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Invertebrate bycatch from bottom trawls in the New Zealand EEZ

Wilma Blom[1], Richard Webber[2] and Tom Schultz[2]

1 Auckland War Memorial Museum, Private Bag 92018, Auckland, New Zealand (wblom@aucklandmuseum.com)
2 Museum of New Zealand Te Papa Tongarewa, PO Box 467, Wellington, New Zealand (rickw@tepapa.govt.nz)

ABSTRACT: Benthic invertebrate bycatch was collected, as part of the Conservation Services Programme Observer Project, from 35 bottom trawls at water depths ranging from 130 m to 1250 m, mainly from the northern, eastern and southern edges of the Chatham Rise, the Bounty Plateau, the Campbell Plateau and the southern Norfolk Ridge/Three Kings Rise region. A total of 398 samples had robust locality data and yielded a minimum of 216 separate taxa, from eight phyla. Sponges, branched and unbranched corals, ophiuroids and decapod crustaceans were well represented. The presence of anthozoans appeared to correspond to higher numbers of species at four of the most common trawl locations. The larger branched corals (gorgonians and anthipatharians) were collected predominantly from the Three Kings Rise, the Bounty Plateau and the Campbell Plateau, whereas the smaller forms (actiniarians, scleractinians and other anthozoans) were collected predominantly from the northern and southeastern Chatham Rise. The lack of an asymptote in the relationship between 'sampling effort' (i.e. trawls) and number of species implies that at least some of the assemblages have not yet been 'fully sampled'.

KEYWORDS: Benthic invertebrate bycatch, bottom-trawl fisheries, New Zealand EEZ.

Introduction

New Zealand has an extensive Exclusive Economic Zone (EEZ), which, at 4 million square kilometres, is one of the largest in the world. This vast area spans two oceanic systems (Tasman Sea and Pacific Ocean) from the subtropics to cold-temperate waters, and includes a number of plateaux, ridges, seamounts and troughs.

The region's water masses include the Subtropical and Subantarctic Surface Waters, separated by the Subtropical Front over the Chatham Rise, and to the north of New Zealand the Tasman Front. From the surface down, deep-water masses include Antarctic Intermediate Water and Circumpolar Deep Water (e.g. Hayward *et al.* 2006, 2007).

The remoteness of deep oceanic regions within and beyond the EEZ, and the high costs of surveying marine ecosystems, mean that our understanding of their biodiversity and community structures still lags far behind that of on-land or near-shore ecosystems. The invertebrate samples that are the subject of this paper provided an opportunity to extend this knowledge. They were collected as part of the Conservation Services Programme (CSP) Observer Project run by the New Zealand Department of Conservation (DoC) in conjunction with the New Zealand Ministry of Fisheries (MFish). They represent bycatch from deep-water bottom-trawl fisheries, particularly off the east coast of the South Island on the Chatham Rise (including the Graveyard Seamount Complex), the Bounty Plateau and the Campbell Plateau, and, to the northwest of the North Island, on the southern Norfolk Ridge and southern Three Kings Rise.

Under the CSP, only protected species (red and black corals) are required to be collected. However, a decision was made by DoC to require observers to collect representative specimens of all invertebrate bycatch fauna.

This paper is a limited and preliminary report on a project that allowed for little design beyond taking advantage of an opportunity to observe and record poorly known invertebrate biota collected by commercial deep-sea trawling within the New Zealand EEZ. While the present samples will add information on the biology and ecology of benthic invertebrates, we acknowledge that there are difficulties in using data associated with bycatch from trawl fisheries (Grove & Probert 1998; Burns & Kerr 2008). The opportunistic use of observers means that our samples represent a geographically dispersed dataset, and are limited by the lack of formal sampling design and non-standardised 'sampling methods'. These include bottom trawling employed by a variety of operators with little or no data on practice similarity/dissimilarity in net use. Likewise, the approach to bycatch selection and retention, undertaken by different observers in varying conditions of climate and catch rate, are also non-standardised. The results presented in this paper are therefore descriptive only.

The objectives of the Museum of New Zealand Te Papa Tongarewa (Te Papa) were to acquire new or rare specimens not held in its collections, and to collect taxonomic and location information for the invertebrate database. Its acquisition programme provided an opportunity to identify these specimens to the lowest taxonomic level possible within the expertise of one part-time person (Wilma Blom) over a 12-month period. The samples have been lodged in Te Papa's collections.

Methods

Sample types

'Observers' collected specimens of all benthic invertebrate bycatch species regardless of whether these species were protected or not.

Processing

Specimens were selectively collected from the fish catch onboard ship, placed separately in plastic bags, labelled and immediately frozen. Frozen specimens from a single trip were kept together in a large sack or box, and were dispatched by frozen freight to Te Papa once the ship returned to port.

Specimens were subsequently defrosted, further separated into taxonomic groups if needed, and placed in glass jars. Depending on the taxonomic group, they were preserved in either 70% ethanol, or 5% formaldehyde followed by 70% ethanol.

The specimens were then couriered to Auckland War Memorial Museum for further processing, and for identification to the lowest taxon possible within the available time.

Data collection

All location, field, taxonomic and any other quantifiable data pertaining to the samples are held in an Excel spreadsheet at Te Papa. These will be transferred to Te Papa's electronic database and be made publicly accessible through Te Papa's 'Collections Online'.

Results

Samples came from 35 bottom-trawl tows taken between April 1999 and August 2006. Among the >430 samples processed, 398 had robust locality data and locations (Fig. 1).

The majority of samples came from three main areas:

- Chatham Rise to the east of the South Island, approximately bounded by latitudes 42° and 45°S, and longitudes 172°E and 174°W, from *c.*600 m to *c.*1200 m depth.
- Bounty Plateau/Campbell Plateau region east and south of the South Island, approximately bounded by latitudes 46° and 52°S, and longitudes 168° and 180°E, from *c.*130 m to *c.*1250 m depth.
- Southern Norfolk Ridge/Three Kings Rise region northwest of New Zealand, approximately bounded by latitudes 31° and 37°S, and longitudes 165° and 172°E, from *c.*640 m to *c.*1130 m depth.

Nineteen samples came from outside the above areas. Nine of these were still within the EEZ but 10 were from the Louisville Seamount Chain to the east of the New Zealand EEZ (Fig. 1). A further 29 samples lacked data, and a small number of samples were discarded because they were either poorly preserved or consisted of rocks or sediments barren of biota.

With the exception of some small invertebrates found on or in pieces of wood and rock, all of the samples contained epibenthic macrofauna.

The specimen lots yielded a minimum of 216 separate taxa from eight phyla (Table 1), with two of the phyla, Cnidaria and Echinodermata, containing more than 50% of the total number of taxa found (Fig. 2). The number of taxa will undoubtedly increase as many of the specimens were identified to higher taxonomic levels only.

Easily obtained and up-to-date literature for the Arthropoda and Echinodermata made it possible to identify most taxa within these phyla to family level or lower. A dearth of literature, dispersed literature and also the need for expert

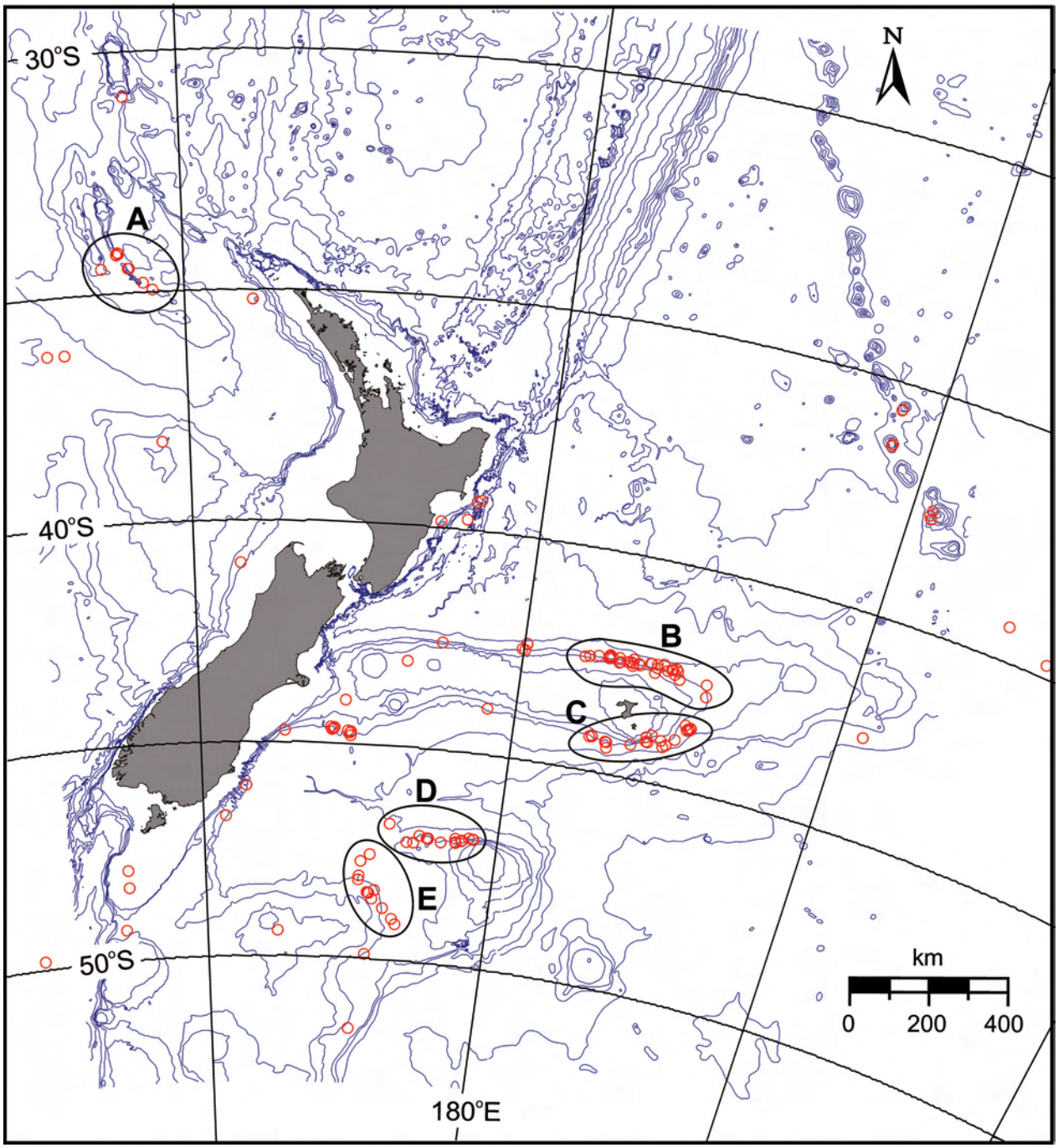

Fig. 1 Sample locations indicated by red circles, with the five most common trawl areas (A–E) encircled.

knowledge made this much less likely for the other phyla, particularly the Porifera and Cnidaria. Expert analysis in future should show there are many more taxa than those recognised here.

The observer samples contain an unknown number of undescribed taxa. At a rough estimate, more than 10% of the total number of taxa is likely to be new to science.

When phyla are broken down further into major groups, there appear to be peaks for, particularly, the sponges, branched and unbranched corals, the ophiuroids and the decapod crustaceans (Fig. 3). The presence of a peak for the ophiuroids is presumably intimately related to the presence of a peak for the branching structures, such as the Gorgonacea, as at least the euryalinid ophiuroids are epizootic on the

Table 1 Taxonomic composition of the macro-invertebrate bycatch from >430 specimen lots broken down by region (NW EEZ = Norfolk Ridge/Three Kings Rise; CR = Chatham Rise; BCP = Bounty Plateau and Campbell Plateau). The samples yielded a minimum of 216 separate taxa from eight phyla, with two of the phyla, Cnidaria and Echinodermata, containing >50% of the total number of taxa found.

Phylum	Class	Order	Total no. of species	NW EEZ	CR region	BCP region
Porifera	Demospongiae	Astrophorida	2	1	1	0
		Hadromerida	1	0	0	1
		?Poecilosclerida	1	1	0	0
		Spirophorida	1	0	0	1
		Indeterminate	6	2	3	2
	Hexactinellida	Hexactinosida	4	3	2	0
		Lyssacinosida	3	1	2	1
		Indeterminate	7	6	0	1
	Indeterminate	Indeterminate	2	0	0	2
Cnidaria	Anthozoa	Actiniaria	13	0	11	4
		Alcyonacea	5	0	5	1
		Antipatharia	6	0	3	3
		Gorgonacea	16	4	9	10
		Pennatulacea	2	0	1	1
		Scleractinia	8	5	6	2
		Zoanthidae	1	0	1	1
	Hydrozoa	Anthoathecatae	5	4	2	1
	Hydroidolina	Conica	4	0	3	1
	Scyphozoa	Indeterminate	1	0	1	0
Annelida	Polychaeta	Eunicida	5	0	4	2
		Phyllodocida	11	2	8	2
		Scolecida	1	0	1	0
		Terebellida	3	0	2	1
		Indeterminate	1	0	0	1
Sipuncula	Indeterminate	Indeterminate	2	0	0	2
Mollusca	Monoplacophora	Tryblidiidae	1	0	0	1
	Polyplacophora	Lepidopleurina	2	0	0	2
	Bivalvia	Arcoida	1	0	0	1
		Myloida	1	0	1	0
		Pterioida	1	0	1	0

Phylum	Class	Order	Total no. of species	NW EEZ	CR region	BCP region
Mollusca *contd*	Gastropoda	Neogastropoda	1	0	1	0
		Neotaenioglossa	1	0	1	0
	Cephalopoda	Octopoda	3	0	2	1
		Teuthida	3	2	2	0
		Teuthoidea	1	0	1	0
Arthropoda	Malacostraca	Amphipoda	1	0	1	0
		Anomura	1	0	1	0
		Decapoda	18	4	13	3
		Isopoda	2	0	2	0
		Lophogastrida	1	0	0	1
	Maxillopoda	Pedunculata	3	0	3	1
		Sessilia	2	1	0	1
	Pycnogonida	Indeterminate	2	0	1	1
Bryozoa	Gymnolaemata	Cheilostomata	1	0	1	0
Echinodermata	Holothuroidea	Aspidochirotida	2	0	2	1
		Elasipodida	1	0	1	0
	Crinoidea	Bourgueticrinida	1	0	0	1
		Isocrinida	2	1	1	0
	Asteroidea	Brisingida	2	0	1	1
		Forcipulatida	3	0	3	1
		Notomyotida	1	0	1	0
		Paxillosida	4	1	2	1
		Valvatida	3	0	2	1
	Echinoidea	Cidaroida	2	1	1	0
		Echinoida	1	1	0	0
		Echinothurioida	2	0	0	2
		Spatangoida	1	0	1	0
		Temnopleuroida	3	1	0	2
	Ophiuroidea	Euryalinida	8	3	2	4
		Ophiurida	13	4	4	7
		Indeterminate	4	0	4	0

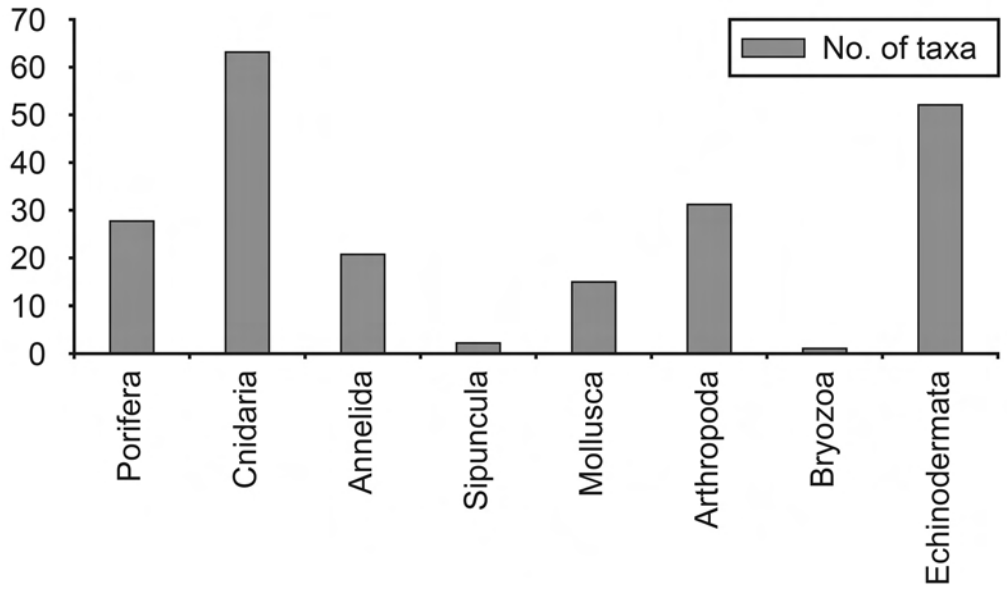

Fig. 2 Number of phyla, and minimum number of taxa represented within them.

corals. Similarly, a peak for decapod crustaceans may be related to the presence of branching structures.

Discussion

Despite the limitations of the samples, some general impressions are worth noting. The presence of anthozoans appears to correspond to higher numbers of species at four of the most common trawl locations (Table 2: areas A, B, C and E). This is not unexpected, as many anthozoans are upright branching forms or reef-builders and provide habitat for epizootic species, such as euryalinid snakestars (McKnight 2000), and commensal species, such as polynoid polychaetes (Cairns 1991; Pettibone 1991). Three such associations for the observer samples were: the euryalinid snakestar *Ophiocreas mortenseni* Koehler, 1930, found on the bubblegum coral *Paragorgia arborea* (Linnaeus, 1758); the polynoid *Malmgreniella dicirra* Hartman, 1967, found on the stylasterid *Calyptopora reticulata* Boschma, 1968; and unidentified polynoid polychaetes on antipatharian corals. Cairns (1995) recorded a diverse biota associated with *Goniocorella dumosa* (Alcock, 1902), which included other scleractinians, sponges, stylasterids, polychaetes, gastropods, bivalves, anemones, ophiuroids and asteroids. The fauna found with *Goniocorella dumosa* in the observer samples consisted of other scleractinian corals, ophiuroids, polychaetes, stylasterids, anemones and pedunculate barnacles.

There appears to be a geographic separation between the larger branched corals (gorgonians and anthipatharians) and smaller forms (actiniarians, scleractininans and other anthozoans), with the former appearing in samples collected predominantly from the Three Kings Rise, the Bounty Plateau and the Campbell Plateau (Table 2; Fig. 1: areas A, D and E), and the latter predominantly from the northern and eastern Chatham Rise (Table 2; Fig. 1: areas B and C).

Benthic assemblages are considered to be vulnerable to disturbance from fisheries, including trawl fisheries (e.g. Thrush & Dayton 2002). As the Chatham Rise has been commercially trawl-fished since the late 1970s (e.g. Probert *et al.* 1997), it may be that the lower numbers of tall branching corals in the above areas are due at least in part to some of this disturbance.

The total number of taxa recorded in the observer samples continued to increase in every subsequent batch of samples sent to Auckland War Memorial Museum, with approximately one additional taxon per every two samples. This lack of an asymptote in the relationship between 'sampling effort' (i.e. trawls) and number of species implies that at least some of the assemblages have not yet been 'fully sampled'. It may also be that those areas on the Bounty Plateau, the Campbell Plateau and the Norfolk Ridge/Three Kings Rise, which show a peak in both branching structures and numbers of taxa, are still relatively untouched by bottom trawling.

Table 2 The number of samples in which each taxon was recorded for the five most common trawl areas by major invertebrate group. (Malacostraca[1] = non-decapod crustaceans; Malacostraca[2] = decapod crustaceans; Anthozoa[3] = larger branched forms, such as gorgonians and antipatharians; Anthozoa[4] = generally smaller unbranched forms, such as actiniarians, scleractinians and zoanthids.)

Major taxonomic groups/ trawl areas	Porifera	Hydrozoa	Hydroidolina	Scyphozoa	Polychaeta	Sipuncula	Monoplacophora	Polyplacophora	Bivalvia	Gastropoda	Cephalopoda	Malacostraca[1]	Malacostraca[2]	Maxillopoda	Holothuroidea	Crinoidea	Asteroidea	Echinoidea	Ophiuroidea	Anthozoa[3]	Anthozoa[4]	No. of major groups excluding Anthozoa
A	10	1	0	0	1	0	0	0	0	0	2	0	5	0	2	1	1	5	10	8	2	9
B	6	1	0	1	8	0	0	0	1	3	2	2	13	1	2	0	8	1	0	5	10	13
C	4	1	3	0	5	0	0	0	1	1	1	1	2	1	0	1	1	1	15	5	16	14
D	5	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	2	10	14	4	5
E	1	1	0	0	6	1	1	4	1	0	0	1	4	2	0	0	4	4	6	17	4	13

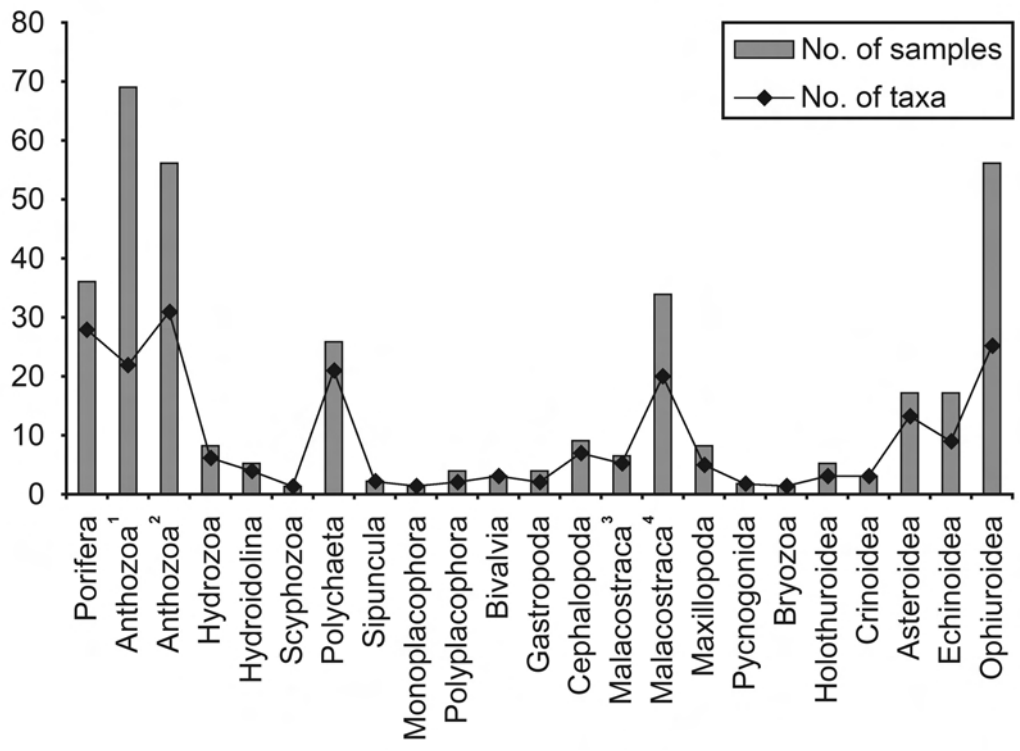

Fig. 3 Major invertebrate groups represented, number of samples (stations) in which each group was present and number of taxa identified within each group. (Anthozoa[1] = larger branched forms, such as gorgonians and antipatharians; Anthozoa[2] = generally smaller unbranched forms, such as actiniarians, scleractinians and zoanthids; Malacostraca[3] = non-decapod crustaceans; Malacostraca[4] = decapod crustaceans.)

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