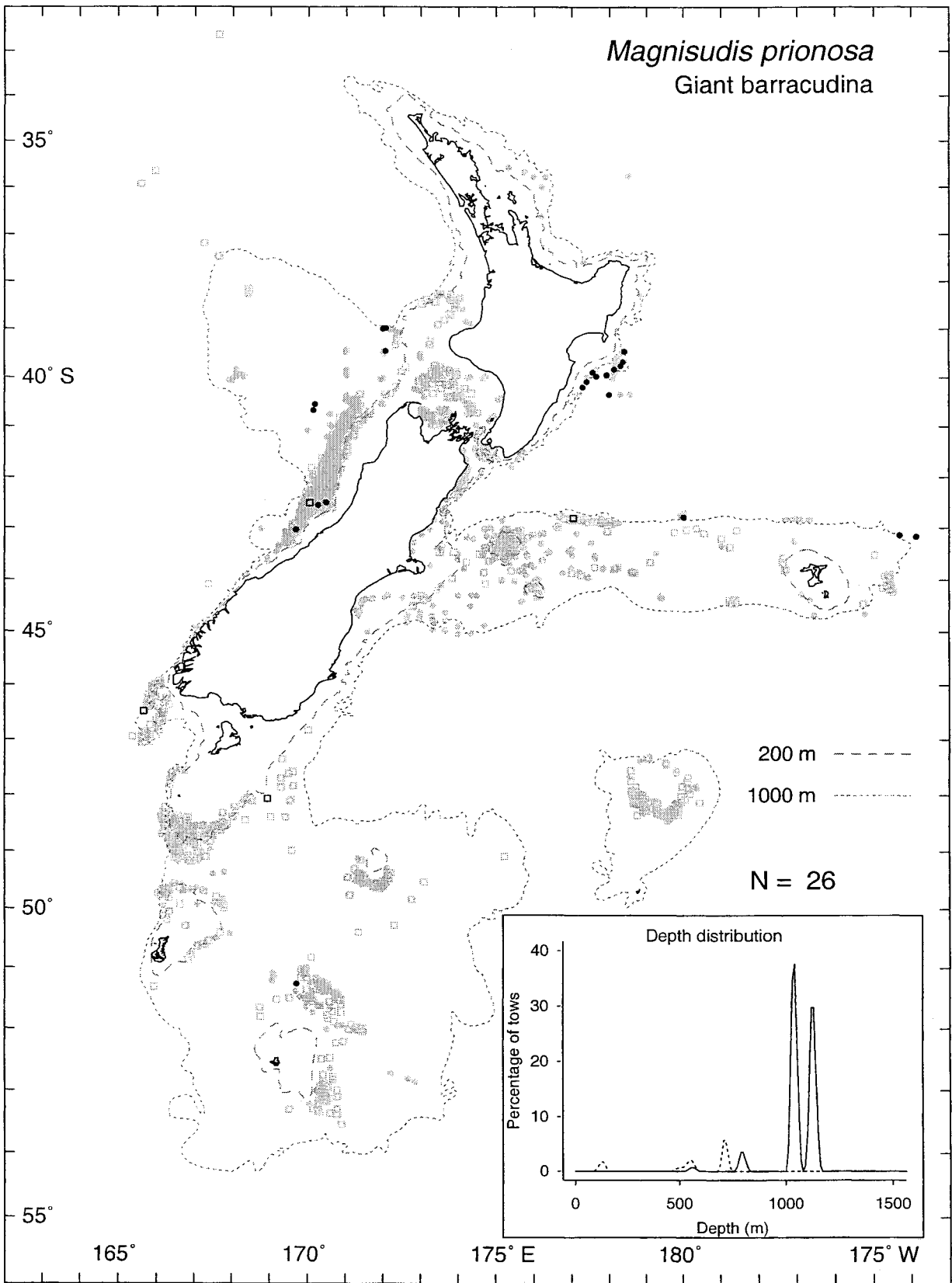
Lepidorhynchus denticulatus
Javelinfish

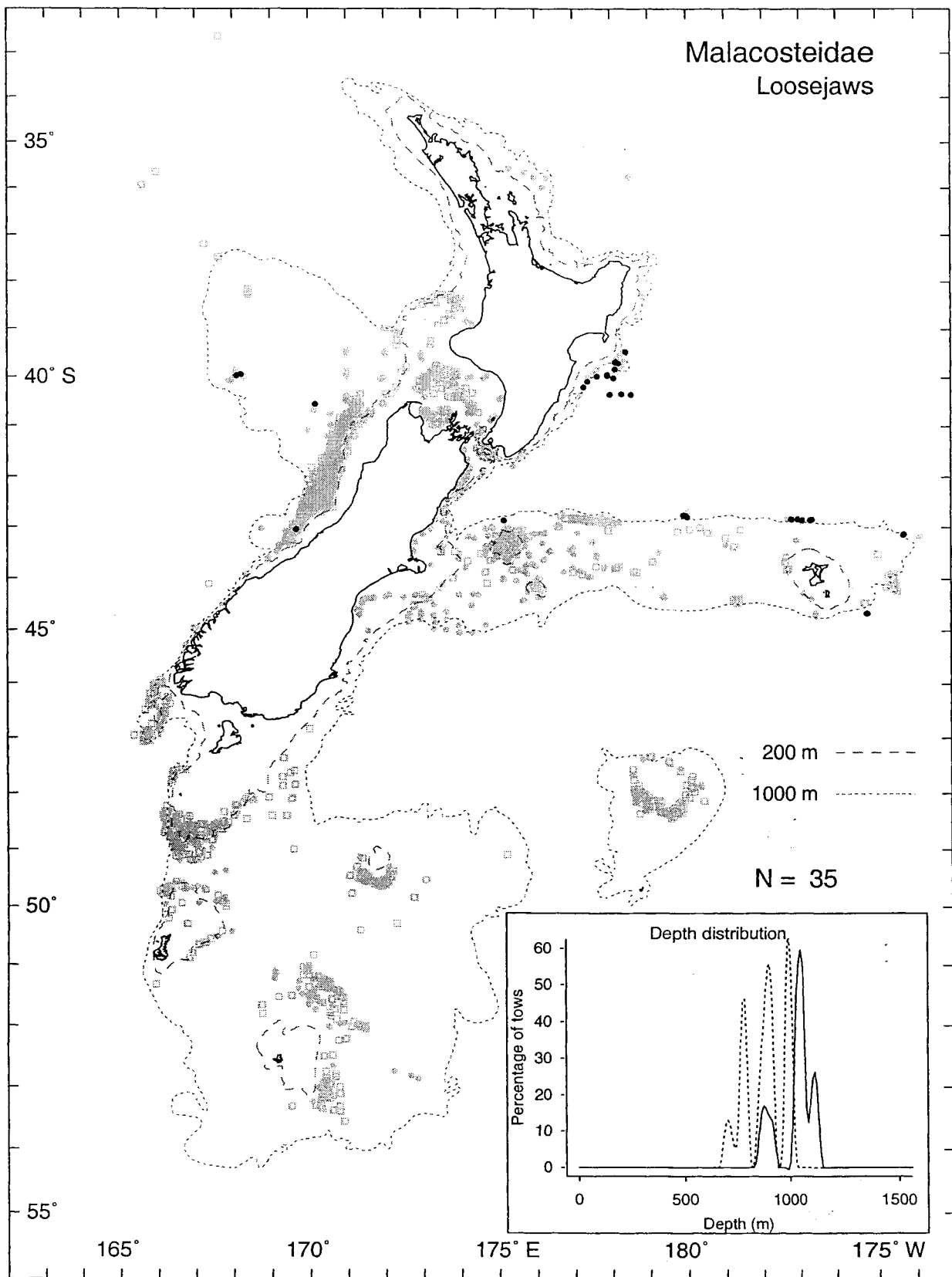


Macruronus novaezelandiae
Hoki



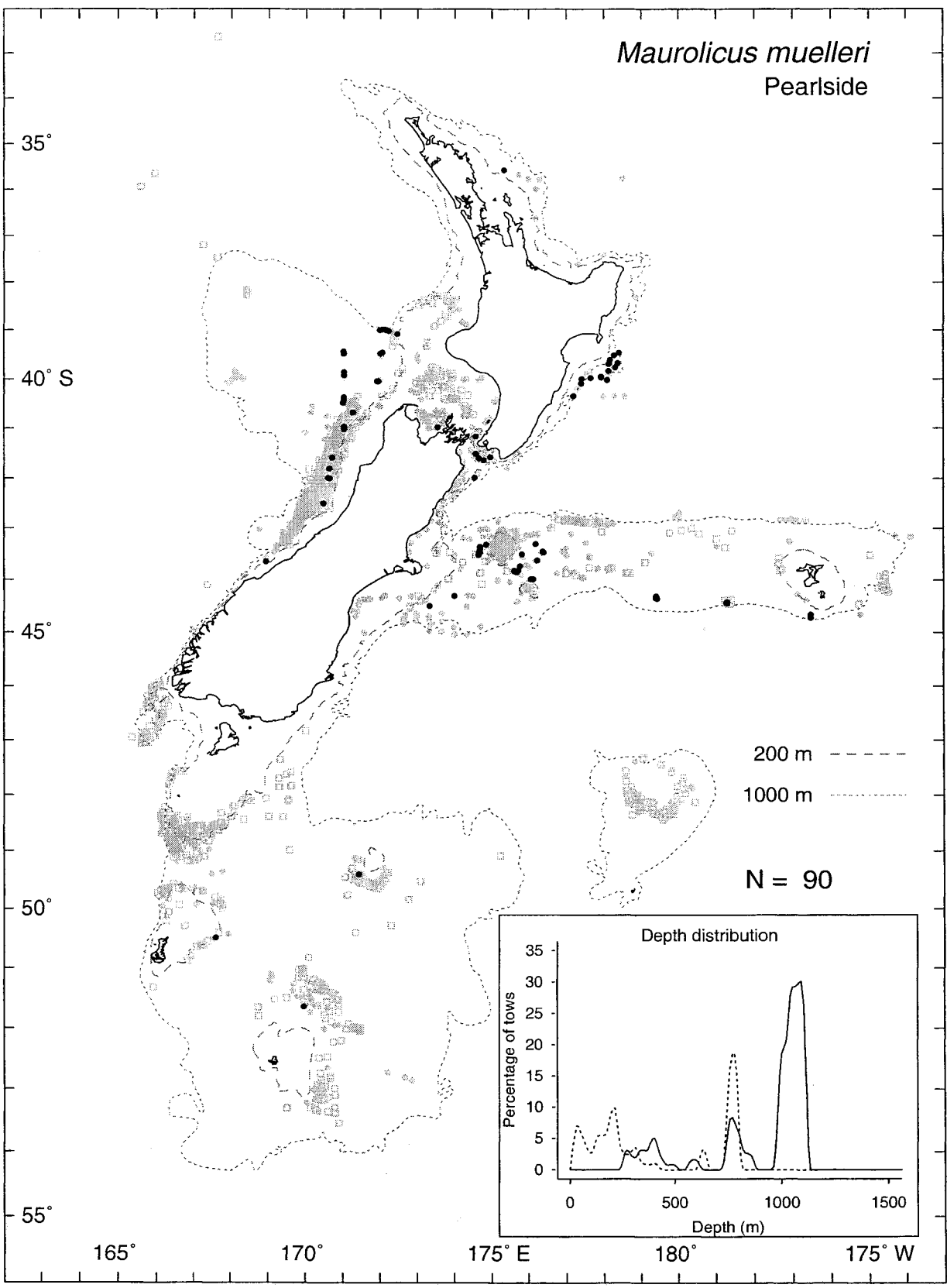
Magnisudis prionosa
Giant barracudina

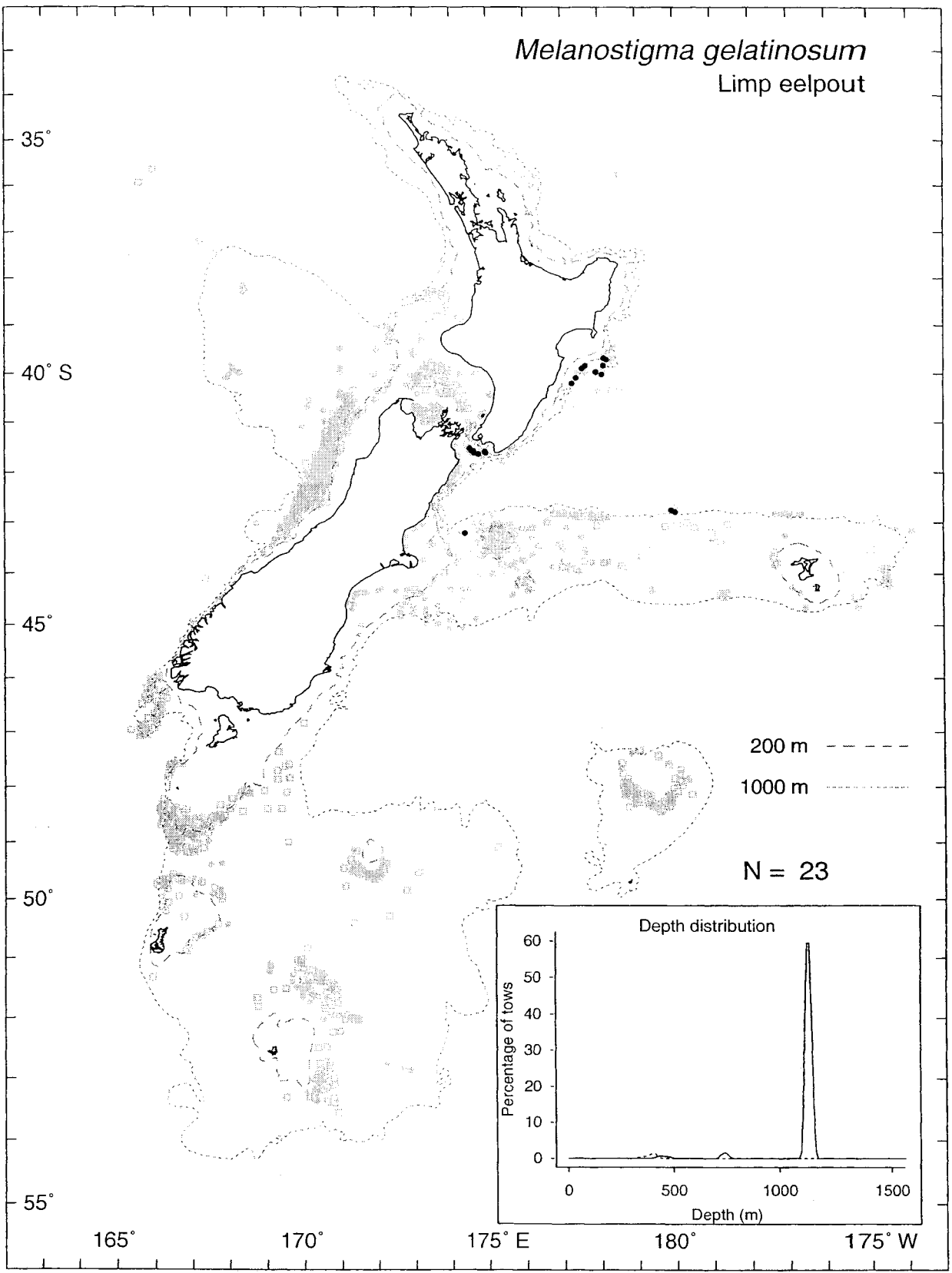




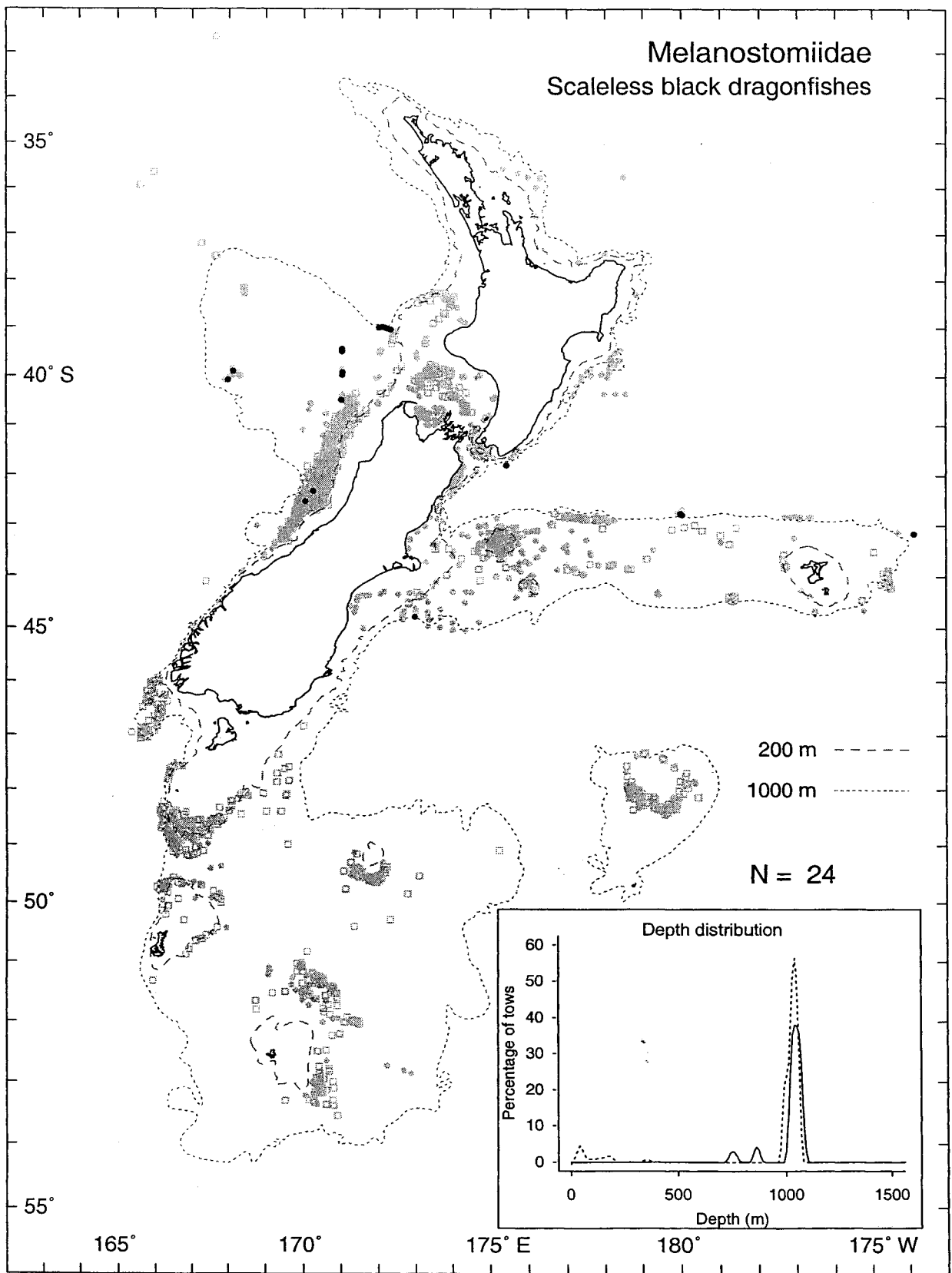
May include four species in three genera.

Maurolicus muelleri
Pearlside



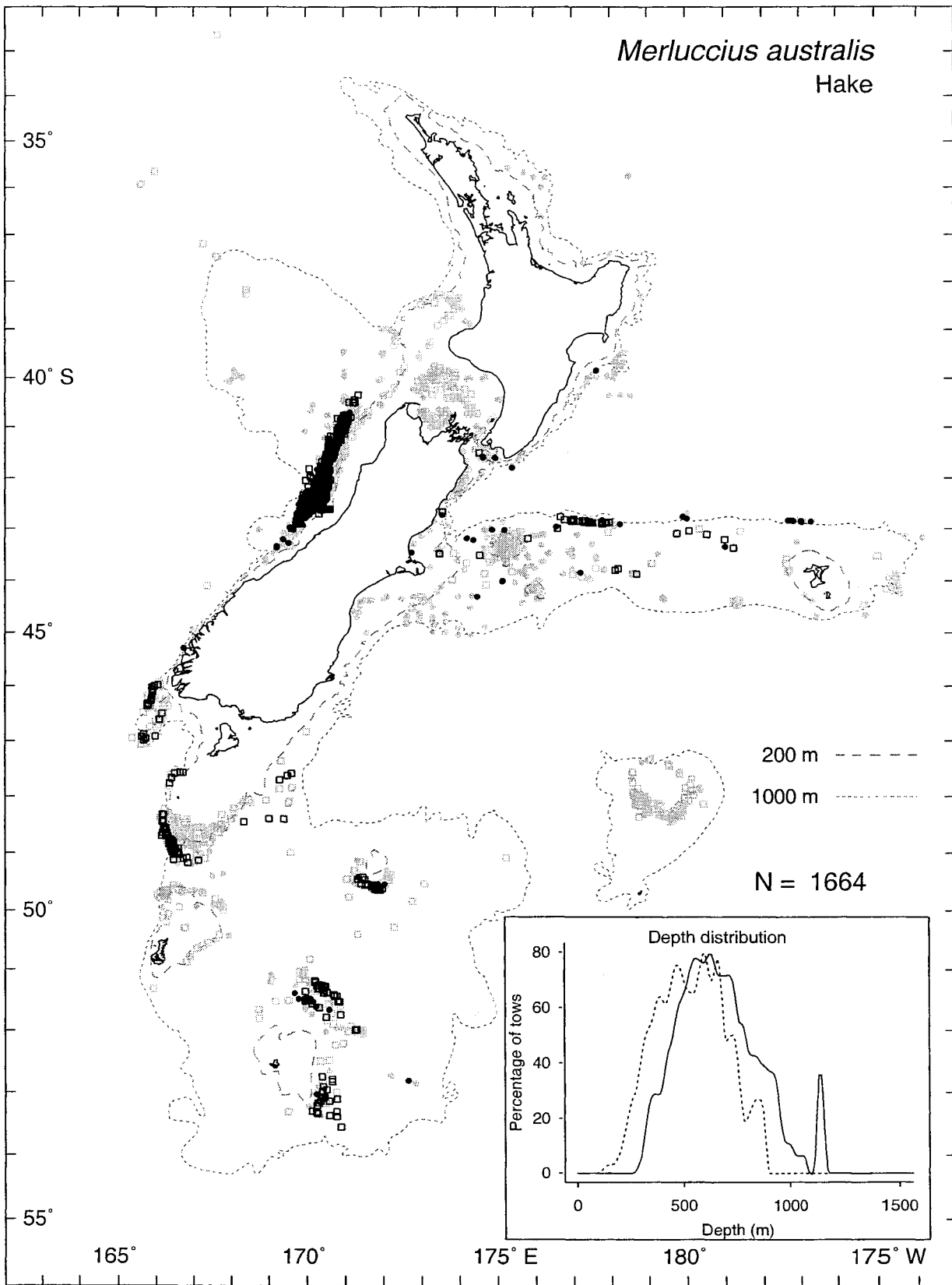


May include other *Melanostigma* spp.

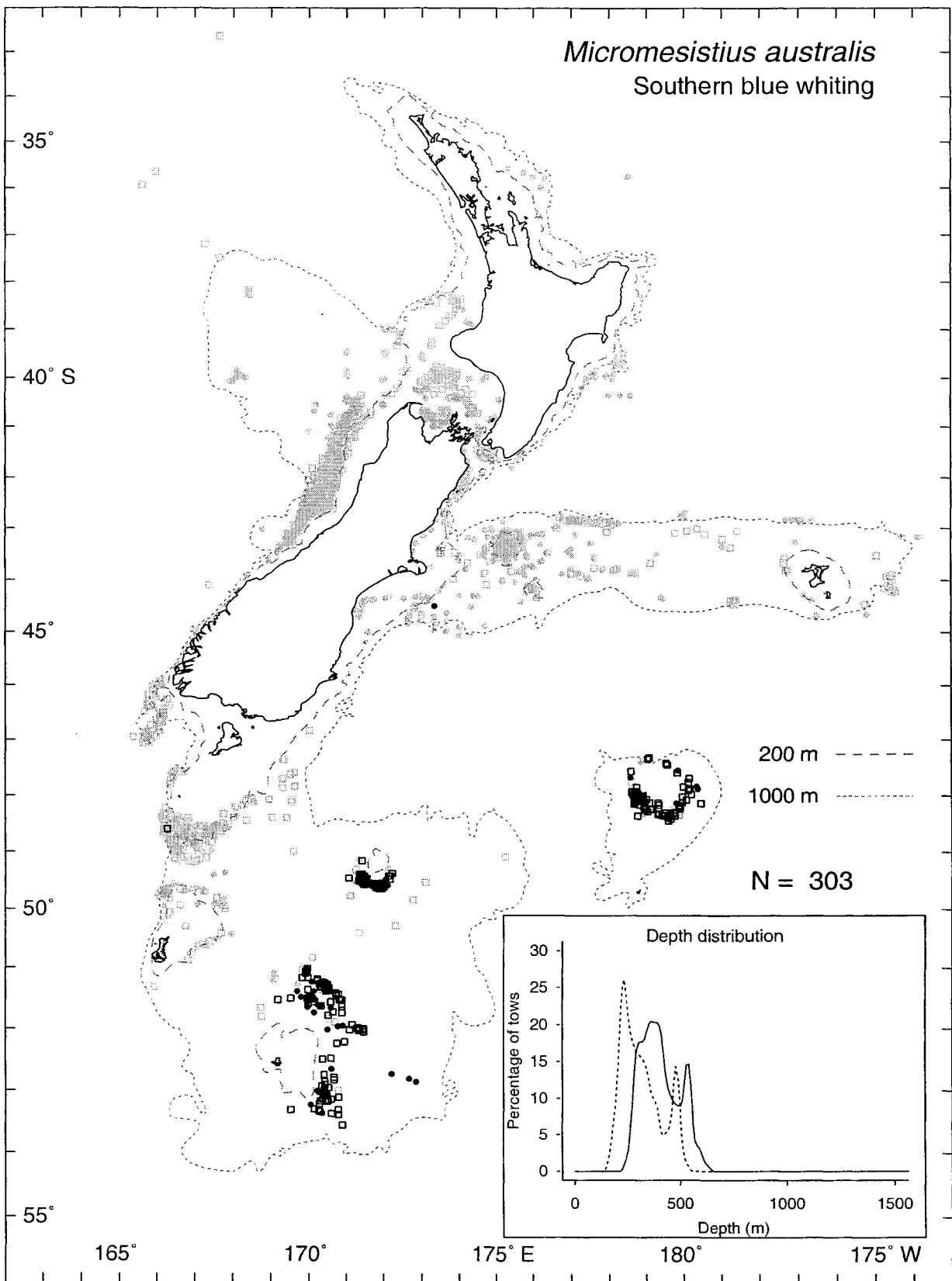


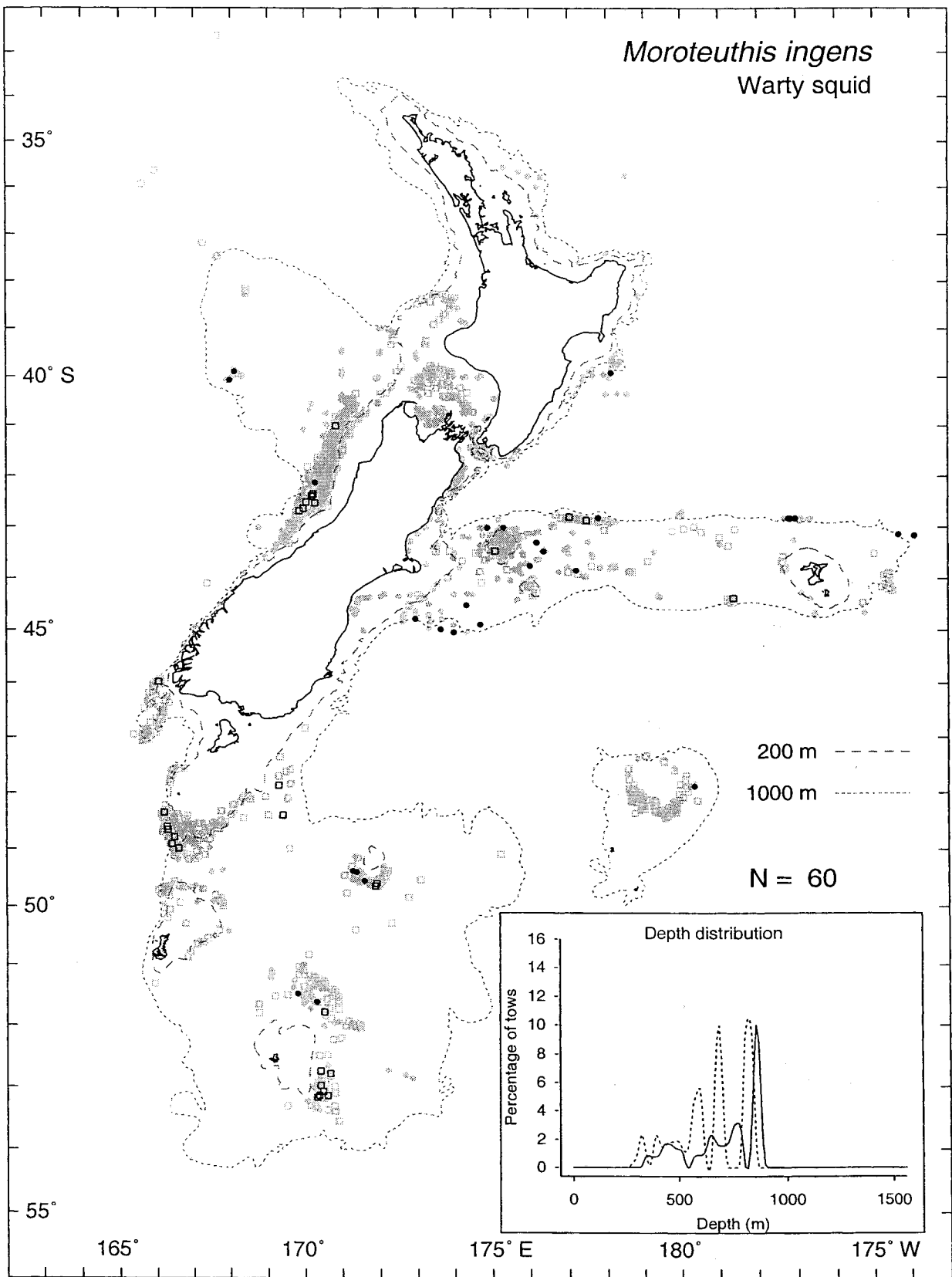
Includes about 25 species in 9 genera:

Merluccius australis
Hake



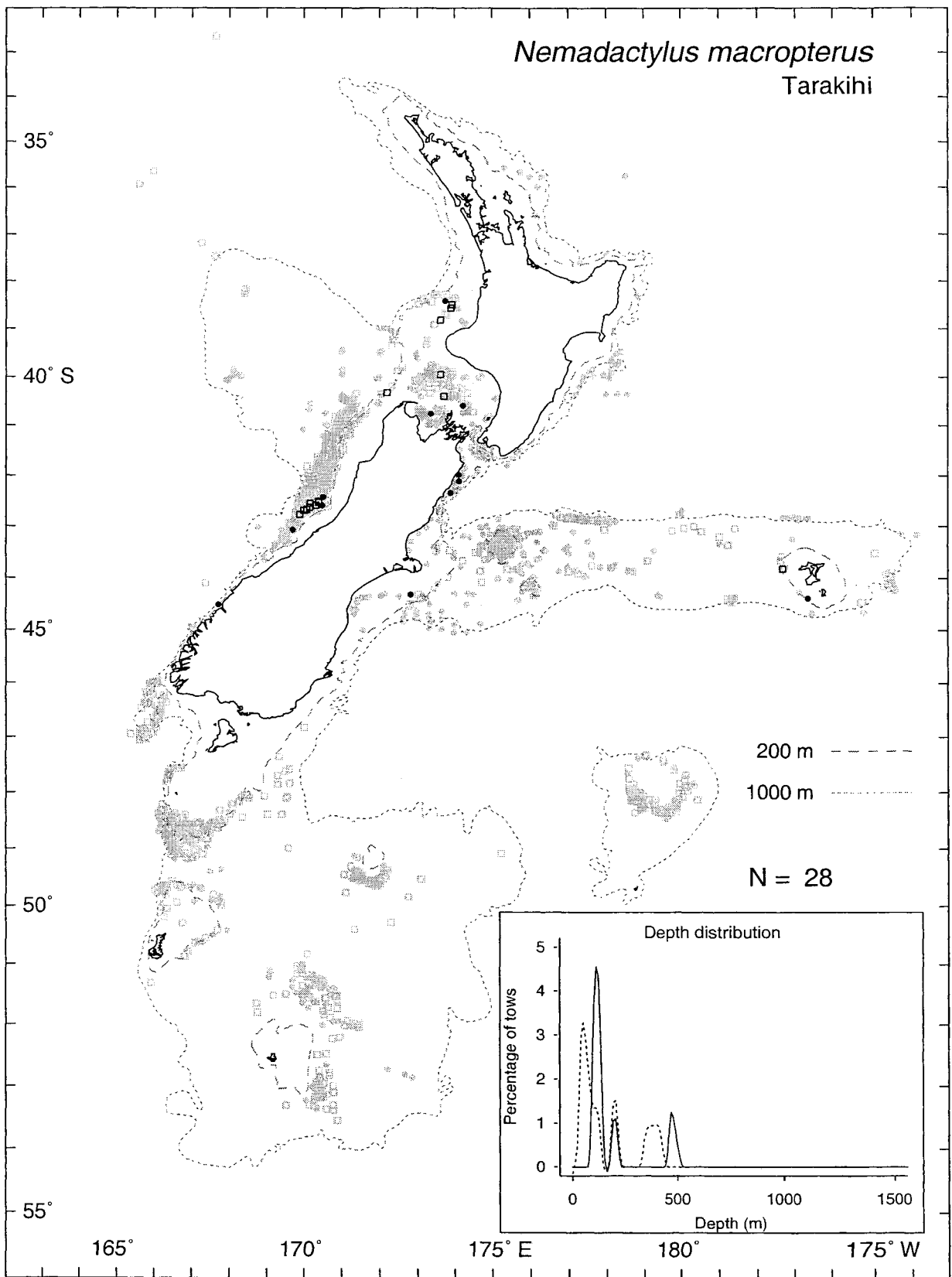
Micromesistius australis
Southern blue whiting

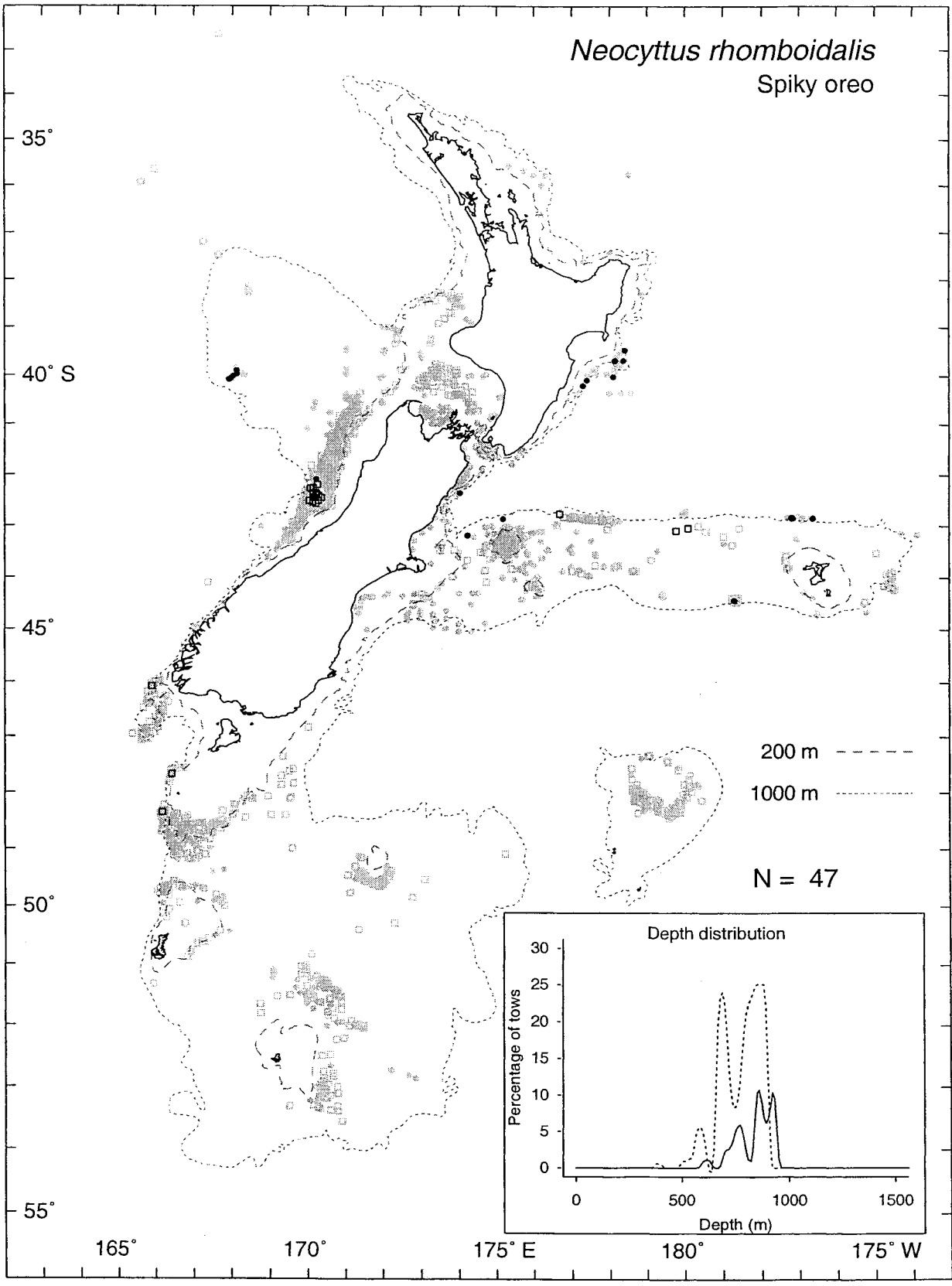




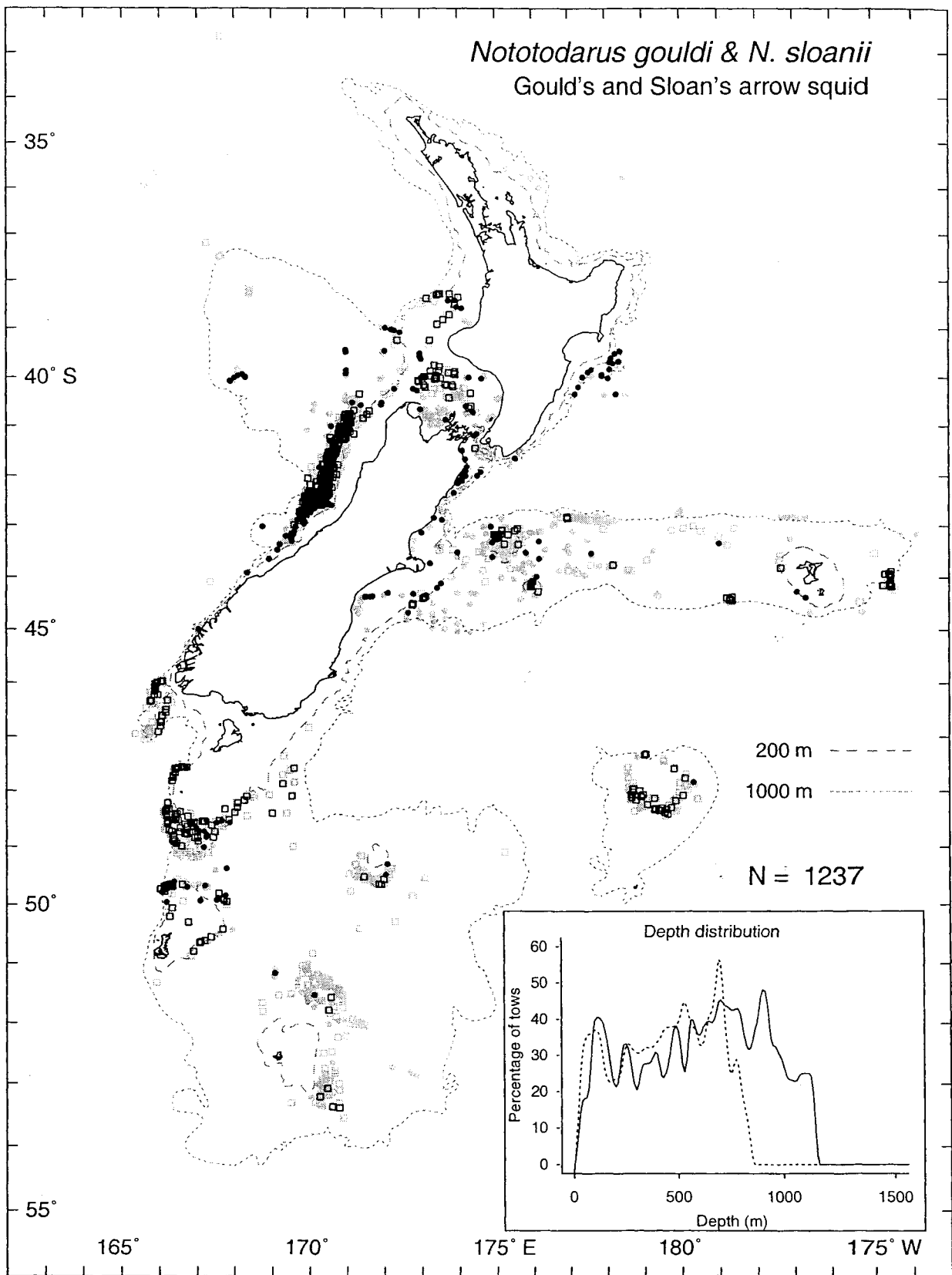
May include some *M. robsoni*.

Nemadactylus macropterus
Tarakihi

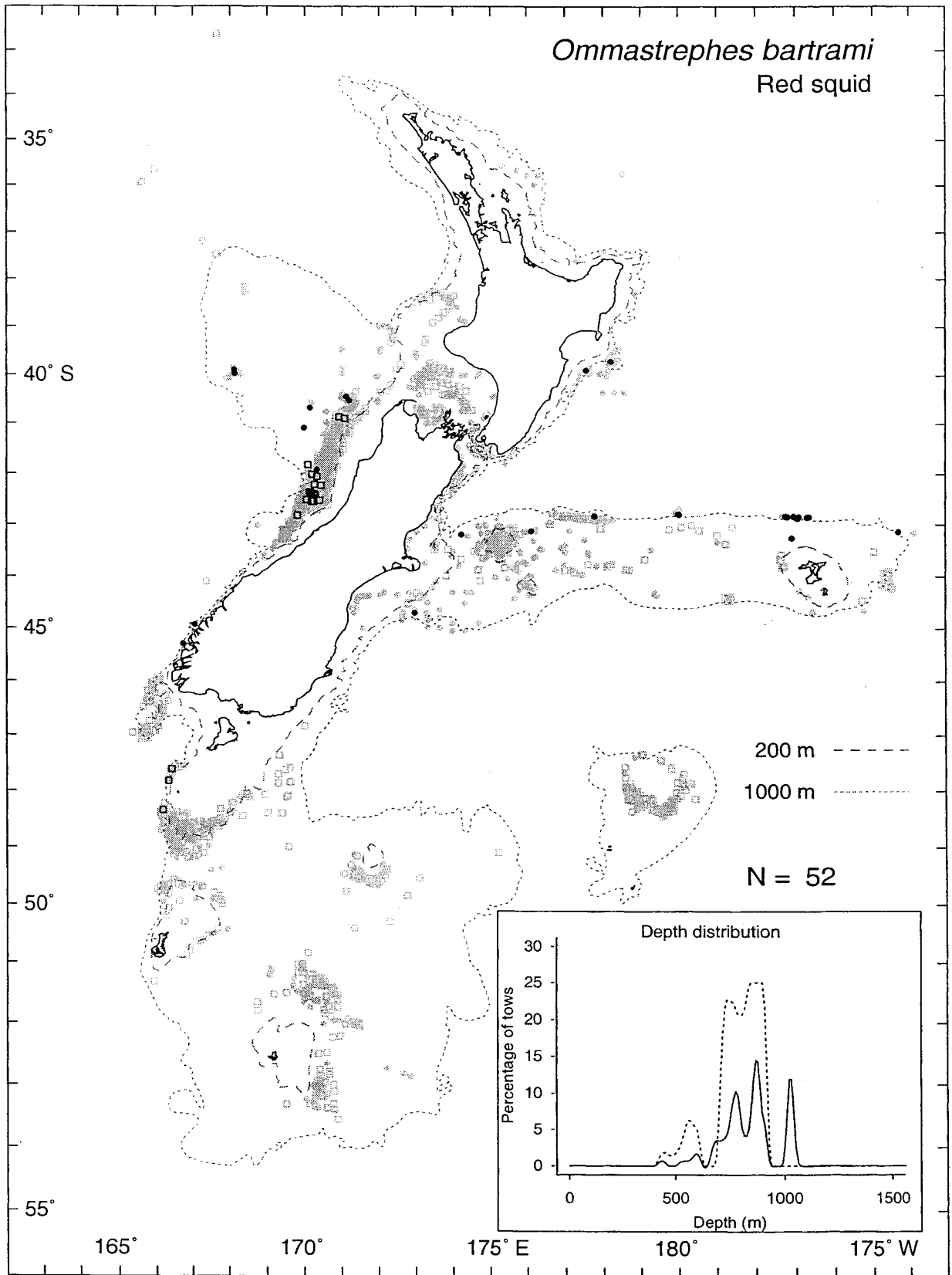




May include some *Alloctytus niger*.

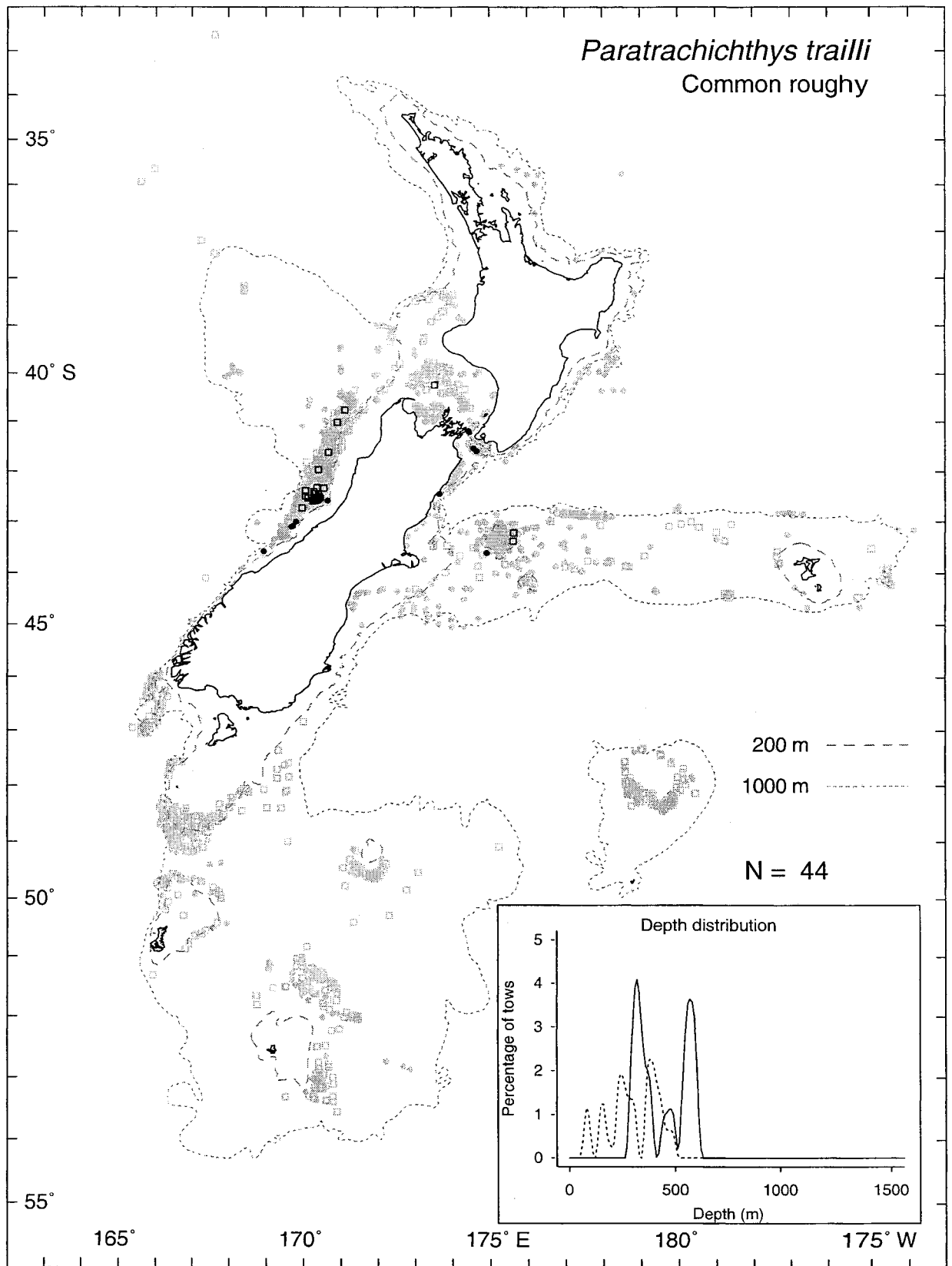


Deepest records may include other squids.

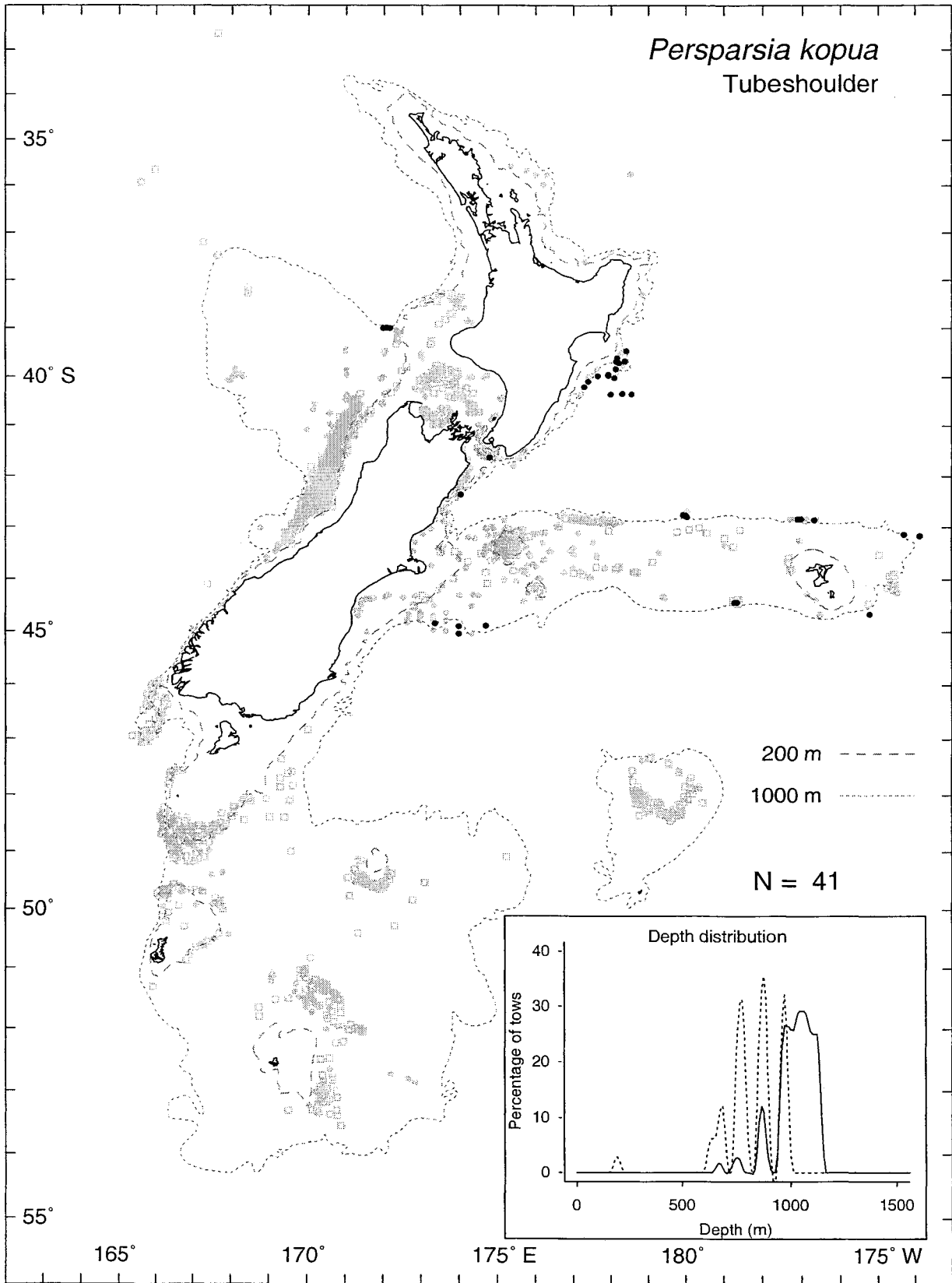


May include some *Todarodes* spp.

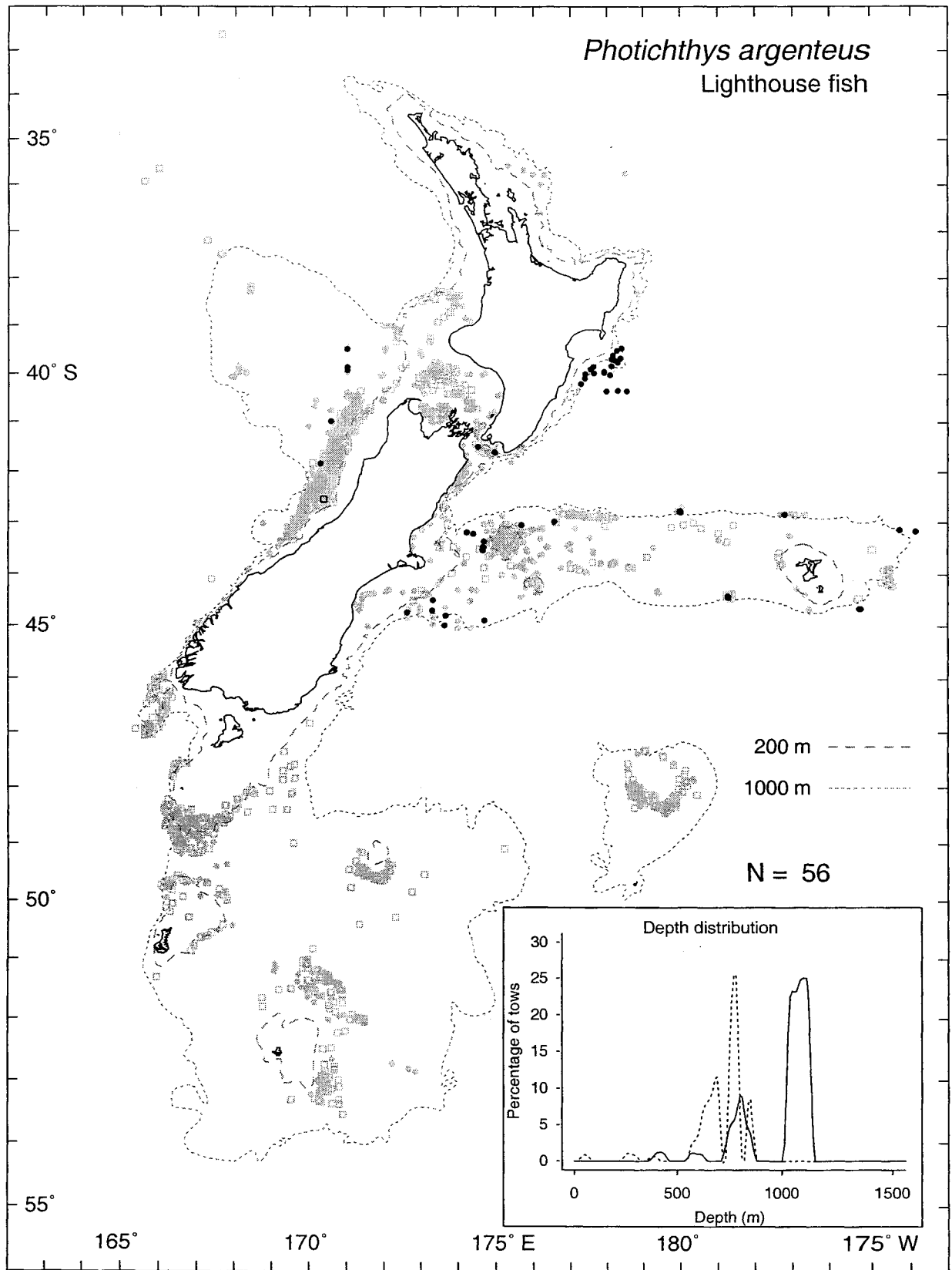
Paratrachichthys trilli
Common roughy

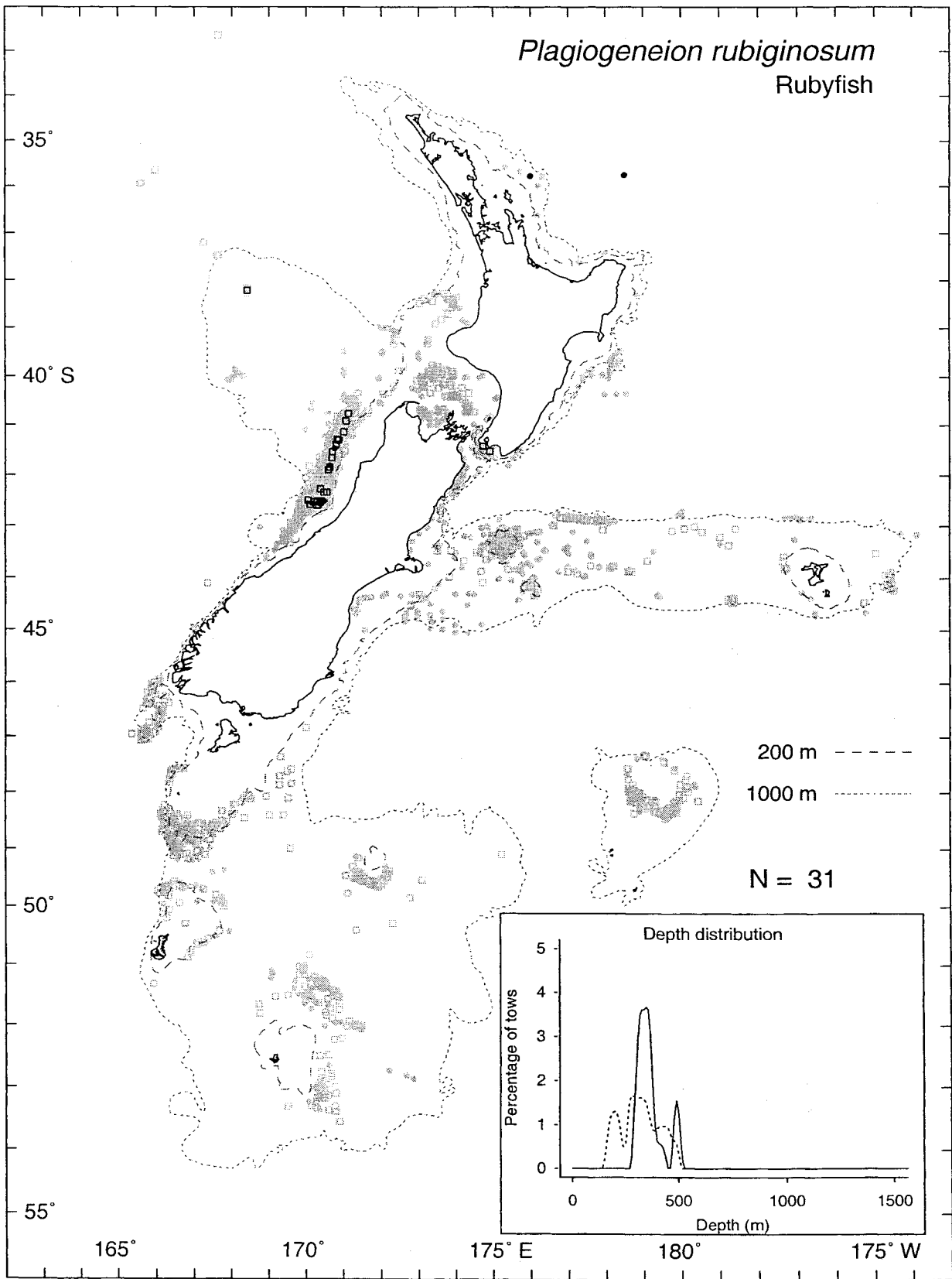


Persparsia kopua
Tubeshoulder



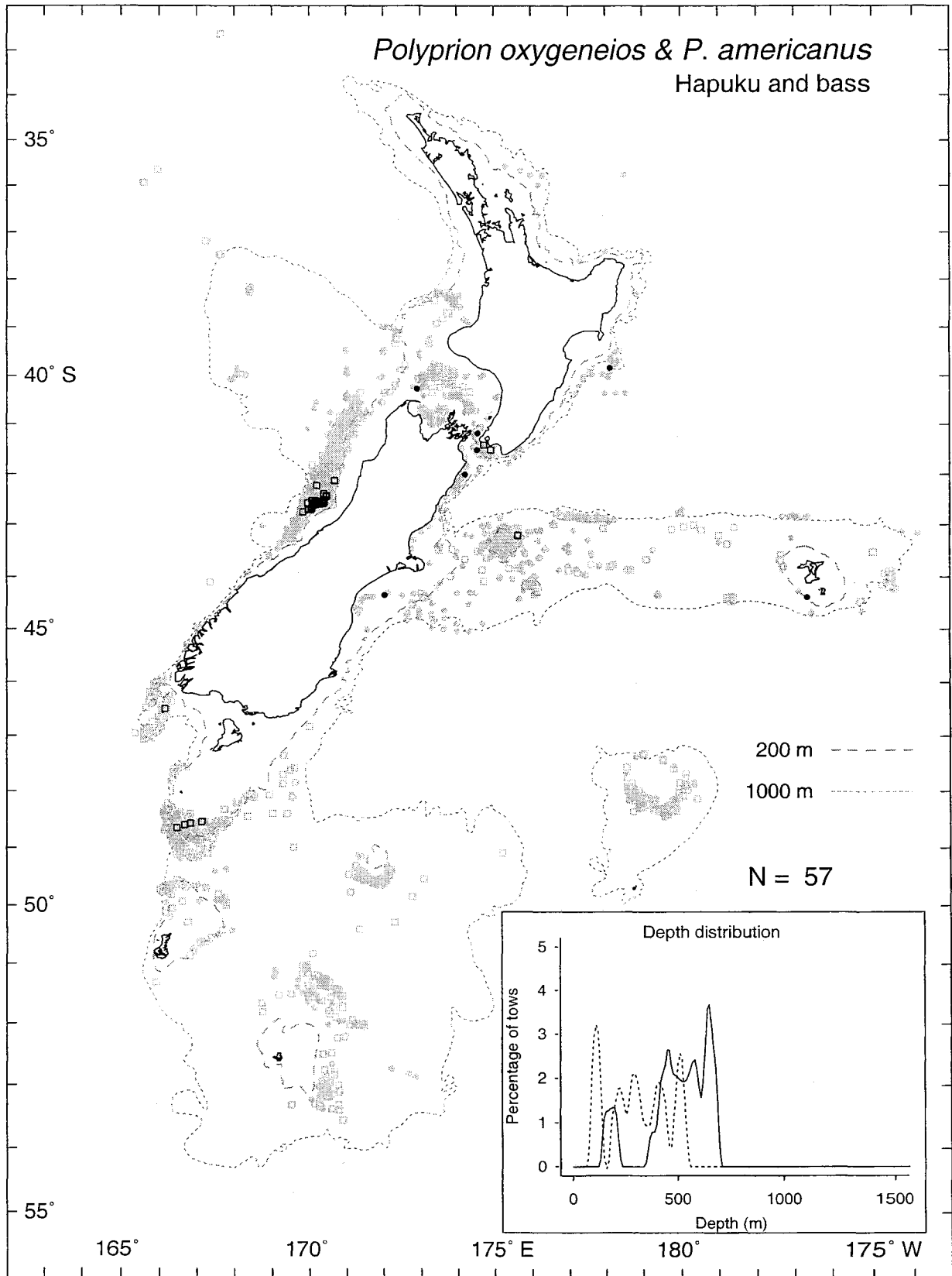
Photichthys argenteus
Lighthouse fish



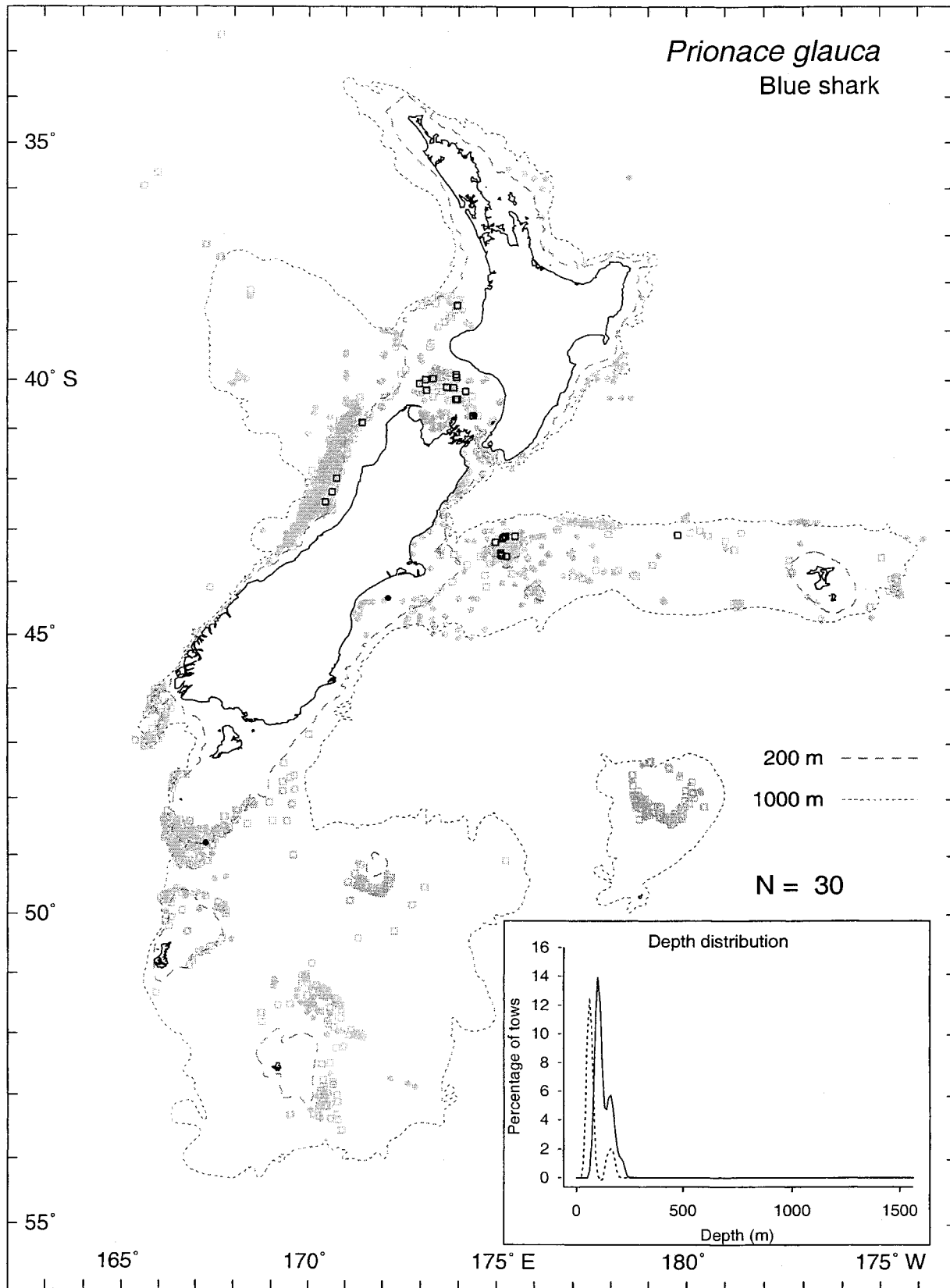


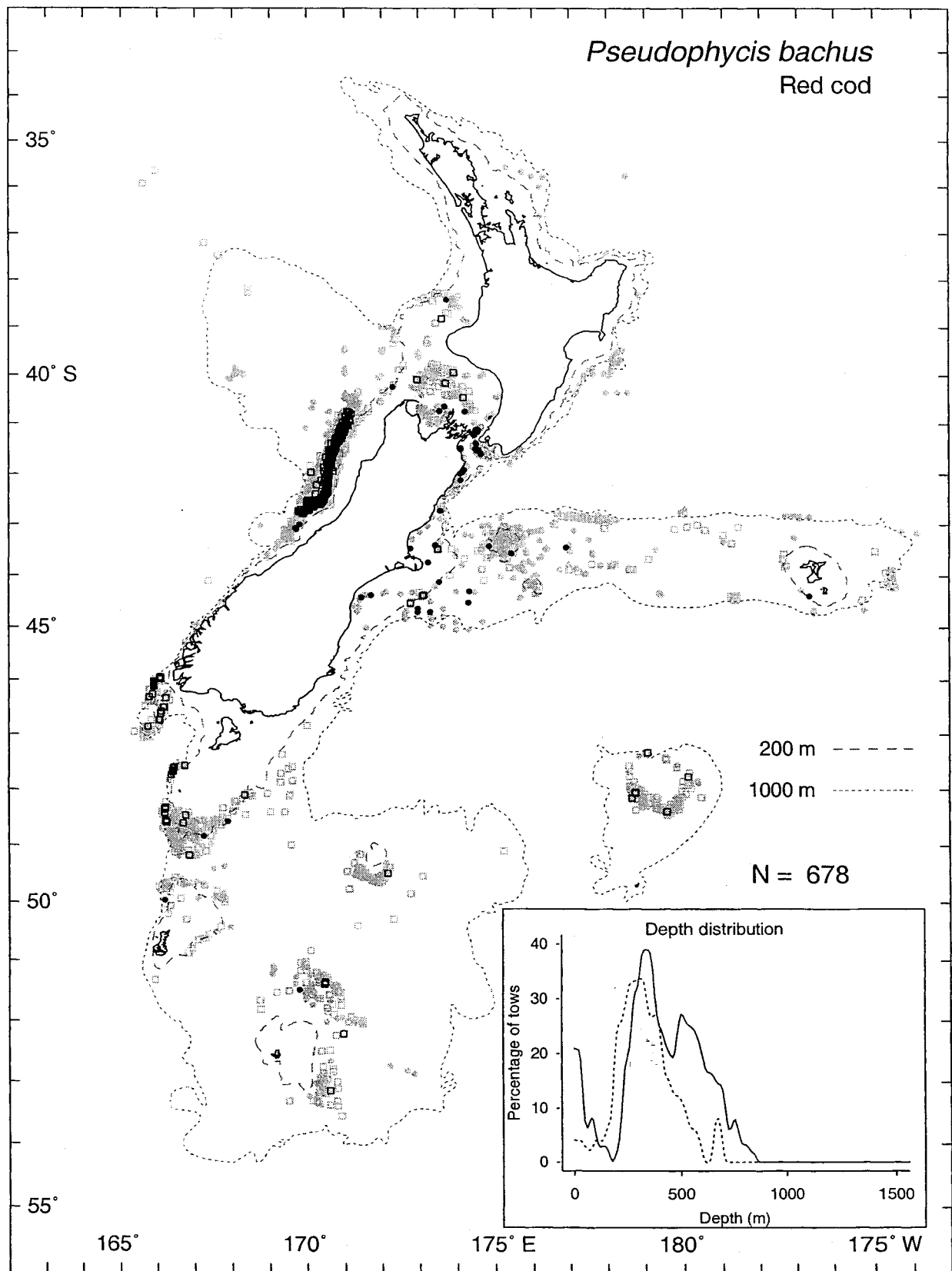
The northernmost research station outside the 1000 m contour is on a seamount in 365 m bottom depth.

Polyprion oxygeneios & *P. americanus*
Hapuku and bass

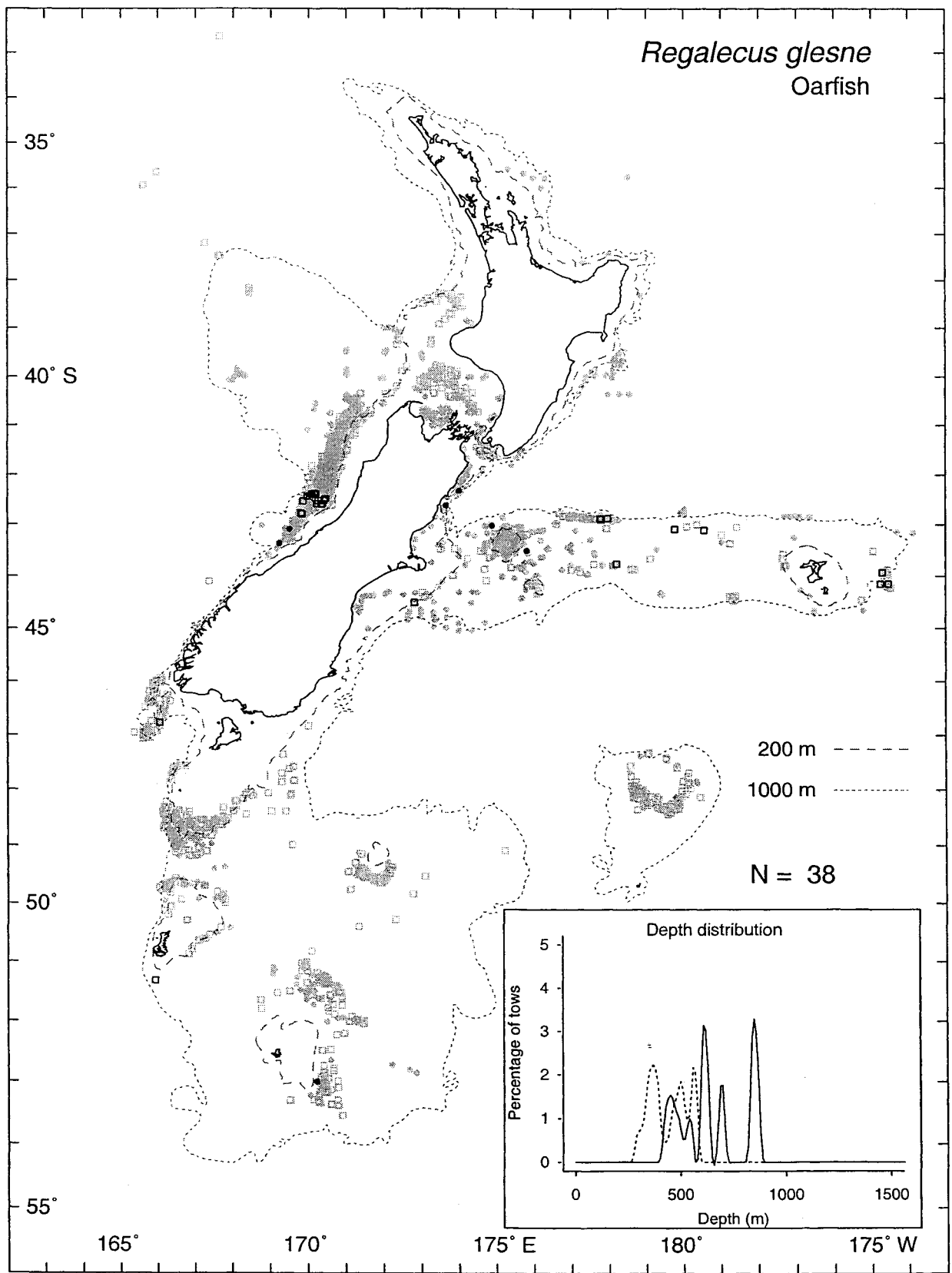


Prionace glauca
Blue shark

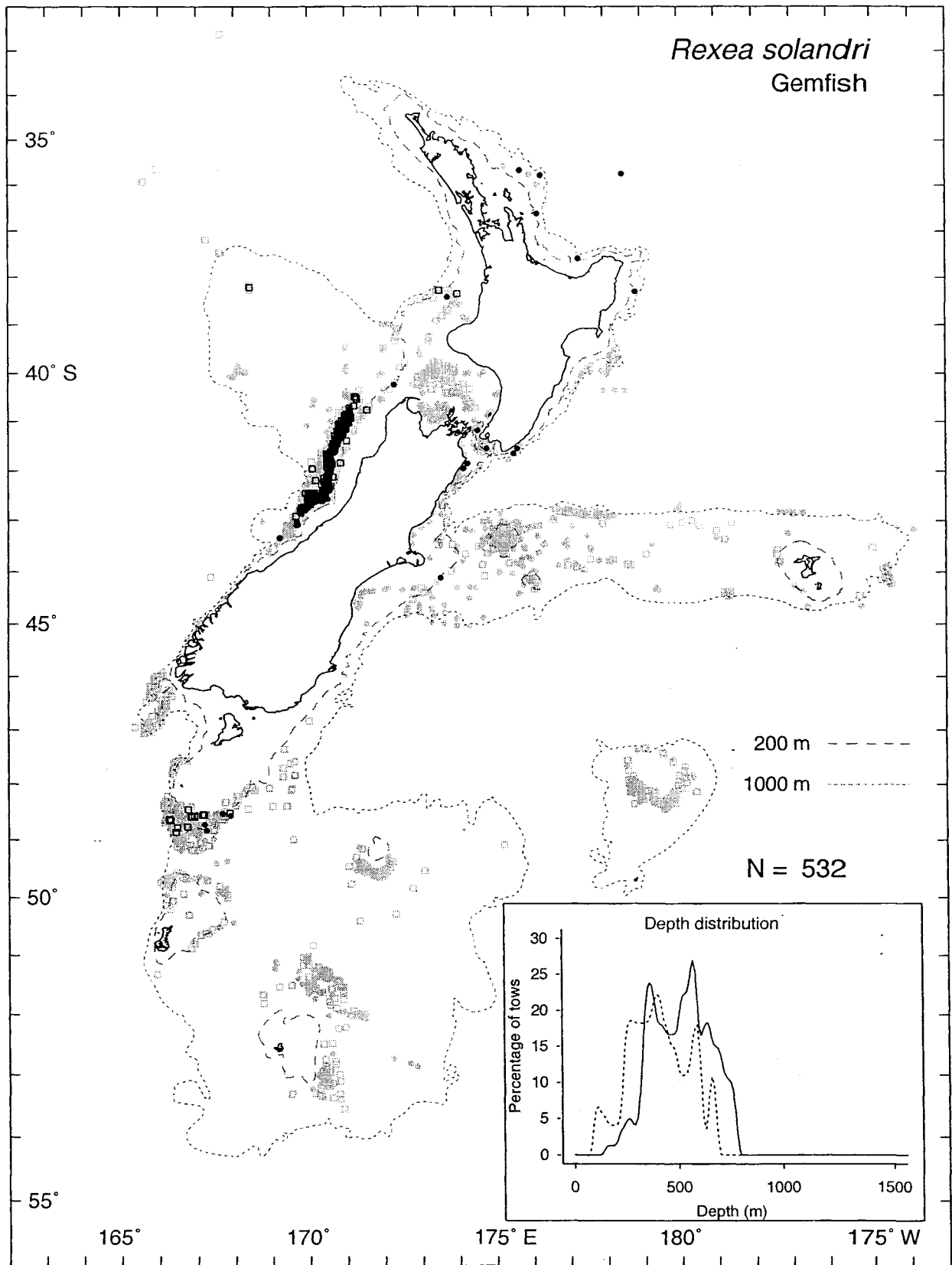




May include some records of *Pseudophycis barbata*.

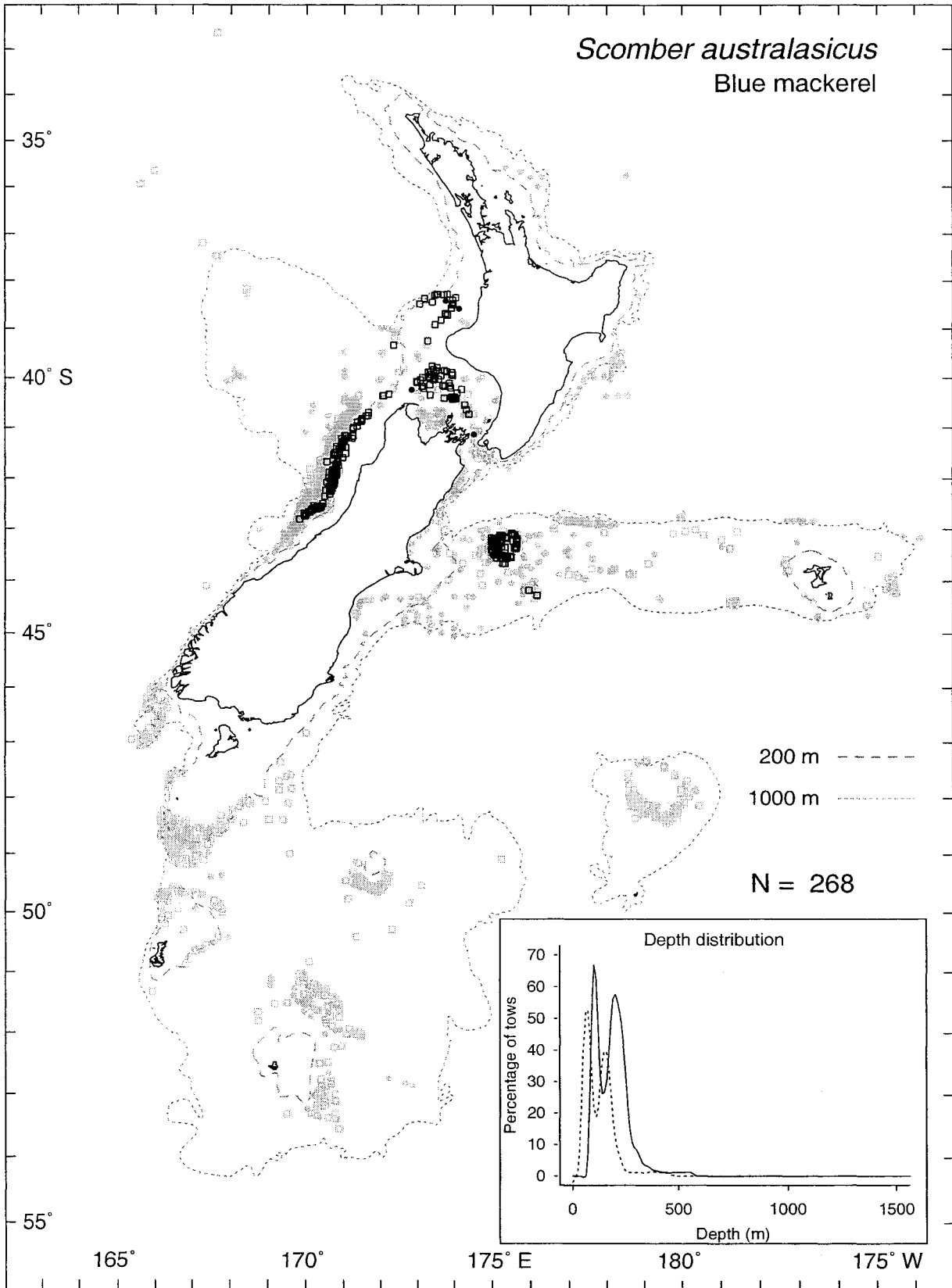


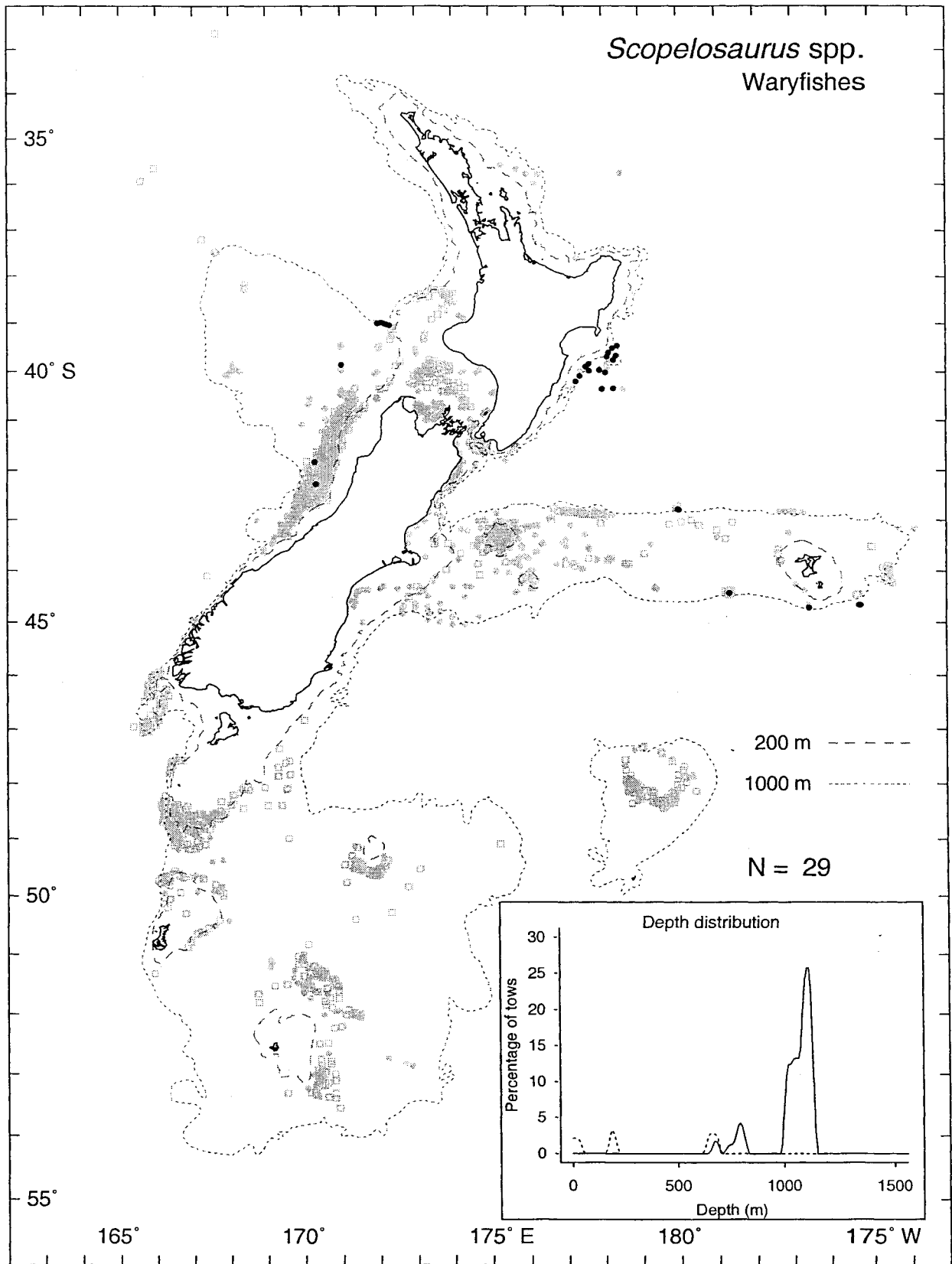
May include some records of *Agrostichthys parkeri* and *Trachipterus* spp.



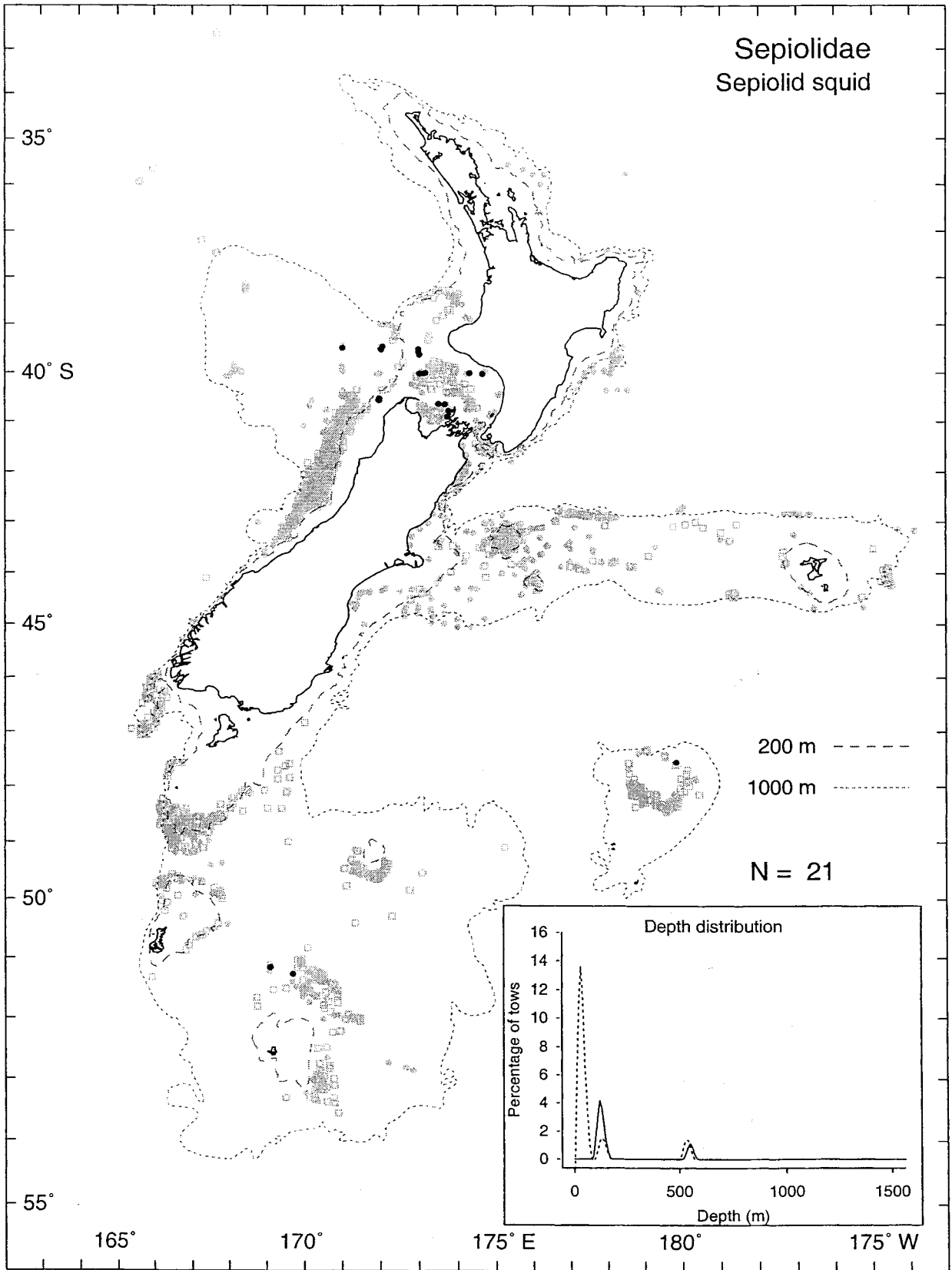
Northern records may include *Rexea antefurcata*. The northernmost research station outside the 1000 m contour is on a seamount in 359 m bottom depth.

Scomber australasicus
Blue mackerel

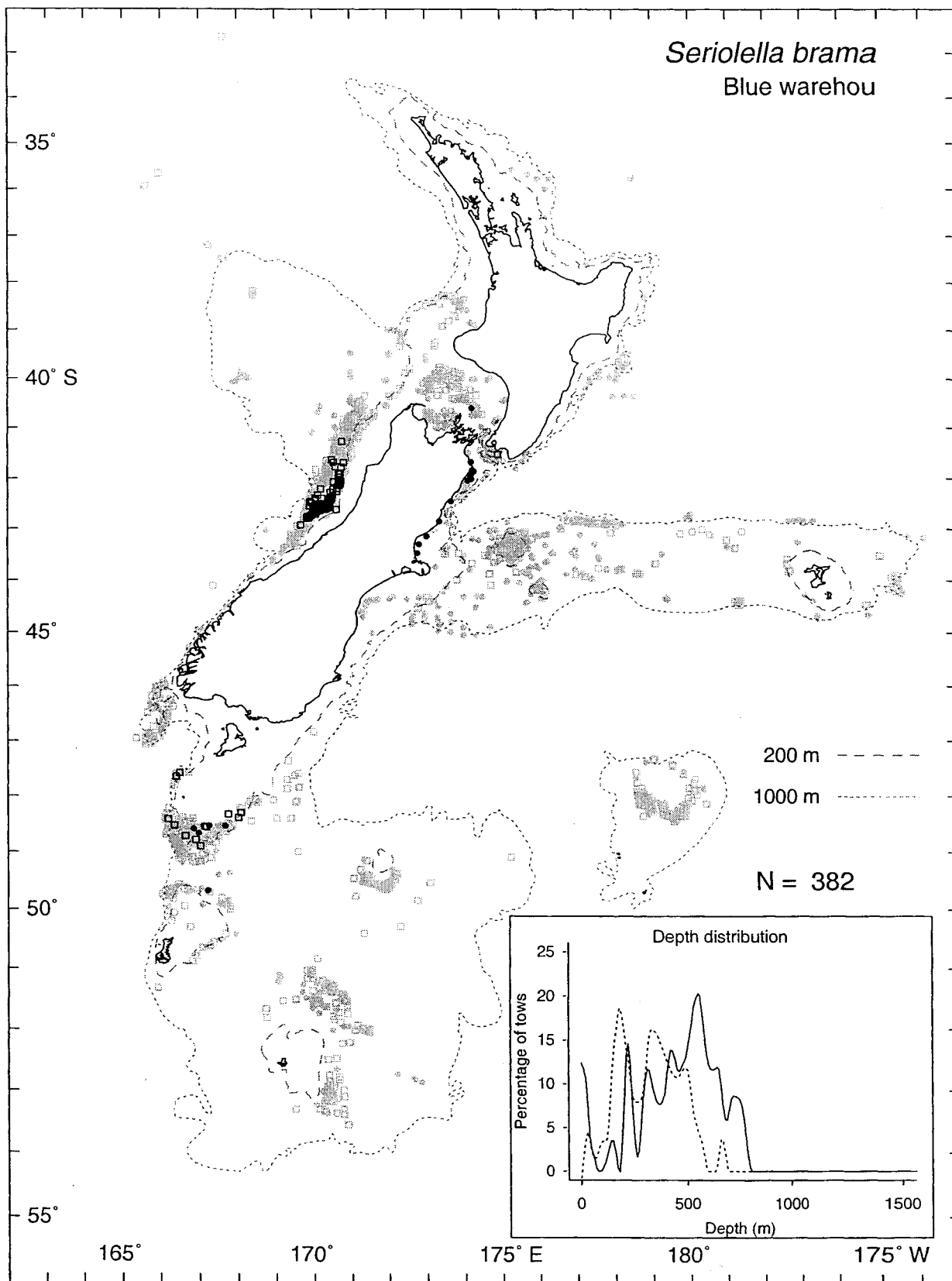




May include up to seven species in three genera.

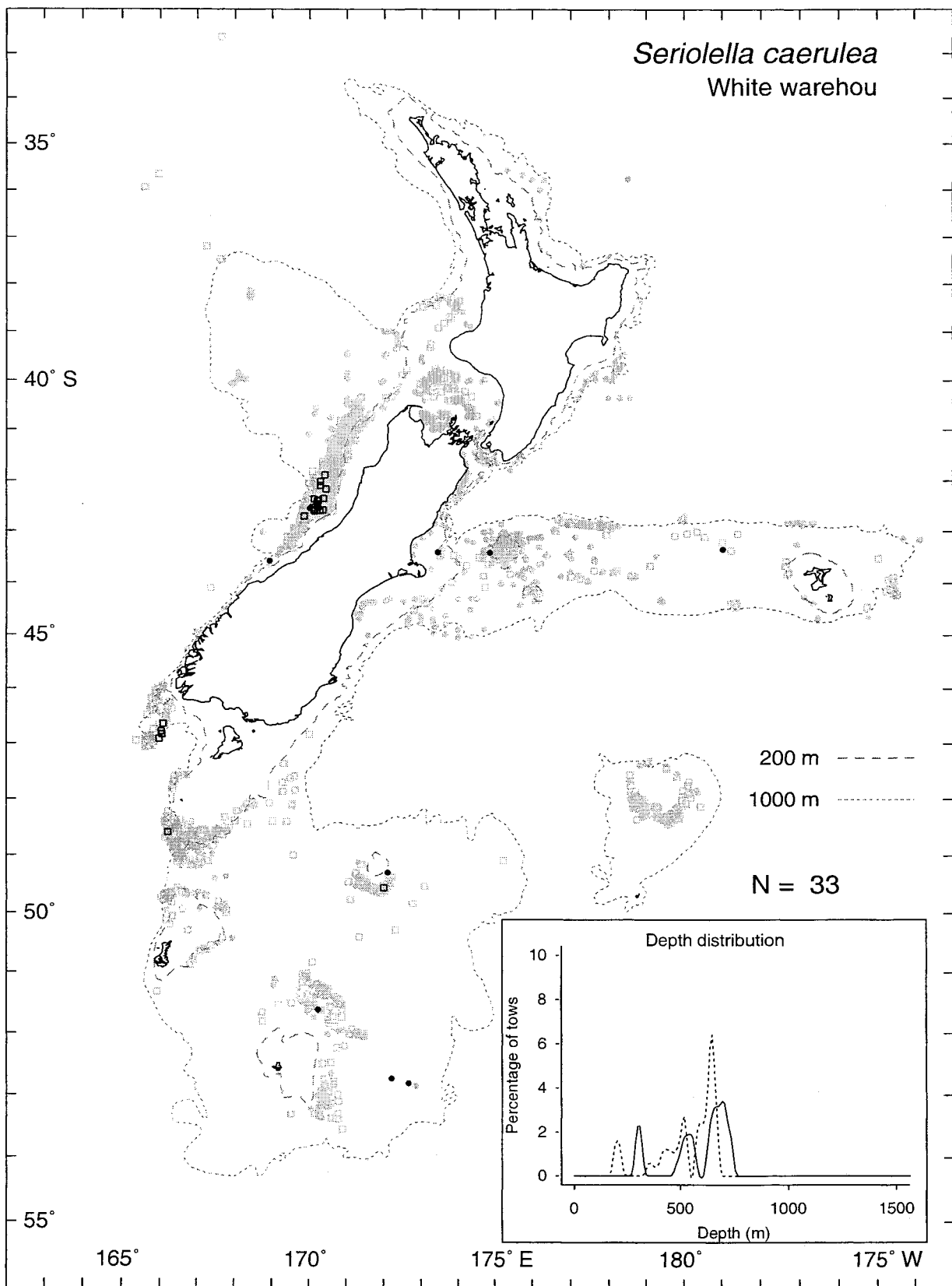


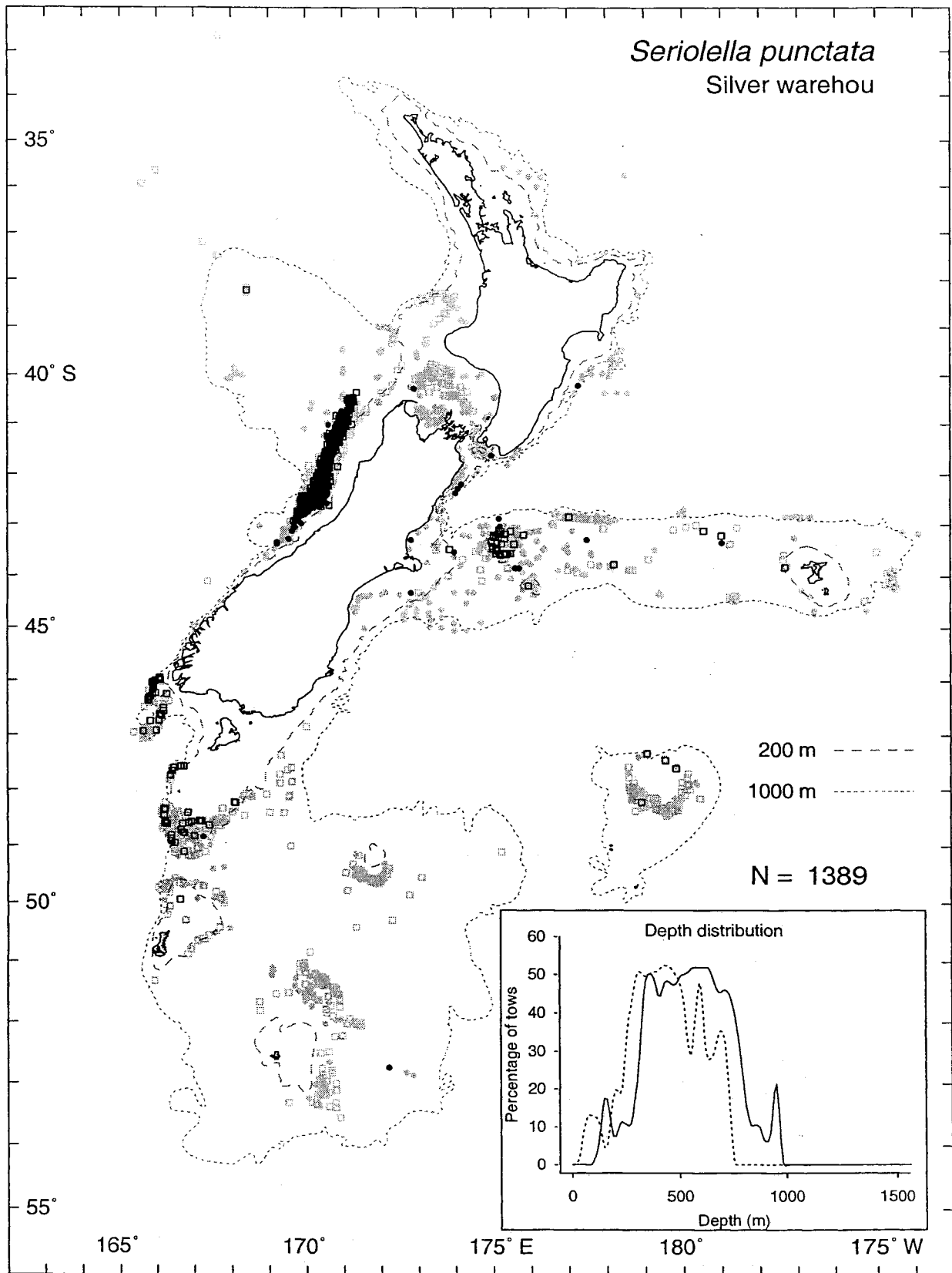
Includes up to two species.



Some deeper records may be *S. punctata* or *S. caerulea*.

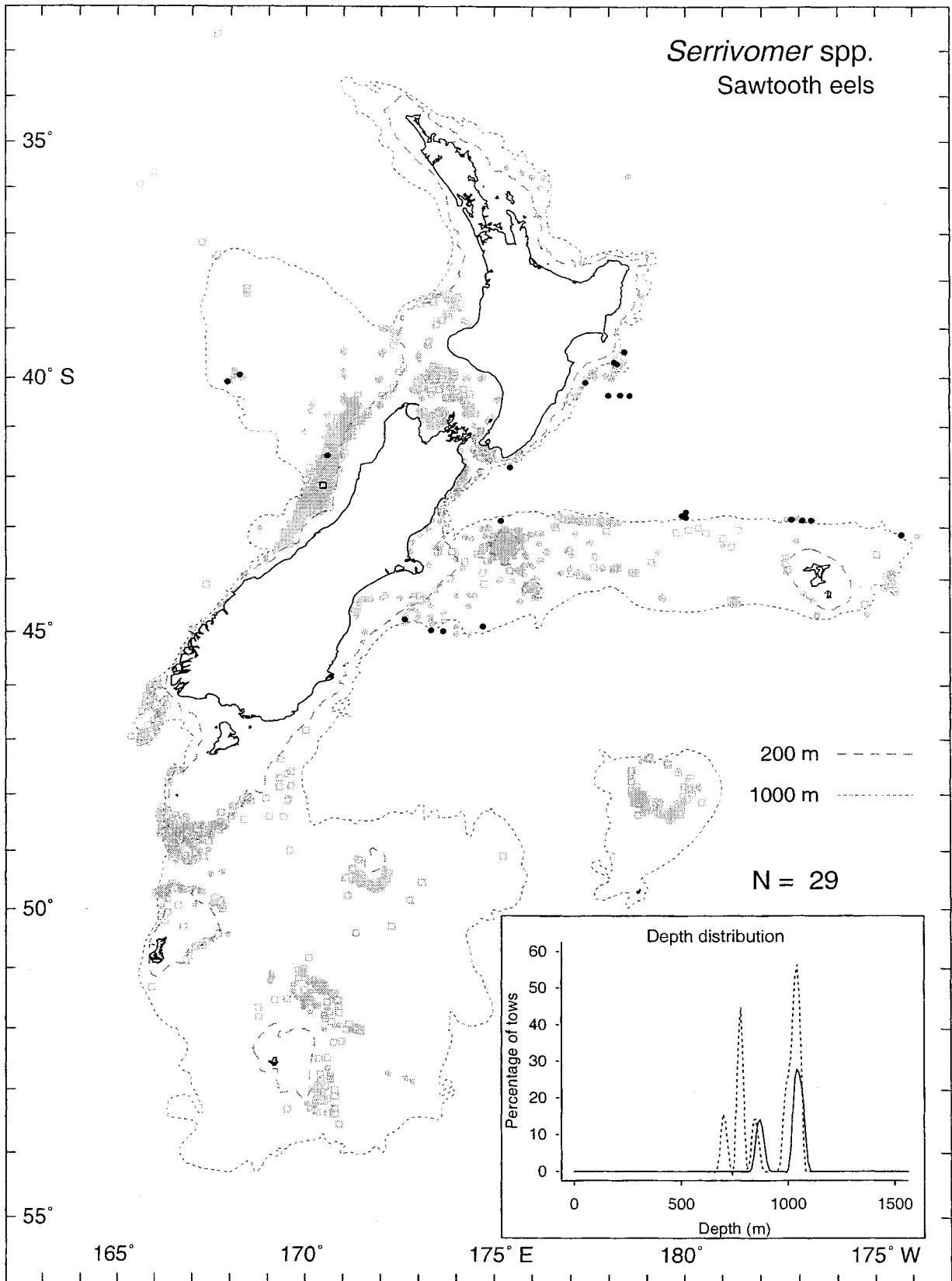
Seriolella caerulea
White warehou

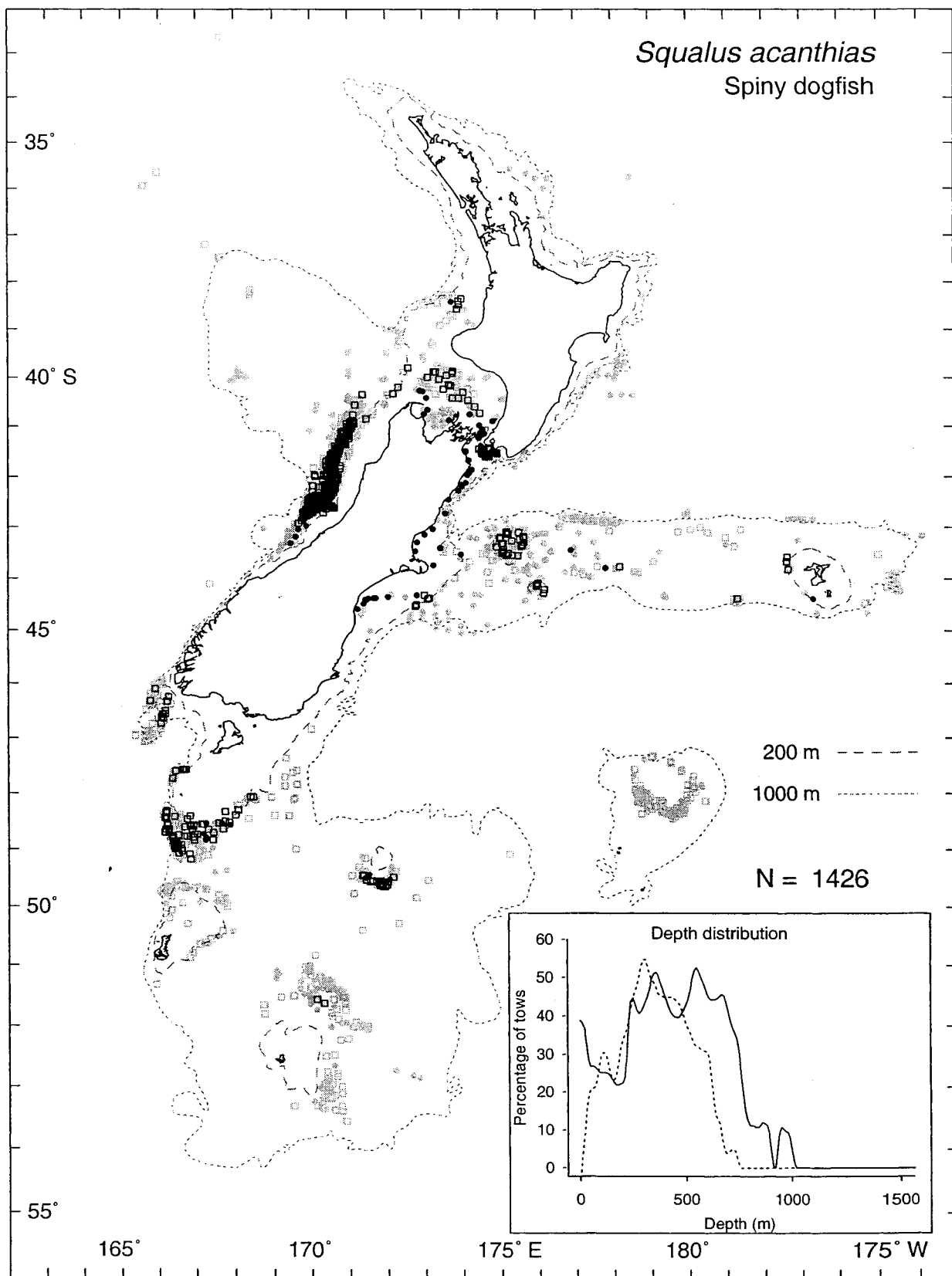




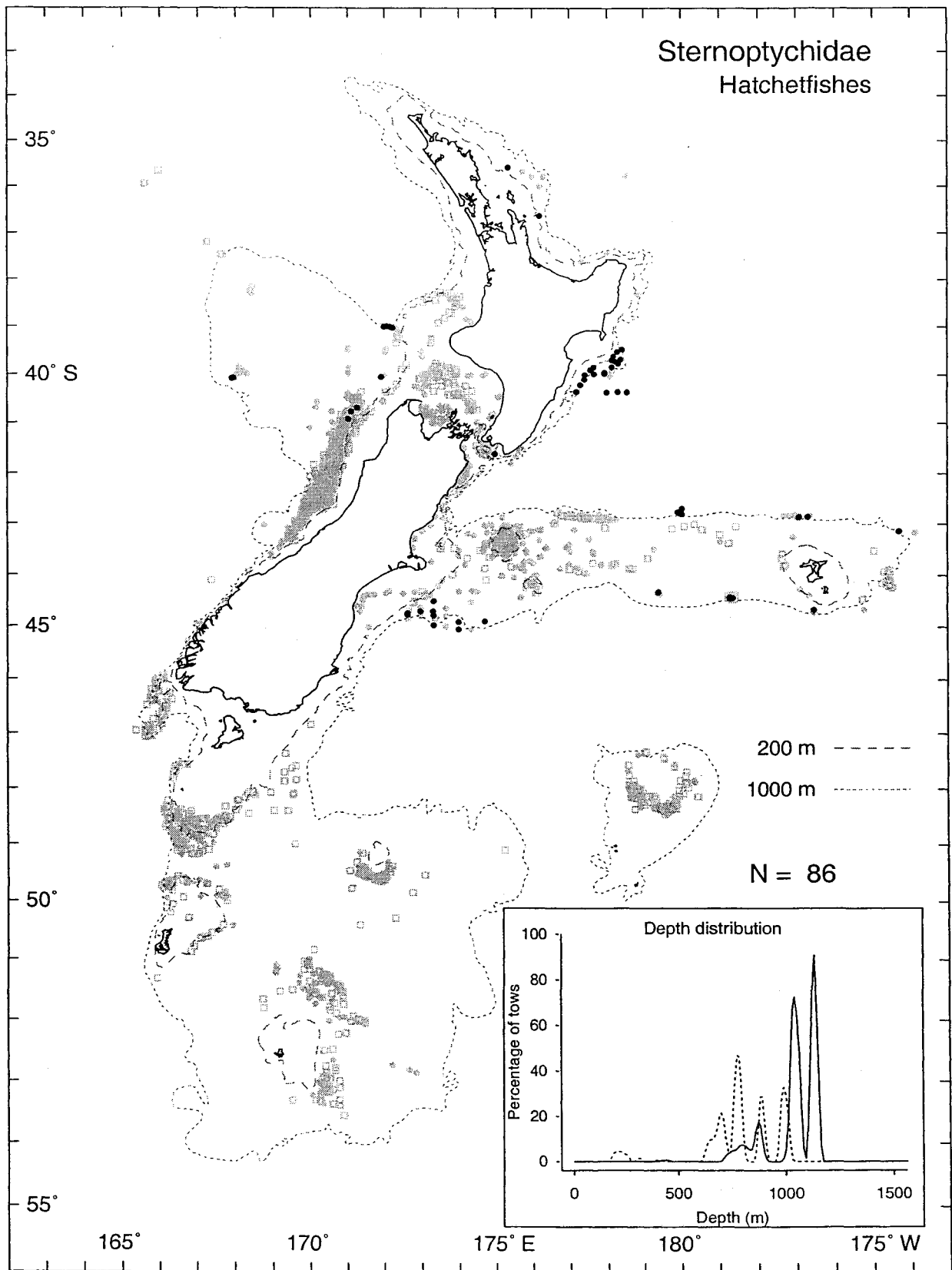
Some records may be *S. caerulea*.

Serrivomer spp.
Sawtooth eels

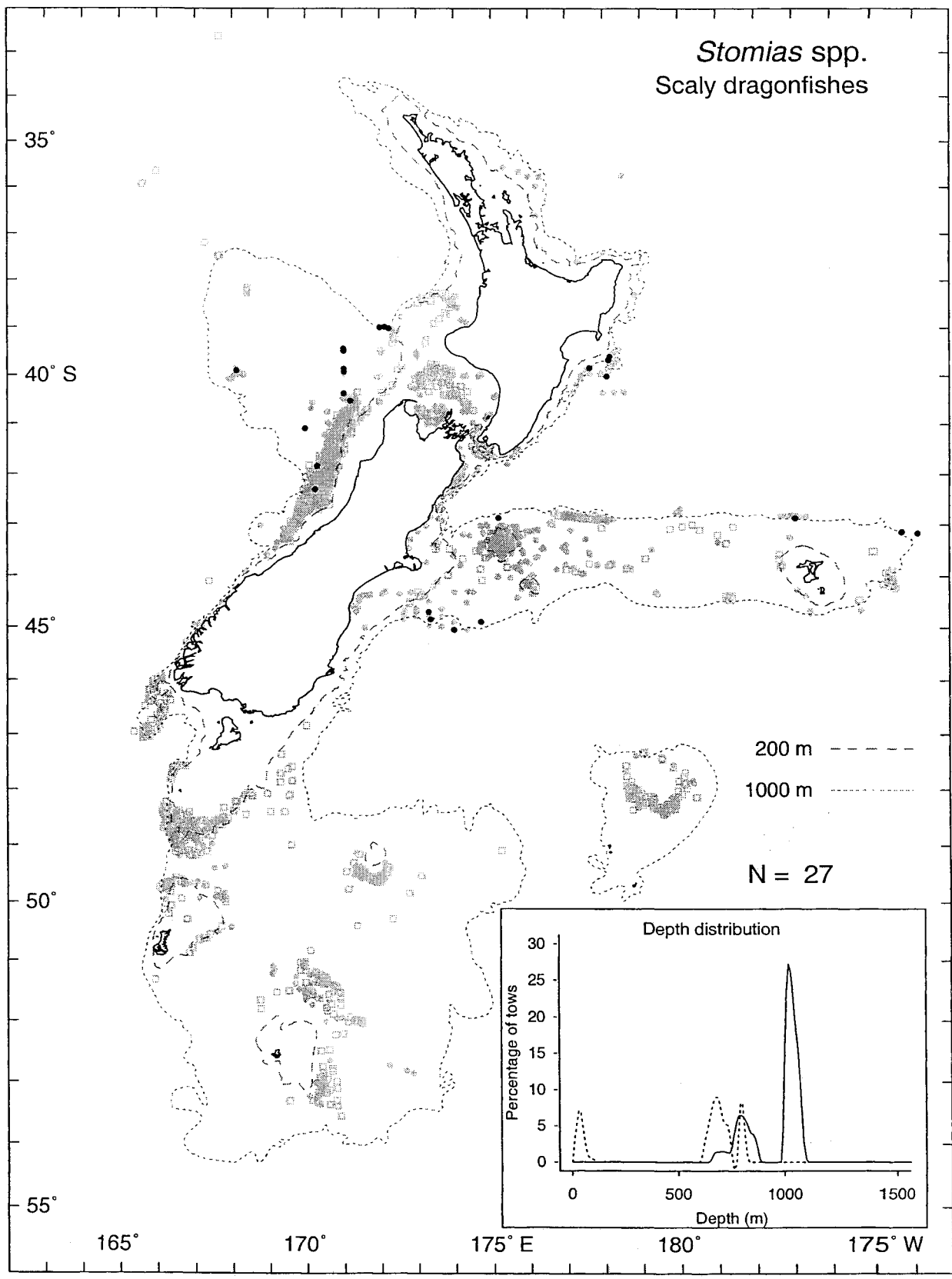




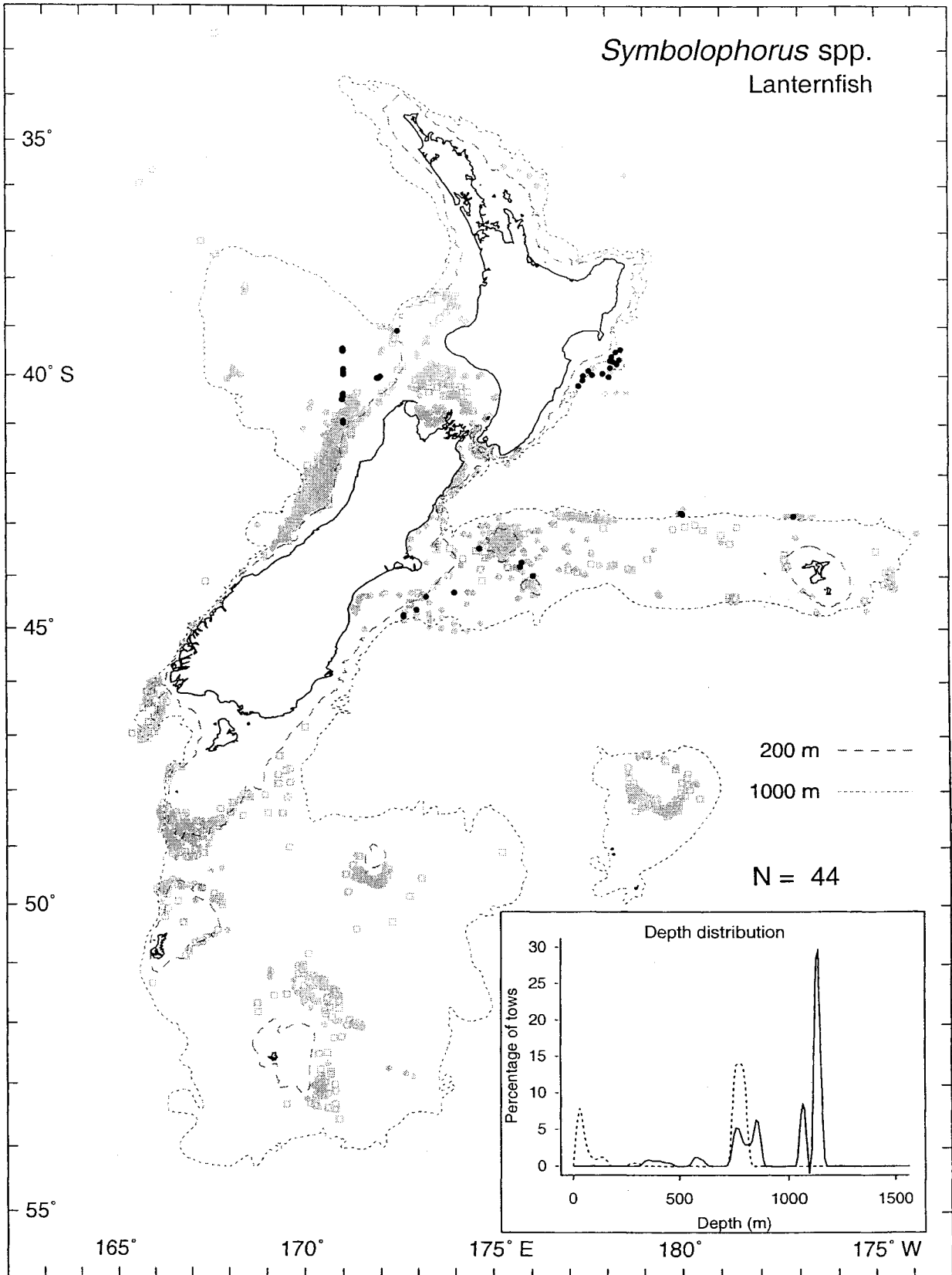
May include some *S. mitsukurii*.



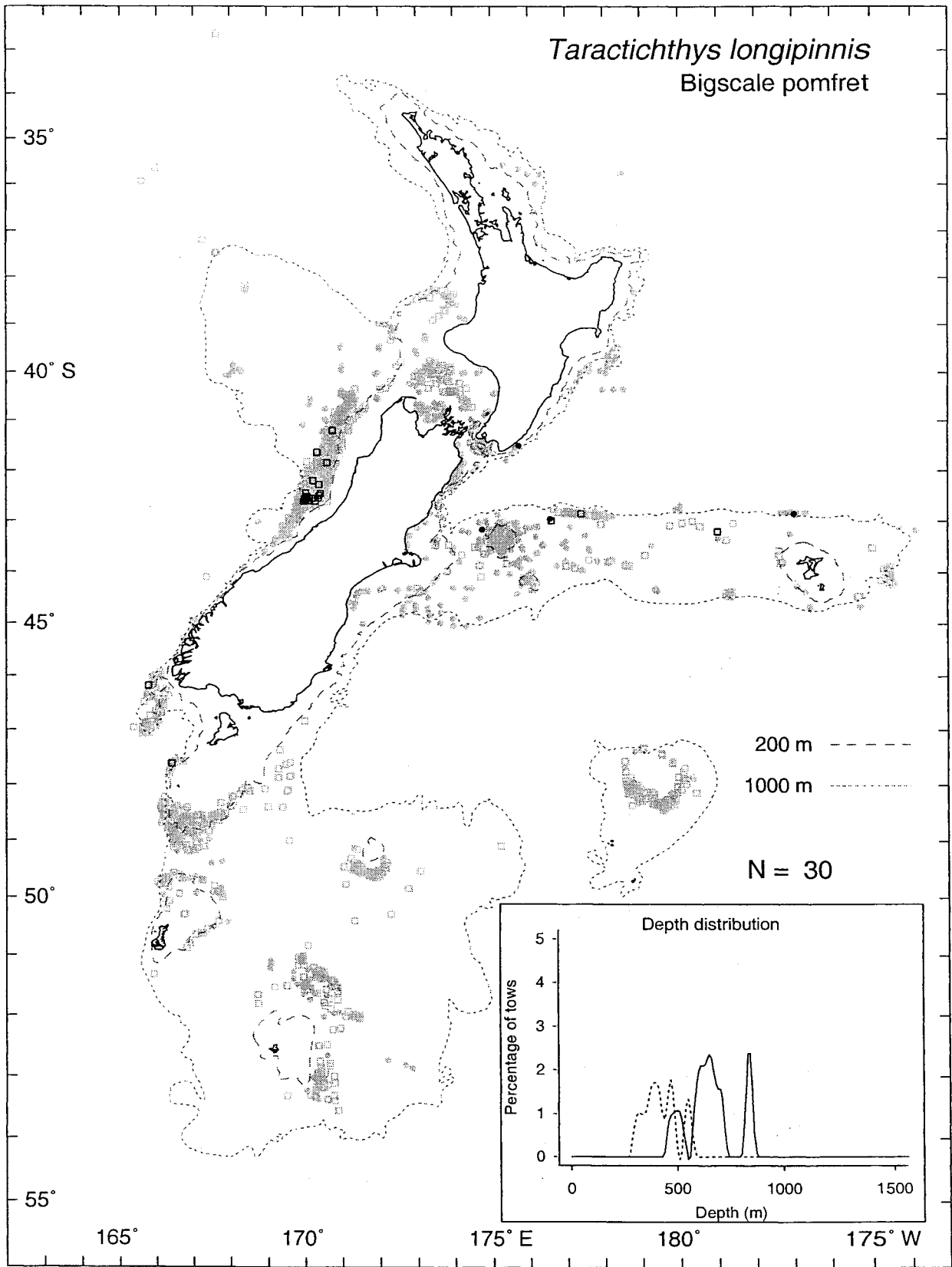
About 14 species, including *Argyropelecus* spp., *Polyipnus* spp., and *Sternoptyx* spp., occur in New Zealand.



May include at least two species.

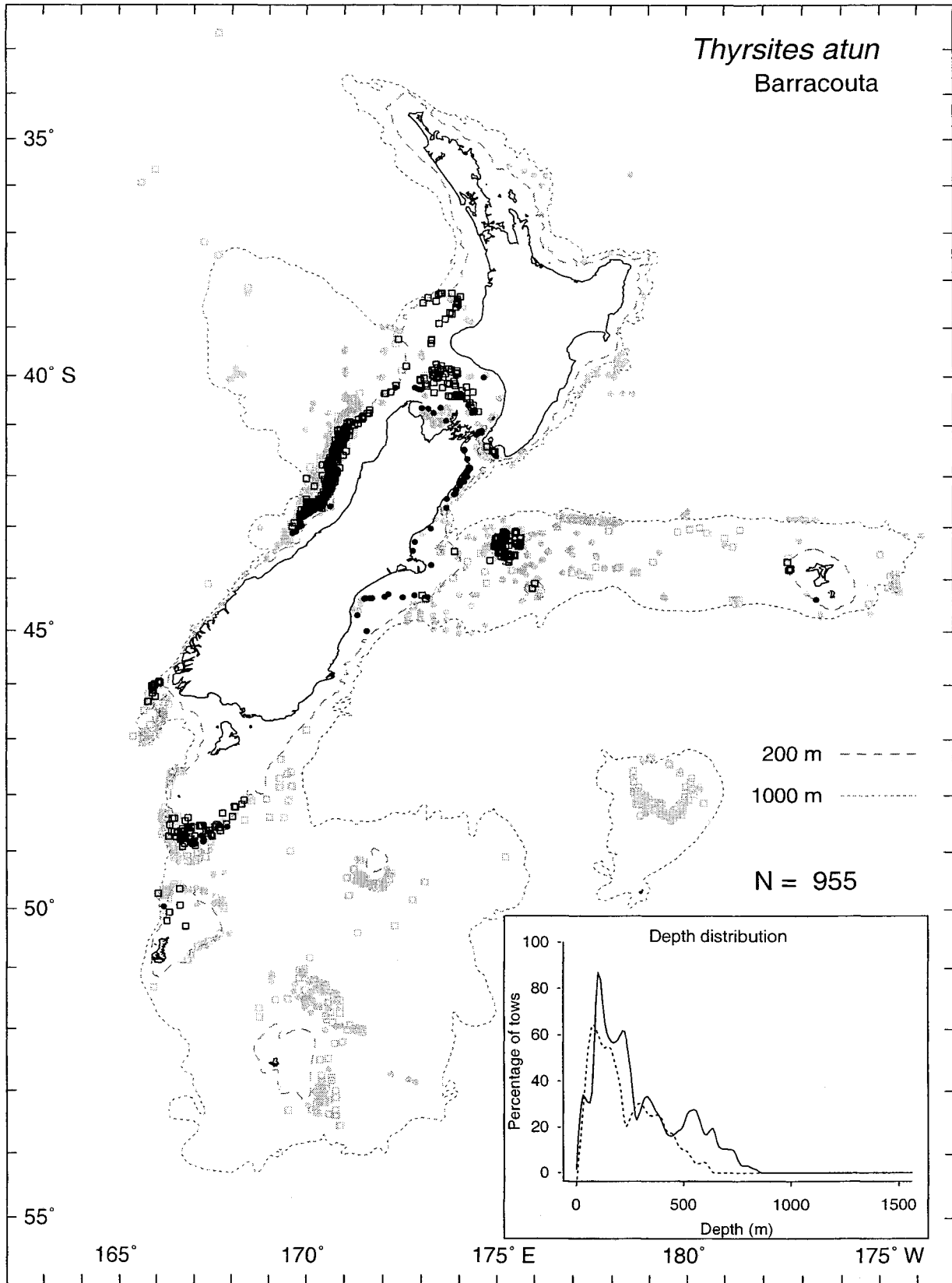


May include up to four species.

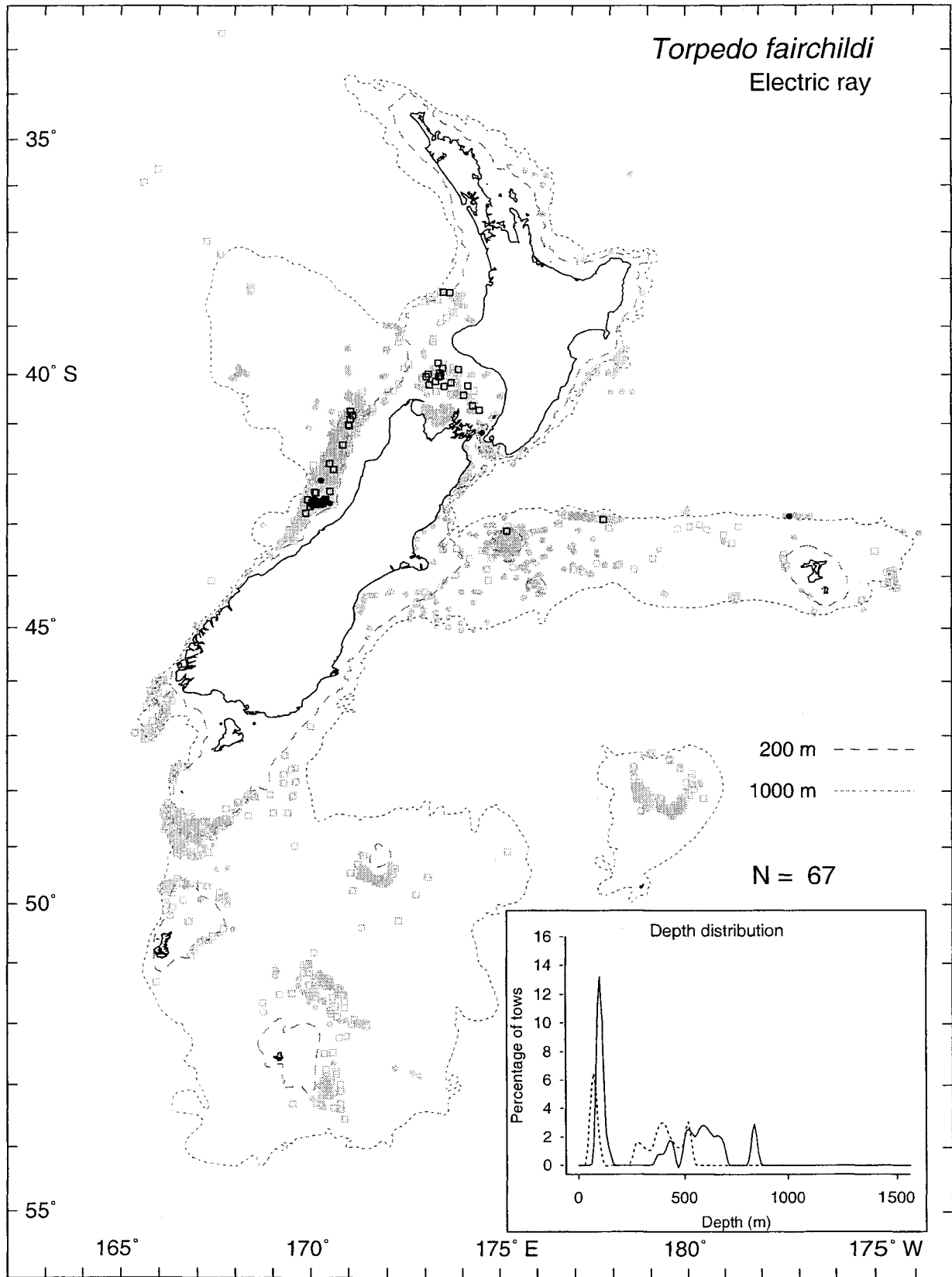


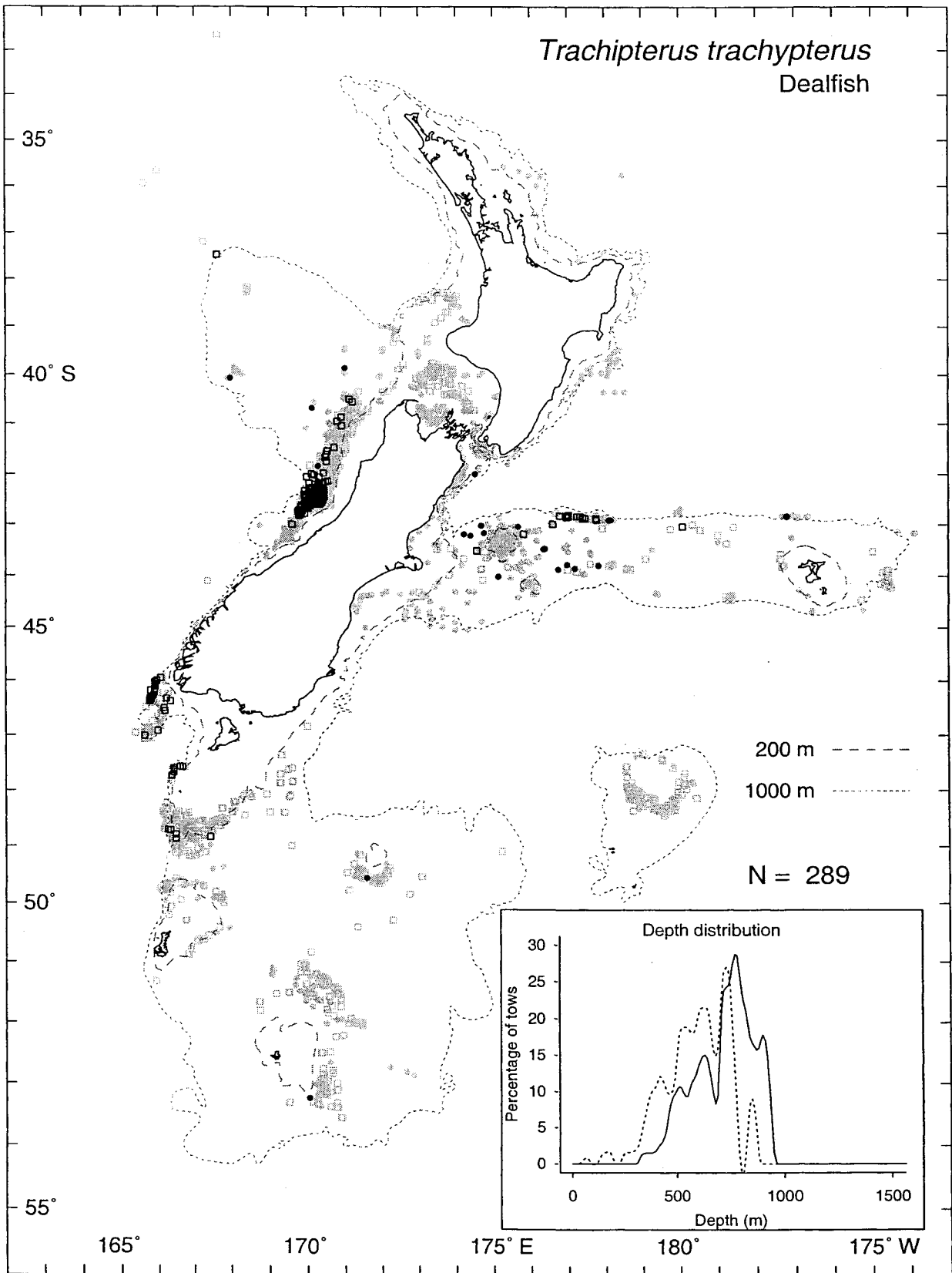
May include some *Taractes asper*.

Thyrsites atun
Barracouta

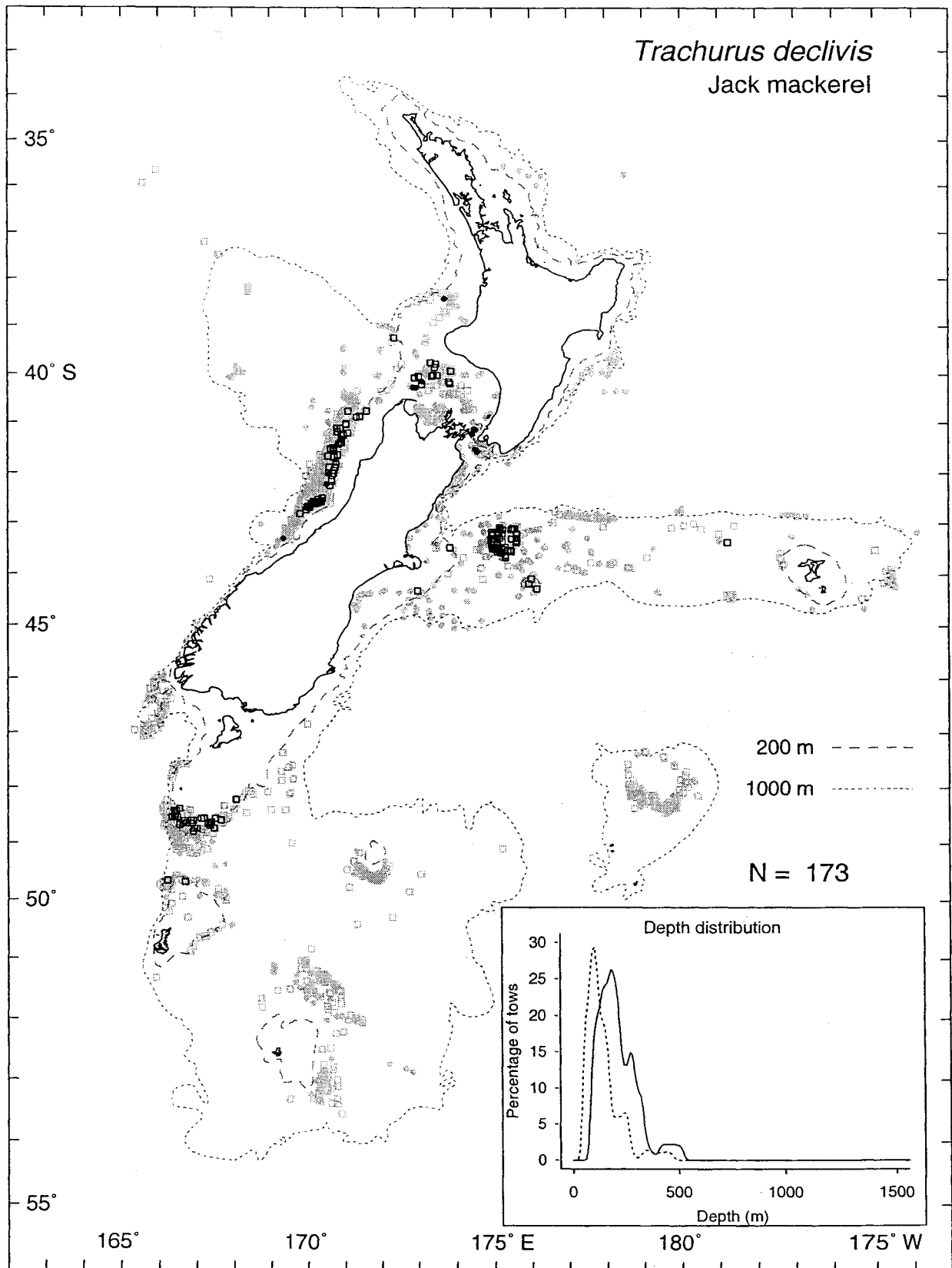


Torpedo fairchildi
Electric ray

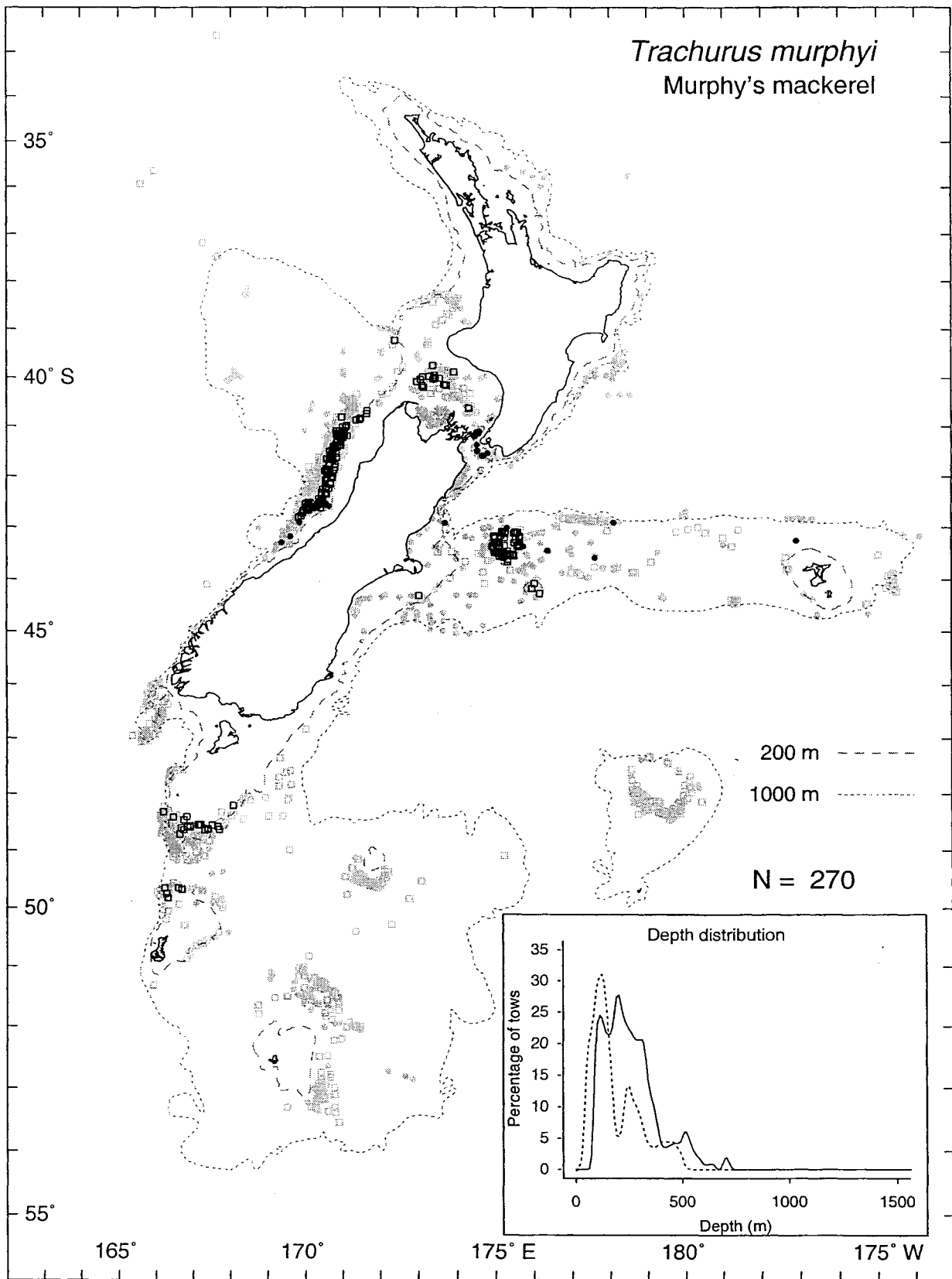




May include some *Trachipterus jacksonensis*.



Some records may be *T. murphyi*.

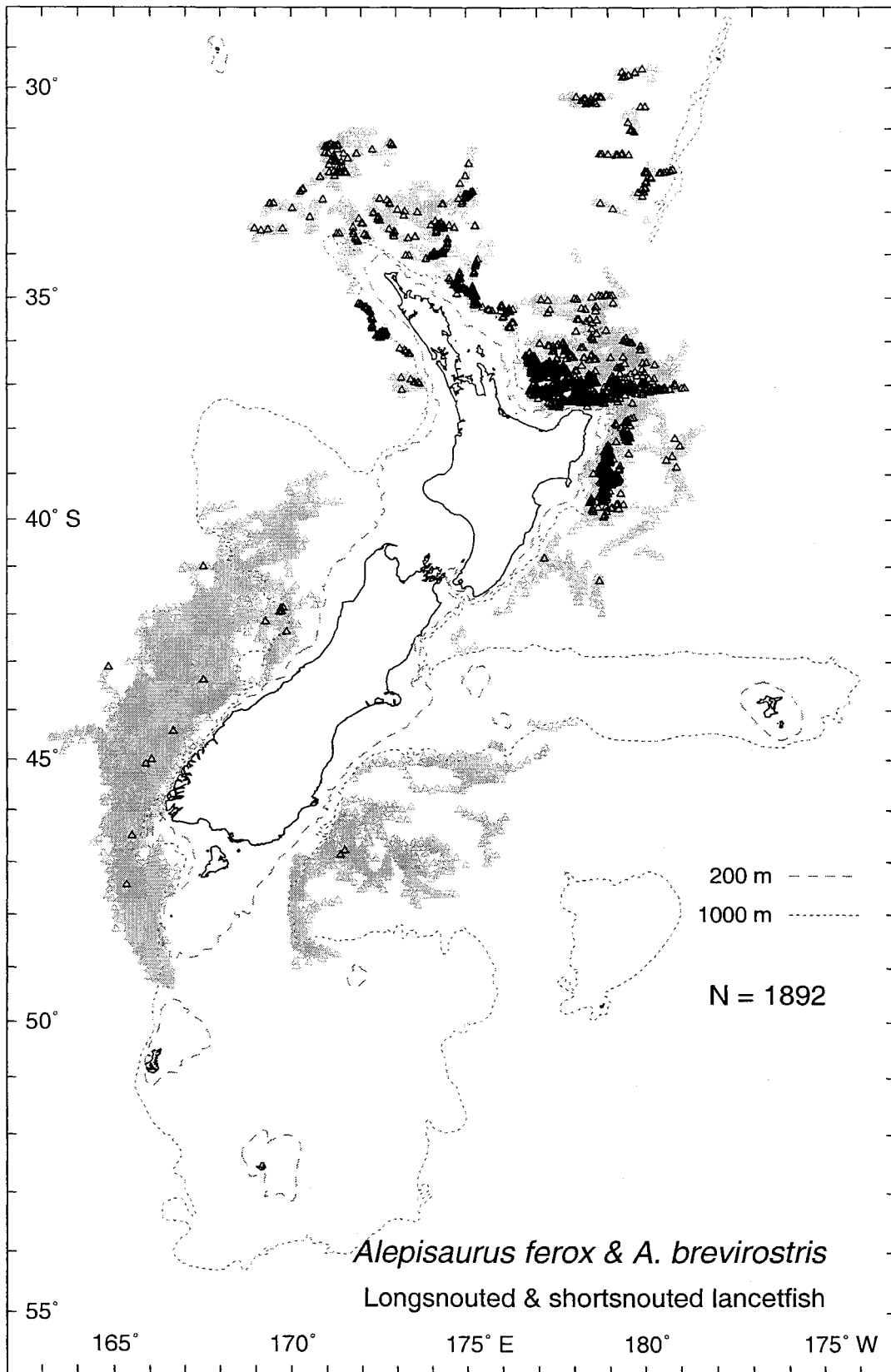


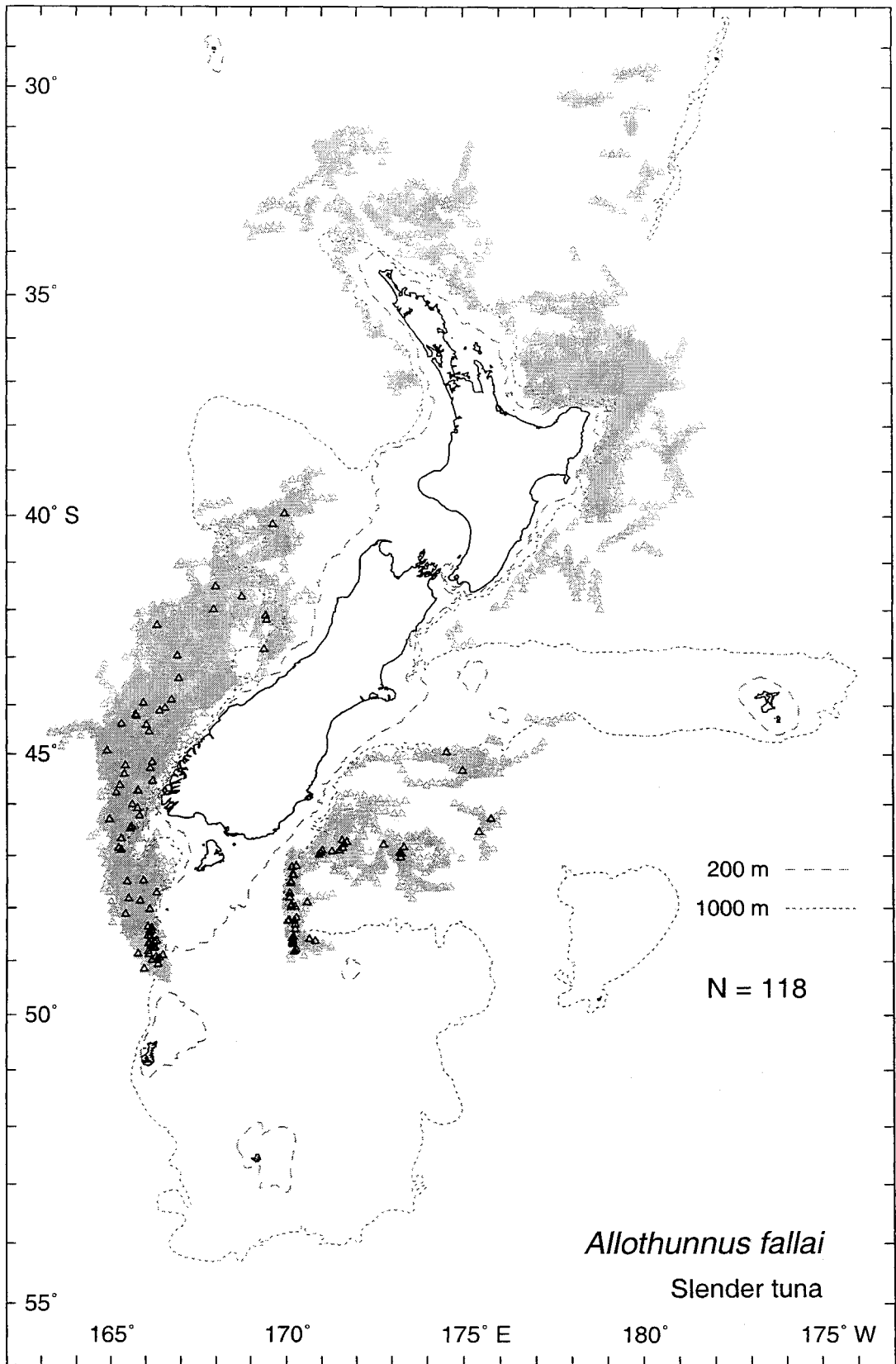
Some records may be *T. declivis*. Stepien & Rosenblatt (1996) suggested that *T. murphyi* may not be a separate species from *T. symmetricus*.

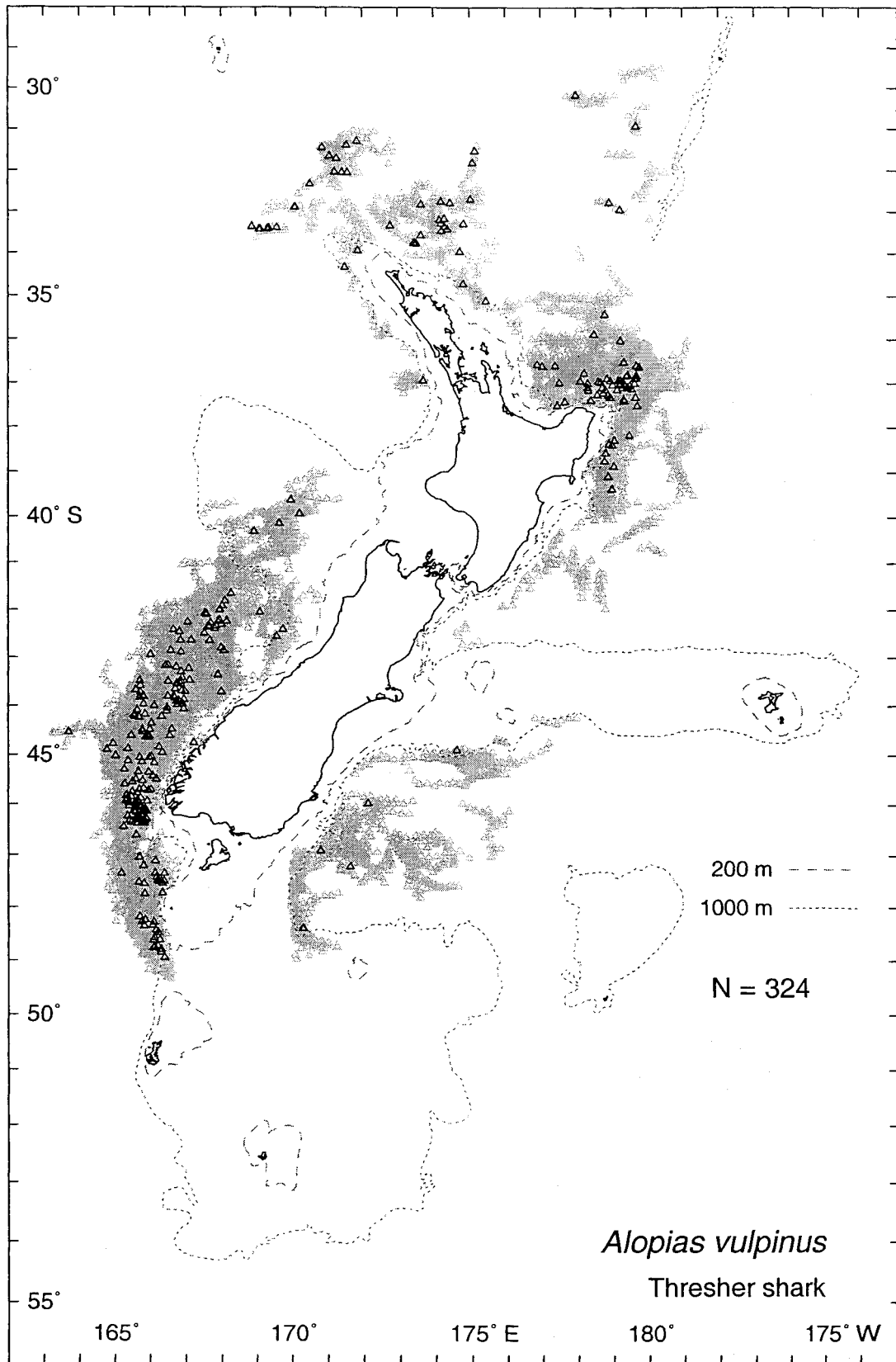
Tuna longline distributions

Key to symbols used in the distribution plots

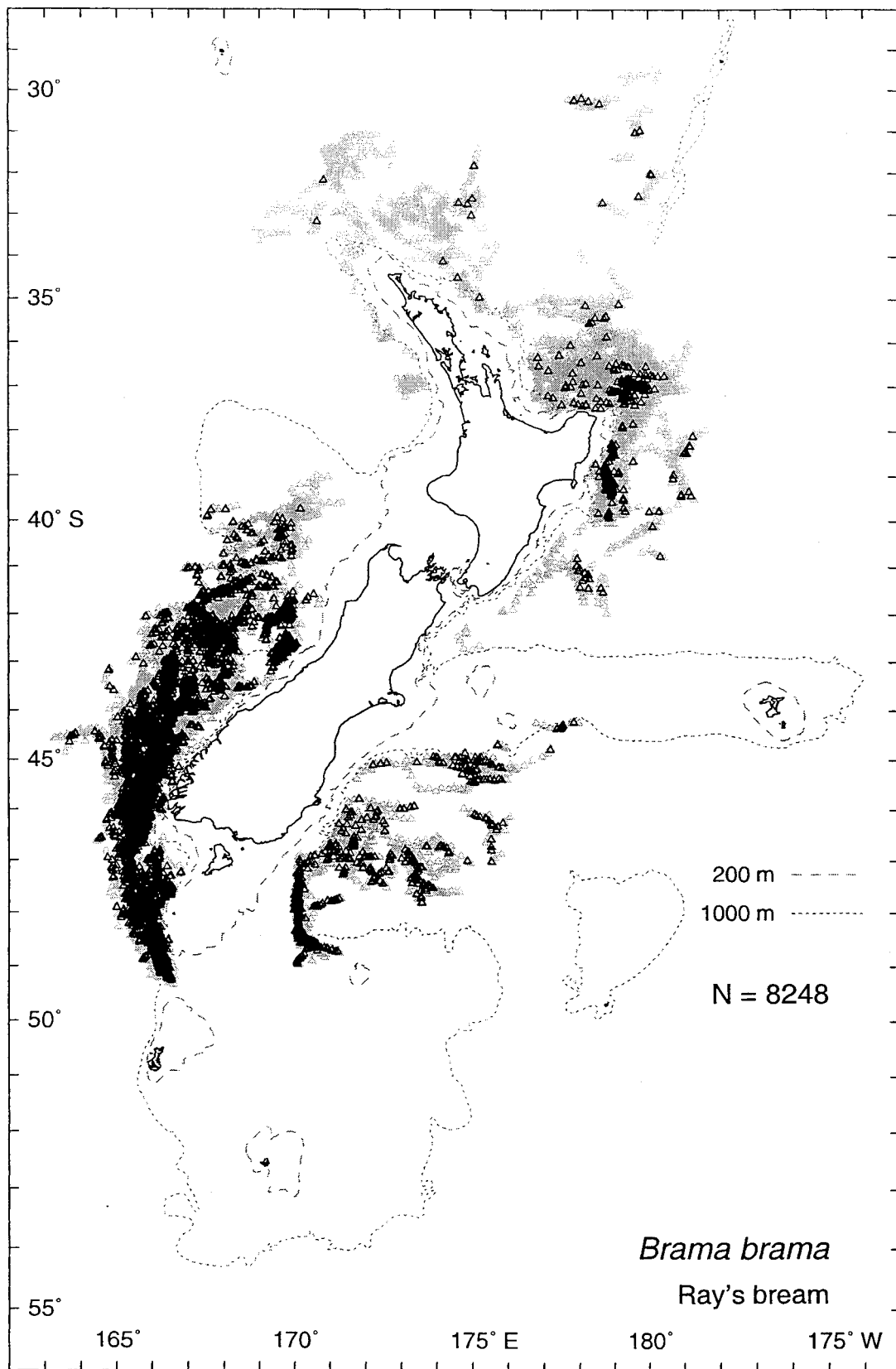
Δ	Tuna longline sets. The first hook and every 500 th hook thereafter are marked in grey.
---	--



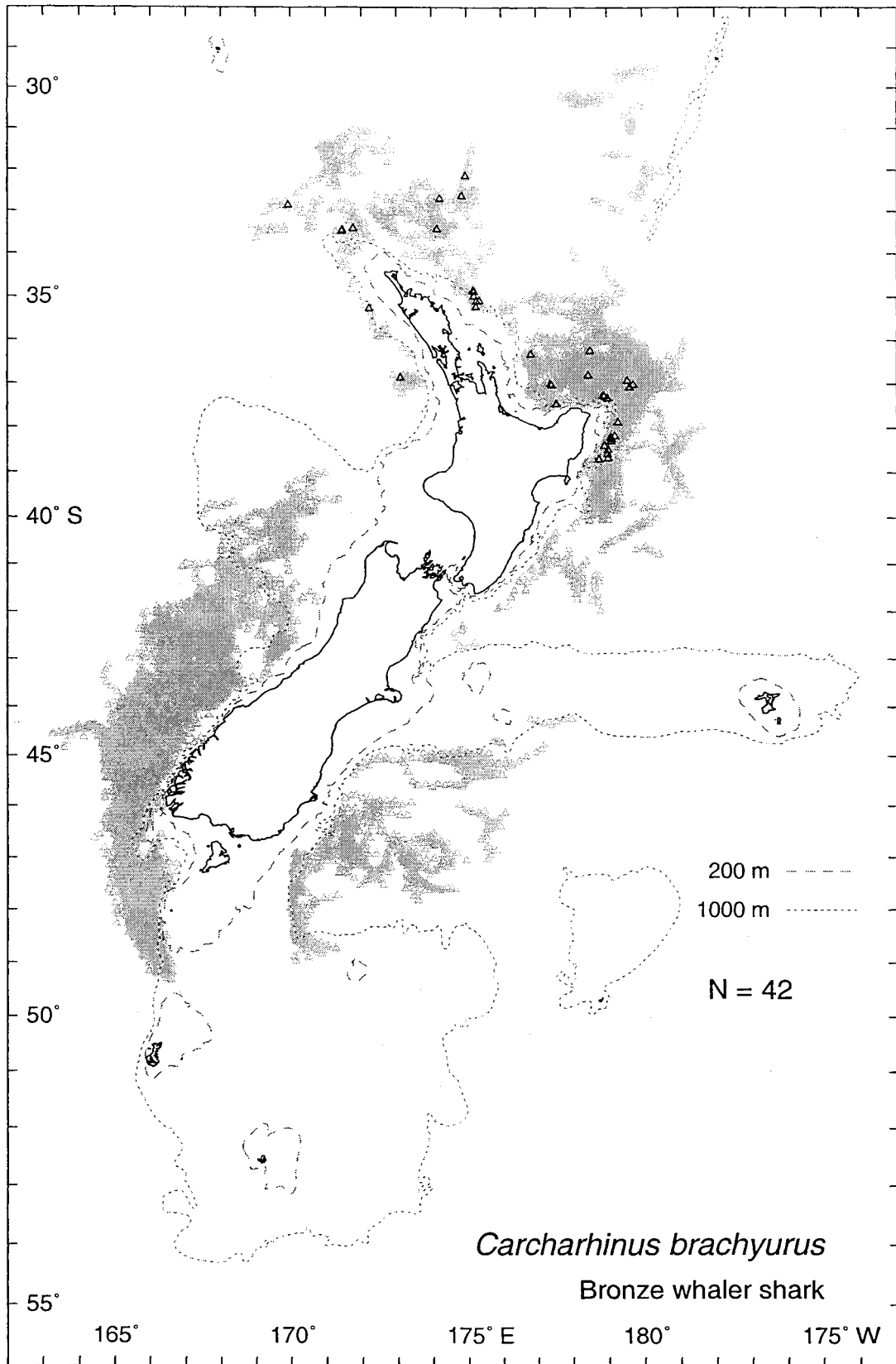




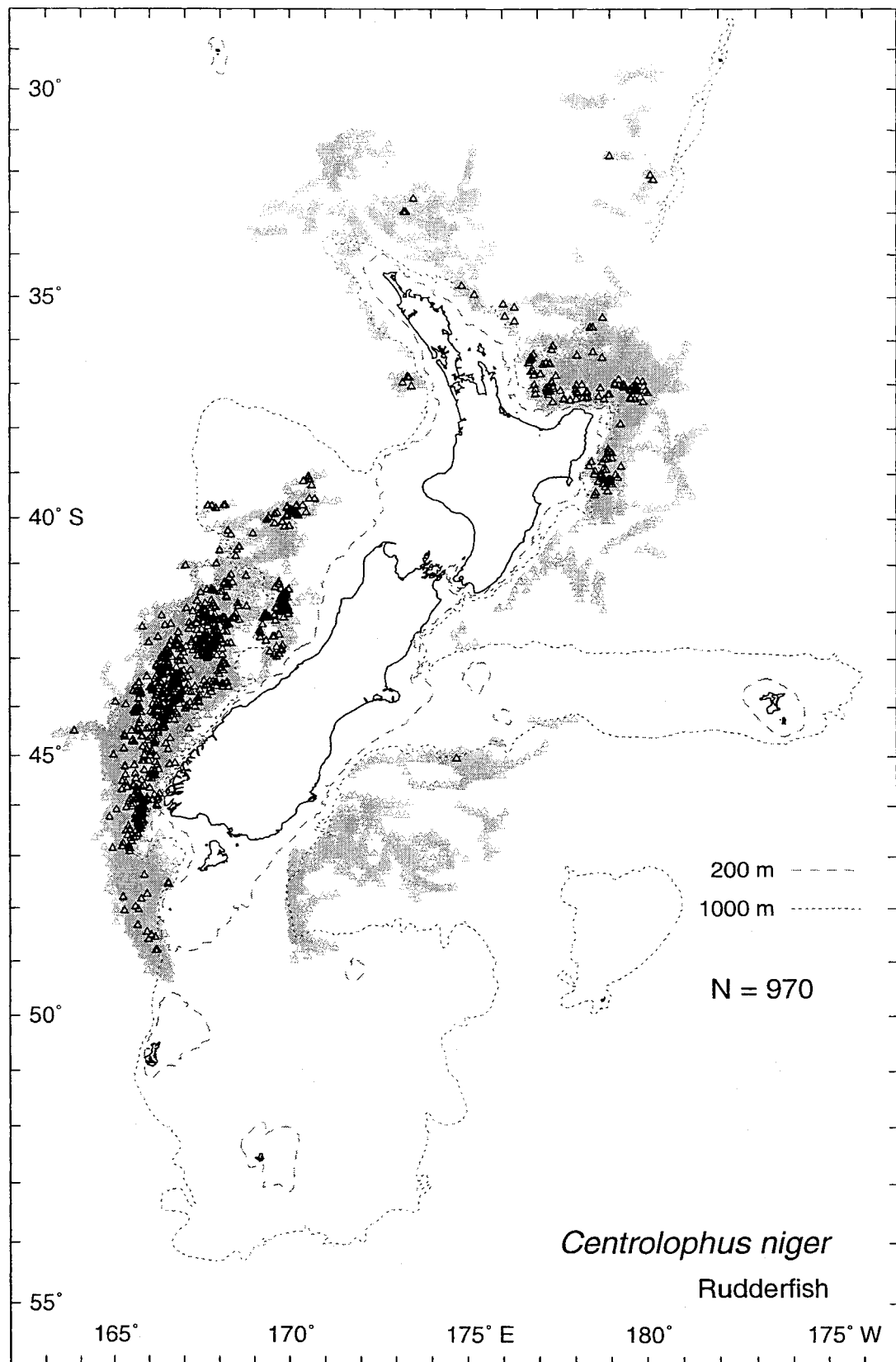
Northern records may include some *A. superciliosus*.



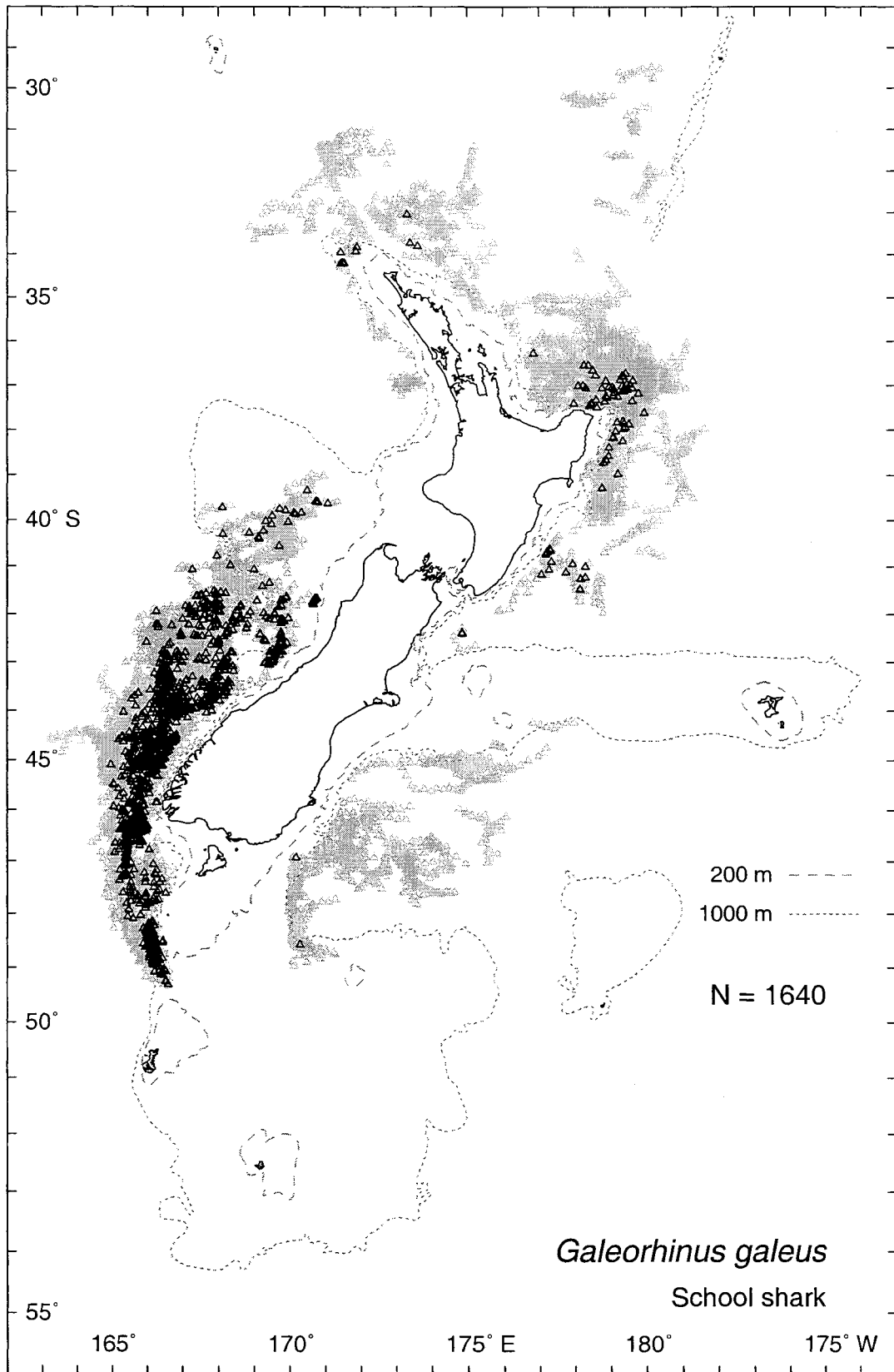
Includes some other pomfrets (Bramidae).

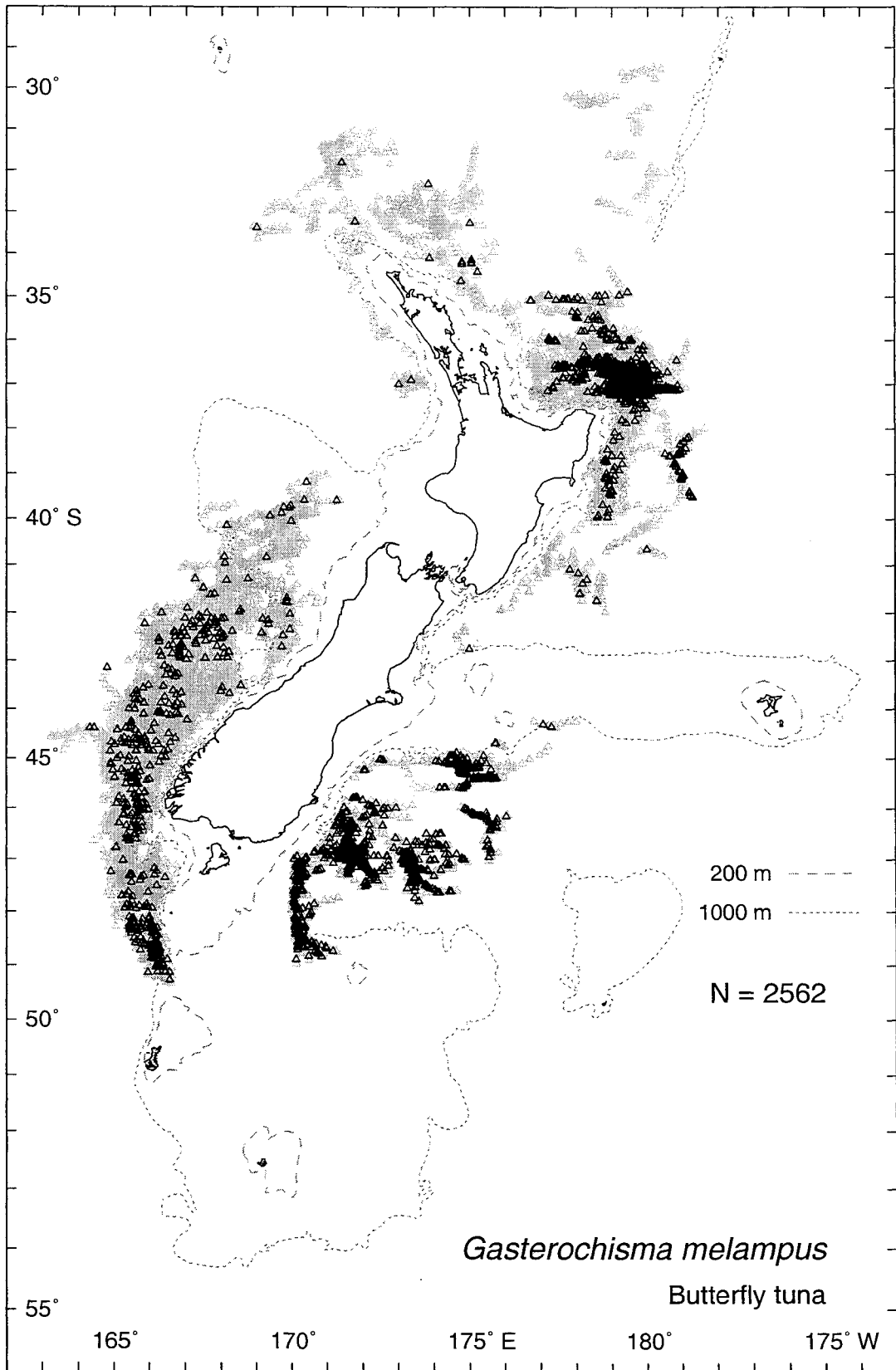


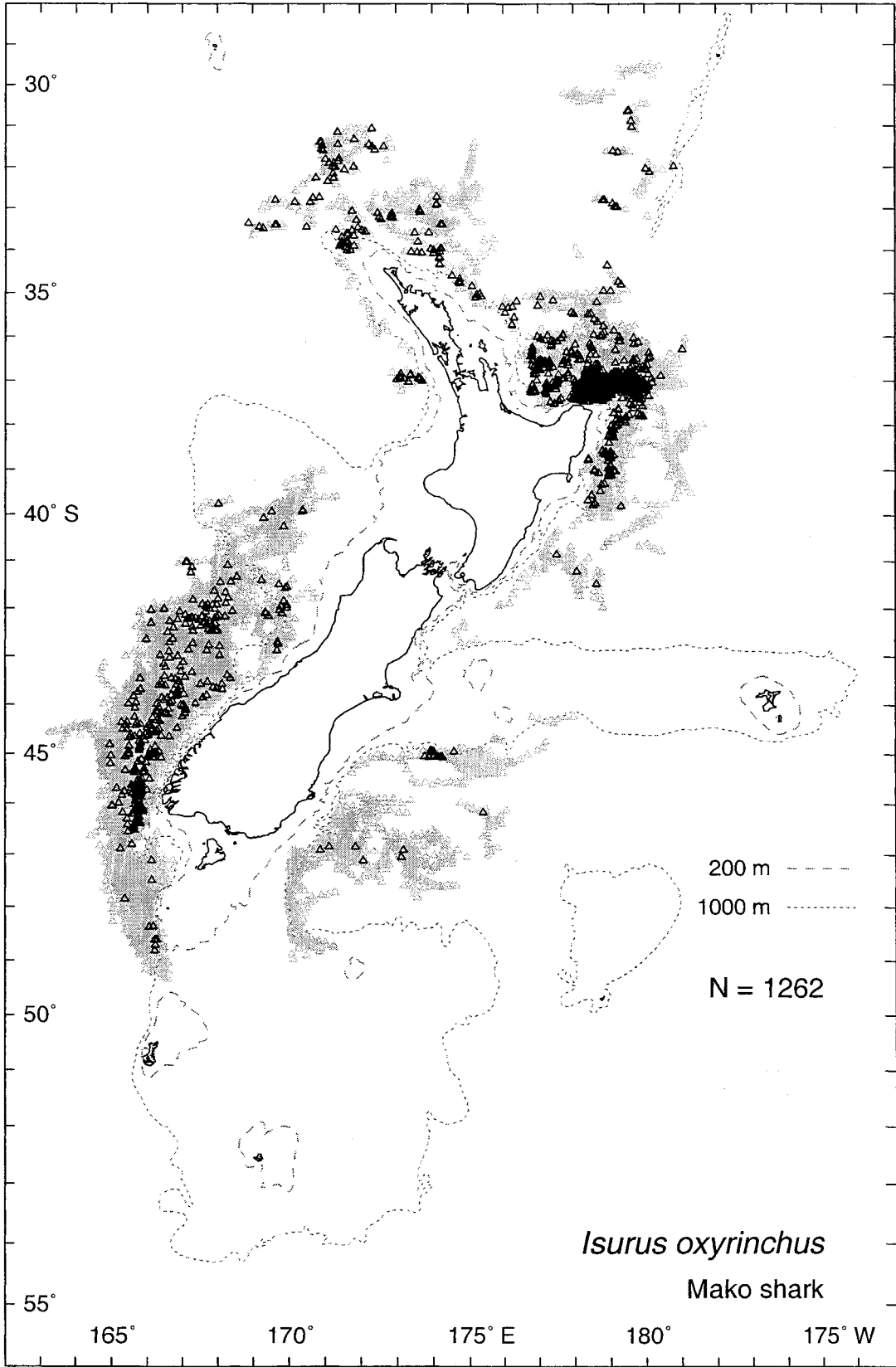
May include some other *Carcharhinus* spp.

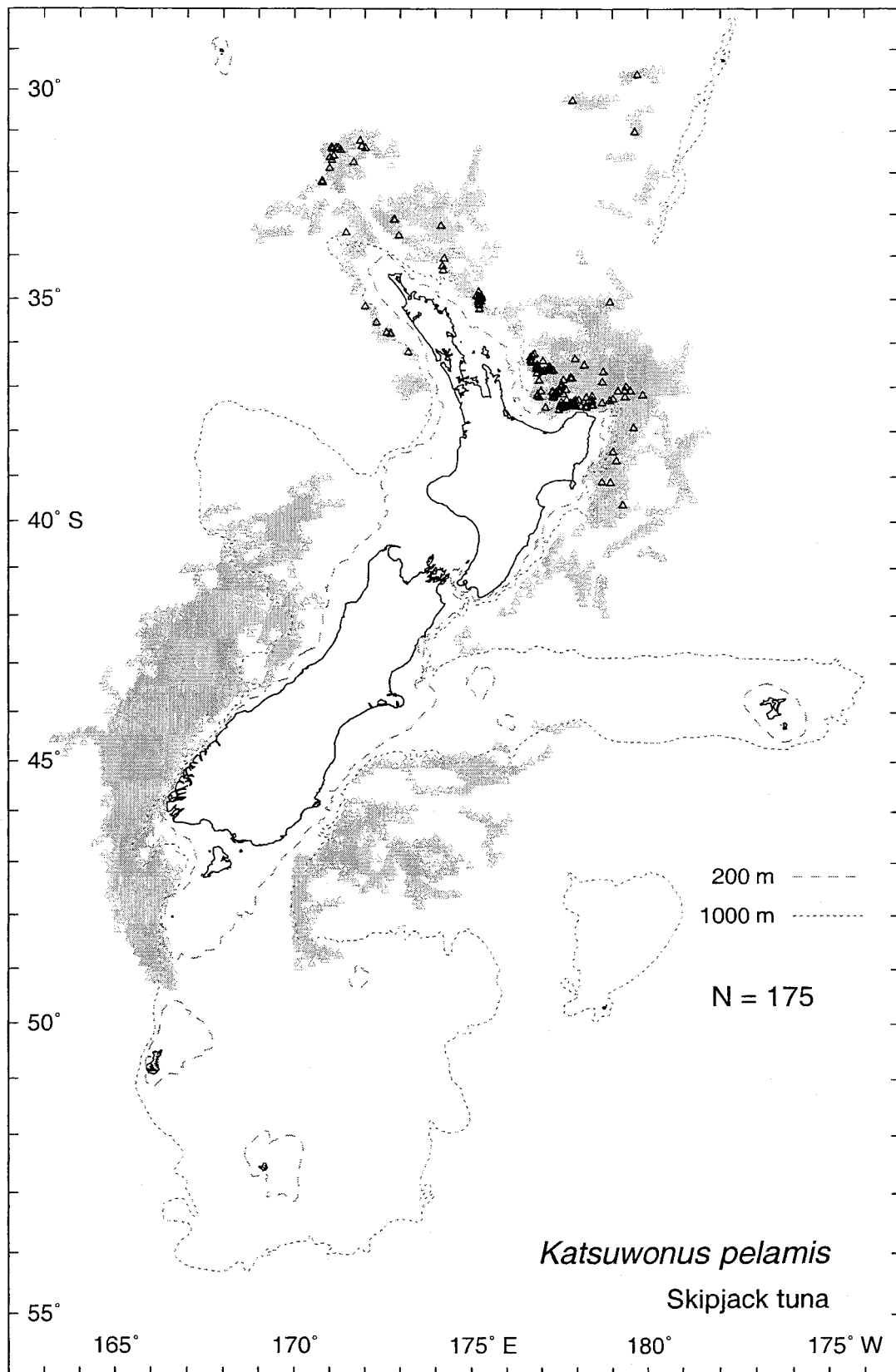


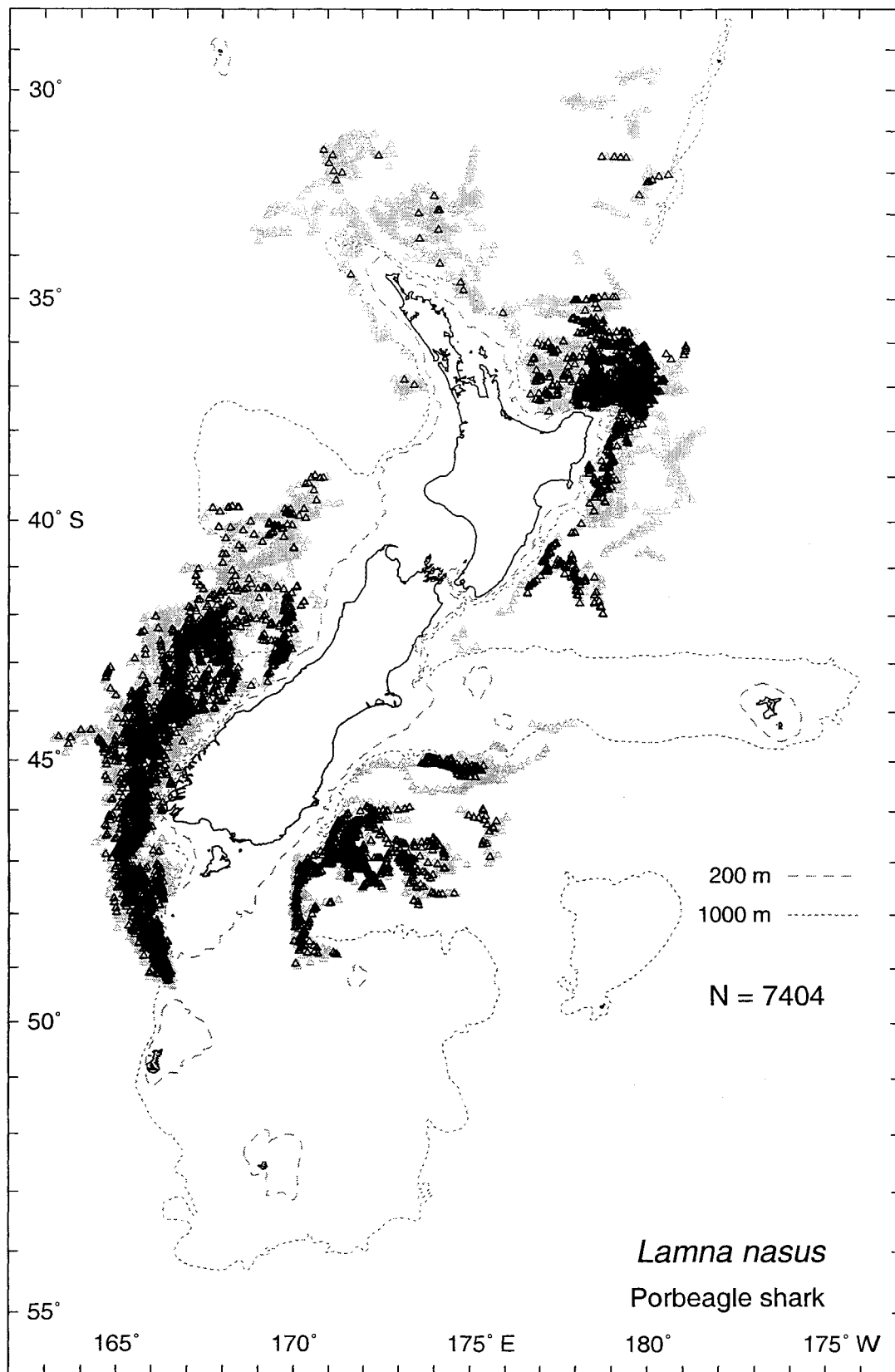
May include *Tubbia* spp.

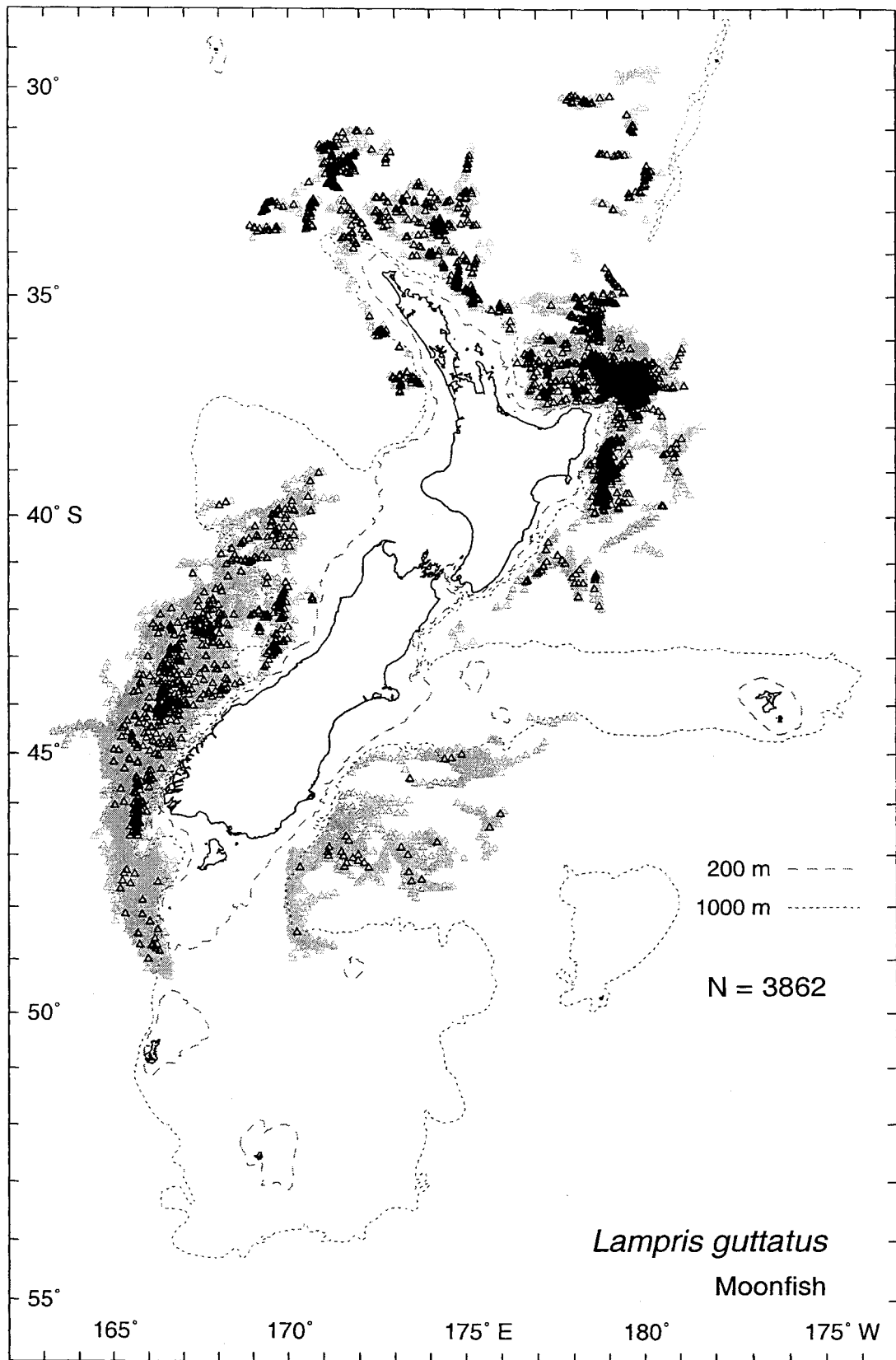




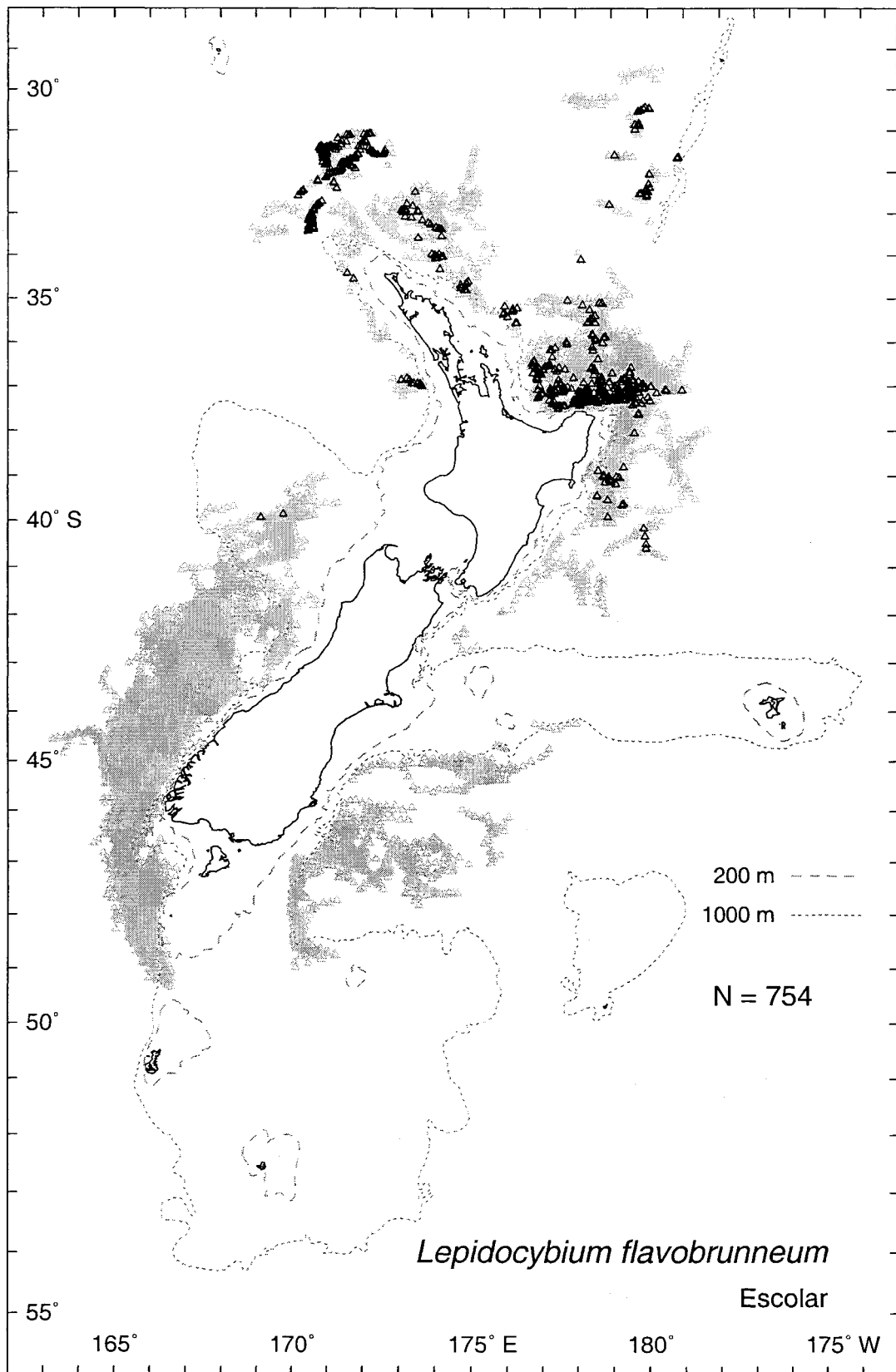


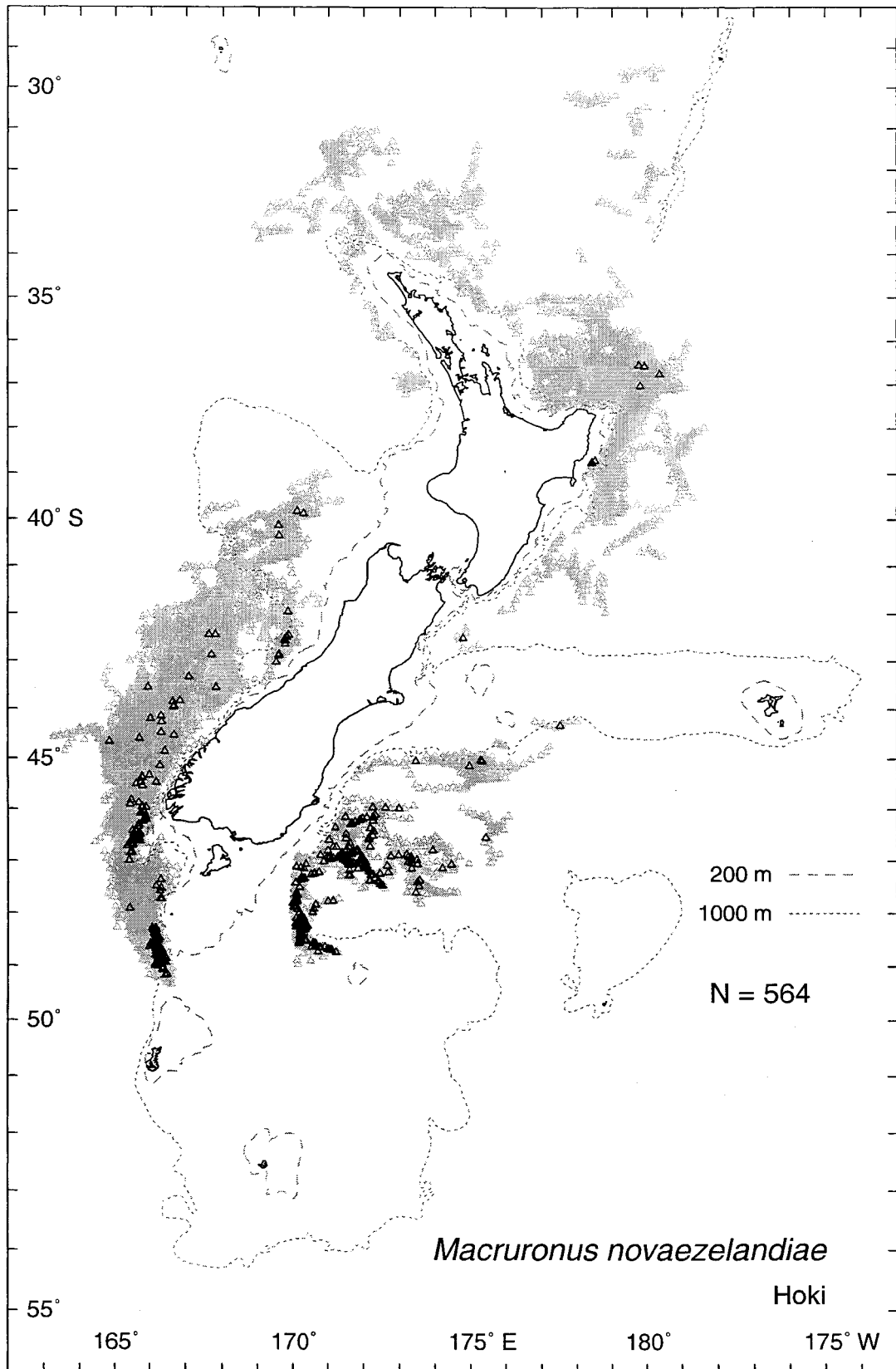


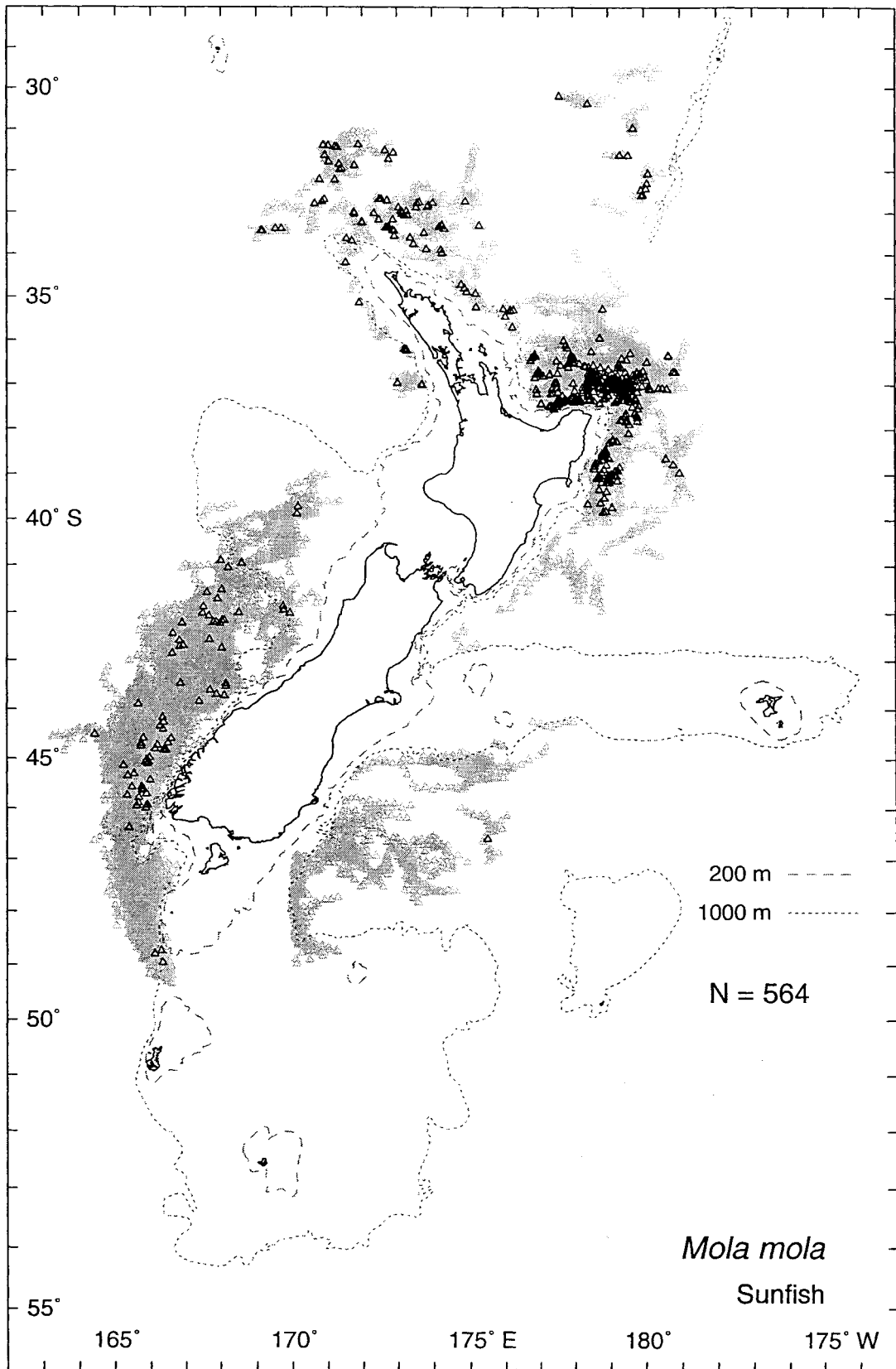




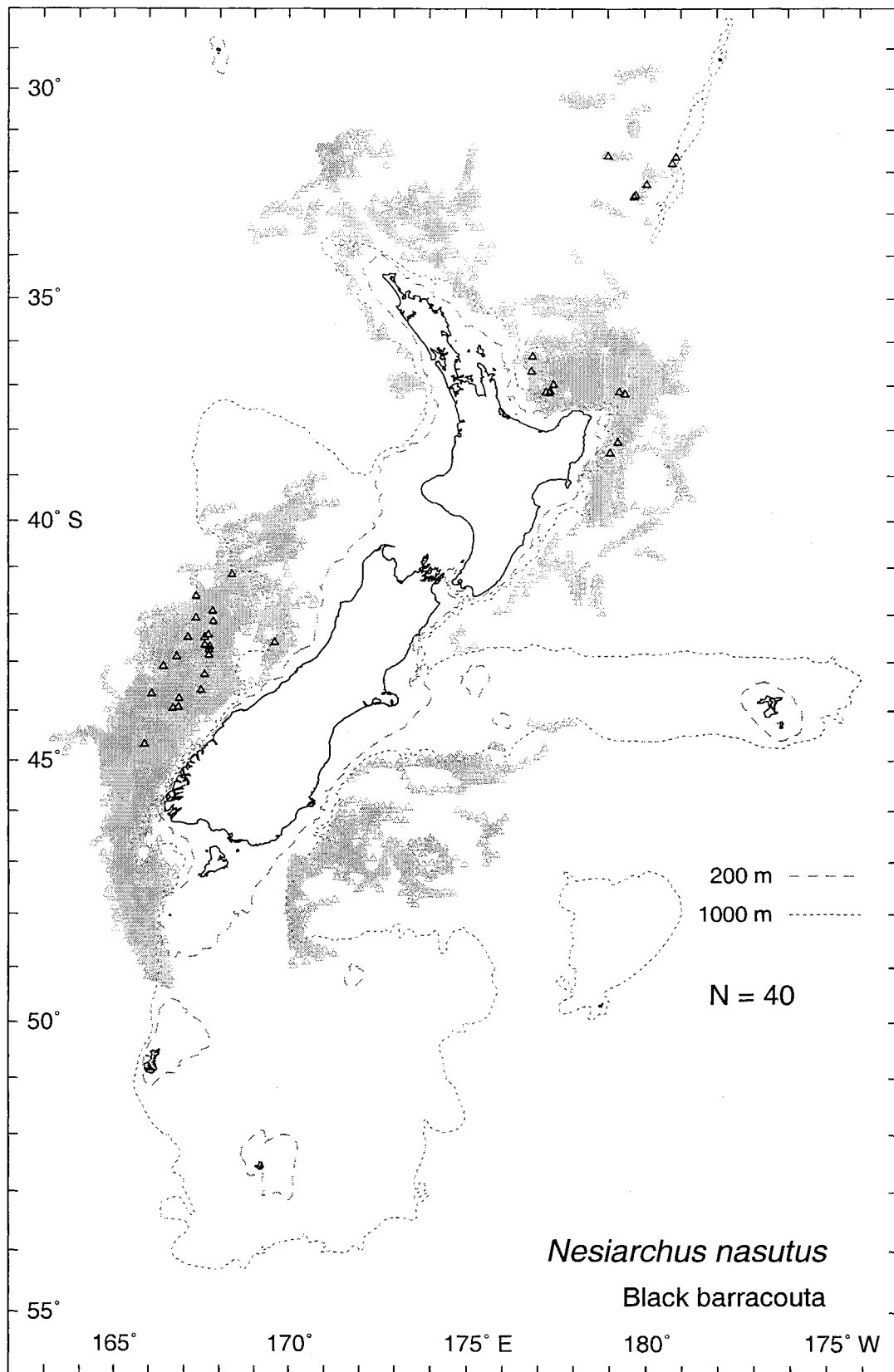
Includes some *L. immaculatus*.

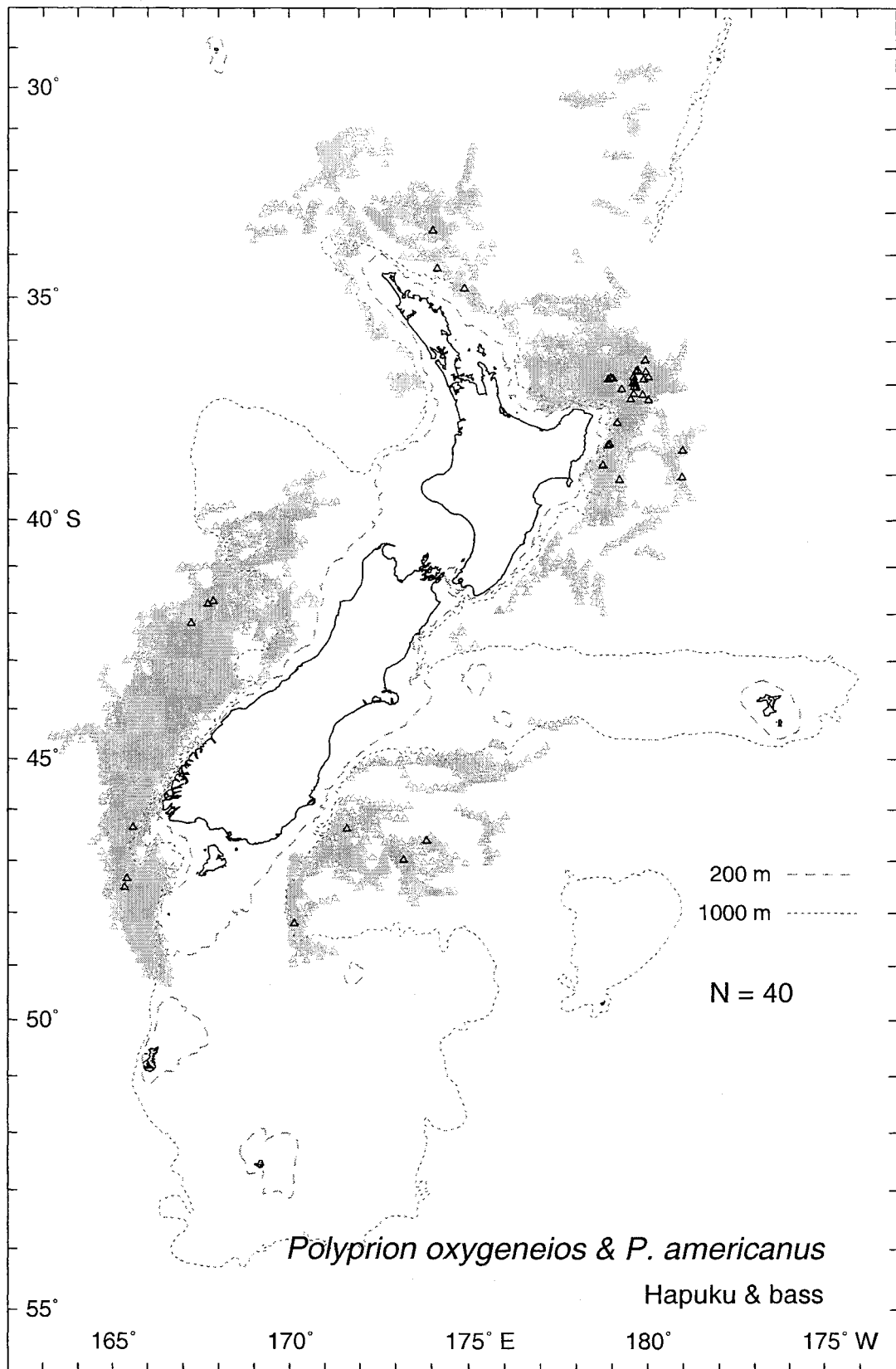


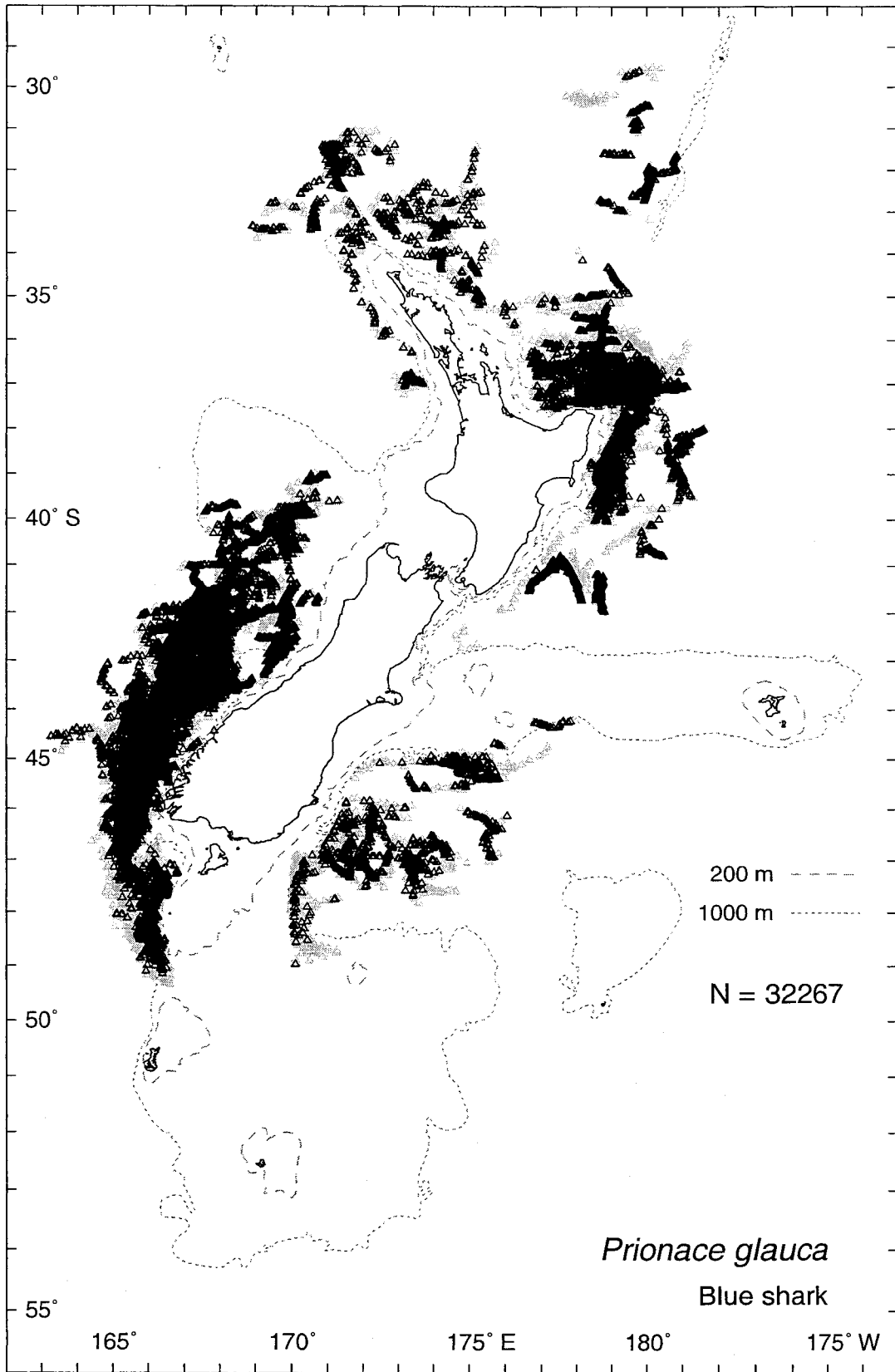


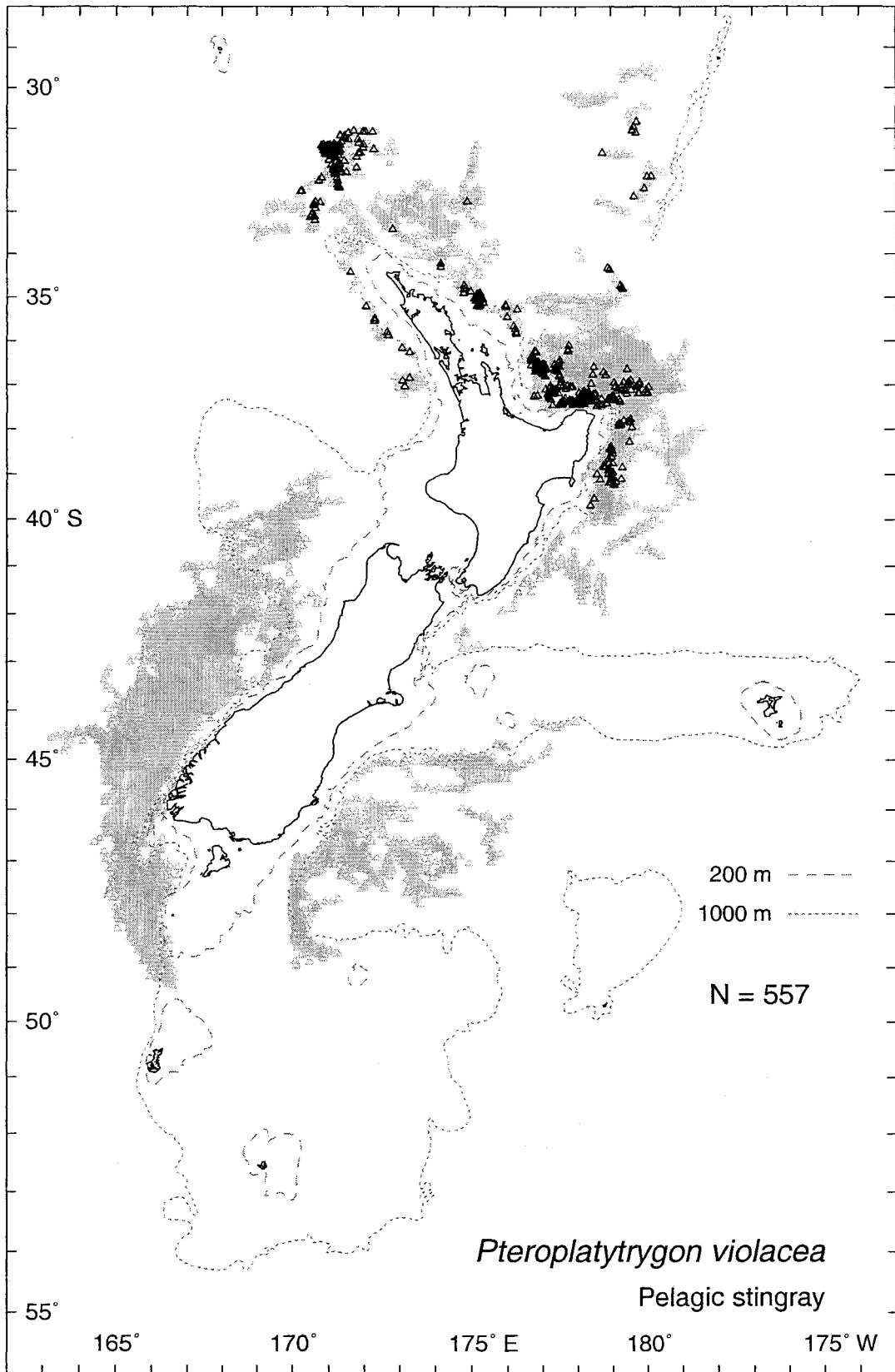


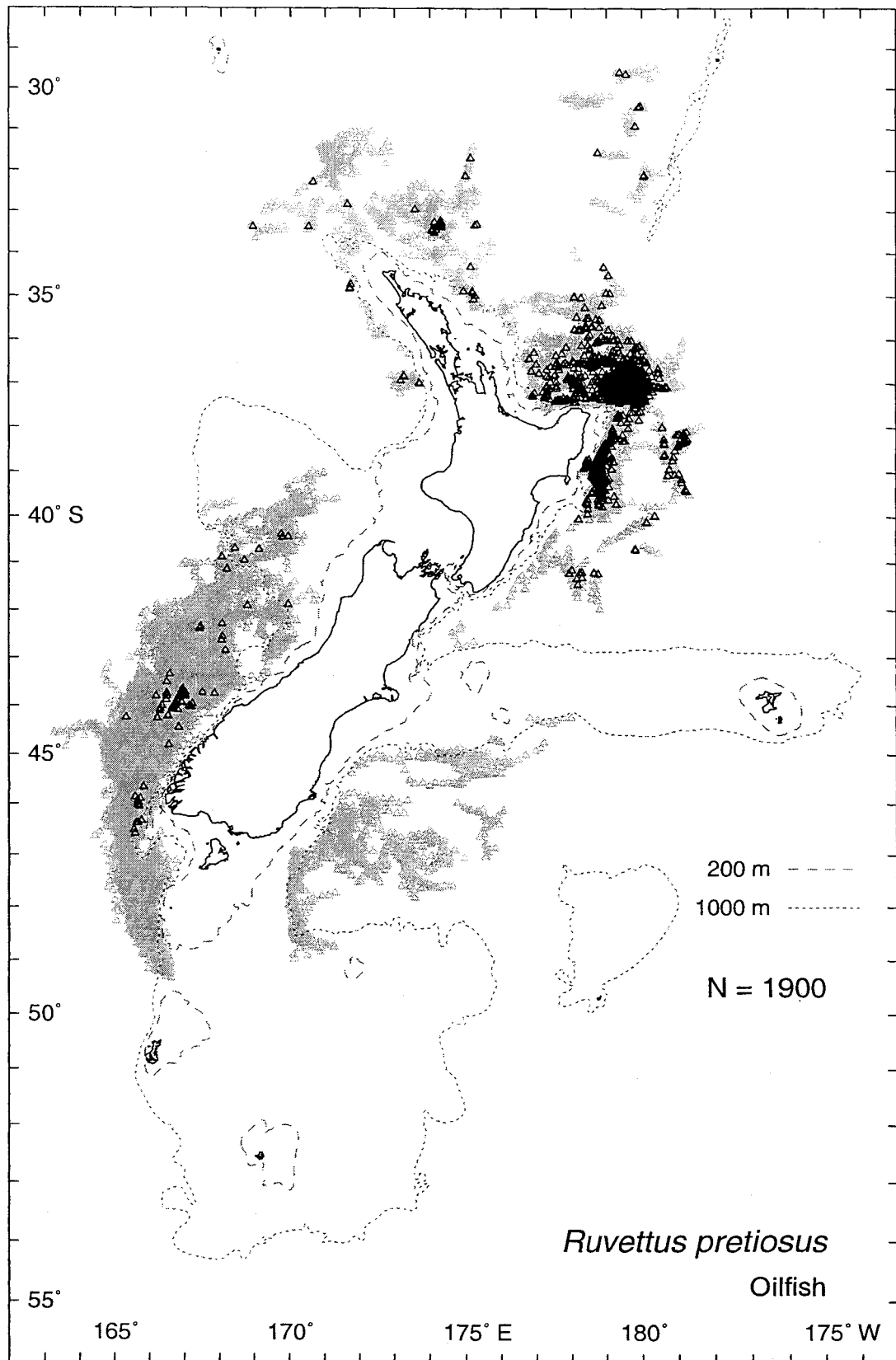
The sharptailed sunfish, *Masturus lanceolatus*, may be present in northern records.



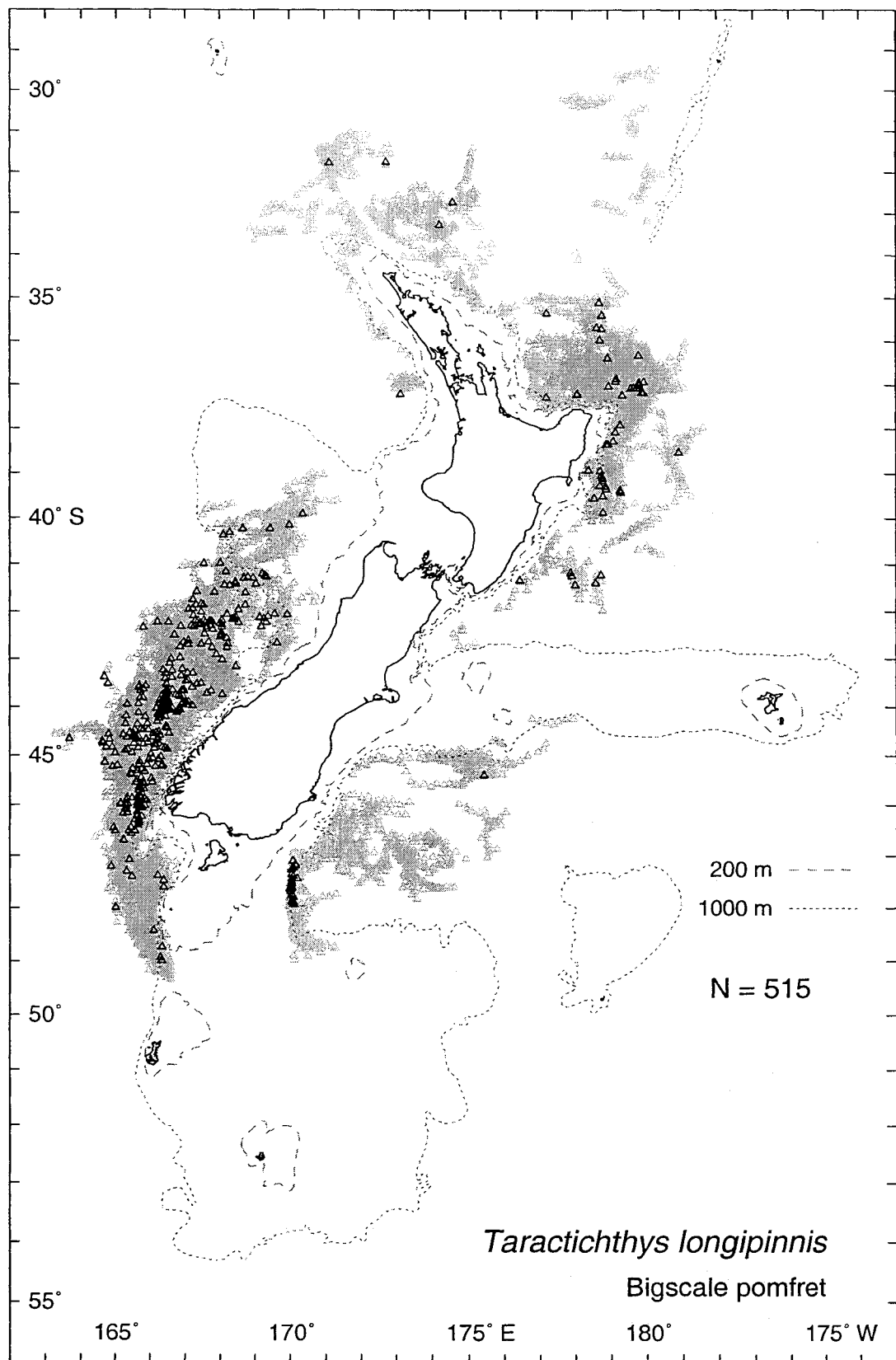




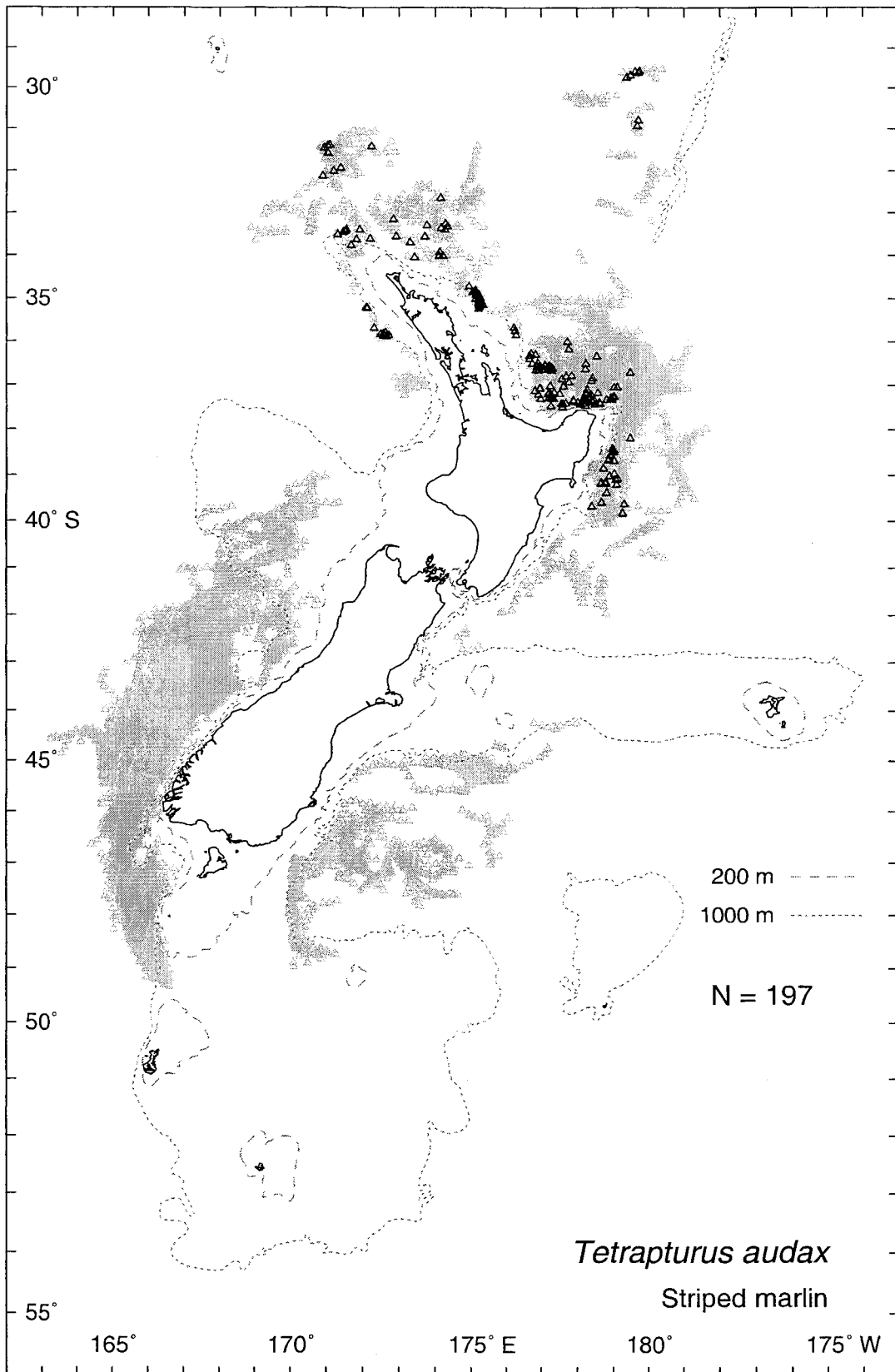


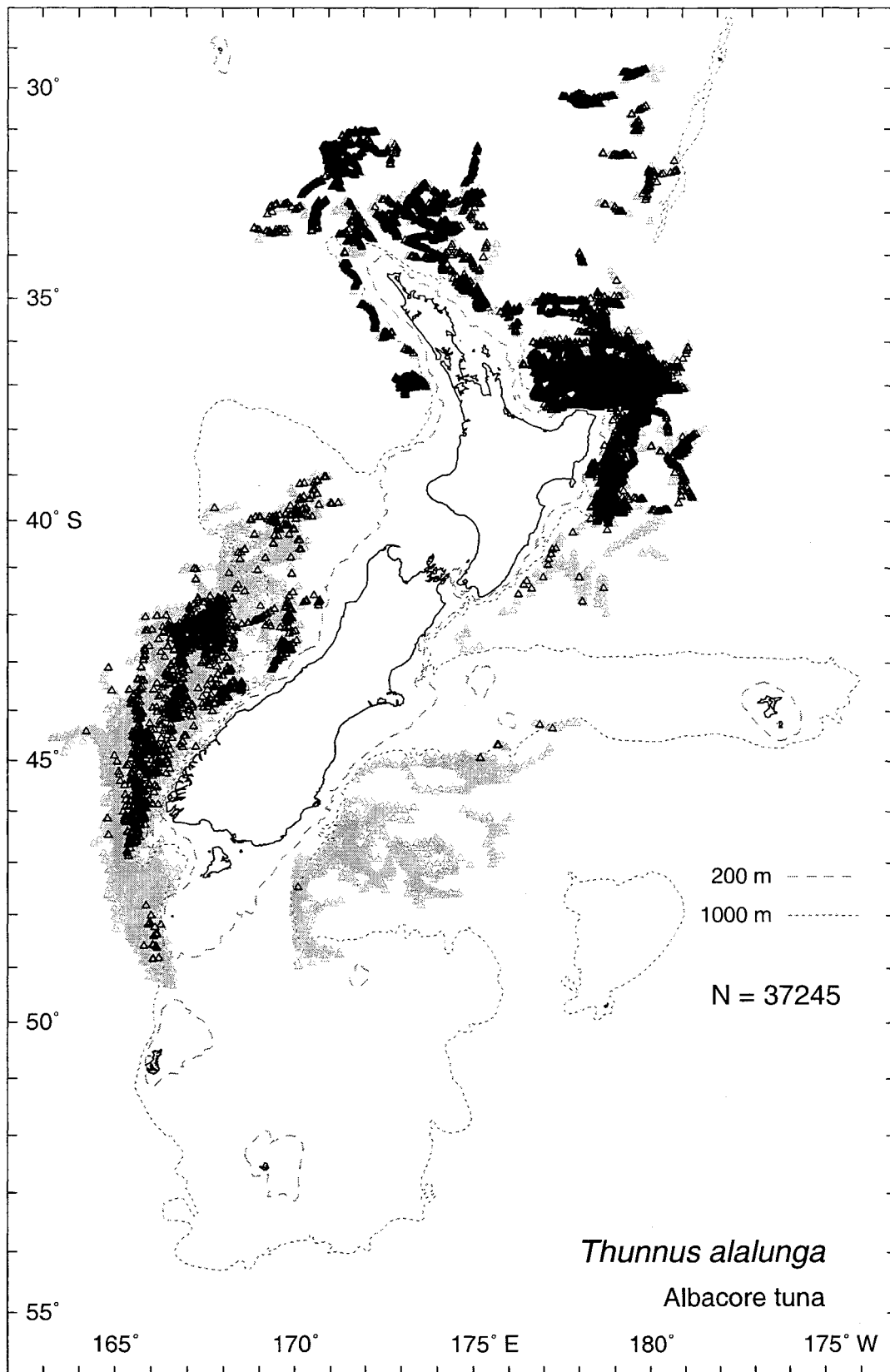


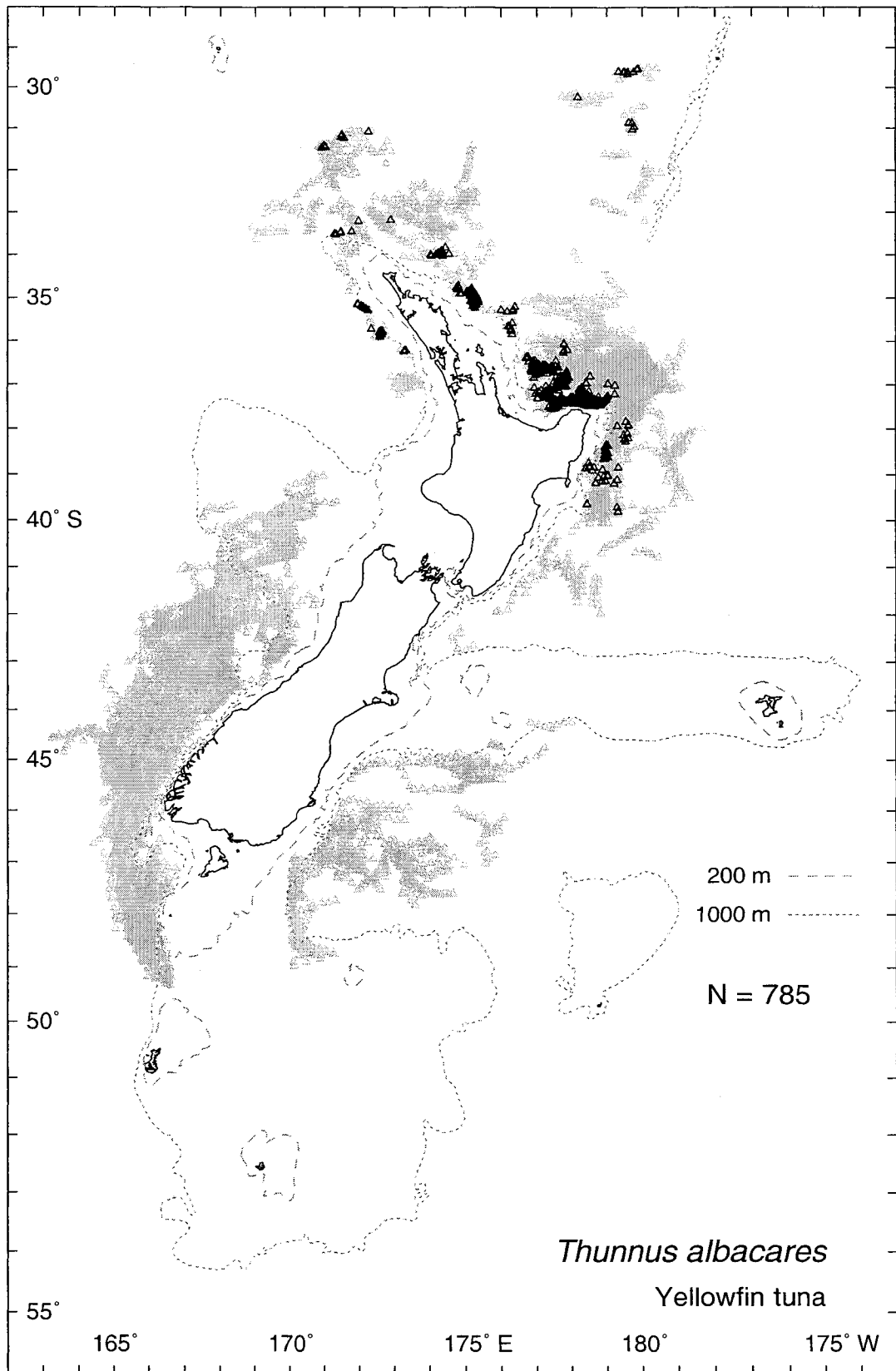
May include some *Lepidocybium flavobrunneum*.

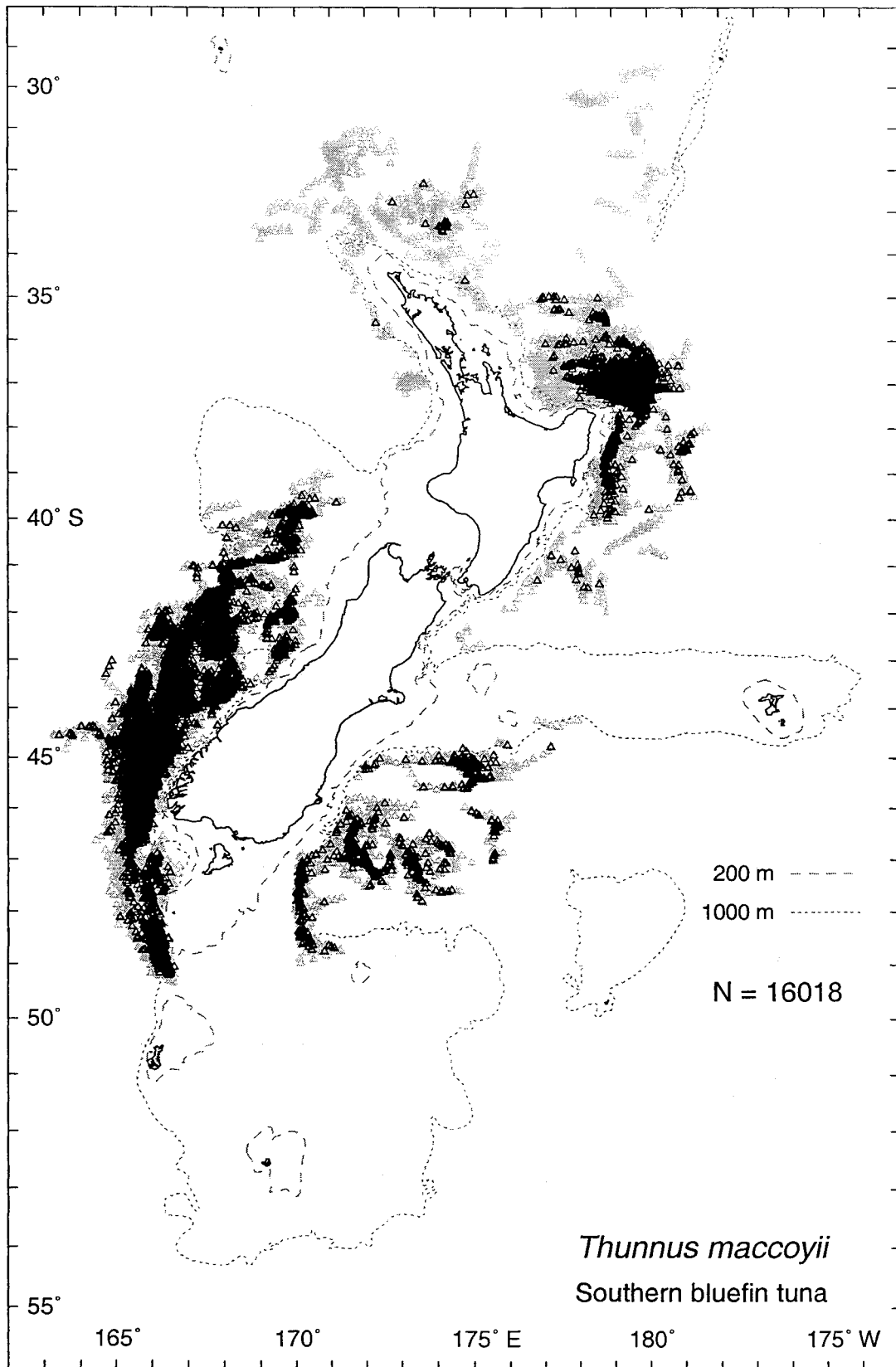


May include some other pomfrets (Bramidae).

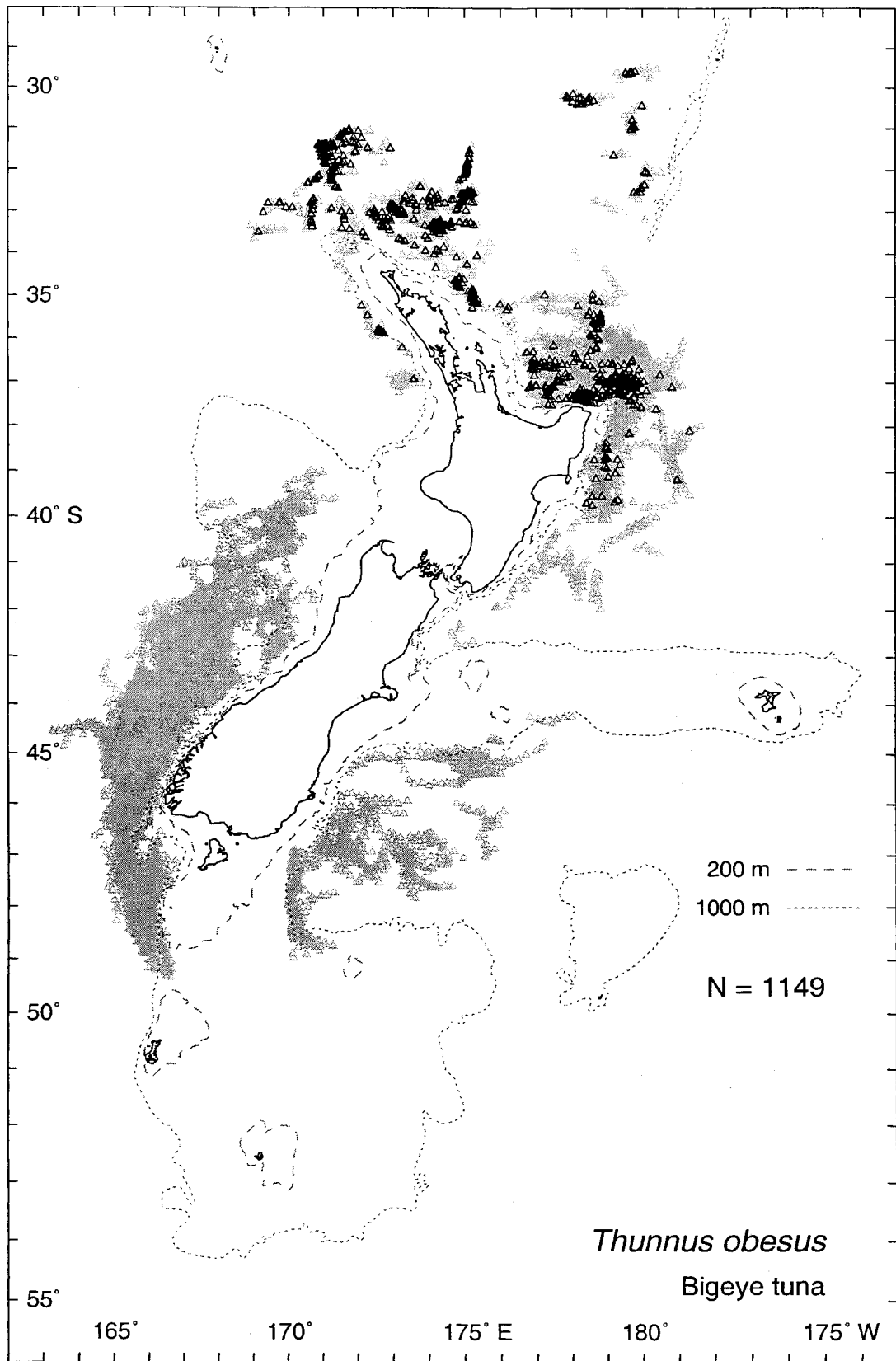




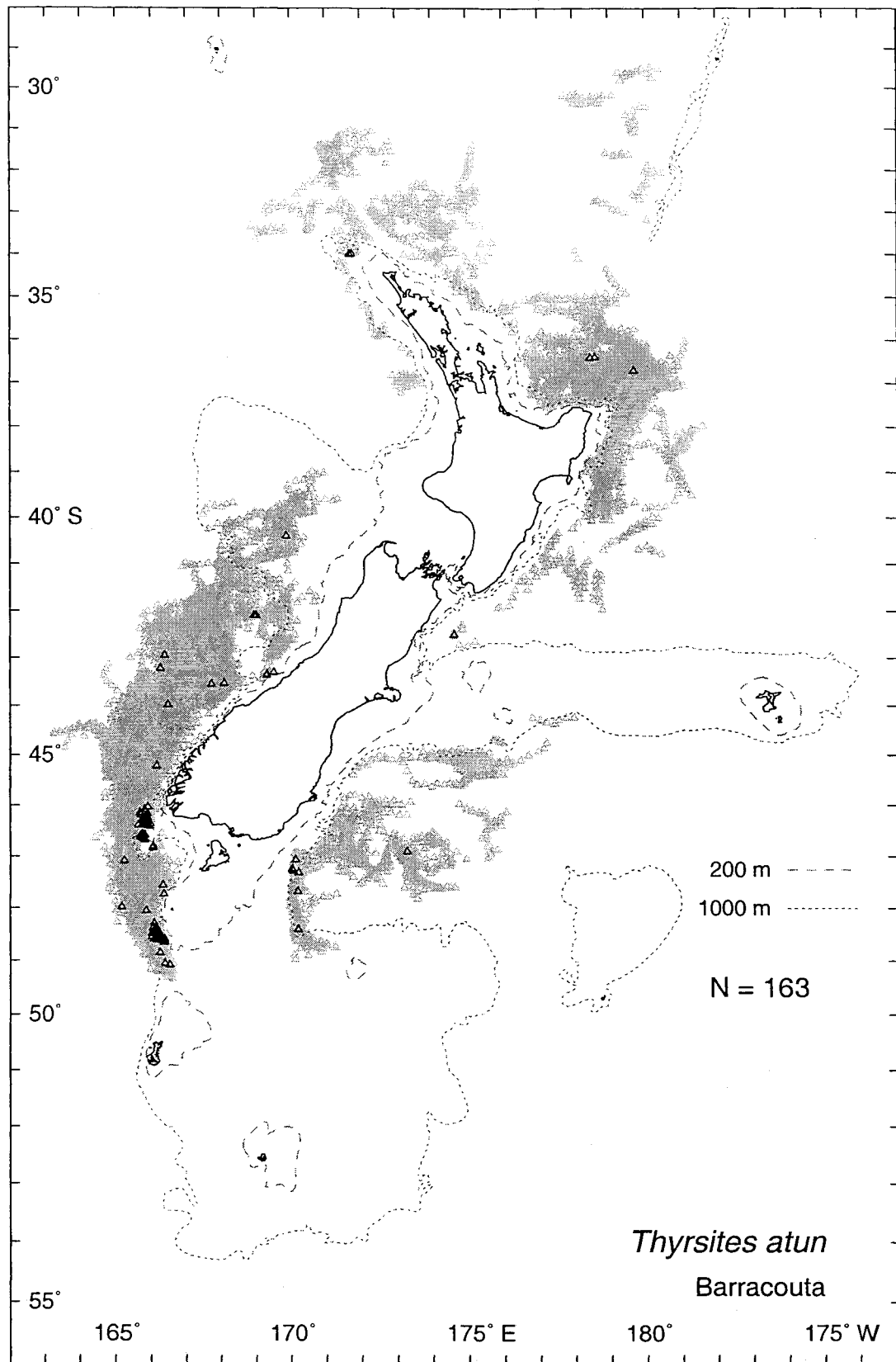




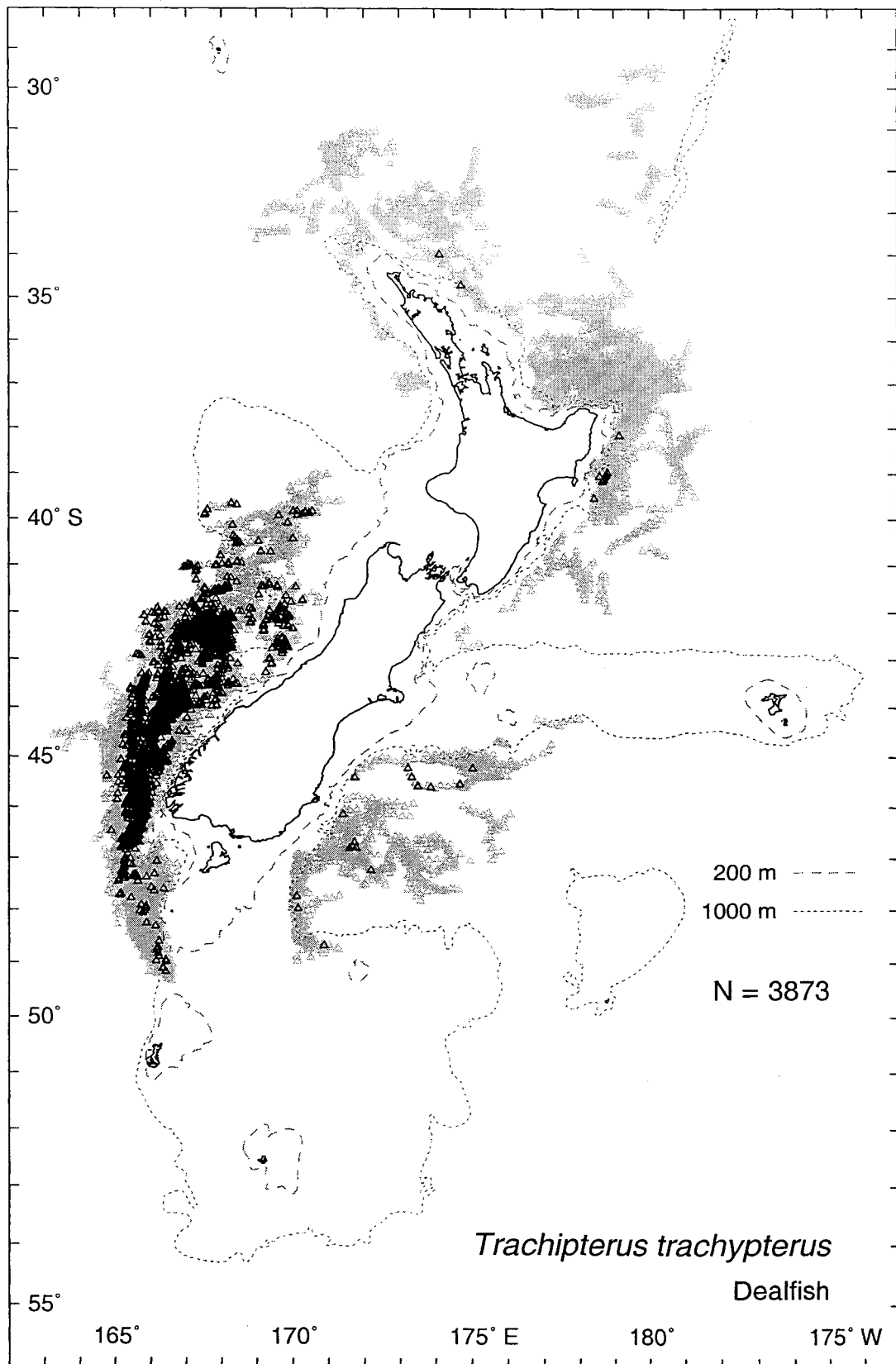
Northern records may include some *T. thynnus* and *T. obesus*.



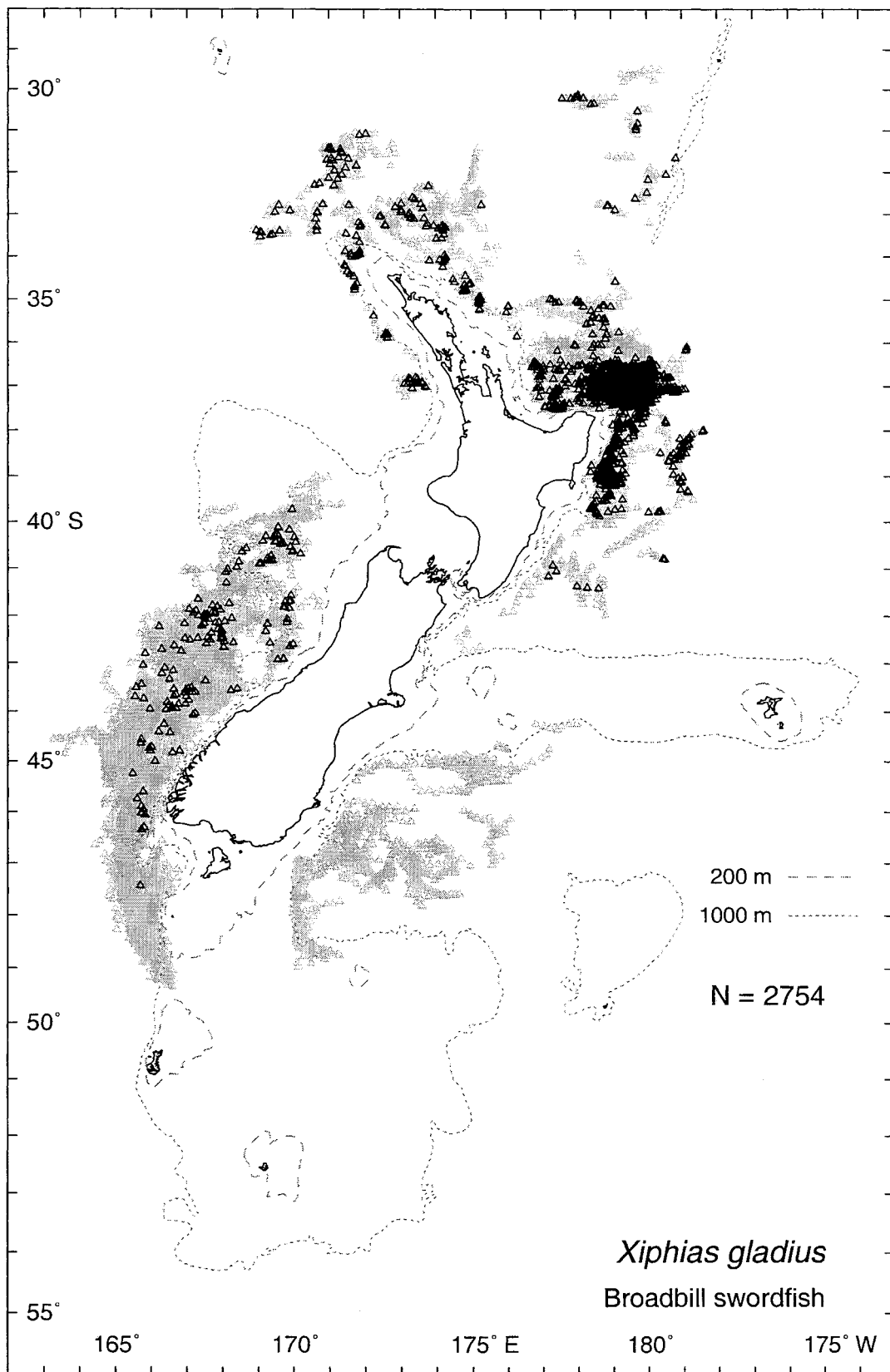
Small specimens are difficult to distinguish from *T. maccoyii*.



Some early records may be black barracouta, *Nesiarchus nasutus*.



May include some *T. jacksonensis* and *Regalecus glesne*.



Aerial sighting distributions

Arripis trutta
Kahawai

34° S

Number of schools*

- 1 - 100
- 101 - 500
- 501 - 1000
- 1001 - 5000
- >5000

40° S

167° E

171°

175°

179°

N (sightings) = 15147

34° S

Number of tonnes*

- 1 - 500
- 501 - 1000
- 1001 - 10,000
- 10,001 - 100,000
- >100,000

40° S

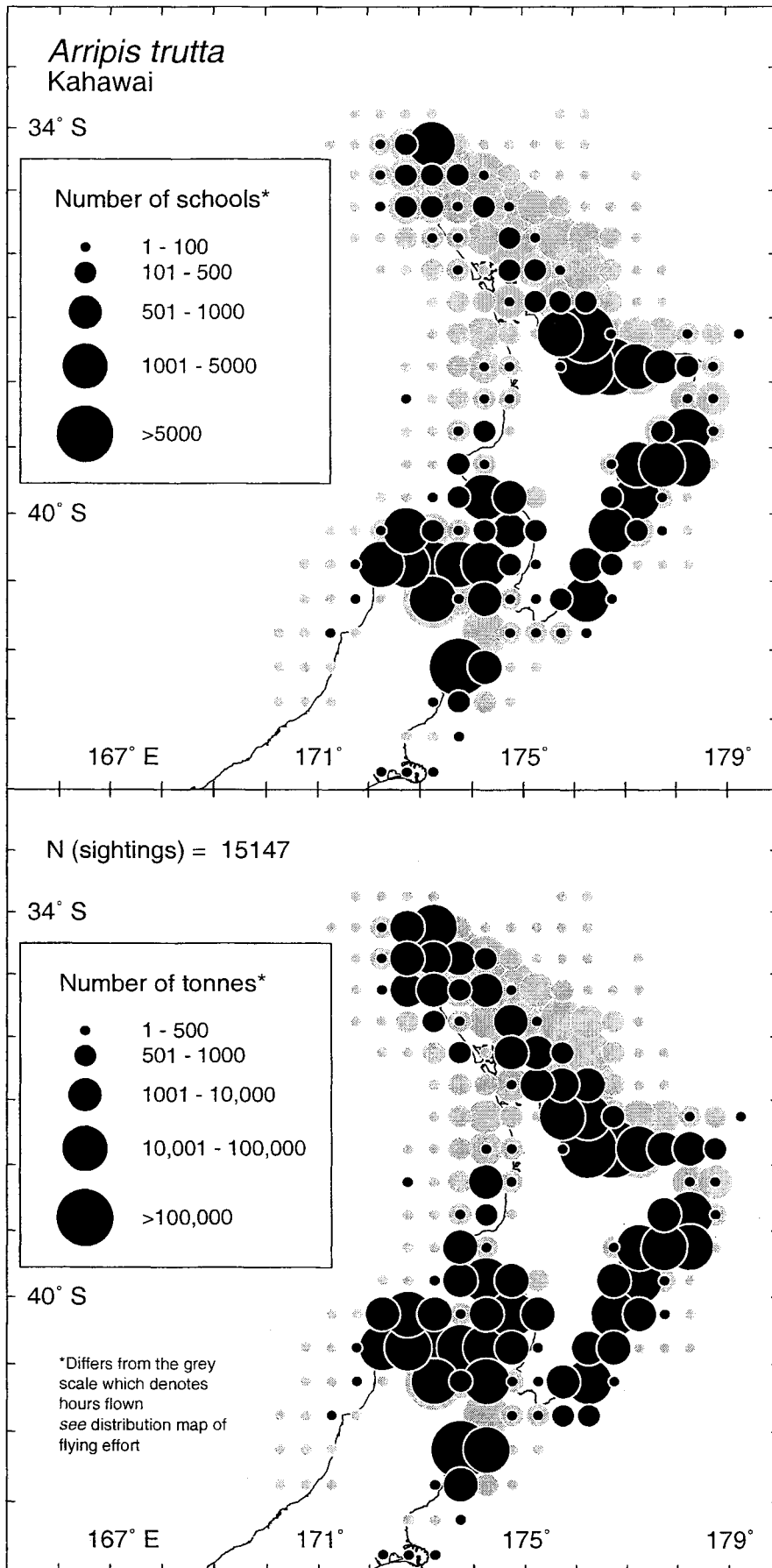
*Differs from the grey
scale which denotes
hours flown
see distribution map of
flying effort

167° E

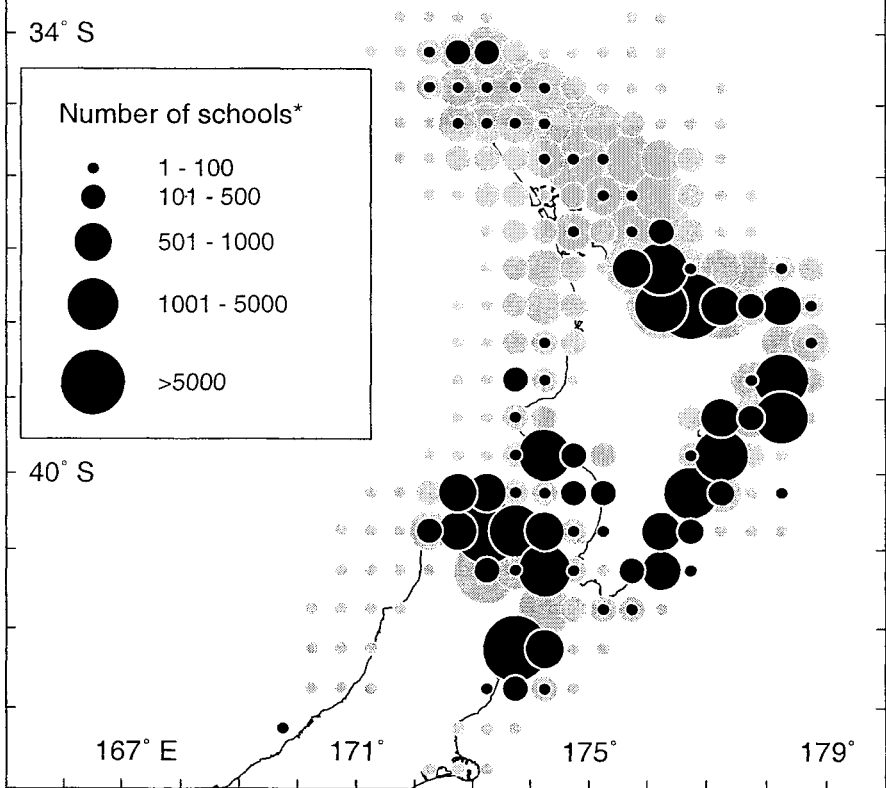
171°

175°

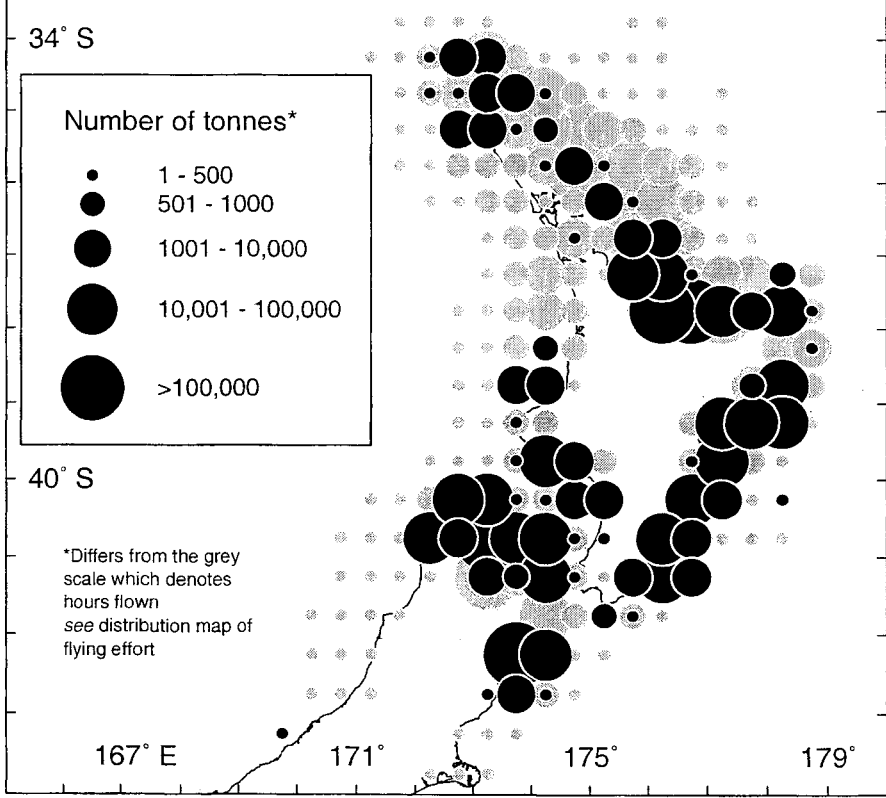
179°



Arripis trutta in mixed schools
Kahawai



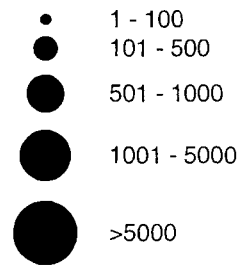
N (sightings) = 3648



Arripis trutta & *Trachurus* spp. (mixed together)
Kahawai & jack mackerel

34° S

Number of schools*



40° S

167° E

171°

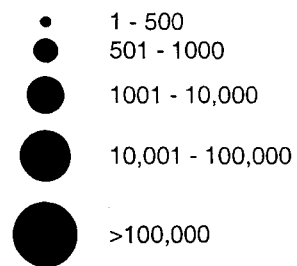
175°

179°

N (sightings) = 2326

34° S

Number of tonnes*



40° S

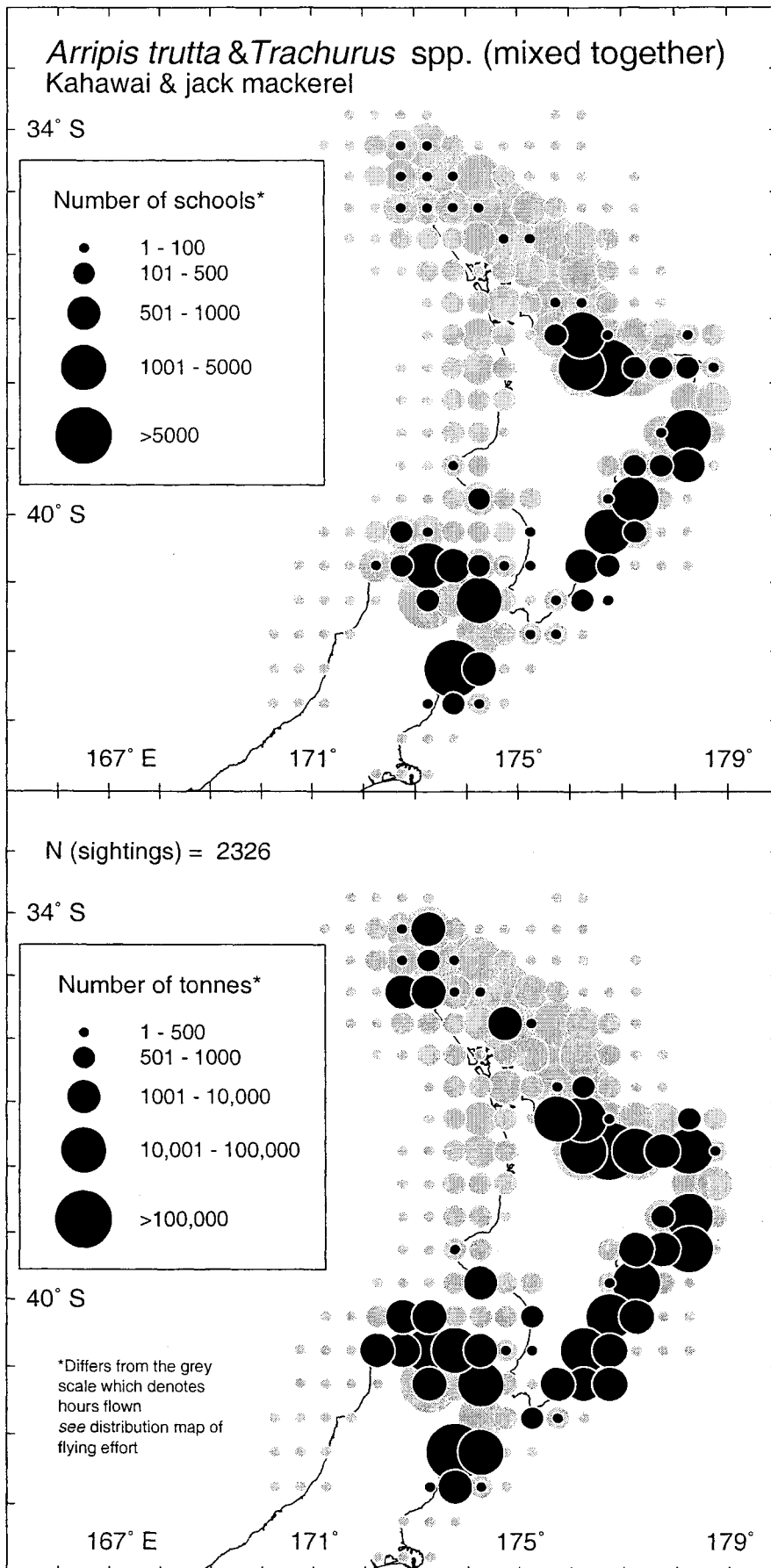
*Differs from the grey scale which denotes hours flown
hours flown
see distribution map of flying effort

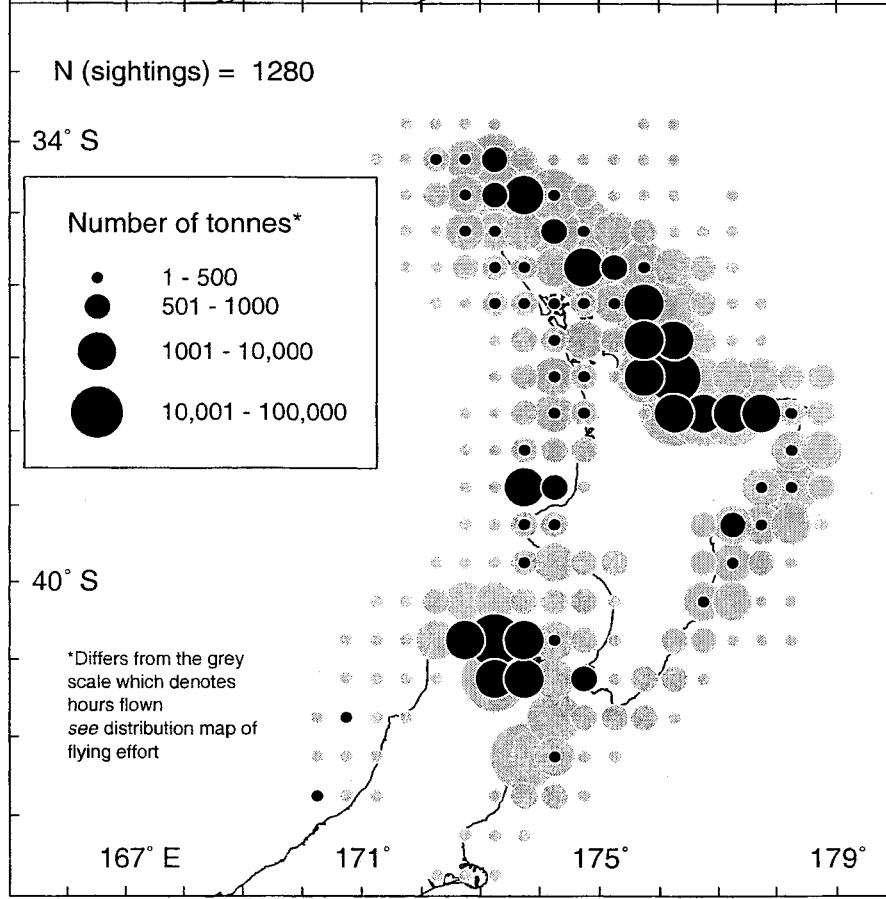
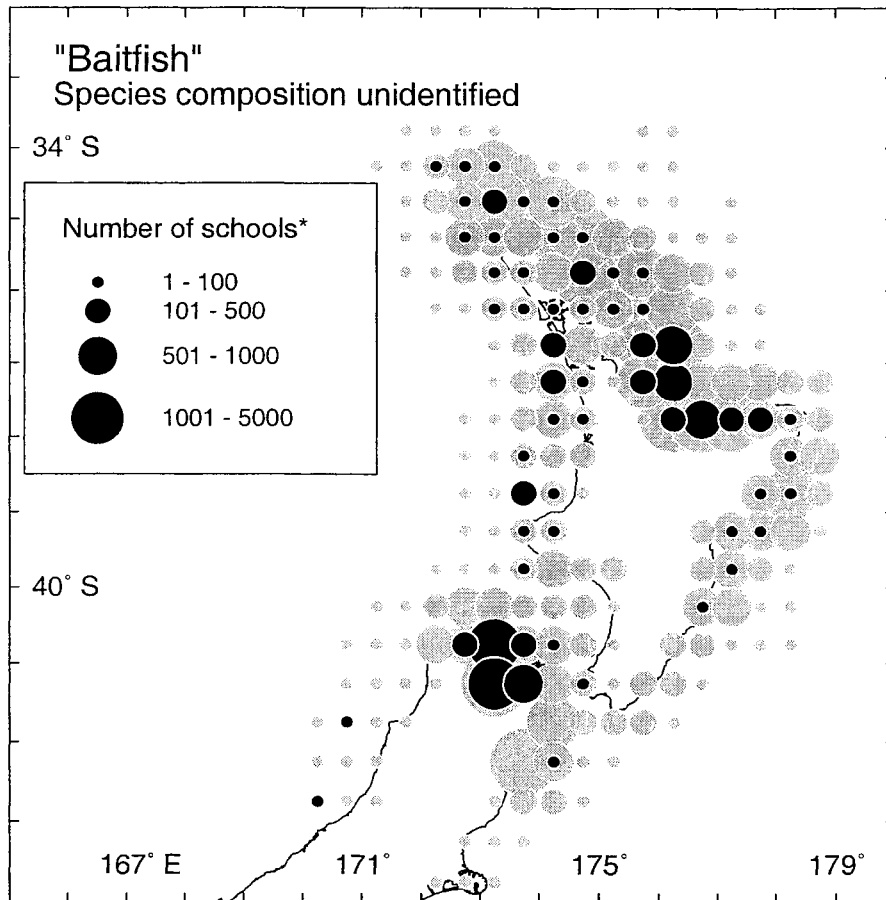
167° E

171°

175°

179°





Pseudocaranx dentex
Trevally

34° S

Number of schools*

- 1 - 100
- 101 - 500
- 501 - 1000
- 1001 - 5000

40° S

167° E

171°

175°

179°

N (sightings) = 6150

34° S

Number of tonnes*

- 1 - 500
- 501 - 1000
- 1001 - 10,000
- 10,001 - 100,000

40° S

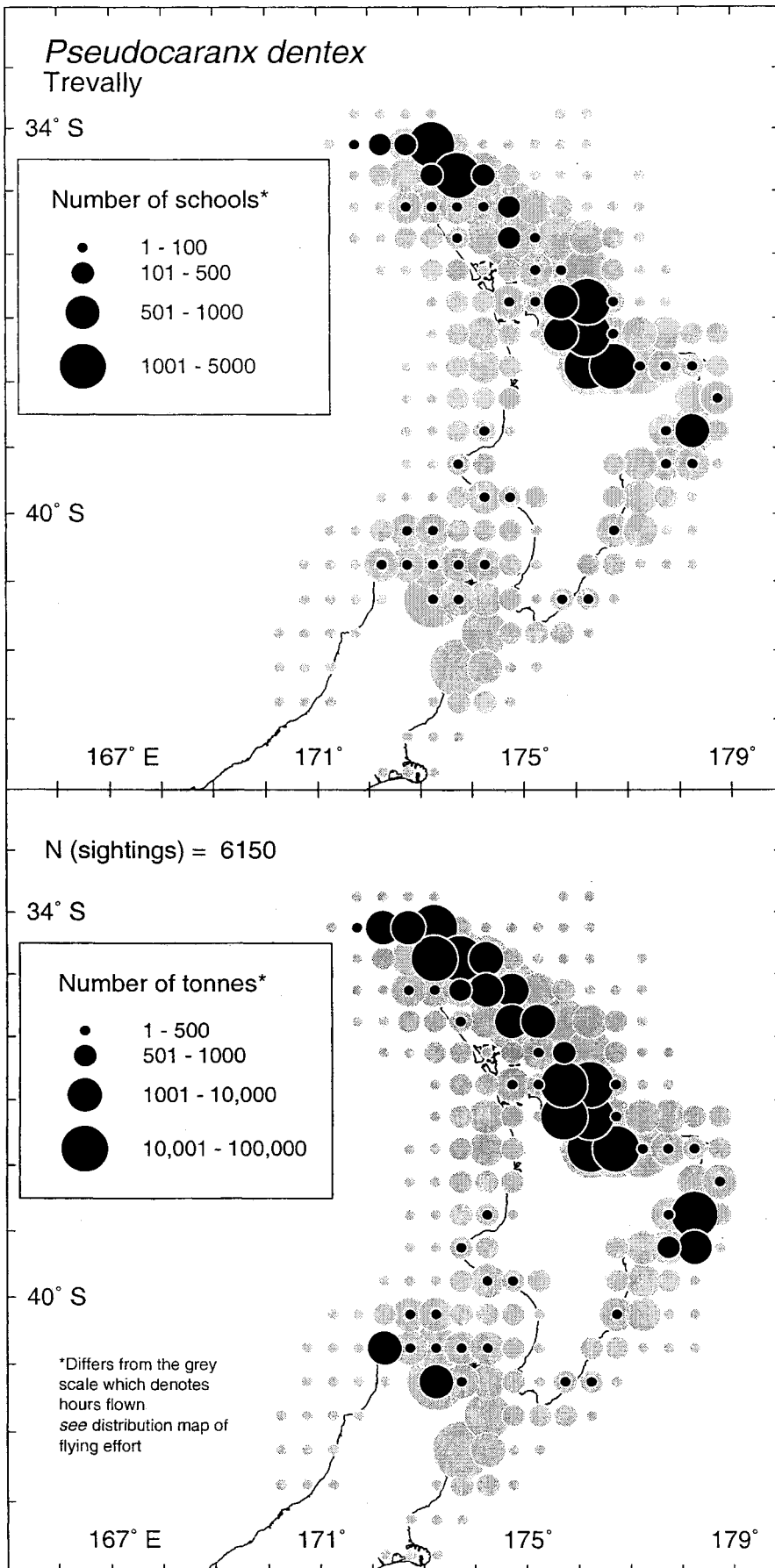
*Differs from the grey
scale which denotes
hours flown
see distribution map of
flying effort

167° E

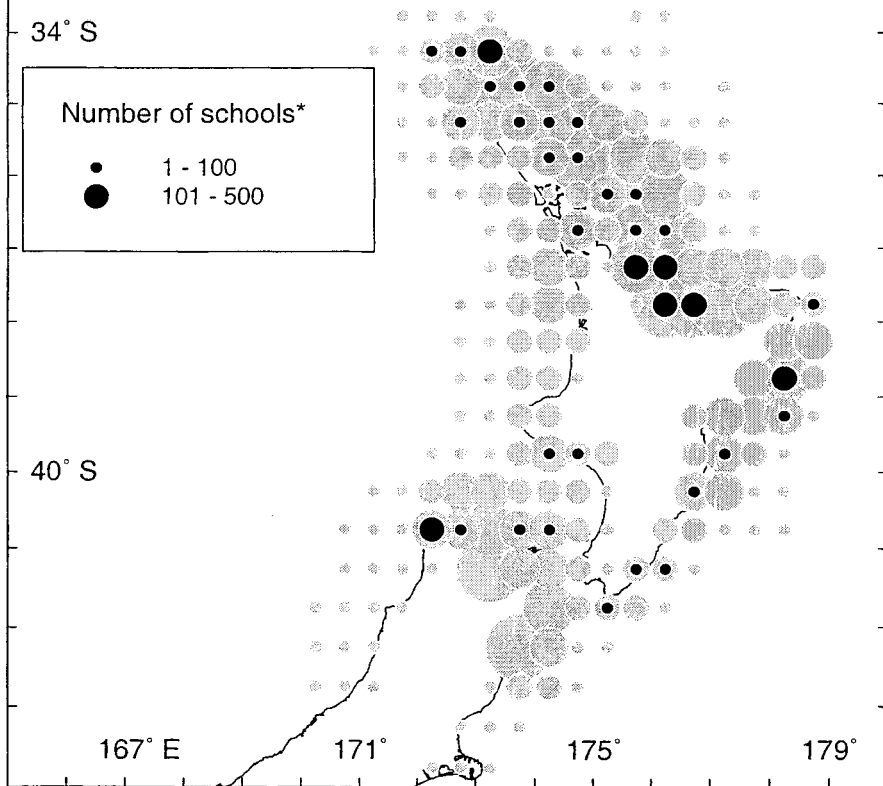
171°

175°

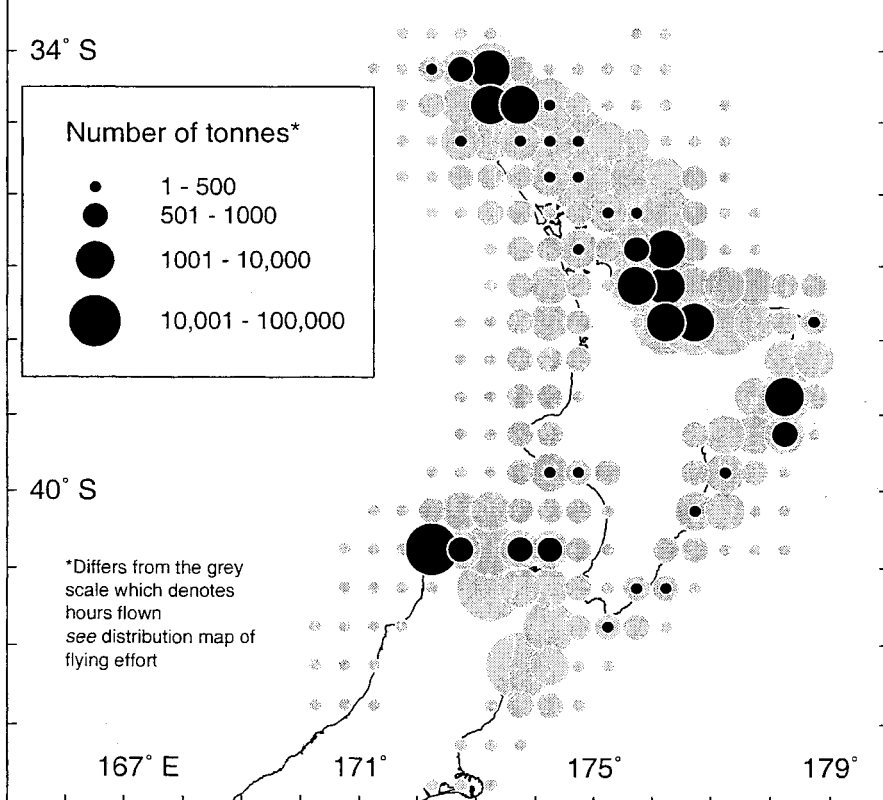
179°



Pseudocaranx dentex in mixed schools
Trevally



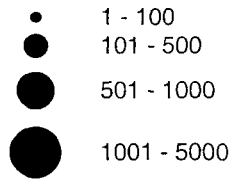
N (sightings) = 541



Katsuwonus pelamis
Skipjack tuna

34° S

Number of schools*



40° S

167° E

171°

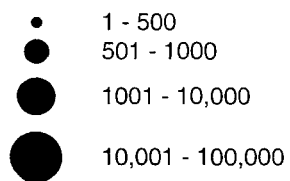
175°

179°

N (sightings) = 12922

34° S

Number of tonnes*



40° S

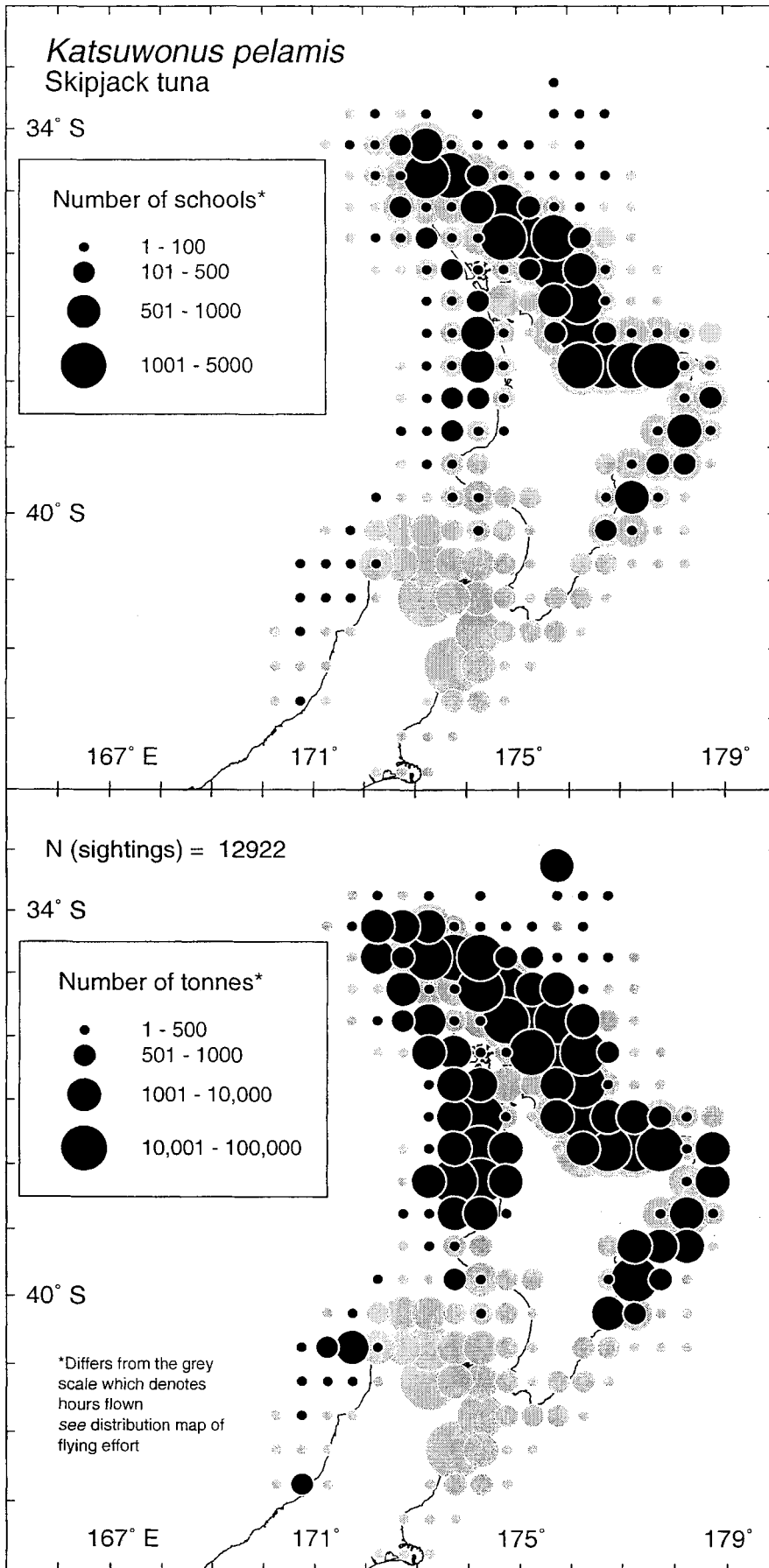
*Differs from the grey
scale which denotes
hours flown
see distribution map of
flying effort

167° E

171°

175°

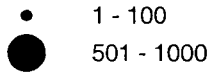
179°



Pagrus auratus
Snapper

34° S

Number of schools*



40° S

167° E

171°

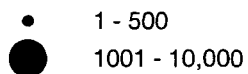
175°

179°

N (sightings) = 67

34° S

Number of tonnes*



40° S

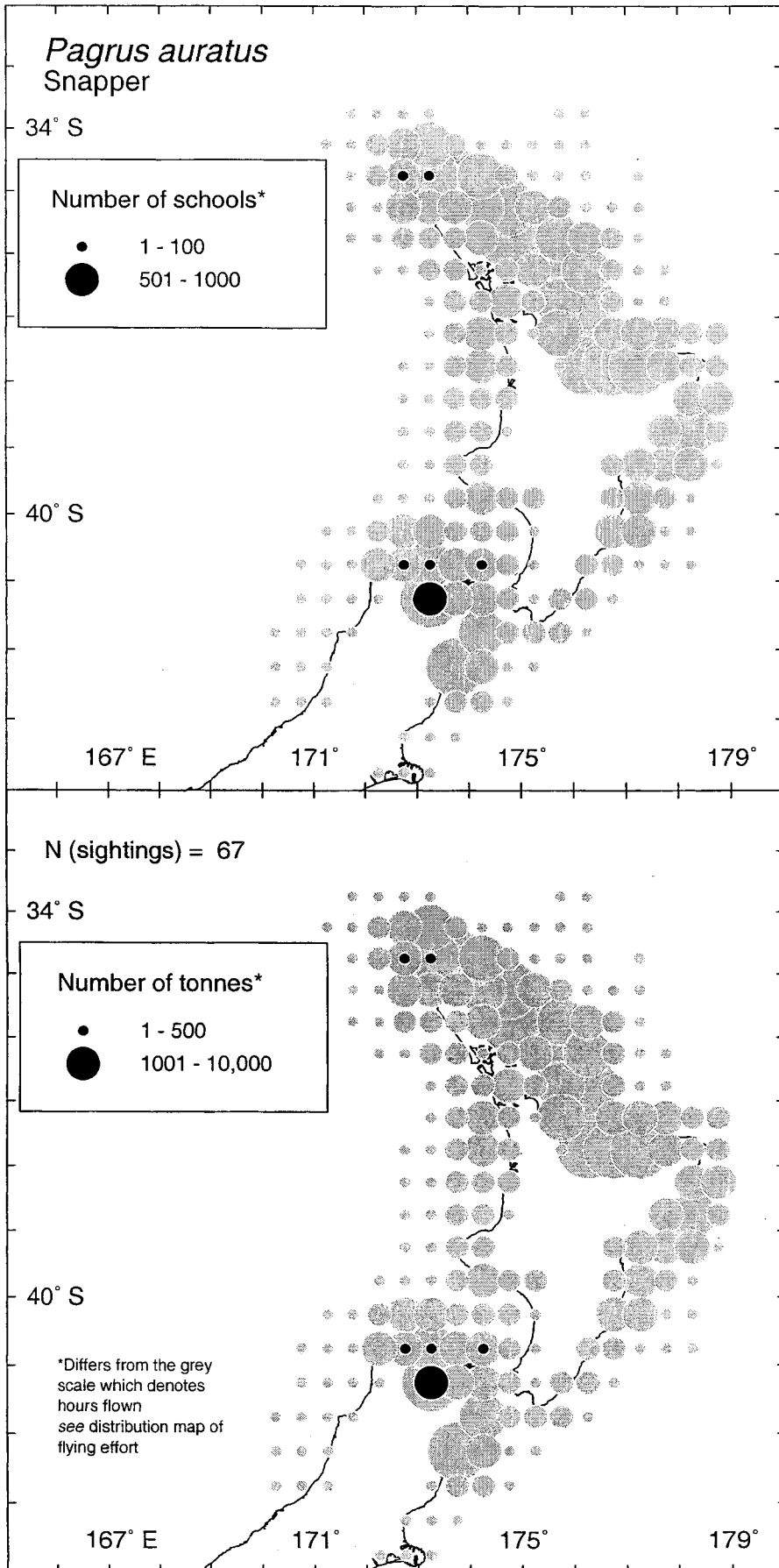
*Differs from the grey
scale which denotes
hours flown
see distribution map of
flying effort

167° E

171°

175°

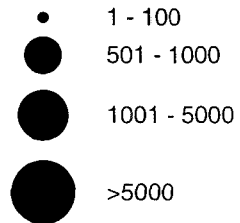
179°



Sardinops neopilchardus
Pilchard

34° S

Number of schools*



40° S

167° E

171°

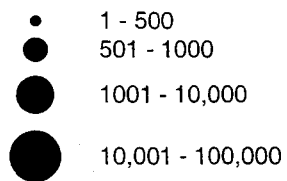
175°

179°

N (sightings) = 158

34° S

Number of tonnes*



40° S

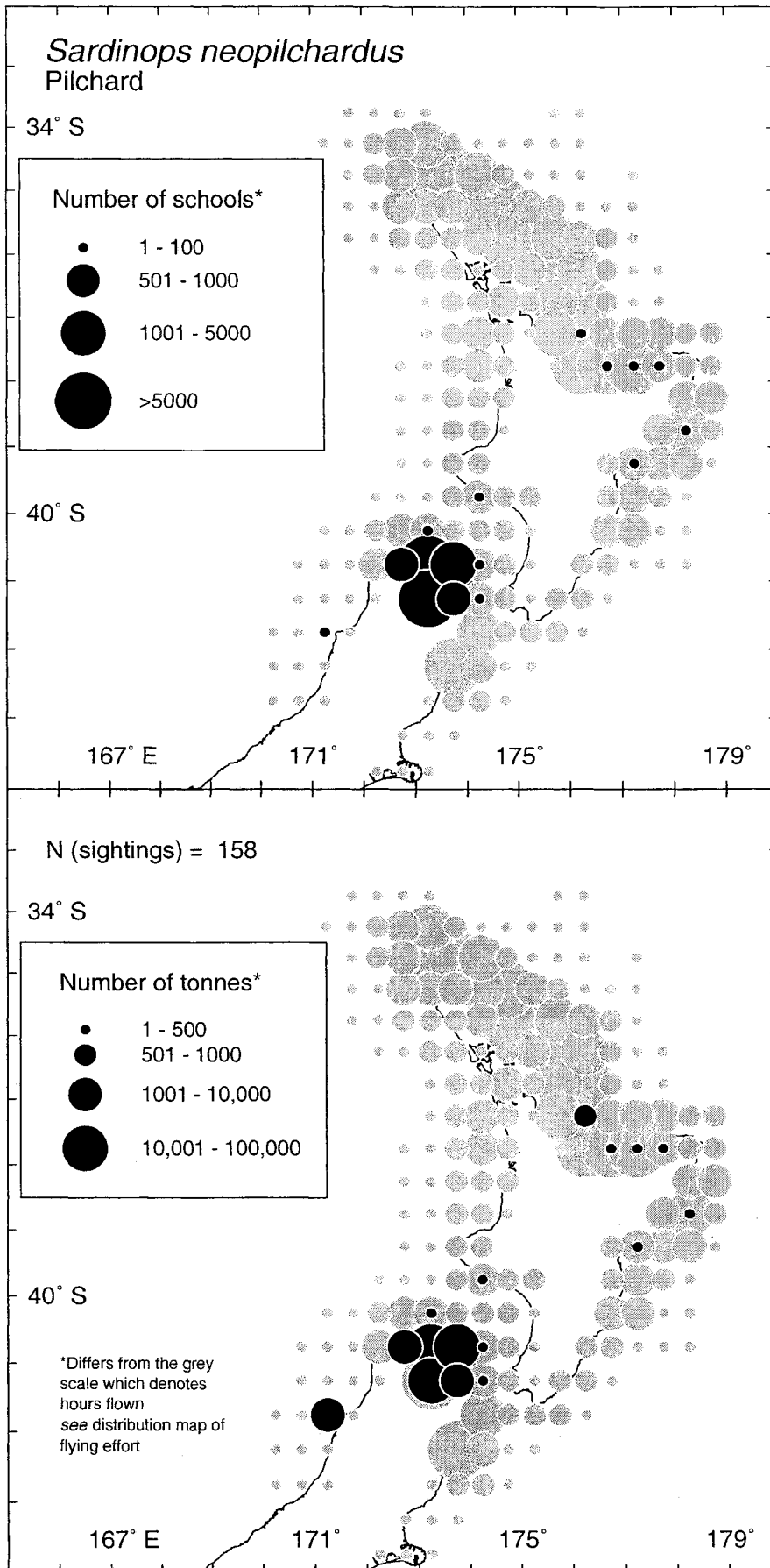
*Differs from the grey scale which denotes hours flown
see distribution map of flying effort

167° E

171°

175°

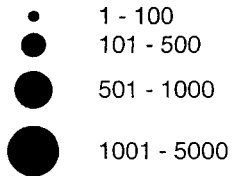
179°



Scomber australasicus
Blue mackerel

34° S

Number of schools*



40° S

167° E

171°

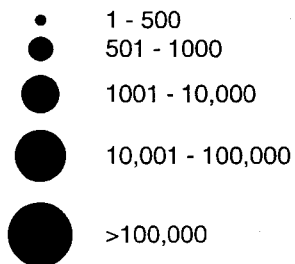
175°

179°

N (sightings) = 4461

34° S

Number of tonnes*



40° S

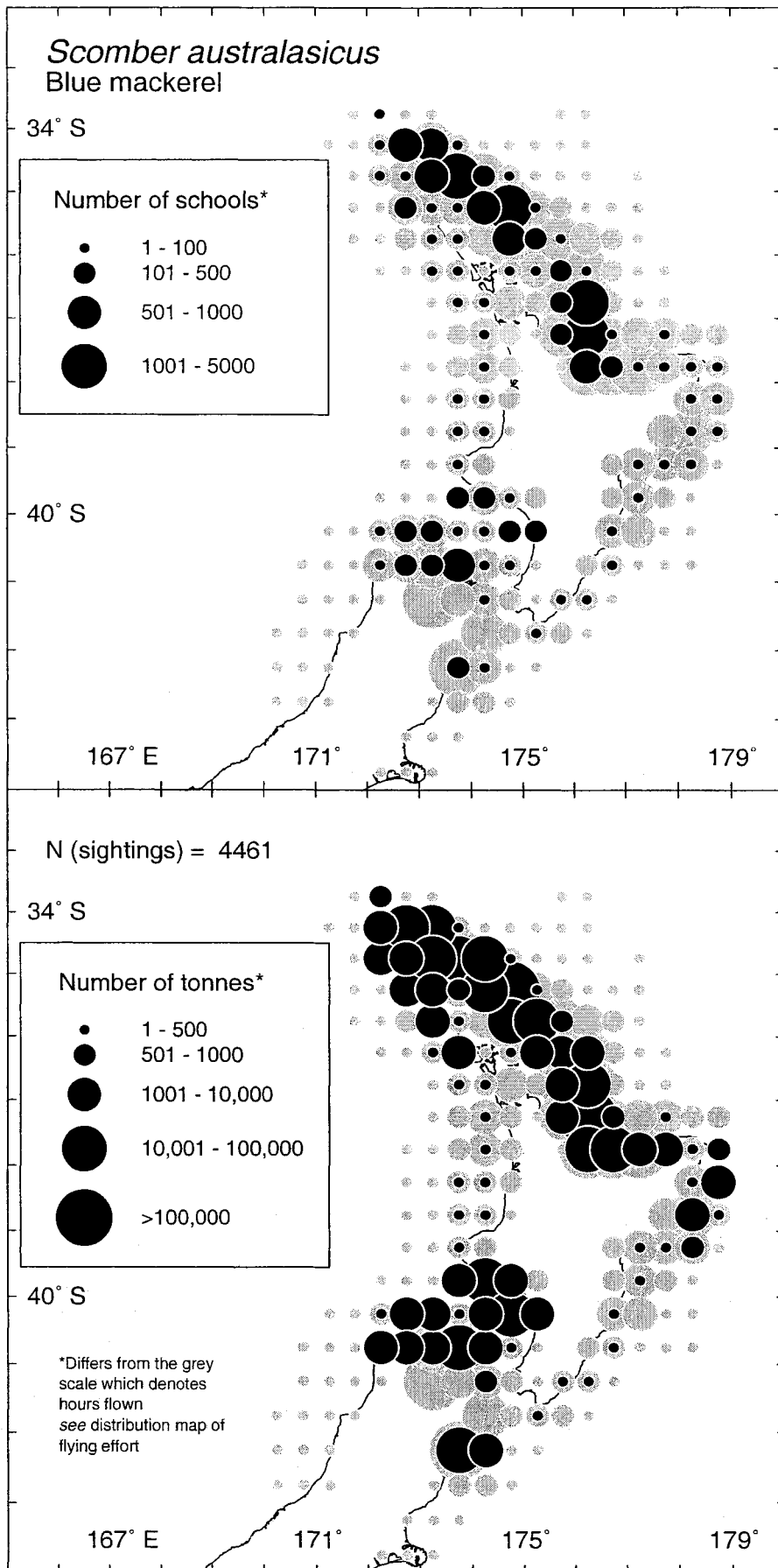
*Differs from the grey
scale which denotes
hours flown
see distribution map of
flying effort

167° E

171°

175°

179°



Scomber australasicus in mixed schools
Blue mackerel

34° S

Number of schools*

- 1 - 100
- 101 - 500
- 501 - 1000
- 1001 - 5000

40° S

167° E

171°

175°

179°

N (sightings) = 1882

34° S

Number of tonnes*

- 1 - 500
- 501 - 1000
- 1001 - 10,000
- 10,001 - 100,000
- >100,000

40° S

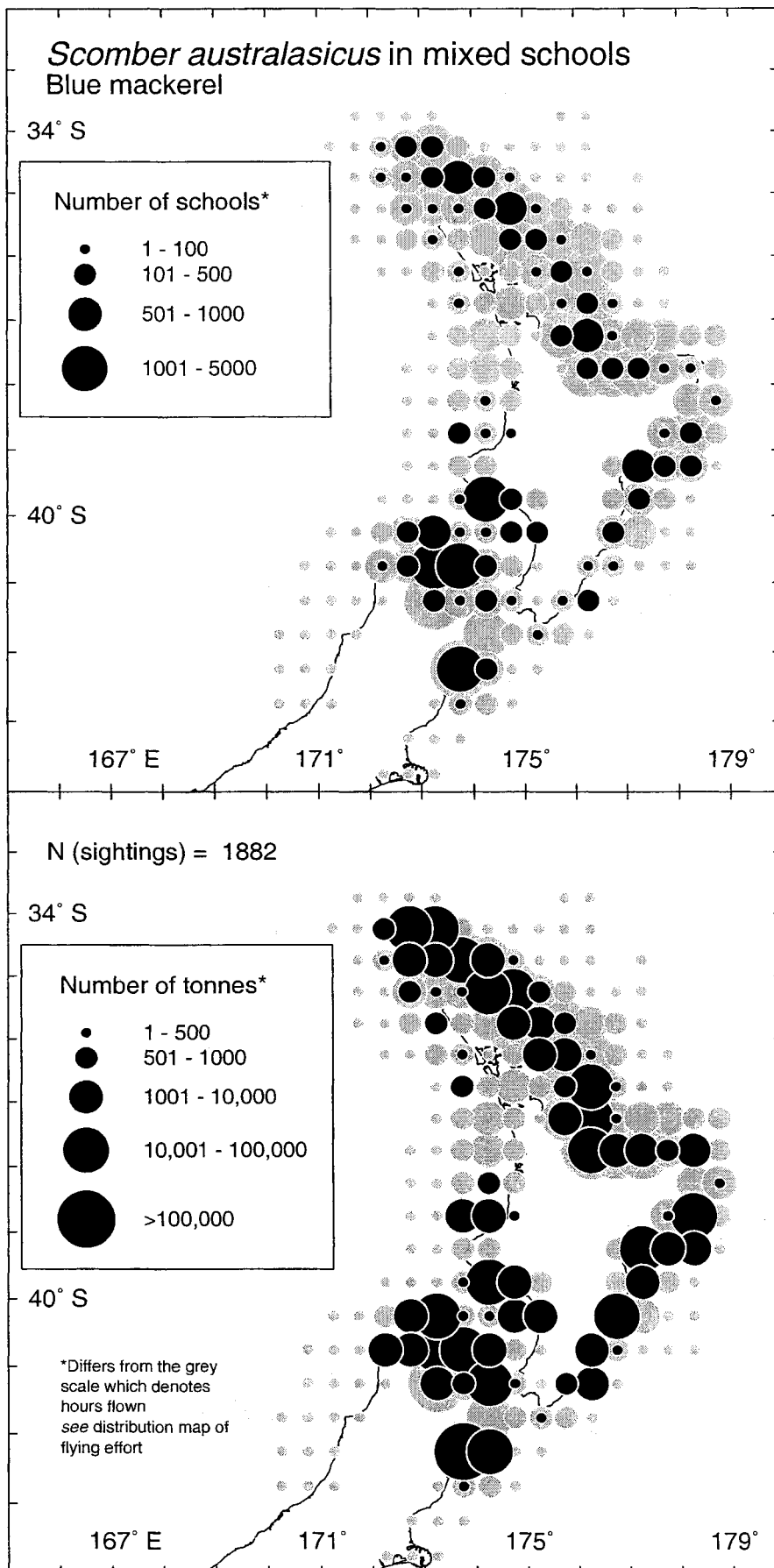
*Differs from the grey
scale which denotes
hours flown
see distribution map of
flying effort

167° E

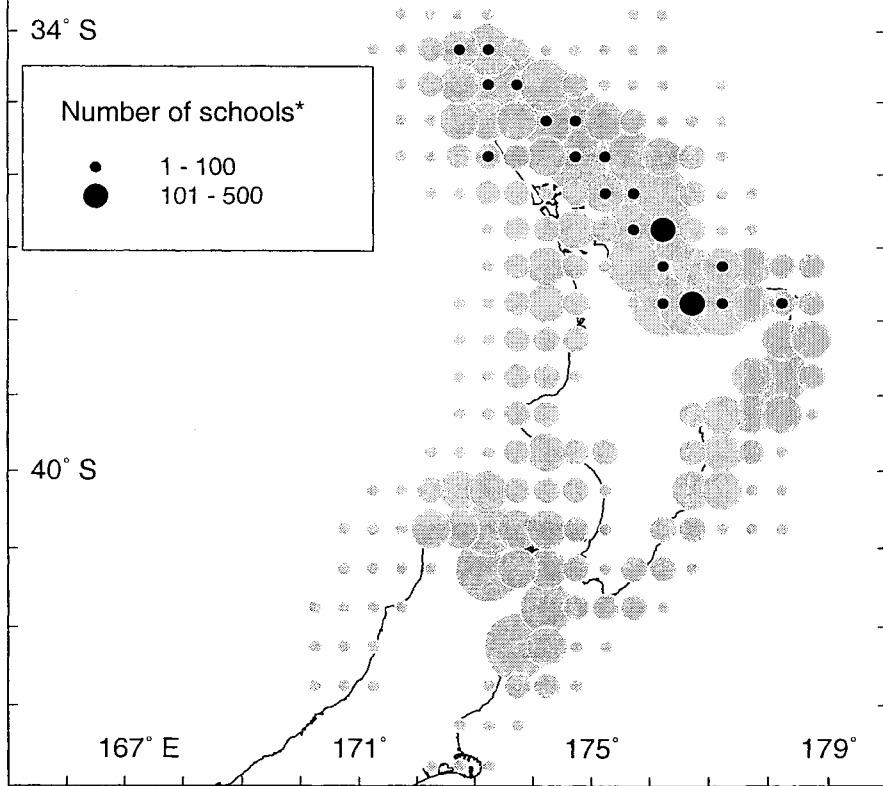
171°

175°

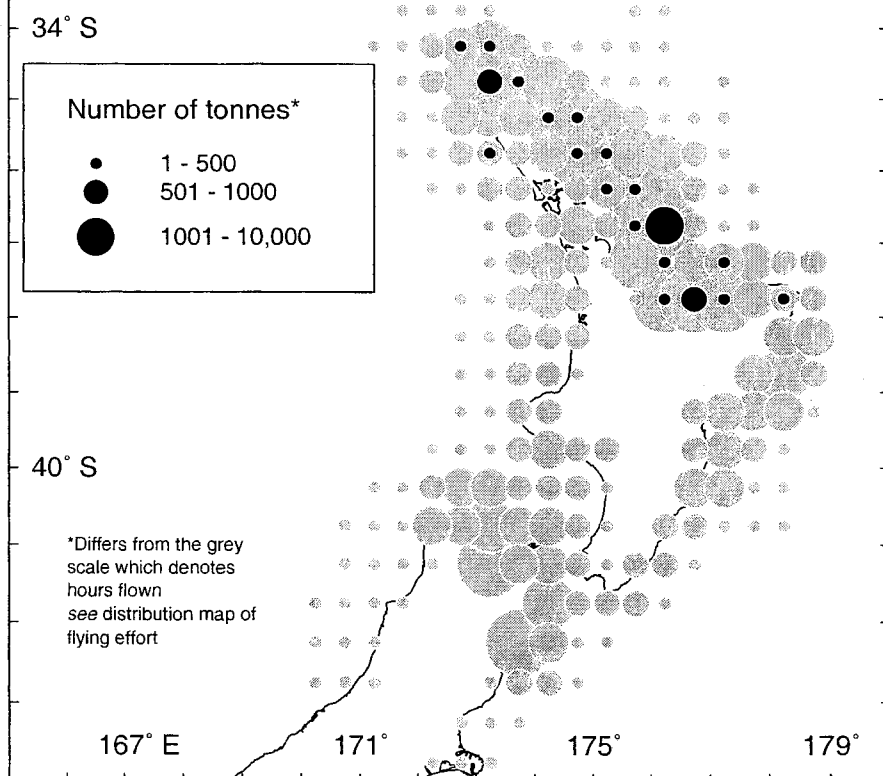
179°

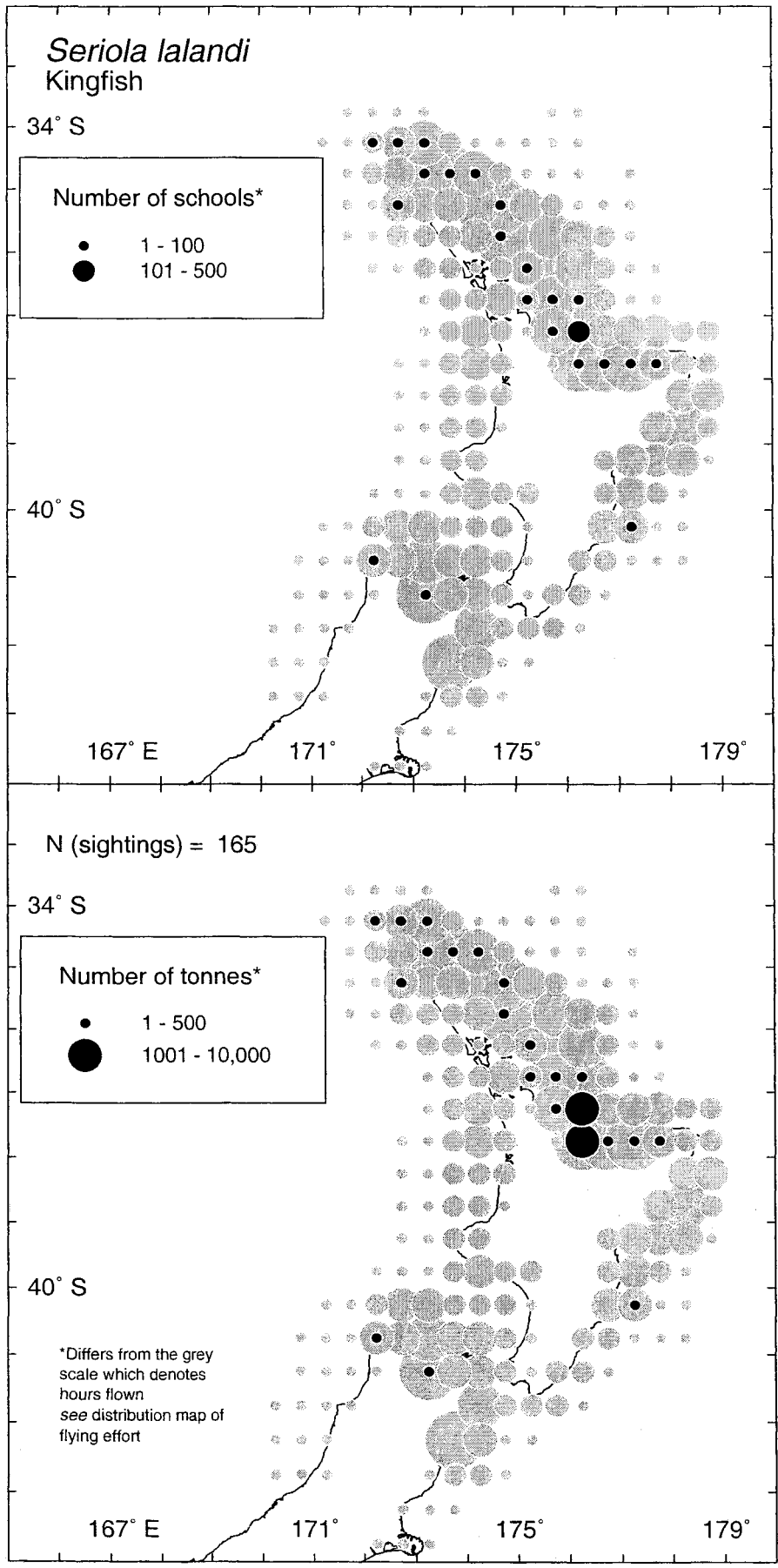


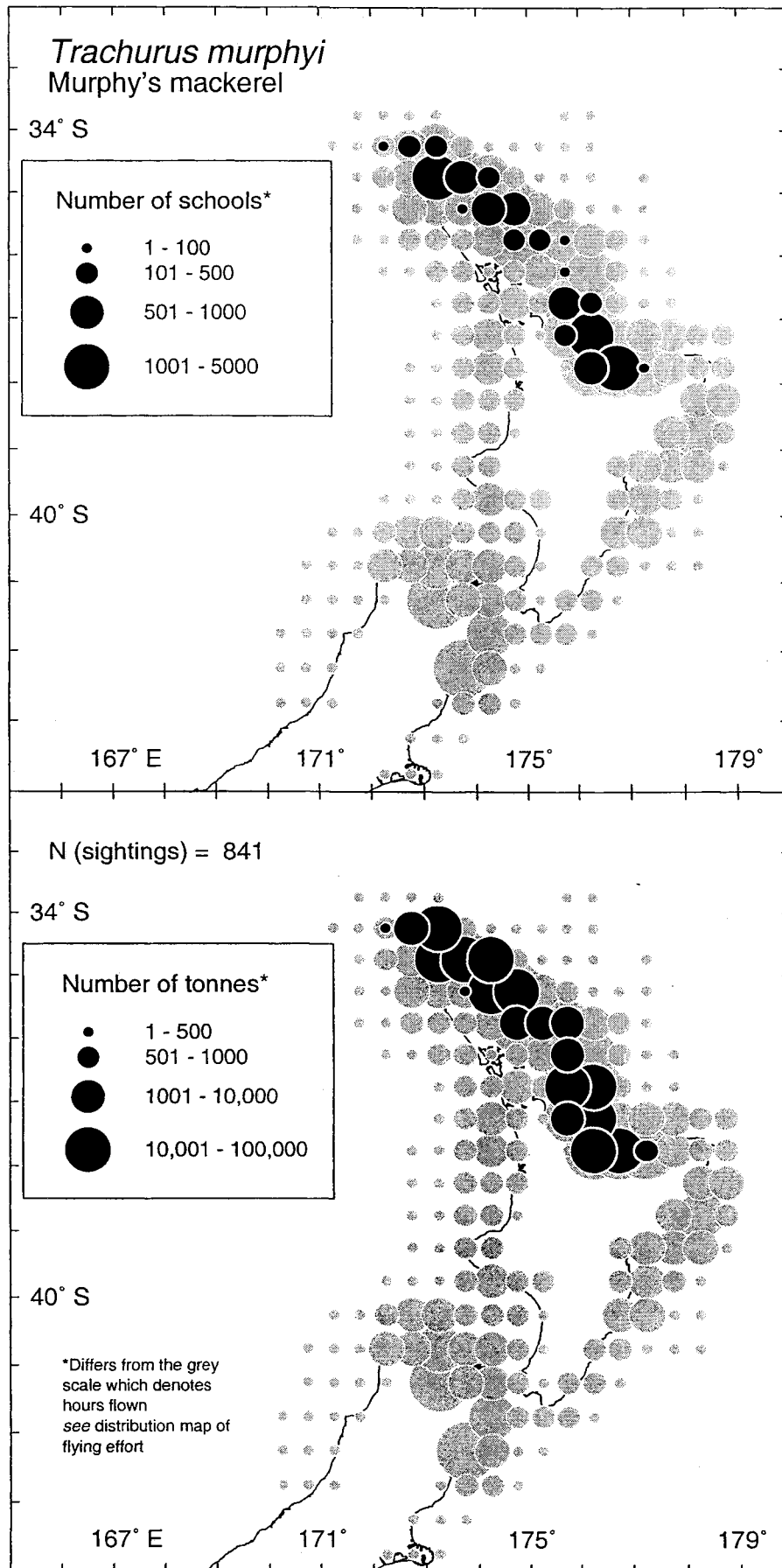
Scorpius violaceus in pure & mixed schools
Blue maomao



N (sightings) = 239, N (sightings of pure schools) = 197





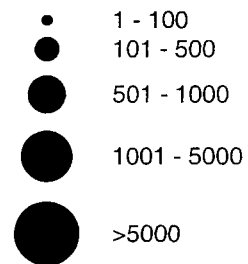


Stepien & Rosenblatt (1996) suggest that *T. murphyi* may not be a separate species from *T. symmetricus*.

Trachurus spp.
Jack mackerel

34° S

Number of schools*



40° S

167° E

171°

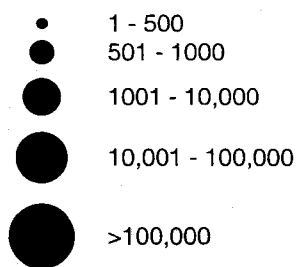
175°

179°

N (sightings) = 5692

34° S

Number of tonnes*



40° S

*Differs from the grey
scale which denotes
hours flown
see distribution map of
flying effort

167° E

171°

175°

179°

Trachurus spp. in mixed schools
Jack mackerel

34° S



40° S

167° E

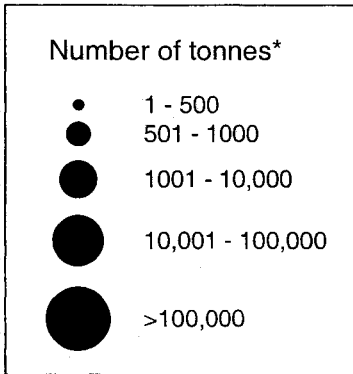
171°

175°

179°

N (sightings) = 3798

34° S



40° S

*Differs from the grey scale which denotes hours flown
see distribution map of flying effort

167° E

171°

175°

179°

Indexes and Appendix 1

Index 1: Common names. Names in bold are as used on the plots, those not bolded are other occasionally used New Zealand common names. A diamond indicates the presence of a distribution map in the appropriate section. Midwater, research and scientific observer midwater trawl; Pelagic, tuna longline; Aerial, aerial sightings

Common name	Scientific name	Midwater	Pelagic	Aerial
Albacore tuna	<i>Thunnus alalunga</i>		♦	
Alfonsino	<i>Beryx splendens</i>	♦		
Argentine	<i>Argentina elongata</i>	♦		
Arrow squid	<i>Nototodarus sloanii</i> & <i>N. gouldi</i>	♦		
Barracouta	<i>Thyrsites atun</i>	♦	♦	
Bass	<i>Polyprion americanus</i>	♦	♦	
Baitfish	see text for species list			♦
Baxter's dogfish	<i>Etmopterus baxteri</i>	♦		
Bigeye tuna	<i>Thunnus obesus</i>		♦	
Bigscale pomfret	<i>Taractichthys longipinnis</i>	♦	♦	
Black barracouta	<i>Nesiarchus nasutus</i>		♦	
Black dragonfishes	<i>Idiacanthus</i> spp.	♦		
Black oreo	<i>Allocyttus niger</i>	♦		
Blue grenadier	<i>Macruronus novaezealandiae</i>	♦		
Blue mackerel	<i>Scomber australasicus</i>	♦		♦
Blue maomao	<i>Scorpius violaceus</i>			♦
Blue shark	<i>Prionace glauca</i>	♦	♦	
Blue warehou	<i>Seriolella brama</i>	♦		
Bluenose	<i>Hyperoglyphe antarctica</i>	♦		
Bollons' rattail	<i>Caelorinchus bollonsi</i>	♦		
Bonita	<i>Hyperoglyphe antarctica</i>	♦		
Broadbill swordfish	<i>Xiphias gladius</i>		♦	
Bronze whaler shark	<i>Carcharhinus brachyurus</i>		♦	
Butterfly tuna	<i>Gasterochisma melampus</i>		♦	
Capro dory	<i>Capromimus abbreviatus</i>	♦		
Chilean mackerel	<i>Trachurus murphyi</i>	♦		
Common roughy	<i>Paratrachichthys trailli</i>	♦		
Common warehou	<i>Seriolella brama</i>	♦		
Cranchiid squid	Cranchiidae	♦		
Cutlassfish	<i>Lepidopus caudatus</i>	♦		
Dark ghost shark	<i>Hydrolagus novaezealandiae</i>	♦		
Dealfish	<i>Trachipterus trachipterus</i>	♦	♦	
Deepsea cod	<i>Mora moro</i>	♦		
Deepsea smelts	<i>Bathylagus</i> spp.	♦		
Electric ray	<i>Torpedo fairchildi</i>	♦		
English hake	<i>Merluccius australis</i>	♦		
English mackerel	<i>Scomber australasicus</i>	♦		♦
Escolar	<i>Lepidocybium flavobrunneum</i>		♦	
Frostfish	<i>Lepidopus caudatus</i>	♦		
Gemfish	<i>Rexea solandri</i>	♦		
Ghost shark	<i>Hydrolagus novaezealandiae</i>	♦		
Giant barracudina	<i>Magnisudis prionosa</i>	♦		
Giant stargazer	<i>Kathetostoma giganteum</i>	♦		
Googly eyed cod	<i>Mora moro</i>	♦		
Gould's arrow squid	<i>Nototodarus gouldi</i>	♦		
Grey shark	<i>Galeorhinus galeus</i>	♦	♦	
Groper	<i>Polyprion oxygeneios</i> & <i>americanus</i>	♦	♦	

Index 1 — *continued*

Common name	Scientific name	Midwater	Pelagic	Aerial
Hake	<i>Merluccius australis</i>	♦		
Hapuku	<i>Polyprion oxygeneios</i>	♦	♦	
Hatchetfishes	Sternoptychidae	♦		
Hoki	<i>Macruronus novaezelandiae</i>	♦	♦	
Jack mackerel	<i>Trachurus declivis</i>	♦		
	<i>Trachurus murphyi</i>	♦		♦
	<i>Trachurus</i> spp.			♦
Javelinfinh	<i>Lepidorhynchus denticulatus</i>	♦		
Jock Stewart	<i>Helicolenus</i> spp.	♦		
Johnson's cod	<i>Halargyreus johnsonii</i>	♦		
Kahawai	<i>Arripis trutta</i>			♦
Kingfish	<i>Seriola lalandi</i>			♦
Lancetfish	<i>Alepisaurus ferox</i> & <i>A. brevirostris</i>		♦	
Lanternfish	<i>Ceratospopelus warmingi</i>	♦		
	<i>Diaphus</i> spp.	♦		
	<i>Lampadena</i> spp.	♦		
	<i>Lampanyctodes hectoris</i>	♦		
	<i>Lampanyctus</i> spp.	♦		
	<i>Symbolophorus</i> spp.	♦		
Leafscale gulper shark	<i>Centrophorus squamosus</i>	♦		
Lighthouse fish	<i>Photichthys argenteus</i>	♦		
Limp eel pout	<i>Melanostigma gelatinosum</i>	♦		
Ling	<i>Genypterus blacodes</i>	♦		
Longfinned beryx	<i>Beryx decadactylus</i>	♦		
Longnose velvet dogfish	<i>Centroscymnus crepidater</i>	♦		
Longnosed lancetfish	<i>Alepisaurus ferox</i>		♦	
Lookdown dory	<i>Cyttus traversi</i>	♦		
Loosejaws	Malacosteidae	♦		
Lucifer dogfish	<i>Etmopterus lucifer</i>	♦		
Mako shark	<i>Isurus oxyrinchus</i>	♦	♦	
Monkfish	<i>Kathetostoma giganteum</i>	♦		
Moonfish	<i>Lampris guttatus</i>	♦	♦	
Murphy's mackerel	<i>Trachurus murphyi</i>	♦		♦
New Zealand hake	<i>Merluccius australis</i>	♦		
Notable rattail	<i>Caelorinchus innotabilis</i>	♦		
Oarfish	<i>Regalecus glesne</i>	♦		
Oilfish	<i>Ruvettus pretiosus</i>		♦	
Oliver's rattail	<i>Caelorinchus oliverianus</i>	♦		
Orange roughy	<i>Hoplostethus atlanticus</i>	♦		
Owston's dogfish	<i>Centroscymnus owstoni</i>	♦		
Pearlside	<i>Maurolicus muelleri</i>	♦		
Pelagic stingray	<i>Pteroplatytrygon violacea</i>		♦	
Peruvian mackerel	<i>Trachurus murphyi</i>	♦		♦
Pilchard	<i>Sardinops neopilchardus</i>			♦
Red cod	<i>Pseudophycis bachus</i>	♦		
Red squid	<i>Ommastrephes bartrami</i>	♦		
Redbait	<i>Emmelichthys nitidus</i>	♦		
Ribaldo	<i>Mora moro</i>	♦		
Ribbonfish	<i>Agrostichthys parkeri</i>	♦		
Rubyfish	<i>Plagiogeneion rubiginosum</i>	♦		

Index 1 — *continued*

Common name	Scientific name	Midwater	Pelagic	Aerial
Plunket's shark	<i>Centroscymnus plunketi</i>	◆		
Porbeagle shark	<i>Lamna nasus</i>	◆	◆	
Porcupine fish	<i>Allomycterus jaculiferus</i>	◆		
Ray's bream	<i>Brama brama</i>	◆	◆	
Rudderfish	<i>Centrolophus niger</i>	◆	◆	
Sandpaper fish	<i>Paratrachichthys trailli</i>	◆		
Sawtooth eels	<i>Serrivomer</i> spp.	◆		
Scabbardfishes	<i>Benthodesmus</i> spp.	◆		
Scaleless black dragonfishes	Melanostomiidae	◆		
Scaly dragonfishes	<i>Stomias</i> spp.	◆		
Scarpee	<i>Helicolenus</i> spp.	◆		
School shark	<i>Galeorhinus galeus</i>	◆	◆	
Sea perch	<i>Helicolenus</i> spp.	◆		
Seal shark	<i>Dalatias licha</i>	◆		
Sepiolid squid	Sepiolidae	◆		
Shortnosed lancetfish	<i>A. brevirostris</i>		◆	
Shovelnose dogfish	<i>Deania calcea</i>	◆		
Silver dory	<i>Cyttus novaezealandiae</i>	◆		
Silver roughy	<i>Hoplostethus mediterraneus</i>	◆		
Silver warehou	<i>Seriolella punctata</i>	◆		
Silverside	<i>Argentina elongata</i>	◆		
Skipjack tuna	<i>Katsuwonus pelamis</i>		◆	◆
Slender mackerel	<i>Trachurus murphyi</i>	◆		◆
Slender tuna	<i>Allothunnus fallai</i>	◆	◆	
Sloan's arrow squid	<i>Nototodarus sloanii</i>	◆		
Snapper	<i>Pagrus auratus</i>			◆
Snoek	<i>Thyrsites atun</i>	◆		
Southern blue whiting	<i>Micromesistius australis</i>	◆		
Southern bluefin tuna	<i>Thunnus maccoyii</i>		◆	
Southern kingfish	<i>Rexea solandri</i>	◆		
Southern spiny dogfish	<i>Squalus acanthias</i>	◆		
Spiky oreo	<i>Neocyttus rhomboidalis</i>	◆		
Spiny dogfish	<i>Squalus acanthias</i>	◆		
Spotted warehou	<i>Seriolella punctata</i>	◆		
Stargazer	<i>Kathetostoma giganteum</i>	◆		
Striped marlin	<i>Tetrapturus audax</i>		◆	
Sunfish	<i>Mola mola</i>		◆	
Tarakihi	<i>Nemadactylus macropterus</i>	◆		
Thresher shark	<i>Alopias vulpinus</i>	◆	◆	
Tope	<i>Galeorhinus galeus</i>	◆	◆	
Trevally	<i>Pseudocaranx dentex</i>			◆
Yellowfin tuna	<i>Thunnus albacares</i>		◆	
Yellowtail kingfish	<i>Seriola lalandi</i>			◆
Tubeshoulder	<i>Perspersia kopua</i>	◆		
Two saddle rattail	<i>Caelorinchus biclinozonalis</i>	◆		
Violet squid	<i>Histioteuthis</i> spp.	◆		
Viper fish	<i>Chauliodus sloani</i>	◆		
Warty squid	<i>Moroteuthis ingens</i>	◆		
Waryfishes	<i>Scopelosaurus</i> spp.	◆		
White warehou	<i>Seriolella caerulea</i>	◆		

Index 2: Alphabetical list of families and species

Group	Family	Species or species group	
Cephalopoda	Cranchiidae	Cranchiidae	
	Histioteuthidae	<i>Histioteuthis</i> spp.	
	Ommastrephidae	<i>Nototodarus gouldi</i> & <i>N. sloanii</i> <i>Ommastrephes bartrami</i>	
Chondrichthyes	Onychoteuthidae	<i>Moroteuthis ingens</i>	
	Sepiolidae	Sepiolidae	
	Alopiidae	<i>Alopias vulpinus</i>	
	Carcharhinidae		<i>Carcharhinus brachyurus</i> <i>Prionace glauca</i>
		Centrophoridae	<i>Centrophorus squamosus</i> <i>Deania calcea</i>
	Chimaeridae	<i>Hydrolagus novaezealandiae</i>	
	Dalatiidae	<i>Dalatias licha</i>	
	Dasyatidae	<i>Pteroplatytrygon violacea</i>	
	Etmopteridae		<i>Etmopterus baxteri</i> <i>Etmopterus lucifer</i>
		Lamnidae	<i>Isurus oxyrinchus</i> <i>Lamna nasus</i>
	Somniosidae	<i>Centroscymnus crepidater</i> <i>Centroscymnus owstoni</i> <i>Centroscymnus plunketi</i>	
	Squalidae	<i>Squalus acanthias</i>	
	Torpedinidae	<i>Torpedo fairchildi</i>	
	Triakidae	<i>Galeorhinus galeus</i>	
Teleostei	Alepisauridae	<i>Alepisaurus ferox</i> & <i>A. brevirostris</i>	
	Argentinidae	<i>Argentina elongata</i>	
	Arripidae	<i>Arripis trutta</i>	
	Bathylagidae	<i>Bathylagus</i> spp.	
	Berycidae	<i>Beryx splendens</i> & <i>B. decadactylus</i>	
	Bramidae		<i>Brama brama</i> <i>Taractichthys longipinnis</i>
		Carangidae	<i>Pseudocaranx dentex</i> <i>Seriola lalandi</i> <i>Trachurus declivis</i> <i>Trachurus murphyi</i> <i>Trachurus</i> spp.
	Centrolophidae	<i>Centrolophus niger</i> <i>Hyperoglyphe antarctica</i> <i>Seriolella brama</i> <i>Seriolella caerulea</i> <i>Seriolella punctata</i>	
	Chauliodontidae	<i>Chauliodus sloani</i>	
	Cheilodactylidae	<i>Nemadactylus macropterus</i>	
	Clupeidae	<i>Sardinops neopilchardus</i>	
	Diodontidae	<i>Allomycterus jaculiferus</i>	
	Emmelichthyidae		<i>Emmelichthys nitidus</i> <i>Plagiogeneion rubiginosum</i>
		Gadidae	<i>Micromesistius australis</i>
	Gempylidae		<i>Lepidocybium flavobrunneum</i> <i>Nesiarchus nasutus</i> <i>Rexea solandri</i> <i>Ruvettus pretiosus</i> <i>Thyrsites atun</i>
		Idiacanthidae	<i>Idiacanthus</i> spp.
		Istiophoridae	<i>Tetrapturus audax</i>

Index 2 — continued

Group	Family	Species or species group	
Teleostei (<i>cont.</i>)	Lampridae	<i>Lampris guttatus</i>	
	Macrouridae	<i>Caelorinchus biclinozonalis</i>	
		<i>Caelorinchus bollonsi</i>	
		<i>Caelorinchus innotabilis</i>	
		<i>Caelorinchus oliverianus</i>	
		<i>Lepidorhynchus denticulatus</i>	
		Malacosteidae	Malacosteidae
		Melanostomiidae	Melanostomiidae
		Merlucciidae	<i>Maruronus novaezealandiae</i>
			<i>Merluccius australis</i>
		Molidae	<i>Mola mola</i>
	Moridae	<i>Halargyreus johnsonii</i>	
		<i>Mora moro</i>	
		<i>Pseudophycis bachus</i>	
		<i>Ceratoscopelus warmingi</i>	
		<i>Diaphus</i> spp.	
		<i>Lampadena</i> spp.	
		<i>Lampanyctodes hectoris</i>	
		<i>Lampanyctus</i> spp.	
		<i>Symbolophorus</i> spp.	
		<i>Scopelosaurus</i> spp.	
		Ophidiidae	<i>Genypterus blacodes</i>
		Oreosomatidae	<i>Allocyttus niger</i>
	<i>Neocyttus rhomboidalis</i>		
	Paralepidae	<i>Magnisudis prionosa</i>	
	Photichthyidae	<i>Photichthys argenteus</i>	
	Platytroutidae	<i>Persarsia kopua</i>	
	Polyprionidae	<i>Polyprion americanus</i> & <i>P. oxygeneios</i>	
	Regalecidae	<i>Agrostichthys parkeri</i>	
		<i>Regalecus glesne</i>	
		<i>Allothunnus fallai</i>	
		<i>Gasterochisma melampus</i>	
		<i>Katsuwonus pelamis</i>	
		<i>Scomber australasicus</i>	
		<i>Thunnus alalunga</i>	
		<i>Thunnus albacares</i>	
		<i>Thunnus maccoyii</i>	
		<i>Thunnus obesus</i>	
	Scorpaenidae	<i>Helicolenus</i> spp.	
	Scorpidae	<i>Scorpius violaceus</i>	
	Serrivomeridae	<i>Serrivomer</i> spp.	
	Sparidae	<i>Pagrus auratus</i>	
Sternoptychidae	Sternoptychidae		
	<i>Mauroliticus muelleri</i>		
Stomiidae	<i>Stomias</i> spp.		
Trachichthyidae	<i>Hoplostethus atlanticus</i>		
	<i>Hoplostethus mediterraneus</i>		
	<i>Paratrachichthys trailli</i>		
Trachipteridae	<i>Trachipterus trachipterus</i>		
Trichiuridae	<i>Benthodesmus</i> spp.		
	<i>Lepidopus caudatus</i>		
Uranoscopidae	<i>Kathetostoma giganteum</i>		
Xiphiidae	<i>Xiphias gladius</i>		
Zeidae	<i>Capromimus abbreviatus</i>		
	<i>Cyttus novaezealandiae</i>		
Zoarcidae	<i>Cyttus traversi</i>		
	<i>Melanostigma gelatinosum</i>		

Appendix 1: Weighted mean depth of capture and bottom depth, and ranges of depth (Min., Max) by species or species group caught by midwater trawl. Means are weighted by the proportion of tows within each 10 m depth interval. Although outliers have been removed where possible, minimum and maximum values should be treated with caution

Species or group	Depth of capture (m)			Bottom depth (m)		
	Mean	Min.	Max.	Mean	Min.	Max.
<i>Agrostichthys parkeri</i>	707	108	1027	920	247	1260
<i>Alloctytus niger</i>	861	325	1050	826	490	1068
<i>Allomycterus jaculiferus</i>	70	51	101	112	87	192
<i>Allothunnus fallai</i>	193	55	607	288	94	747
<i>Alopias vulpinus</i>	199	60	547	242	83	670
<i>Argentina elongata</i>	386	137	683	387	155	730
<i>Bathylagus</i> spp.	931	25	1146	1522	454	3075
<i>Benthodesmus</i> spp.	627	40	891	758	305	1056
<i>Beryx splendens</i> & <i>B. decadactylus</i>	514	65	832	671	285	1117
<i>Brama brama</i>	528	50	1068	710	100	1315
<i>Caelorinchus biclinozonalis</i>	245	182	394	295	237	500
<i>Caelorinchus bollonsi</i>	569	233	720	677	282	954
<i>Caelorinchus innotabilis</i>	940	582	1124	996	582	1132
<i>Caelorinchus oliverianus</i>	645	138	786	755	330	954
<i>Capromimus abbreviatus</i>	462	50	986	598	185	1051
<i>Centrolophus niger</i>	663	62	1124	748	135	1132
<i>Centrophorus squamosus</i>	792	220	910	827	480	954
<i>Centroscymnus crepidater</i>	872	407	1124	952	585	1132
<i>Centroscymnus owstoni</i>	826	430	924	828	626	926
<i>Centroscymnus plunketi</i>	742	324	852	772	387	920
<i>Ceratoscopelus warmingi</i>	871	20	1146	1667	368	3075
<i>Chauliodus sloani</i>	902	25	1146	1343	390	3075
Cranchiidae	944	21	1146	1332	201	3075
<i>Cyttus novaezealandiae</i>	427	70	660	570	132	826
<i>Cyttus traversi</i>	560	61	737	600	72	866
<i>Dalatias licha</i>	711	150	878	773	348	1000
<i>Deania calcea</i>	770	257	1050	799	384	1068
<i>Diaphus</i> spp.	802	20	1125	1528	364	3075
<i>Emmelichthys nitidus</i>	320	41	1125	669	101	3075
<i>Etmopterus baxteri</i>	844	500	1062	935	693	1090
<i>Etmopterus lucifer</i>	591	25	737	772	332	1043
<i>Galeorhinus galeus</i>	339	41	779	411	70	878
<i>Genypterus blacodes</i>	481	65	852	617	132	1150
<i>Halargyreus johnsonii</i>	846	400	1000	934	450	1064
<i>Helicolenus</i> spp.	445	24	680	394	83	768
<i>Histioteuthis</i> spp.	883	138	1124	1280	368	2862
<i>Hoplostethus atlanticus</i>	832	240	1062	892	351	1090
<i>Hoplostethus mediterraneus</i>	628	82	733	544	128	755
<i>Hydrolagus novaezealandiae</i>	563	200	705	569	147	1000
<i>Hyperoglyphe antarctica</i>	464	150	750	574	200	1000
<i>Idiacanthus</i> spp.	870	20	1146	1261	558	2862
<i>Isurus oxyrinchus</i>	200	47	536	327	94	897
<i>Kathetostoma giganteum</i>	317	96	545	379	101	596
<i>Lamna nasus</i>	436	60	667	560	60	925
<i>Lampadena</i> spp.	916	50	1125	1885	292	3075
<i>Lampancytodus hectoris</i>	685	12	1068	880	100	1127

Appendix 1 — continued

Species or group	Depth of capture (m)			Bottom depth (m)		
	Mean	Min.	Max.	Mean	Min.	Max.
<i>Lampanyctus</i> spp.	901	20	1146	1398	368	3075
<i>Lampris guttatus</i>	387	90	602	521	145	740
<i>Lepidopus caudatus</i>	415	43	1050	515	60	1200
<i>Lepidorhynchus denticulatus</i>	637	65	986	664	115	1026
<i>Macruronus novaezelandiae</i>	550	45	1062	702	62	1600
<i>Magnisudis prionosa</i>	919	114	1146	1288	264	2337
Malacosteidae	937	385	1146	1470	492	3075
<i>Maurolicus muelleri</i>	667	20	1146	923	45	1301
<i>Melanostigma gelatinosum</i>	996	138	1146	1085	415	1301
Melanostomiidae	917	25	1050	1001	567	1068
<i>Merluccius australis</i>	573	17	1124	698	18	1231
<i>Micromesistius australis</i>	310	120	562	403	225	720
<i>Mora moro</i>	734	275	924	739	445	926
<i>Moroteuthis ingens</i>	803	68	1000	718	145	1064
<i>Nemadactylus macropterus</i>	174	29	492	174	48	559
<i>Neocyttus rhomboidalis</i>	792	250	1068	918	487	1127
<i>Nototodarus sloanii</i> & <i>N. gouldi</i>	475	17	1146	672	18	2862
<i>Ommastrephes bartrami</i>	814	122	989	867	315	1026
<i>Paratrachichthys trailli</i>	317	51	570	368	62	765
<i>Persparsia kopua</i>	922	114	1146	1437	480	3075
<i>Photichthys argenteus</i>	934	20	1381	1532	368	3075
<i>Plagiogeneion rubiginosum</i>	303	151	500	408	230	661
<i>Polyprion americanus</i> & <i>P. oxygeneios</i>	743	85	1146	830	67	1301
<i>Prionace glauca</i>	94	43	500	142	60	610
<i>Pseudophycis bachus</i>	350	17	790	397	18	992
<i>Regalecus glesne</i>	406	150	570	732	132	985
<i>Rexea solandri</i>	403	50	743	502	100	950
<i>Scomber australasicus</i>	120	30	455	185	80	700
<i>Scopelosaurus</i> spp.	825	20	1068	1478	574	2862
Sepiolidae	79	17	537	162	40	844
<i>Seriolella brama</i>	337	17	690	417	18	992
<i>Seriolella caerulea</i>	532	170	684	605	292	794
<i>Seriolella punctata</i>	447	25	1068	568	25	1127
<i>Serrivomer</i> spp.	957	75	1125	1679	491	3075
<i>Squalus acanthias</i>	354	17	750	468	18	1150
Sternoptychidae	936	75	1146	1533	201	3075
<i>Stomias</i> spp.	779	20	1000	939	485	1064
<i>Symbolophorus</i> spp.	846	12	1146	1023	100	1301
<i>Taractichthys longipinnis</i>	626	205	797	633	321	834
<i>Thyrsites atun</i>	218	14	680	280	18	845
<i>Torpedo fairchildi</i>	436	54	832	362	89	850
<i>Trachipterus trachipterus</i>	603	20	871	782	115	1231
<i>Trachurus declivis</i>	142	41	574	216	85	730
<i>Trachurus murphyi</i>	176	30	585	257	85	702



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