Feeding habits of New Zealand fishes: a literature review and summary of research trawl database records 1960 to 2000

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EXECUTIVE SUMMARY

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This report provides a comprehensive summary of dietary information available for New Zealand fish species up to and including the year 2000. The report does not review publications or research data held 2001–2011 as comprehensive feeding studies are already published elsewhere. This report does not provide any statistical analyses of sampling levels, dietary composition, variability, or potential error or bias in diet descriptions.

This is the fourth report in a series of data summaries about New Zealand fish species. The first three reports are atlases of the spatial distribution of a wide range of New Zealand marine fish and cephalopod species (Anderson et al. 1998, Bagley et al. 2000, Hurst et al. 2000).

This report includes a literature review of published information for all fish species included in the first atlas (Anderson et al. 1998), and summarises dietary records of 25 key species collected from research trawls (bottom, midwater and prawn) held in the Ministry of Fisheries research trawl database. The distribution of the feeding location and size of the fish sampled by area, and major dietary categories by area and fish size (where appropriate) are presented. These summaries exclude species for which there were fewer than 20 tows or 200 fish sampled.

1. INTRODUCTION

Understanding the structure and dynamics of marine ecosystems is critical to develop an ecosystem approach to fisheries management. It allows assessing the impacts of fishing activities and environmental factors not only on target stocks but also on all other species including by-catch and protected species belonging to the ecosystem. The structure of the ecosystem is based on prey-predator relationships among species. Studying trophic dynamics leads to the development of trophic models which can provide a tool to determine the effect of fishing on trophic structure. The first step in the development of trophic models is to quantify the dietary preferences of fish. Until recently, trophic studies on the scale of fisheries were not undertaken in New Zealand. As part of a series of data summaries on New Zealand fish that were collated and published in the late 1990s, a literature review of published feeding studies and a summary of dietary records held in the Ministry of Fisheries research trawl database was also conducted to undertake a stocktake on what was known about the dietary preferences of fish in New Zealand seas at that time.

This is the fourth report in a series of data summaries. The first three reports (Anderson et al. 1998, Bagley et al. 2000, Hurst et al. 2000) were atlases of the spatial distribution of a wide range of New Zealand marine fish and cephalopod species. These atlases summarised data from research and commercial sources, included bottom trawls, midwater trawls, aerial sightings and tuna longlines, and also presented adult and juvenile distributions. They were produced as background information to the analysis of fish community structure in the New Zealand region (*see* Bull et al. 2001, Beentjes et al. 2002, Francis et al. 2002).

The fourth report on feeding studies and dietary records remained unpublished, however. As interest in ecotrophic information has increased, the data held in the report has been increasingly sought. The current material presented here has largely drawn from the original unpublished report and makes the information summarised in the report publicly available.

Apart from several taxonomic updates to prey species, no other changes or updates to the dietary information contained in the original report have been made.

The report therefore provides a comprehensive summary of feeding information available in 2000 for New Zealand fish species that were included in the first atlas (i.e., those caught in bottom trawls, Anderson et al. 1998). No attempt is made in this document to further analyse feeding patterns (e.g. with respect to season), or determine feeding interactions between species. The report is organised into a summary of results and three Appendices:

> Appendix A provides a summary of published and some unpublished dietary information for New Zealand fish species listed in Anderson et al. (1998). Relevant data from northern hemisphere studies were included if information about fishes found in New Zealand was minimal or lacking. Species are grouped by the four main depth assemblages identified by Francis et al. (2002), to facilitate comparison of species diets within a similar depth range.
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> Appendices B and C provide summaries of data on stomach contents of fish collected from research (bottom, midwater and prawn) trawls held on the Ministry of Fisheries research trawl database. Some additional non-digitised data is also included – *see* Table 2). These summaries comprise 25 key species for which there were sufficient feeding data (i.e., over 20 tows or 200 fish sampled in total).
>
> Appendix B provides the location of feeding records collected from research trawls. It comprises length frequencies of the fish sampled by area, and major dietary categories by area and fish size (where possible). Data were not summarised by season as there were not sufficient data to do this for more than a few species.

Appendix C provides tables, by species, of all prey items recorded, by area from research trawls. Within each section, the species are ordered alphabetically by scientific name.

Readers should be aware that there have been a number of substantial dietary studies since 2000 that build considerable understanding of the trophic relationships among New Zealand's marine fish fauna. In particular, a comprehensive trophic study of the Chatham Rise has recently been conducted on a number of deepwater species, including species covered in this review (Dunn 2009, Dunn et al. 2010 a, b, c, Horn et al. 2010, Stevens and Dunn 2011).

2. METHODS

2.1 Literature review (Appendix A)

2.1.1 General overview

The main aim of the literature review was to supplement feeding information held on the Ministry of Fisheries research trawl database about New Zealand fish species included in the first fish distribution atlas (Anderson et al. 1998).

2.1.2 Literature Sources

For New Zealand fish dietary records we have cited the primary source, which may be from published papers, unpublished theses or reports. The only book used was 'A Treasury of New Zealand fishes' (Graham 1953) which provided useful data on the range of prey types consumed by a large number of fish species. A number of other popular books on New Zealand fishes have been published which provide general information on feeding (Parrott 1957, 1960, Moreland 1963, Heath & Moreland 1967, Moreland & Heath 1983, Paul & Heath 1985, Paul 2000, Ayling & Cox 1987, Doak 1984, 1991, Francis 1996) but these data were not included here.

The Aquatic Science and Fisheries Abstracts (ASFA) database was used extensively to source references. ASFA provided references for feeding studies on New Zealand fish species (including international and New Zealand literature) published since 1970. Earlier New Zealand studies were actively sought by other means, but no attempt was made to search out overseas references prior to 1970.

Feeding data collected during New Zealand trawl surveys and published in individual trawl survey reports have not as a rule been summarised as part of the literature review. Instead, all research trawl data have been summarised separately in Appendices B and C of the report.

2.1.3 Data quality and interpretation

The early records of fish feeding in New Zealand (Thomson 1892, Phillipps 1926, Graham 1938, 1953) were generally descriptive rather than quantitative assessments of fish diet. Some stomach content identification errors are likely to be have been reported in these early records due to limited expertise. For example, the earliest data compiled from 12 000 stomachs of 40 fish species had been obtained from lighthouse keepers (Thomson 1892). Phillipps (1926) examined 114 stomachs from 10 species obtained from commercial fishers. In some cases, Phillipps was unable to supervise the data collection and there appears to have been confusion over the identification of red and scaly gurnard.

Records by Graham (1953) duplicated many of the observations from Graham (1938) and these data were therefore combined.

Uncertainty about species identification (both predator and prey) was often increased by the use of non-specific common names and redundant generic and specific names. For example, gemfish (*Rexea solandri*) was reported as New Zealand hake (Thomson 1891), kingfish (Graham 1938), or southern kingfish (Graham 1953); bluenose (*Hyperoglyphe antarctica*) as bream (Graham 1938, 1953), and rock cod (*Lotella rhacinus*) as hake (Thomson 1891). In cases where the fish species could not be determined from the common name provided, those data were excluded from this review. Some early references may also have been missed because of scientific name changes.

The following references were used extensively for prey species identification: seaweeds (Adams 1994), polychaetes (Glasby & Read 1998), molluscs (Suter 1913, 1915, Powell 1976, Roper et al. 1984), crustaceans (Wear & Fielder 1985, McClay 1988), fishes (Ayling & Cox 1987, Paulin et al. 1989) and general (Morton & Miller 1968, Barnes 1987).

Scientific name changes also caused difficulties where prey had been grouped. For example, natant decapods (shrimps and prawns) were grouped as suborder Natantia and later separated into the Infraorders Penaeidea, Stenopodidea, and Caridea (Barnes 1987). Similarly, cephalopods initially grouped into the suborders Octopoda (octopuses) and Decapoda (squid and cuttlefish) were later grouped into a number of subclasses and orders (Barnes 1987). In keeping with the majority of references cited, we grouped shrimps and prawns as natant decapods. The terms Cephalopod, Octopod and Decapod are used extensively in the literature and for consistency have been used in tables in this report. In instances where prey groups had been inappropriately grouped (e.g., euphausiids, cumaceans and mysids grouped as shrimps) the data were omitted.

2.1.4 Data presentation

Summarising the published data was complicated by the wide range of methods used for feeding studies and different levels of detail presented by different authors. We standardised across reports by grouping and coding data as follows:

Empty: Everted stomachs and empty stomachs are not distinguished in the tables in Appendix A. This information was rarely available and, in a number of studies, fish with everted stomachs were discarded from further analysis (e.g., Sedberry & Musick 1978).

Fish length: In a number of studies, feeding data were divided into a number of predator length divisions (e.g., 1 cm size classes for *Parapercis colias*, Mutch 1983) to reflect size specific changes in diet. Although the diet of fish often changes as they grow, incorporating these data was beyond the scope of the current exercise. If overall totals were presented these were used in preference to the size class data.

Method: The variety of methods used to collect, analyse and present feeding data have been grouped and coded. To standardise the data summaries as much as possible, and to provide comparison for our New Zealand data, we chose percentage of frequency of occurrence (F) in stomachs containing food as the preferred method. Codes are as follows:

- B – percentage of occurrence by biomass. Edgar & Shaw (1995) calculated the biomass of mobile invertebrates in guts using biomass/sieve size relationships (Edgar 1990) and length/weight relationships. These data were then combined with percent occurrence data for plants and sessile animals.
- C – percentage of transect coverage. Choat & Clements (1992) agitated and spread the gut contents of each specimen evenly over a Perspex tray divided into 10 horizontal transects. Four transects were randomly selected and 'the extent of each transect covered by particles of each food category' was recorded as a percentage of the total amount per transect.

- D – percentage of diet composition. A semi-quantitative volumetric estimate based on assigning food points for each category according to stomach fullness, expressed as a percentage of total food points awarded to all stomachs. (e.g., Godfriaux 1968, 1969, 1974a, b, Baker 1971).
- F – percentage of frequency of occurrence of one or more individuals of each prey category in stomachs containing food (e.g., Rapson 1956, Godfriaux 1969, 1974a, b, Rosecchi et al. 1988, Hanchet 1991).
- F* – percentage of frequency of occurrence of one or more individuals of each prey category in all stomachs. (e.g., Johnston 1983, Rojas et al. 1985). Also includes results from Webb (1973) who scaled down the percentage in stomachs with food so that the total percentage = 100.
- I – number of individual prey in a prey category (e.g., Clarke 1980, 1982).
- IRI – Index of relative importance which incorporates proportional occurrence, number and weight of prey (e.g., Yano 1993).
- N – percentage of number. The total number of individuals of each food category expressed as percentage of the total number of individuals in all food categories (e.g., Godfriaux 1974a,b, Rosecchi et al. 1988).
- P – presence of a food item in a stomach (e.g., Thomson 1892, Phillipps 1926, Graham 1938, 1953).
- V – percentage of volume composition. Food points for each category are expressed as a percentage of the total potential stomach volume (total number of stomachs x 20). This method provides the percentage of stomach volume occupied by each food item in the fishes diet (e.g., Godfriaux 1969, 1974a, b).
- W – percentage of weight. The total weight of each food category expressed as a percentage of total weight of all stomach contents (e.g., Rapson 1956, Rosecchi et al. 1988).

Unidentified: predominantly unidentified or unidentifiable prey items, and includes detritus (defined by Webb 1973, as organic matter not attributable to any group, but which was classified as food).

Extraneous matter: predominantly benthic substrate (i.e., sand, mud, gravel) but includes plastics, vinyls, wood, rubber, straw, leaves, grass, kelp, faecal pellets and even human remains (a finger).

Algae: simple photosynthetic, non-vascular plants, diatoms, dinoflagellates, and blue green algae.

Seaweeds: complex macroscopic algal assemblages, including the three main divisions: the green seaweeds (Chlorophyta), brown seaweeds (Phaeophyta), and the red seaweeds (Rhodophyta) (Adams 1994).

References: Note that all references marked with an asterisk (*) were sourced from Cortés 1999.

Invertebrate and teleost groups: although identification to species level was sometimes available, data have mostly been combined into higher taxonomic groups. For the fish families, Macrouridae (rattails) and Myctophidae (lantern fishes) and the crustacean family Galatheidae, individual genera or species of significance have been included in some tables, alongside the appropriate prey grouping. For overseas references, if a teleost species was a significant prey item but the family was not present in New Zealand waters, the family was included in the table and marked with an asterisk (*). If the species was of minor importance it was placed in the other fish category.

Occurrence estimates: In some papers, feeding data were presented graphically and values were estimated from pie charts and bar graphs. Where it was not possible to obtain complete data for a prey group the largest value of a family or species was used, and therefore the group total may be under-estimated. This problem occurred often with the natant decapods group which comprise a large number of families and species.

Quantitative data were grouped to indicate 3 levels of relative importance of prey in the diet: low (under 10%), moderate (10–50%) and high (over 50%). These levels are indicated on the tables by increasing intensity of shading (Appendix A).

Feeding summaries are presented (Appendix A) for 108 New Zealand species and 97 species from elsewhere (divided into Northern or Southern Hemispheres). These summaries are also divided into four assemblages on the basis of mean depth of occurrence (*see* Anderson et al. 1998, Bagley et al. 2000) and the assemblage analysis of Francis et al. (2002). The depth ranges were: inshore (less than 100 m), continental shelf (100 to 400 m), upper-slope (400 to 700 m), and mid-slope (over 700 m). For species that were studied in New Zealand waters, there are 33 inshore species, 34 continental shelf, 16 upper slope, and 10 mid-slope species, and for New Zealand species that were studied elsewhere, there are 12 inshore, 18 continental shelf, 15 upper slope, and 44 mid-slope species. An alphabetical list of the species by the four depth ranges is given in Table 1.

Each diet table comprises two parts. The first part is a summary of the majority dietary groups. The subsequent one or two parts give more detailed taxonomic data for the following prey groups, where they existed: Mollusca, Crustacea, Echinodermata, Chondricthyes, and Osteichthyes. For example, the first table in Appendix A (Table A1a) relates to feeding records for fish species found in 0–100 metres depths in New Zealand waters. The first three pages of this table summarises the major dietary groups for each species. The next six pages give more detailed prey data for molluscs, crustaceans, and cartilaginous and bony fish.

2.2 Research trawl data (Appendices B and C)

2.2.1 Species selection

An outline of the catch data contained in the Ministry of Fisheries research trawl database was given by Anderson et al. 1998. The database incorporates surveys from about 1960 to 2000, although the database is incomplete 1960—1980. Many of the feeding records from these early surveys have already been published and are cited in the literature review (Appendix A).

The usual sample size of dietary information about fish during research trawl surveys was 20 individuals per species, per tow but there are a few cases where larger numbers of fish were sampled (e.g., specific orange roughy feeding studies), or the number of species sampled was expanded.

A summary of the number of feeding records on the database up to the year 2000 is given in Table 2. Attention to detail and the identification of stomach contents has received differing priority on trawl surveys because of time and practical constraints and are therefore often patchy within surveys or inconsistent between surveys. The species sampled were usually those sampled for a full range of biological data (e.g. size, weight, spawning condition, otoliths) and are predominantly those of commercial importance. In selecting the species to include in this report, we used a minimum cutoff of 20 stations or 200 fish examined for a given species over all data. Using these criteria, 25 species were selected for inclusion here: black oreo, *Allocyttus niger*; alfonsino, *Beryx splendens*; red gurnard, *Chelidonichthys kumu*; lookdown dory, *Cyttus traversi*; ling, *Genypterus blacodes*; sea perch, *Helicolenus percoides*; orange roughy, *Hoplostethus atlanticus*; pale ghost shark, *Hydrolagus bemisi*; dark ghost shark, *H. novaezealandiae*; bluenose, *Hyperoglyphe antarctica*; banded stargazer, *Kathetostoma binigrasella*; giant stargazer, *K. giganteum*; hoki, *Macruronus novaezelandiae*; hake, *Merluccius australis*; southern blue whiting, *Micromesistius australis*; blue cod, *Parapercis colias*; hapuku, *Polyprion oxygeneious*; smooth oreo, *Pseudocyttus maculatus*; red cod, *Pseudophycis bachus*; gemfish, *Rexea solandri*; blue warehou, *Seriolella brama*; white warehou, *S. caerulea*; silver warehou, *S. punctata*; barracouta, *Thyrsites atun*; and Murphy's mackerel, *Trachurus murphyi*.

2.2.2 Research trawl data presentation

Distribution maps of the feeding records are presented for each species in Appendix B. The start position was used to determine the location of the tow. The number recorded is the number of stations from which feeding data are available for that species. Overall, coverage by research trawls in the EEZ is extensive (see Anderson et al. 1998, Bagley et al. 2000), although the Fiordland coast, the Kermadec Ridge, and parts of the Challenger Plateau have not been well sampled.

Where sufficient feeding data was available the data was separated into geographic regions. These regions are largely self-explanatory however two regions need to be defined. The 'Challenger' region is defined as the Challenger Plateau and extends along the upper west coast of the South Island to Jackson Head. The 'Southern N.Z.' region is defined as south of Jackson Head on the west coast of the South Island and south of the Otago Peninsula on the East Coast.

The length frequency of the fish sampled for feeding and number of stomachs sampled is shown in Appendix B, to the right of the maps, by area where appropriate. Lengths recorded here were measured to the nearest centimetre below actual length by the following methods: total, fork, standard, and chimera (tip of snout to posterior end of the dorsal fin). Where the data were adequate, fish size has been divided into two or three arbitrary groups and summaries of percentage frequency of prey items, as a percentage of stomachs containing prey, is presented by area and fish size.

Detailed tables of feeding data, by area, for each species are presented in Appendix C. These tables include dietary summaries by the main prey groups, or more detailed identification of prey if available. For many species, prey items were only identified to higher taxonomic levels and some of these were quite broad (e.g., fish). Key taxa are identified in bold and summarise all subsequent prey or prey groups not in bold. Additional sub-groups not indented also contain summaries of subsequent prey or prey groups. Prey groups (e.g. teleost Families) which do not include totals for all the species in that group are indented.

In general, for invertebrates, the key taxa represent the top taxonomic level recorded in a Phylum (e.g., Phylum Crustacea, or Class Polychaeta in Phylum Annelida) and, for vertebrates, the top taxonomic level recorded in Class (e.g., Chondrichthyes, Osteichthyes etc.). For some invertebrate phyla, there are also summaries of "main" groups at a variety of lower levels, down to Superfamily in a few cases. Note that Class Cephalopoda, although a sub-group of the Phylum Mollusca, appears in bold as it contains a summary of the three further sub-groups. No attempt was made to combine teleosts by family, mainly because of the low proportions of teleosts identified, but they were grouped as mesopelagics and "others". Summaries of data by the various taxonomic levels may be less than the total of the individual prey items added together because some stomachs contain more than one prey species in that group.

2.2.3 Sources of error and uncertainty

Details of possible sources of uncertainty in the positions of bottom and midwater were outlined by Anderson et al. (1998) and Bagley et al. (2000) and are not repeated here. Many of the fish identification problems outlined in the previous two atlases are not relevant to the fish examined for feeding as the 25 key species chosen were common commercial species and the risk of misidentification very low.

Errors in feeding records may have occurred through:

- variable identification of prey. This may have been influenced by the availability of identification guides as well as the skill of seagoing personnel.
- detection errors and biases (i.e. small prey such as copepods may not be detected in visual inspections at sea).
- potential regurgitation (total or partial) may not always be routinely checked.
- mis-coding of prey
- data transcription or computer entry.

Appendix C uses the method of frequency of occurrence for the diet tables, a method which overestimates the importance of small prey. Any such errors are unlikely to affect the general patterns of feeding observed, although we did correct records of the pelagic octopus *Amphitretus* spp. (code AMP) which were generally incorrect due to confusion with the code for amphipods (APH).

Some errors in fish length measurement may have occurred during data collection, transcribing, or computer entry and not have been corrected during normal error checking procedures. To minimize problems, potential outliers were removed.

3. RESULTS

3.1 Diet summaries for the 25 key New Zealand species

General

This summary by species is based on information contained in Appendices A–C. Only the 25 key species included in Appendices B and C are included below. The comparison of these findings (Appendices B and C) is made with other feeding studies that are summarised in Appendix A.

The distribution of feeding records and overall summary of diet by predator size and area of capture come from Appendix B. Descriptions of where fish are caught refer to the occurrence of fish in research trawls (i.e., the grey dots on the distribution plots) and do not necessarily reflect where fish are most abundant (Appendix B).

The details of the number of fish examined, stomach state, and percentage frequency of occurrence of prey in stomachs containing food come from Appendix C. Reference to the number of "main" invertebrate groups relates to the prey groups listed in Appendix C which include groupings at a variety of taxonomic levels from Class down to Superfamily.

The main diet for the 25 key species is summarised in Figure 1.

Allocyttus niger black oreo

Black oreo are caught in depths greater than 500 m mainly on the Chatham Rise, but extending northward along the south-east coast of the North Island and southward to the northern edge of the Pukaki Rise (Figure B1a). Feeding records are mainly available from the southern Chatham Rise (Figure B1a). A total of 6282 fish, mainly 20–45 cm total length, were sampled, of which only 14% had stomachs containing food (Figure B1b, Table C1). A high proportion of stomachs (67%) were everted (Table C1).

Overall, teleosts (48%), crustaceans (36%) salps (24%) and cephalopods (mainly squid, 6%) were important in the diet (Table C1). Mesopelagics (5%), mainly myctophids, were the most commonly identified teleost. Non-mesopelagics made up less than 1 % of those identified. Crustaceans were

mainly natant decapods (22%). In total, at least 12 main invertebrate groups in four phyla and eight teleost species were recorded (Table C1).

The relative proportion of teleosts increased and tunicates decreased slightly as fish grew (Figure B1c, Table C1). Relative importance of prey was slightly different between areas: crustaceans and salps were more important on the Chatham Rise (45% and 31% respectively) than off Southern N.Z. (20% and 10%); teleosts and cephalopods were more important off Southern N.Z. (72% and 13%) than on the Chatham Rise (34% and 2%) (Figure B1c, Table C1).

These findings differ from those reported by Clark et al. (1989) who found that salps (68%), amphipods (72%) and natant decapods (42%) were the most important items in the diet of black oreo from the south-west Chatham Rise (Table A4a).

Beryx splendens alfonsino

Alfonsino are caught mainly on the northern Chatham Rise, east coast North Island and WCSI (Figure B2a). Feeding records are available from a few samples around the North Island and Chatham Islands (Figure B2a). A total of 365 fish (mainly 20–50 cm fork length) were sampled, of which 44% had stomachs containing food (Figure B2b, Table C2).

Overall, crustaceans were the most important (over 60%) prey group of smaller (up to 30 cm) and larger fish around the North Island (Figure B2c, Table C2). However, in larger Chatham Rise fish, teleosts were the most important (79%) prey, with crustaceans and cephalopods about equal at 18 and 15% (Figure B2c, Table C2).

Invertebrates from North Island samples were mainly natant decapods (81%) with some euphausiids and squid (both 3%) and mysids (2%) (Figure B2c, Table C2). Teleosts (30%) were mainly mesopelagic myctophids (23%). On the Chatham Rise, natant decapods were also the most important (15%) crustacean but squid importance increased to 15% and teleosts to 79% (Figure B2c, Table C2). Identified teleosts were all mesopelagics (33%), mainly *Maurolicus australis* (24%) with some *Photichthys argenteus* (9%). In total, at least five main invertebrate groups in two phyla and two mesopelagic teleost species were identified (Table C2).

These findings are similar to records from the Naska Seamount (SE Pacific) where crustaceans, mainly euphausiids and natant decapods were important, with teleosts and squid also recorded (Dubochkin & Kotlyar 1989) (Table A3b). The main teleost genus recorded was *Diaphus*, a myctophid.

Chelidonichthys kumu red gurnard

Red gurnard are caught in inshore shelf areas around New Zealand and the Chatham Islands. Feeding records are available only from the ECSI (Figure B3a). A total of 987 fish (mainly 20–55 cm fork length) were sampled, of which 30% had stomachs containing food (Figure B3b, Table C3).

Crustaceans comprised 57% overall; those identified were mainly *Munida* spp. (20%), *Ovalipes catharus* (18%) and unidentified crabs (12%) (Table C3). Teleosts comprised 43% overall. Red cod was the most commonly identified (6%). Smaller (up to 35cm) fish and larger fish had a similar diet. In total at least five main invertebrate groups in two phyla and six species of fish were identified (Figure B3c, Table C3).

The importance of crustaceans in the diet of red gurnard is consistent with other records from New Zealand. Godfriaux (1968, 1970) found Hauraki Gulf fish had been eating mainly crustaceans, mostly crabs and decapods and some fish (Table A1a). On the WCSI, Ingerson (1996) found that brachyuran crabs and polychaetes were important (Table A1a). These studies include areas not covered by the Ministry of Fisheries research trawl database but many areas remain un-sampled.

Cyttus traversi lookdown dory

Lookdown dory are caught mainly in 200–800 m depth around New Zealand, on the Challenger Plateau and in the Sub-Antarctic (Figure B4a). Feeding records are patchy and are mostly from around the North Island (Figure B4a). A total of 549 fish, (mainly 15–55 cm total length) were sampled, of which 38% had stomachs containing food (Figure B4b, Table C4).

Around the North Island, crustaceans were the dominant prey group (82% overall) in the diet and were mainly natant decapods (74%) (Figure B4c, Table C4). Teleosts comprised 20% overall, the most commonly identified were myctophids and silver roughy, *Hoplostethus mediterraneus* (both 2%). Teleosts also increased in importance in larger fish (36 cm or above) (Figure B4c). The small number of samples from other areas is not adequate to assess relative importance of prey groups. In total, at least five main crustacean groups, and seven fish species were identified (Table C4).

At the time of this review, there were no other feeding records known for this species in New Zealand. However a study of *C. traversi* off Tasmania, also found that crustaceans, in particular natant decapods, and fish, in particular myctophids, were important (Blaber & Bulman 1987) (Table A3b).

Genypterus blacodes ling

Ling are caught in shelf and slope areas around New Zealand, the Chatham Islands, and the Sub-Antarctic (Figure B5a). Feeding records are available from most of these areas but are patchy from around the North Island and rare from depths under 200 m (Figure B5a). About 18 000 fish (mainly 15–165 cm total length) were sampled, of which 40% had stomachs containing food (Figure B5b, Table C5).

Teleosts were the most important prey, comprising 65% overall (Table C5). Of the teleosts identified, macrourids were an important group (6%, possibly up to 9% including individual species), and hoki (3%) was the most commonly identified species. The proportion of prey identification beyond phylum level was however very low. Mesopelagics were infrequently identified in the diet (0.1%). Crustaceans were also important (37%) with natant decapods (15%) and *Munida* spp. (15%) the most commonly identified. Cephalopods, particularly squid, were the next most common (3%) prey group. In total, at least 19 main invertebrate groups in six phyla, and over 50 fish species were identified (Table C5).

Teleosts were more important (75%) and crustaceans were less important (27%) in Southern N.Z. than in other areas (Figure B5c, Table C5). In all areas except Southern N.Z., there was a trend of changing dominance of prey groups from crustaceans in the smallest fish (up to 70 cm) to teleosts in the largest fish (111 cm or above). In Southern N.Z., teleost prey always dominated but may also be more important in larger fish (Figure B5c, Table C5).

The main prey groups identified are consistent with other records from around New Zealand (Mitchell 1984, Clark 1985) and Australia (Blaber & Bulman 1987). Mitchell (1984) also found crustaceans to decrease in relative importance between northern and southern New Zealand (Tables A3a, A3b).

Helicolenus percoides sea perch

Sea perch are caught in shelf and slope waters down to about 800 m depth around New Zealand and on the Challenger Plateau, but not in the Sub-Antarctic (Figure B6a). Feeding records are patchy and are mainly from the ECSI (Figure B6a). About 300 fish (mainly 15–45 cm total length) were sampled, of which 42% had stomachs containing food (Figure B6b, Table C6).

The main prey items recorded from the ECSI were crustaceans (62%), mainly *Munida* spp., and teleosts (18%) and the diet was similar for smaller (up to 30 cm) and larger fish (Figure B6c, Table C6). The small number of samples from other areas is not adequate to assess relative importance of

prey groups in these areas but, overall, salps, crabs, and squid individually comprised more than 4% of the diet. In total, at least seven main invertebrate groups in four phyla and two fish species were identified (Table C6).

Graham (1938, 1953) recorded crustaceans, particularly decapods and crabs, as important in the diet of sea perch caught off Otago (Table A3a).

Hoplostethus atlanticus orange roughy

Orange roughy are caught in depths over about 800 m around New Zealand (Figure B7a). Feeding records are available from most of these areas except that the Sub-Antarctic samples are patchy (Figure B7a). A total of almost 106 000 fish (mainly 10–45 cm standard length) were sampled, of which 29% had stomachs containing food (Figure B7b, Table C7).

Dominant prey groups were crustaceans, teleosts and cephalopods (Figure B7c, Table C7). The relative proportion of the prey groups changed with fish size; smaller fish (up to 20 cm) ate more crustaceans whilst larger fish (31 cm and above) ate more teleosts and cephalopods. Relative proportions of the three prey groups were similar between areas (Figure B7c, Table C7).

Crustaceans were the most important prey, comprising 58% overall (range by area 55–62%) (Table C7). Of those identified, natant decapods were the most important (33%), particularly *Pasiphaea* and *Sergestes* spp., followed by euphausiids (5%), amphipods (4%) and mysids (2%). The Southern N.Z. area had the lowest proportion of natant decapods (22%) and the highest proportion of amphipods (19%) recorded. Molluscs (10%), particularly squid (9%), were also important. A total of at least 21 main invertebrate groups in seven phyla were identified (Figure B7c, Table C7).

Teleosts comprised 41% of the diet overall (range by area 36–52%) (Table C7). A large number of species have been identified, including at least 35 mesopelagic and 48 others. Individually they comprise low percentages, but the most commonly identified groups were myctophids (2%) and macrourids (nearly 1%, including individual species). At least four species of elasmobranch were recorded, but totalled less than 0.1% (Table C7).

These findings are consistent with other records from around New Zealand (Rosecchi et al. 1988), i.e., crustaceans, particularly natant decapods, were the most important prey group in areas (Table A4a). Other published work did not fill in the gap in knowledge from Sub-Antarctic areas of New Zealand. Some seasonal studies have been published from the Challenger area (Rosecchi et al. 1988) and this could be expanded with data from the research trawl database, although most recent data are probably from winter months (Table A4a). An Australian feeding study (Bulman & Koslow 1992), found that teleosts were more important than crustaceans by weight, and that this increased in adult-sized fish (Table A4b). This is consistent with the change in importance of crustaceans by size in New Zealand fish.

Hydrolagus bemisi pale ghost shark

Pale ghost shark are caught mainly in slope waters of about 300–1200 m depth around New Zealand, on the Challenger Plateau, and in the Sub-Antarctic (Figure B8a). A total of 109 fish (mainly 30–100 cm chimera length) have been sampled, of which 71% had stomachs containing food (Figure B8b, Table C8). The main prey items recorded were salps (39%), crustaceans (29%, mainly crabs at 13%), echinoderms (23%, mainly starfish at 14%), and molluscs (16%, including and squid). Teleosts were unimportant at only 1%. The small sample size from other areas was not adequate to assess relative importance of prey groups by area or fish size (Figure B8c). In total, 12 main invertebrate groups in five phyla and one fish species were identified (Table C8).

At the time of this review, there were no other feeding records known for this species or genus. The range of prey groups was similar to that recorded here for *Hydrolagus novaezealandiae* but

differences in the relative importance of various prey groups are inconclusive given the small sample sizes.

Hydrolagus novaezealandiae dark ghost shark

Dark ghost shark are caught mainly on the shelf edge, in 100–500 m depth around New Zealand, on the Challenger Plateau, and in the Sub-Antarctic (Figure B9a). A total of 226 fish (mainly 30–75 cm chimera length) have been sampled, of which 40% had stomachs containing food (Figure B9b, Table C9).

The main prey items recorded were crustaceans (57%), mainly *Munida* spp. (21%) and crabs (19%) (Table C9). Teleosts (11%, including mesopelagics), molluscs (9%, including bivalves and octopods), echinoderms (8%, mainly starfish), polychaetes (8%), and salps (7%) were also important. The small number of samples is not adequate to assess relative importance of prey groups by area or fish size (Figure B9c). In total, at least 10 main invertebrate groups in five phyla and one teleost family were identified (Table C9).

At the time of this review, there were no other feeding records known for this species or genus. The prey groups were similar to that recorded here for *Hydrolagus bemisi* but differences in the relative importance of various prey groups are inconclusive given the small sample sizes.

Hyperoglyphe antarctica bluenose

Bluenose are caught in slope waters, mainly 300–700 m depth, around New Zealand, on the Challenger Plateau, on the Chatham Rise (Figure B10a). They are not recorded from Sub-Antarctic. A total of 224 fish (mainly 45–95 cm length) have been sampled, of which 28% had stomachs containing food (Figure B10b, Table C10).

The main prey items recorded were salps (55%), cephalopods (27%, mainly squids), teleosts (18%, both benthic and mesopelagic at 8 and 10% respectively), and natant decapod crustaceans (13%) (Table C10). The small sample size was not adequate to assess relative importance of prey groups by area or fish size (Figure B10c). In total, five main invertebrate groups in four phyla and at least six fish species were identified (Table C10).

Graham (1938, 1953) recorded tunicates, mollusks, crustaceans, and fish present in bluenose from Otago, New Zealand (Table A3a). Winstanley (1978) also recorded salps as the main (over 50%) prey, with molluscs, crustaceans, and fish also important (each over 10%) (Table A3b).

Kathetostoma binigrasella banded stargazer

Banded stargazer are recorded mainly from the Southland shelf, although a few have been recorded at the Chatham Islands (Figure B11a). Feeding records are entirely from Southern N.Z. A total of 406 fish (mainly 20–70 cm total length) were sampled, of which 91% had stomachs containing food (Figure B11b, Table C11). Feeding records should be treated with caution as stargazers are voracious feeders and freshly caught prey taken in the trawl net may have been included in the feeding records.

Overall, cephalopods were the most important prey (66%), comprising mainly squid (59%) but including octopods (10%) (Table C11). Teleosts were the next most important (52%) group. The main species identified was opal fish, *Hemerocoetes* spp. (4%). Minor groups included salps (3%) and crustaceans (2%). In total, at least six main invertebrate groups in three phyla and 28 teleost species were identified (Table C11).

For both size categories, teleosts and cephalopods were the dominant groups identified (Figure B11c, Table C11). Although the proportion of cephalopods doubled in larger (46 cm and above) fish, some

of this increase could be attributable to a reduction in the relatively large proportion of unidentified items (about 20% in smaller fish) (Figure B11c).

There are no other feeding records known for this species. The diet described here is similar to that of the giant stargazer, *Kathetostoma giganteum*, from Southern N.Z., described below.

Kathetostoma giganteum giant stargazer

Giant stargazer are caught in shelf and upper slope areas around New Zealand, on the Challenger Plateau, on the Chatham Rise, and occasionally around the northernmost Sub-Antarctic Islands (Figure B12a). Feeding records are available mainly from the ECSI and Southland, with a few from the Chatham Rise. A total of 3470 fish (mainly 15–80 cm total length) were sampled, of which 79% had stomachs containing food (Figure B12b, Table C11). Feeding records should be treated with caution as stargazers are voracious feeders and freshly caught prey taken in the trawl net may have been included in the feeding records.

Teleosts were the most important prey, comprising 58% overall (Table C11). The main species identified were opal fish, *Hemerocoetes* spp. (3%), silver conger, *Gnathophis habenatus*, and red cod, *Pseudophycis bachus* (both 2%). Cephalopods were the next most important group (38%), mainly squid (34%) but including octopods (5%). Crustaceans occurred in 12% of stomachs overall, with crabs (7%) and *Munida* spp. (2%) the most commonly identified. In total, at least 19 main invertebrate groups in seven phyla and 40 teleost (including one mesopelagic) species were identified (Table C11).

For all areas, teleosts were important but the relative importance decreased southwards, from 82% on the Chatham Rise to 48% off Southern N.Z. (Figure B12c, Table C11). Cephalopods (mainly squid) were also important in all areas (17–53%), reaching the maximum off Southern N.Z. which was about equal (53%) to teleosts. Crustaceans were represented in all areas but ranged from 4–15%. Salps were recorded mainly from Southern N.Z. (6%). There were no clear changes in diet with fish size (Figure 12c, Table C11).

There is little other published information on New Zealand stargazer diet. Thomson & Anderton (1921) and Graham (1938, 1953) reported the presence of similar prey groups off Otago (Table A2a). Feeding in WCSI, North Island and Sub-Antarctic areas remains unknown. The diet described here is similar to that of the banded stargazer, *Kathetostoma binigrasella* from Southern N.Z., described above.

Macruronus novaezelandiae hoki

Hoki are caught in slope areas around New Zealand, mainly on the Chatham Rise, the southern plateau and west coast of the South Island (Figure B13a). Feeding records are available from most of these areas except that records from the Challenger Plateau and North Island are patchy and there are few records from deepwater (over 800 m) on the Chatham Rise. A total of 33 745 fish (mainly 30–120 cm total length) were sampled, of which 42% had stomachs containing food (Figure B13b, Table C12). The proportion of empty stomachs was high (80%) off the west coast of the South Island, probably because many of the fish were sampled during spawning.

Teleosts were the most important prey, comprising 60% overall (Table C12). Of those identified, mesopelagics were important (15%) in the overall diet, particularly myctophids (about 13%) and particularly around the North Island (36%). Crustaceans comprised 43% of the diet overall, mainly natant decapods (27%) and euphausiids (12%). Cephalopods, particularly squid (5%) and salps (3%), were the next most common invertebrate prey groups. In total, at least 15 main invertebrate groups in five phyla and 49 teleost (including 15 mesopelagic) species were identified (Table C12).

Teleosts were important in all areas (range 55–69%), particularly in the north and west (North Island and Challenger) (Figure B13c, Table C12). Crustaceans were also important in all areas (range 28–

49%), but slightly less so to the west. Natant decapods were important in all areas (25–29%) but euphausiids were only commonly reported from the Chatham Rise (20%). There were no major differences in diet between size groups of fish (Figure B13c, Table C12).

The dominance of teleosts and crustaceans in the diet is consistent with results from the other main studies around New Zealand (Kuo & Tanaka 1984, Clark 1985) (Table A3a) and Tasmania, Australia (Bulman & Blaber 1986) (Table A3b), although Clark (1985) also found salps to be of moderate importance on the Campbell Plateau (Table A3a). The New Zealand studies, combined with the data on the research trawl database, could be used to examine seasonal trends in feeding of hoki in more detail.

Merluccius australis hake

Hake are caught in slope areas around New Zealand, mainly on the Chatham Rise, the southern plateau and west coast of the South Island (Figure B14a). Feeding records are available from most of these areas except that records from the Challenger Plateau and North Island are patchy. There are also few records from deepwater (over 800 m) on the Chatham Rise and WCSI and all shallow (under 200 m) areas where hake occur (Figure B14a). A total of 7452 fish (mainly 30–130 cm total length) were sampled, of which 31% had stomachs containing food (Figure B14b, Table C13).

Teleosts comprised 85% of the diet overall (Table C13). Of those identified, hoki (22%) and javelinfish, *Lepidorhynchus denticulatus* (13%), were the most common. Mesopelagics were relatively unimportant (under 2%) in the diet. Cephalopods, mainly squid (9%) were also important and included a variety of genera other than *Nototodarus*. Crustaceans comprised mainly natant decapods (5%). In total, at least eight main invertebrate groups in five phyla and 38 teleost (including five mesopelagic) species were identified (Table C13).

Teleosts made up more than about 70% of the diet in all areas and across all size groups of hake (Figure B14c, Table C13). The main species identified, hoki, varied in importance from 15% off Southern N.Z. to 35% on the WCSI. Crustaceans comprised about 10–25% of the diet of small (up to 60 cm) hake but decreased in importance with increasing hake size. Teleosts and cephalopods showed a corresponding increase in importance with increasing hake size, in some areas (Figure B14c, Table C13).

At the time of this review, there were no other published studies of hake feeding in New Zealand that do not include data summarised here. A feeding study on the same species off Chile, using percentage of stomach mass (Paya 1992), found similar results: teleosts comprised at least 70% of the diet and the importance increased with increasing fish size; merluccids were the most commonly recorded teleost prey; squids were also important (although decreasing in importance with increasing fish size); and natant decapods were the main crustacean comprising 5% of the diet (Table A3b).

Micromesistius australis southern blue whiting

Southern blue whiting are caught mainly in 200–700 m depths in the Sub-Antarctic, although they also occur infrequently on the Chatham Rise (Figure B15a). Feeding records reflect this distribution. A total of 5857 fish (mainly 15–60 cm total length) were sampled, of which 40% had stomachs containing food and 16% had stomachs which had everted (Figure B15b, Table C14). For both size groups, crustaceans and teleosts were the dominant prey groups (Figure B15c).

In the Sub-Antarctic, crustaceans comprised 70% of the diet, mainly euphausiids (37%), natant decapods (24%) and amphipods (11%) (Figure B15c, Table C14). Teleosts comprised 32%, of which most of those identified were mesopelagics (10%), mainly myctophids. Salps (7%) and cephalopods (2%) were of less importance. On the Chatham Rise, only seven of the 43 stomachs contained food, mainly crustaceans and teleosts (Figure B15c). In total, 10 main invertebrate groups in four phyla, and 10 teleost (including four mesopelagic) species were identified (Table C14).

The overall diet described here is consistent with other records from the Sub-Antarctic waters of around New Zealand (Clark 1985, Shpak 1976) (Table A3a). Shpak (1976) found more teleosts (mainly myctophids) in the diet of Bounties fish and correspondingly less crustaceans (particularly less amphipods) (Table A3a).

Parapercis colias blue cod

Blue cod are caught in inshore shelf waters around the mainland and at the Chatham Islands (Figure B16a). They occur primarily over rough ground and are therefore not readily accessible to trawls, but a few feeding records were available from the ECSI and Southern N.Z. (Figure B16a). A total of 131 fish (mainly 25–55 cm total length) were sampled, of which 46% had stomachs containing food (Figure B16b, Table C15).

Overall, teleosts were the most important (47%), with opal fish, *Hemerocoetes* spp., (3%) as the main species identified (Table C15). Crustaceans (23%), mainly *Munida* spp. (12%), and tunicates (17%) were also important. Sample sizes were too small to allow between area comparisons (Figure B16c). In total, at least six main invertebrate groups in three phyla and four teleost species were identified (Table C15).

There are many reports of feeding of blue cod in New Zealand waters (Thomson & Anderton 1921, Graham 1938, 1953, Rapson 1956, Mutch 1983, Russell 1983) (Table A2a). These may not be directly comparable to our findings as the fish may have been caught over different habitats. However, prey groups recorded as being important by these authors are teleosts, crabs, mysids, bivalves, octopods, echinoderms, ctenophores and salps.

Polyprion oxygeneious hapuku

Hapuku are caught over the shelf around the mainland and on the Chatham Rise (Figure B17a). They occur primarily over rough ground and are therefore not readily accessible to trawls, especially as adults. Feeding records are available mainly from Southland but include some from the Chatham Rise (Figure B17a). A total of 319 fish (mainly 50–110 cm total length) were sampled, of which 47% had stomachs containing food (Figure B17b, Table C16).

Overall, teleosts were the most important (68%), with red cod (18%) the main species identified (Table C16). Molluscs (25%), mainly squid (20%), and crustaceans (18%), mainly crabs (10%) and *Munida* spp. (7%) were also important. Most fish off Southern N.Z. were small (up to 80 cm) so diet was not summarised by size groups (Figure B17b). Comparison of diet by area was restricted because of the small sample size from the Chatham Rise (Figure B17c). However, feeding from both areas was dominated by fish, with cephalopods of secondary importance. In total, at least six main invertebrate groups in two phyla and 13 teleost species were identified (Table C16).

Other feeding records of hapuku in New Zealand waters are mainly from Cook Strait (Thomson 1892, Thomson & Anderton 1921, Graham 1938, 1953, Johnston 1983) (Table A2a). These studies also found fish (particularly macrourids and myctophids), squid, and crustaceans, particularly *Munida gregaria* and natant decapods to be important (Table A2a). A study of similar sized hapuku in the south-east Pacific (Rojas et al. 1985) recorded similar prey groups but included bryozoans and coelenterates (Table A2b).

Pseudocyttus maculatus smooth oreo

Smooth oreo are caught in depths over about 500 m mainly on the Chatham Rise, the south-east coast of the North Island, Southern N.Z. and the WCSI (Figure B18a). Feeding records are mainly available from the Chatham Rise and Southern N.Z. (Figure B18a). A total of 8125 fish (mainly 15–60 cm total length) were sampled, of which 31% had stomachs containing food and 26% were everted (Figure B18b, Table C17).

Salps comprised 80% of the diet overall. Molluscs were the next most important (9%), comprising mainly of squid (8%) but including octopods (Table C17). Teleosts comprised 5% overall, with mesopelagics the most important group identified. Coelenterates comprised 4% and crustaceans 3%, mainly amphipods and natant decapods. In total, at least 11 main invertebrate prey groups in six phyla and seven teleost species were recorded (Table C17).

Diet of fish on the Chatham Rise was dominated by salps, regardless of fish size, but larger fish (31 cm or above) off Southern N.Z. had a more varied diet, dominated by teleosts but including tunicates, cephalopods and echinoderms as important (over 10%) groups (Figure B18c). The few samples from the North Island also indicated a more varied diet with tunicates, cephalopods and coelenterates important (Figure B18c).

These findings are similar to those of Clark et al. (1989) who recorded mainly salps (82%) as being the most important item in the diet of about 240 smooth oreo from the south-west Chatham Rise (Table A4a). However, their study also recorded amphipods as important (38%) whereas crustaceans were relatively unimportant (3%) in our findings.

Pseudophycis bachus red cod

Red cod are caught in shelf areas around New Zealand, shallower parts of the Chatham Rise, and occasionally around Sub-Antarctic Islands (Figure B19a). Most feeding records are available from the ECSI with some from Southern N.Z. and a few from the Chatham Rise (Figure B19a). A total of 3703 fish (mainly 10–75 cm total length) were sampled, of which 50% had stomachs containing food (Figure B19b, Table C18).

Crustaceans were the most important prey group, comprising 79% overall, and were mainly *Munida* spp. (61%) (Table C18). Teleosts comprised 25% overall, the most commonly identified species were red cod, stargazer, tarakihi and witch. In total, at least 12 main invertebrates groups in three phyla and 23 species of fish (non-mesopelagic) were identified (Table C18).

There was some indication that crustaceans may become less dominant in the diet of larger (41 cm or above) ECSI fish; samples from other areas were insufficient to determine any trends (Figure 19c). *Munida* spp. was more important in the diet of fish on the ECSI (64%) compared to Southern N.Z. (22%) where other invertebrates such as crabs (24%) and squid (11%) were also important (Figure B19c, Table C18).

The importance of *Munida* spp. in the diet of ECSI red cod is consistent with other records from this area ECSI (Graham 1938, 1953, Habib 1975) (Table A2a). Habib (1975) also sampled off the WCSI and a few east coast North Island areas not represented in this study. Crustaceans and teleosts are also important in these areas, although the predominance of *Munida gregaria* decreases and is replaced by natant decapods and mysids on the east coast of the North Island and merlucciids on the WCSI (Table A2a). Areas not well sampled to date include the North Island, the Chatham Rise and Sub-Antarctic Islands.

Rexea solandri gemfish

Gemfish are caught in outer shelf areas around New Zealand, and infrequently on the Chatham Rise (Figure B20a). Feeding records are available only from Southland. A total of 1109 fish (mainly 30–105 cm fork length) were sampled, of which 52% had stomachs containing food (Figure B20b, Table C19).

Teleosts were the most important prey, comprising 63% overall (Table C19). Of those species identified, *Trachurus* spp. (over 6%) and hoki (3%) were the most common. A few mesopelagics (2%) were also recorded. Cephalopods, all squid (43%), were also important and were mainly *Nototodarus* species (over 27%). Other invertebrate groups made up less than 1%. In total, at least 20

teleost species and three main invertebrate groups in three phyla were identified (Table C19). There was no consistent trend in change of diet between small (up to 71 cm), medium and large (91 cm and above) gemfish (Figure B20c).

A variety of fish species and squids were recorded as present in other New Zealand studies from Otago (Thomson & Anderton 1921, Graham 1938, 1953) and Cook Strait (Phillips 1926). *Munida gregaria* were also recorded from Otago (Graham 1938, 1953) (Table A2a).

Seriolella brama blue warehou

Blue warehou are caught mainly in shelf areas around New Zealand and infrequently on the Chatham Rise and in the Sub-Antarctic (Figure B21a). Feeding records are available only from Southern N.Z. (Figure B21a). A total of 974 fish (mainly 25–65 cm fork length) were sampled, of which 87% had stomachs containing food (Figure B21b, Table C20).

Salps were the main (97%) prey group; the only other group to exceed 1% occurrence was crustaceans (7.5%), mainly euphausiids (7%) (Table C20). There were no major differences in diet between three size classes of blue warehou (Figure 21c). A total of at least six main invertebrate groups in two phyla and one teleost species were recorded (Table C20).

The most comparable New Zealand feeding study is that of South Island fish by Gavrilov & Markina (1979) who found similar results: salps made up more than 50% of the diet by weight, with euphausiids of moderate importance (actually 27% by weight) (Table A2a). Other New Zealand feeding studies include presence records from Portland Island (Thomson 1892) and Otago (Thomson & Anderton 1921, Graham 1938, 1953) which include a variety of invertebrate groups not recorded here (polychaetes, molluscs, natant decapods) (Table A2a).

Seriolella caerulea white warehou

White warehou are caught on the Chatham Rise, off Southland and in the Sub-Antarctic (Figure B22a). They occur infrequently on the WCSI and south-east coast of the North Island. Feeding records are available mainly from the Chatham Rise and Southland (Figure B22a). A total of 262 fish (mainly 20–50 cm fork length) were sampled, of which 68% had stomachs containing food (Figure B22b, Table C20).

Salps were the main (96%) prey and this was consistent for the two main sampling areas and for both size groups (Figure B22c, Table C20). The only other prey groups to exceed 1% occurrence were crustaceans (6%), mainly amphipods (3%) and euphausiids (1%), and unidentified teleosts (2%). A total of at least three main invertebrate groups in two phyla and one teleost species were recorded (Table C20).

Gavrilov & Markina (1979) also found salps were the main prey of white warehou (actually 98% by weight) in fish 30–64 cm, with amphipods also present (Table A3a).

Seriolella punctata silver warehou

Silver warehou are mainly caught in shelf and upper slope areas around central and southern New Zealand and on the Chatham Rise (Figure B23a). Catches from the north of the North Island and the Sub-Antarctic are sporadic. Feeding records are available mainly from the Chatham Rise and Southland (Figure B23a). A total of 2022 fish (mainly 20–60 cm fork length) were sampled, of which 90% had stomachs containing food (Figure B23b, Table C21).

Salps were the main (97%) prey and this was consistent for the two main sampling areas and for all size groups (Figure B23c, Table C21. The only other prey groups to exceed 1% occurrence were

polychaetes (1.4%) and crustaceans (3%), mainly euphausiids. A total of at least 10 main invertebrate groups in six phyla and one teleost species were recorded (Table C21).

Gavrilov & Markina (1979) also found salps were the main prey of adult silver warehou (Table A2a). However, they also examined small fish, 12–18cm, and found other invertebrate prey groups were important: amphipods (75%) chaetognaths (60%) euphausiids (38%) and copepods (23%). In 24–31 cm fish, salps were found in at least 85% of stomachs with food, but chaetognaths and amphipods were still present (Table A2a).

Thyrsites atun barracouta

Barracouta are caught in shelf areas around New Zealand, the Chatham Islands, and occasionally at the Auckland Islands (Figure B24a). Feeding records are available from most of the main areas except the west coast of the North Island (Figure B24a). A total of 15 542 fish (mainly 30–100 cm fork length) were sampled, of which 48% had stomachs containing food (Figure B24b, Table C22). The proportion of empty stomachs was high (79%) from the North Island area, possibly related to sampling during the spawning season.

Crustaceans were the most important prey, comprising 77% overall (Table C22). The main crustaceans identified were euphausiids (74%), and *Munida* spp. (4%). Teleosts comprised 18% overall, with hoki the most commonly identified (4%), mainly from the WCSI, and some myctophids (1%) and sprats (0.6%). Cephalopods, particularly squid, were also important (9%). In total, at least eight main invertebrate groups in four phyla and 24 teleost (including two mesopelagic) species were identified (Table C22).

There were no major differences in diet between smaller (up to 60 cm) and larger fish (Figure B24c). However, in northern and western areas (North Island and Challenger), teleosts were more important in the diet (about 50%) than off the east and southern coasts of the South Island and at the Chatham Islands (about 10%) (Table 22). Euphausiids (about 40–60%) and cephalopods (1%) were correspondingly less important in the north and west and more important in the other areas (about 70–90% euphausiids and 6–15% squid). *Munida* spp. was locally important (up to 9%) off the east and southern coasts of the South Island (Figure B24c, Table 22).

These findings are consistent with other records (Thomson 1892, Thomson & Anderton 1921, Phillips 1926, Graham 1938, 1953, Mehl 1969, Hurst 1980, Russell 1983, O'Driscoll 1998) from around New Zealand (i.e., euphausiids and fish were important in all studies; *Munida gregaria*, hoki and sprats are locally important) (Table A2a). Other published work did not fill in the gap in knowledge from the west coast of the North Island. These studies, combined with the data on the research trawl database, could be used to examine seasonal trends in feeding of barracouta.

Trachurus murphyi Murphy's mackerel

Murphy's mackerel have been recorded in research trawls from shelf areas around New Zealand and on the Chatham Rise, mainly down to 500 m depth (Figure B25a). This species is known to occur off the north and west coasts of the North Island, but has not always been identified beyond genus level in research catches. Feeding records are mainly from Southland, with a few from the Chatham Rise (Figure B25a). A total of 414 fish (mainly 40–60 cm fork length) were sampled, of which 48% had stomachs containing food (Figure 25b, Table C23).

Crustaceans (55%) were the main prey group, mainly euphausiids (38%), amphipods (12%) and *Munida* spp. (6%) (Table C23). Salps comprised 36% and teleosts 11%. Crustaceans and teleosts were important in both areas while cephalopods were more important on the Chatham Rise and salps were only recorded in Southern N.Z. (Figure B25c). A total of at least seven main invertebrate groups in three phyla and one teleost group (myctophid) were recorded (Table C23).

There are no published records of feeding for *T. murphyi* from New Zealand. A summary of feeding from catch sampling of purse seine catches off the north-east of the North Island found euphausiids in 98% of stomachs (Paul Taylor, NIWA, Wellington, pers. comm.). A study by Hurst (1980) of two related species, *T. novaezelandiae* and *T. declivis* from the Bay of Plenty, Northland and the WCSI; found euphausiids to be the dominant prey with few amphipods and fish (Tables A1a, A2a). Godfriaux (1968, 1970) also recorded crustaceans (in at least nine groups) as the dominant prey of *T. novaezelandiae* from the Hauraki Gulf, as well as some fish and polychaetes (Table A1a). Studies of *T. murphyi* off Peru (Konchina 1978, 1979, 1980) found that crustaceans dominated the diet, mainly euphausiids, but including copepods, ostracods and decapods (Table A2b). Other prey groups of less importance included fish and molluscs. Salps were not recorded.

3.2 Overall Summary

Appendix A comprises a literature review of feeding studies up to and including 2000. However, a number of important dietary studies have been conducted since 2000, in particular a comprehensive trophic study of the Chatham Rise (Dunn 2009, Dunn et al. 2010 a, b, c, Horn et al. 2010, Stevens and Dunn 2011). Although these studies were beyond the scope of this report, it is acknowledged that our understanding of the diet and trophic relationships of some of these species has improved.

Appendices B and C presents feeding data collected opportunistically at sea by several researchers with varying levels of experience in prey identification over several research trawl surveys up to and including 2000. Although these data were groomed and obvious errors corrected or removed, there are likely to be unresolved issues with the identification of some prey, in particular small and/or delicate species. However such errors are unlikely to affect the overall diet of these species. The level of potential error or bias was not studied here.

A summary of key results for the 25 key species is provided in Figure 1.

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Table 1: Alphabetical list of species included in the literature review, by depth range.

Inshore (<100 m)	Shelf (100–400 m)	Upper slope (400-700 m)	Mid slope (> 700 m)
Aldrichetta forsteri	*Alopias vulpinus*	*Argentina elongata*	*Alepocephalus australis*
Arripis trutta	*Arnoglossus scapha*	*Beryx decadactylus*	*Alepisaurus ferox*
Auchenoceros punctatus	*Caelorinchus biclinozonalis*	*B. splendens*	*Allocyttus niger*
Callorhinchus milii	*Caesioperca lepidoptera*	*Brama brama*	*A. verrucosus*
Chelidonichthys kumu	*Cephaloscyllium isabellum*	*Caelorinchus aspercephalus*	*Anoplogaster cornuta*
Colistium guntheri	*Congiopodus leucopaecilus*	*C. fasciatus*	*Antimora rostrata*
C. nudipinnis	*Cyttus novaezelandiae*	*C. oliverianus*	*Aristomias* spp.
Conger verreauxi	*Emmelichthys nitidus*	*Centriscops humerosus*	*Astronesthes indicus*
C. wilsoni	*Galeorhinus galeus*	*Centrolophus niger*	*A. splendidus*
Crapatalus novaezelandiae	*Gonorynchus gonorynchus*	*Cyttus traversi*	*Bathysaurus ferox*
Dasyatis brevicaudatus	*Helicolenus percoides*	*Epigonus denticulatus*	*Caelorinchus fasciatus*
Engraulis australis	*Heptranchias perlo*	*Etmopterus lucifer*	*Caelorinchus innotabilis*
Genyagnus monopterygius	*Hemerocoetes* sp.	*Genypterus blacodes*	*Centrophorus squamosus*
Girella tricuspidata	*Kathetostoma giganteum*	*Gollum attenuatus*	*Centroscymnus coelolepis*
Latridopsis ciliaris	*Latris lineata*	*Helicolenus percoides*	*C. crepidater*
Leptoscopus macropygus	*Lepidopus caudatus*	*Hoplostethus mediterraneus*	*C. owstoni*
Myliobatis tenuicaudatus	*Lepidotrigla brachyoptera*	*Hyperoglyphe antarctica*	*Chauliodus sloani*
Nemadactylus douglasi	*Macrorhamphosus scolopax*	*Lampanyctodes hectoris*	*Chaunax pictus*
Notolabrus celiodotus	*Mustelus lenticulatus*	*Lepidorhynchus denticulatus*	*Chlamydoselachus anguineus*
Pagrus auratus	*Nemadactylus macropterus*	*Macruronus novaezelandiae*	*Coryphaenoides subserrulatus*
Paranotothenia angustata	*Notolabrus cintus*	*Malacocephalus laevis*	*Cryptopsaras couesi*
Parika scaber	*Notorynchus cepedianus*	*Maurolicus muelleri*	*Cubiceps baxteri*
Paristiopterus labiosus	*Polyprion americanus*	*Merluccius australis*	*Dalatias licha*
Pelt. novaezeelandiae	*P. oxygeneios*	*Micromesistius australis*	*Deania calcea*
Pseudocaranx dentex	*Parapercis colias*	*Neophrynichthys latus*	*Diaphus danae*
Rhombosolea leporina	*Pelotretis flavilatus*	*Paranotothenia microlepidota*	*Diastobranchus capensis*
R. plebeia	*Pseudolabrus miles*	*Seriolella caerulea*	*Epigonus lenimen*
Sardinops neopilchardus	*Pseudophycis bachus*		*E. telescopus*
Scomber australasicus	*P. breviuscula*		*Etmopterus baxteri*
Seriola lalandi	*Raja nasuta*		*Etmopterus pusillus*
Sphyrna zygaena	*Rexea solandri*		*Gonostoma elongatum*
Sprattus antipodum	*Rhombosolea tapirina*		*Halargyreus johnsonii*
Trachurus novaezelandiae	*Seriolella brama*		*Halosauropsis macrochir*
Upeneichthys lineatus	*Seriolella punctata*		*Harriotta raleighana*
Zeus faber	*Squalus acanthias*		*Hoplostethus atlanticus*
	S. mitsukurii		*Idiacanthus fasciola*
	Thyrsites atun		*Lampanyctus alatus*
	Trachurus declivis		*L. nobilis*
	T. murphyi		*Macrourus carinatus*
	Typhlonarke aysoni		*Malacocephalus laevis*
	Zenopsis nebulosus		*Malacosteus niger*
			Mora moro
			Neocyttus rhomboidalis
			Odontomacrurus murrayi
			Photostomias, 2 spp.
			Pseudocyttus maculatus
			Raja hyperborea
			Scopelogadus beanii
			Simenchelys parasiticus
			Stomias boa ferox
			Xenodermichthys copei

Table 2: Feeding records on the fish communities database (Anderson et al (1998), for species with 10 or more fish sampled (*includes some data additional to that in the Ministry of Fisheries trawl database). Where species are indicated in bold, feeding data have been summarised in this report.

Species		Number	Number of stomachs[1]				
Scientific name	Common name	of tows	Empty	Everted	Regurgitated	With prey	Examined
Allocyttus niger	**Black oreo**	**408**	**1 197**	**4 214**		**1 061**	**6 282**
Allocyttus verrucosus *	Warty oreo	6	5	6		9	16
Beryx splendens	**Alfonsino**	**32**	**203**	**4**		**162**	**365**
Brama brama	Ray's bream	4	5			43	28
Caelorinchus matamua *	Mahia rattail	6	2	1		8	10
Centroscymnus coelolepis *	Portuguese dogfish	9	7			9	15
Chelidonichthys kumu	**Red gurnard**	**89**	**557**	**132**		**331**	**987**
Coryphaenoides murrayi	Abyssal rattail	6	13	3		2	18
***Cyttus traversi** *	**Lookdown dory**	**53**	**330**	**13**		**224**	**549**
Deania calcea *	Shovelnose dogfish	6	8			5	13
Diastobranchus capensis *	Basketwork eel	16	18			16	29
Epigonus telescopus	Black cardinalfish	15	60			54	166
Etmopterus baxteri *	Baxter's dogfish	6	4	63		7	11
Genypterus blacodes	**Ling**	**1 535**	**10 592**	**183**	**201**	**8 148**	**18 002**
Harriotta raleighana *	Longnose spookfish	11	8			9	14
***Helicolenus percoides** *	**Sea perch**	**18**	**166**	**6**		**133**	**296**
***Hoplostethus atlanticus** *	**Orange roughy**	**5 856**	**75 249**	**246**	**1**	**35 496**	**105 988**
***Hydrolagus novaezealandiae** *	**Dark ghost shark**	**8**	**133**	**2**		**120**	**226**
***Hydrolagus bemisi** *	**Pale ghost shark**	**24**	**31**	**1**		**105**	**109**
Hyperoglyphe antarctica	**Blue nose**	**36**	**144**	**18**		**79**	**224**
Kathetostoma giganteum	**Giant stargazer**	**474**	**733**	**3**		**3 535**	**3 470**
Kathetostoma binigrasella	**Banded stargazer**	**77**	**36**			**530**	**406**
Lepidopus caudatus	Frostfish	3	19			4	23
Lepidorhynchus denticulatus *	Javelinfish	4	9	24		10	42
***Macruronus novaezelandiae** *	**Hoki**	**1 846**	**18 744**	**827**	**9**	**16 310**	**33 745**
***Merluccius australis** *	**Hake**	**1 423**	**4 904**	**228**	**16**	**2 500**	**7 452**
Mesobius antipodum	Black javelinfish	7	30	27		18	73
Micromesistius australis	**Southern blue whiting**	**357**	**2 560**	**939**		**2 853**	**5 857**
Mora moro *	Ribaldo	50	22	174		2	198

Table 2 (continued)

Species		Number	Number of stomachs[1]				
Scientific name	Common name	of tows	Empty	Everted	Regurgitated	With prey	Examined
Nemadactylus macropterus	Tarakihi	15	106	2		28	135
Neocyttus rhomboidalis *	Spiky oreo	29	107	265		11	382
Nototodarus sloanii	Sloan's arrow squid	4	66			2	68
Parapercis colias	**Blue cod**	**25**	**71**			**66**	**131**
Plagiogeneion rubiginosum	Rubyfish	2	43	2		31	68
Polyprion oxygeneios	**Hapuku**	**85**	**150**	**20**		**182**	**319**
Pseudocyttus maculatus *	**Smooth oreo**	**592**	**3 446**	**2 121**	**2**	**2 713**	**8 125**
Pseudophycis bachus	**Red cod**	**298**	**1 623**	**225**		**2 112**	**3 703**
Raja nasuta	Rough skate	2				23	23
Rexea solandri	**Gemfish**	**177**	**528**			**631**	**1 109**
Rhinochimera pacifica *	Pacific spookfish	11	15			2	17
Seriolella brama *	**Blue warehou**	**88**	**130**			**894**	**974**
Seriolella caerulea	**White warehou**	**44**	**83**			**192**	**262**
Seriolella punctata *	**Silver warehou**	**170**	**198**			**1 927**	**2 022**
Squalus acanthias	Spiny dogfish	5	11			106	93
Thyrsites atun*	**Barracouta**	**688**	**8 035**	**10**		**7 997**	**15 542**
Trachurus declivis	Jack mackerel	5	8			21	29
Trachurus murphyi	**Murphy's mackerel**	**46**	**214**			**225**	**414**
Trachyrincus longirostris *	White rattail	9	9	18		2	29
Trachyscorpia capensis *	Cape scorpionfish	9	9			7	16
Tubbia tasmanica *	*Tubbia tasmanica*	1	1			0	1
Xenodermichthys sp.*	Black slickhead	8	23			7	30
Total		14 758	130 768	9 804	229	89 074	21 8300

Note 1: Some totals don't add up as prey items were occasionally recorded from regurgitated and everted stomachs.

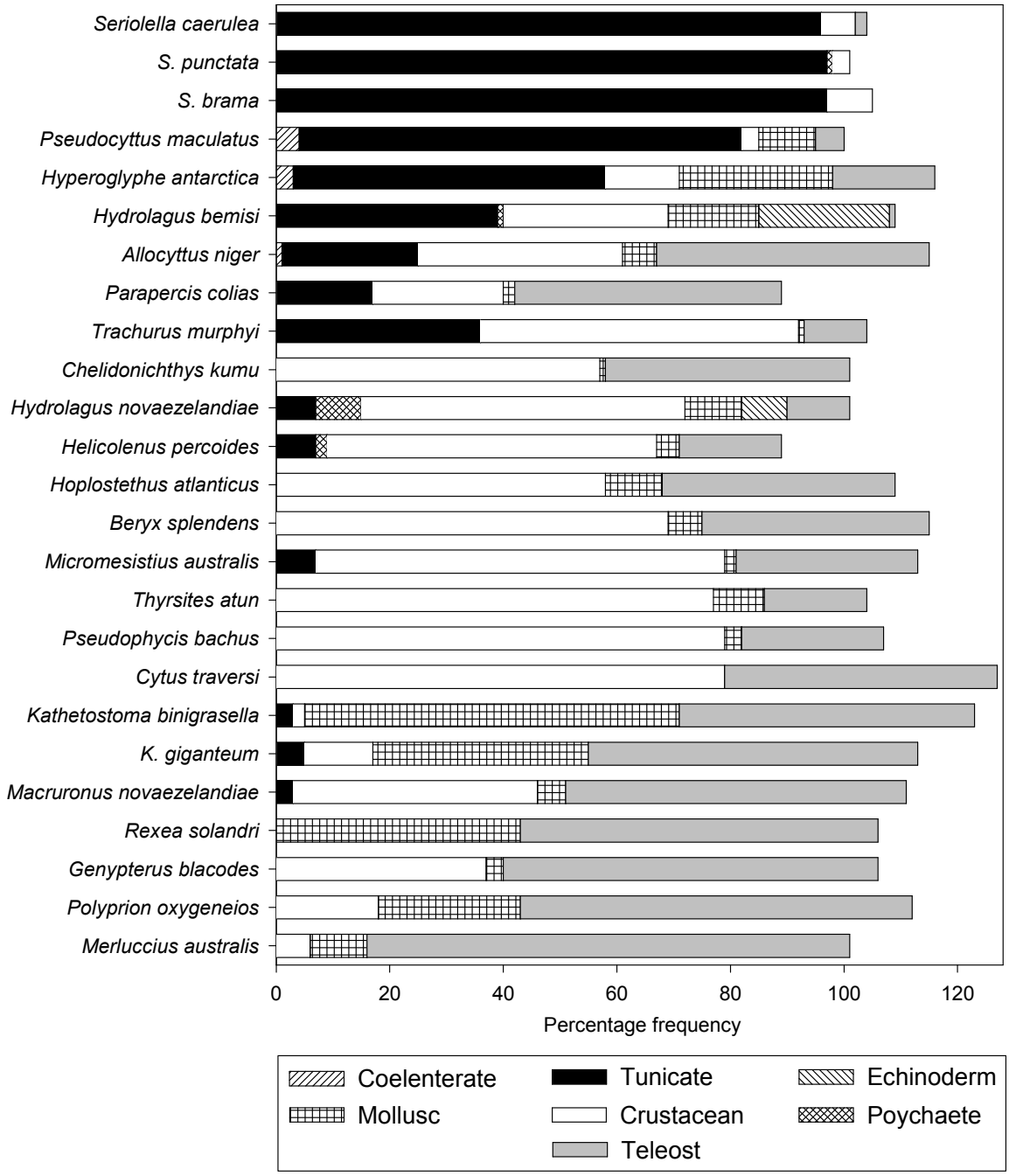


Figure 1: Summary of the percentage frequency of occurrence (%F) of prey groups in the stomach contents of 25 key species collected from New Zealand research trawls.

APPENDIX A: Tabulated summaries of the dietary characteristics of New Zealand fish species, by depth zone, as reported and standardised in this study from cited literature sources.

APPENDIX A: Tabulated summaries of the dietary characteristics of New Zealand fish species, by depth zone, as reported and standardised in this study from cited literature sources.

Table A1a: New Zealand inshore (0–100 m). n, numbers of stomachs examined; P, presence of a food item in the stomach; , ≤ 10% importance in diet; , 11 to 50 % importance in diet; , >51 % importance in diet.

	Study no.	Study area	No. stomachs	No. empty (%)	Fish length (cm)	Method	Unidentified	Extraneous matter	Algae	Seaweeds	Porifera	Coelenterates	Tunicates	Ctenophores	Bryozoans	Echiurans	Polychaetes	Molluscs	Crustaceans	Echinoderms	Osteichthyes	Reference
Aldrichetta forsteri	1	Otago				P		P									P	P	P			Graham 1938, 1953
	2	Avon-Heathcote estuary	496	37	< 15	F*		P	P								P	P	P		P	Webb 1973
	3	Avon-Heathcote estuary	1868	30	> 15	F*																Webb 1973
Arripis trutta	1	New Zealand	101			P				P								P	P		P	Thomson 1891
	2	Otago	350+			P													P		P	Graham 1938, 1953
	3	Wellington Harbour	326	8	4–52	D																Baker 1971
	4	Avon-Heathcote estuary	215	66	>18	P			P								P	P	P		P	Webb 1973
	5	NE North Island	9	33	41–64	F																Russell 1983
Auchenoceros punctatus	1	Otago				P													P			Graham 1938, 1953
Callorhinchus milii	1	Otago				P												P	P			Thomson & Anderton 1921
	2	Otago				P							P					P	P	P	P	Graham 1938, 1953
Chelidonichthys kumu	1	Moeraki, Fiordland	14	0		P												P				Thomson 1891
	2	Hawke Bay	21	5		P		P									P		P			Phillipps 1926
	3	Otago	250+			P											P	P	P		P	Graham 1938, 1953
	4	Hauraki Gulf	85	2	21–48	F																Godfriaux 1968, 1970
	5	WCSI, Golden & Tasman Bays	2304	18	16–52	F		P								P	P		P	P	P	Ingerson 1996
Colistium guntheri	1	Otago				P											P	P	P	P	P	Graham 1938, 1953
C. nudipinnis	1	Otago				P											P	P	P			Graham 1938, 1953
Conger verreauxi	1	New Zealand	23			P												P	P			Thomson 1891
	2	Otago				P												P	P		P	Graham 1938, 1953
C. wilsoni	1	NE North Island	2	0	67–97	F																Russell 1983
Crapatalus novaezelandiae	1	Otago				P													P			Graham 1938, 1953
Dasyatis brevicaudatus	1	Ohiwa & Manukau Harbours				P													P			Graham 1953
	2	Hauraki Gulf	8	5	39–67	F																Godfriaux 1968
Genyagnus monopterygius	1	Otago				P												P			P	Graham 1938, 1953
Girella tricuspidata	1	N North Island				P				P											P	Clark 1899
	2	NE North Island	17	0	21–43	F																Russell 1983
	3	NE North Island	17		17–33	C													P			Choat & Clements 1992

Table A1a (continued)

	Study no.	Study area	No. stomachs	No. empty (%)	Fish length (cm)	Method	Unidentified	Extraneous matter	Algae	Seaweeds	Porifera	Coelenterates	Tunicates	Ctenophores	Bryozoans	Echiurans	Polychaetes	Molluscs	Crustaceans	Echinoderms	Osteichthyes	Reference
Latridopsis ciliaris	1	New Zealand	711	33		P		P		P							P	P	P		P	Thomson 1891
	2	Otago				P													P			Thomson & Anderton 1921
	3	Palliser Bay	25	0		P		P	P								P	P	P	P		Phillipps 1926
	4	Otago				P						P					P	P	P			Graham 1938, 1953
	5	NE North Island	4	0	57–80	F				■							▒	■	■	▒		Russell 1983
Leptoscopus macropygus	1	Otago				P											P	P	P		P	Graham 1938, 1953
Myliobatis tenuicaudatus	1	Hauraki Gulf	49	6	15–63	F	▨				▨					▨	▒	▒	■	▨		Godfriaux 1968, 1970
	2	NE North Island	4	25	21–51	F												■	■			Russell 1983
Nemadactylus douglasi	1	NE North Island	7	0	45–64	F				■			▒				■	▒	■	■	▒	Russell 1983
Notolabrus celiodotus	1	New Zealand	36			P				P								P	P		P	Thomson 1891
	2	Otago				P													P			Thomson & Anderton 1921
	3	Otago				P											P	P	P			Graham 1938, 1953
	4	Avon-Heathcote estuary	124	2	>12	P			P			P					P	P	P		P	Webb 1973
	5	NE North Island	18	0	11–24	F						▨			▒		▒	■	■			Russell 1983
Pagrus auratus	1	North Island	510			P			P									P	P	P	P	Thomson 1891
	2	Hawke Bay	2	0		P												P				Phillipps 1926
	3	Hauraki Gulf	957	10		F							▒	▒			▒	▒	▒	▒	▒	Powell 1937
	4	Otago & Bay of Plenty				P												P	P		P	Graham 1938, 1953
	5	Hauraki Gulf	1194	2	6–76	F	▨	▨	▨		▨	▨	▨			▨	▒	▒	■	▒	▨	Godfriaux 1968, 1969
	6	Hauraki Gulf	6152	36	5–40+	F										▨	▒	▨	▒	▒	▨	Colman 1972
	7	W Bay of Plenty	772		8–50+	D	▒				▨	▨	▨			▨		▨	▒	▒	▨	Godfriaux 1974b
	8	NE North Island	23	22	27–56	F										▨	■	▒	■	■	▒	Russell 1983
Paranotothenia angustata	1	Otago	8			P				P											P	Thomson 1891
	2	Otago				P				P												Thomson & Anderton 1921
	3	Otago				P				P								P	P		P	Graham 1938, 1953
Paristiopterus labiosus	1	NE North Island	5	0	62–84	F										▒	▒	■	▒	■		Russell 1983
Parika scaber	1	Mokohinau Islands	7			P													P			Thomson 1891
	2	Otago				P						P					P		P			Graham 1953
	3	NE North Island	16	0	25–29	F				■	■	▒	■		▒			▒	▒	■		Russell 1983

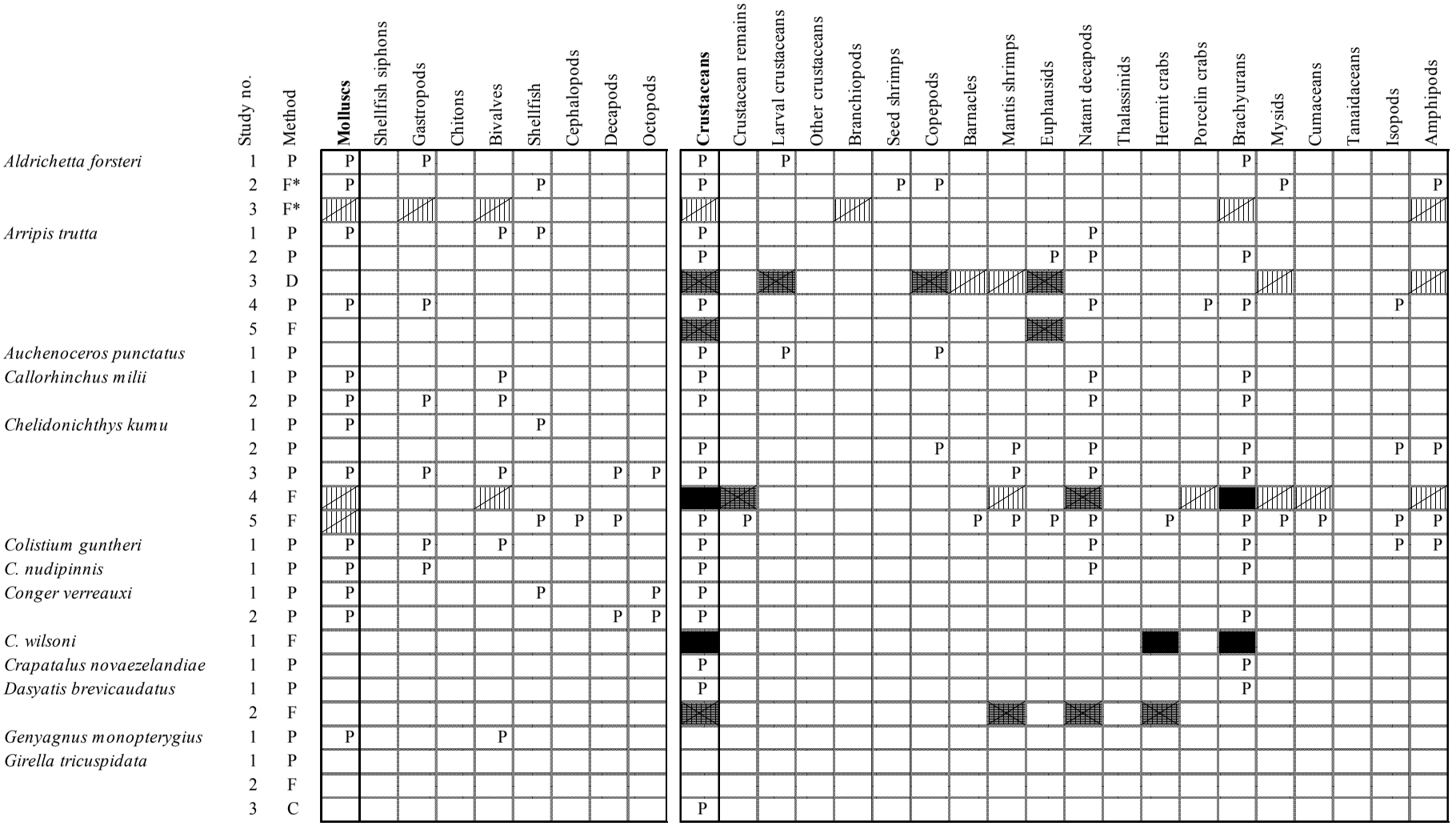
Table A1a (continued)

	Study no.	Study area	No. stomachs	No. empty (%)	Fish length (cm)	Method	Unidentified	Extraneous matter	Algae	Seaweeds	Porifera	Coelenterates	Tunicates	Ctenophores	Bryozoans	Echiurans	Polychaetes	Molluscs	Crustaceans	Echinoderms	Osteichthyes	Reference
Pelt. novaezeelandiae	1	Southland	77			P		P											P			Thomson 1891
	2	Otago				P											P	P	P	P		Thomson & Anderton 1921
	3	Otago				P											P	P	P	P	P	Graham 1938, 1953
	4	Avon-Heathcote estuary	219	22		F*																Webb 1973
	5	Wellington Harbour	98	17	15–45	F																Livingston 1987
Pseudocaranx dentex	1	New Zealand	60			P												P	P		P	Thomson 1891
	2	Otago - demersal				P							P						P			Graham 1938, 1953
	3	Hauraki Gulf - demersal	108	0	15–57	F																Godfriaux 1968, 1970
	4	Bay of Plenty - surface	24	4	40–47	D																James 1972
	5	NE North Island - demersal	7	0	10–49	F																Russell 1983
Rhombosolea leporina	1	Otago				P		P									P	P	P	P		Graham 1938, 1953
	2	Avon-Heathcote estuary	360	34	>10	F*																Webb 1973
	3	Manukau Harbour	350			F																Pearks 1985
	4	Wellington Harbour	116	18	20–39	F																Livingston 1987
R. plebeia	1	Otago				P											P	P	P	P		Thomson & Anderton 1921
	2	Otago				P		P		P							P	P	P	P	P	Graham 1938, 1953
	3	Lyttelton Harbour				P											P	P	P	P		Mundy 1968
	4	Akaroa Harbour				P											P	P	P			Mundy 1968
	5	Pegasus Bay				P						P					P	P	P			Mundy 1968
	6	off Timaru				P											P	P	P			Mundy 1968
	7	Avon-Heathcote estuary	3696	13	> 8	F*																Webb 1973
	8	Wellington Harbour	621	9	15–45	F																Livingston 1987
Sardinops neopilchardus	1	Otago				P													P			Graham 1938, 1953
Seriola lalandi	1	North Island & Cook Strait	7			P												P			P	Thomson 1891
	2	Otago			< 128	P													P		P	Graham 1938, 1953
	3	NE North Island	6	33	66–138	F																Russell 1983
Sphyrna zygaena	1	NE North Island	2	0	85–124	F																Russell 1983
Sprattus antipodum	1	Otago				P													P			Graham 1953

Table A1a (continued)

	Study no.	Study area	No. stomachs	No. empty (%)	Fish length (cm)	Method	Unidentified	Extraneous matter	Algae	Seaweeds	Porifera	Coelenterates	Tunicates	Ctenophores	Bryozoans	Echiurans	Polychaetes	Molluscs	Crustaceans	Echinoderms	Osteichthyes	Reference
Trachurus novaezelandiae	1	Otago				P												P	P		P	Graham 1938, 1953
	2	Hauraki Gulf	94	1	9–45	F																Godfriaux 1968, 1970
	3	Bay of Plenty	222	91	Adu	F																Hurst 1980
	4	North Cape	147	0	Adu	F																Hurst 1980
Upeneichthys lineatus	1	NE North Island	15	20	16–36	F																Russell 1983
Zeus faber	1	Fiordland	270			P				P								P			P	Thomson 1891
	2	Otago				P													P			Graham 1938
	3	Hauraki Gulf	21	5	15–51	F																Godfriaux 1968, 1970
	4	NE North Island	18	22	25–50	F																Russell 1983

Table A1a (continued)



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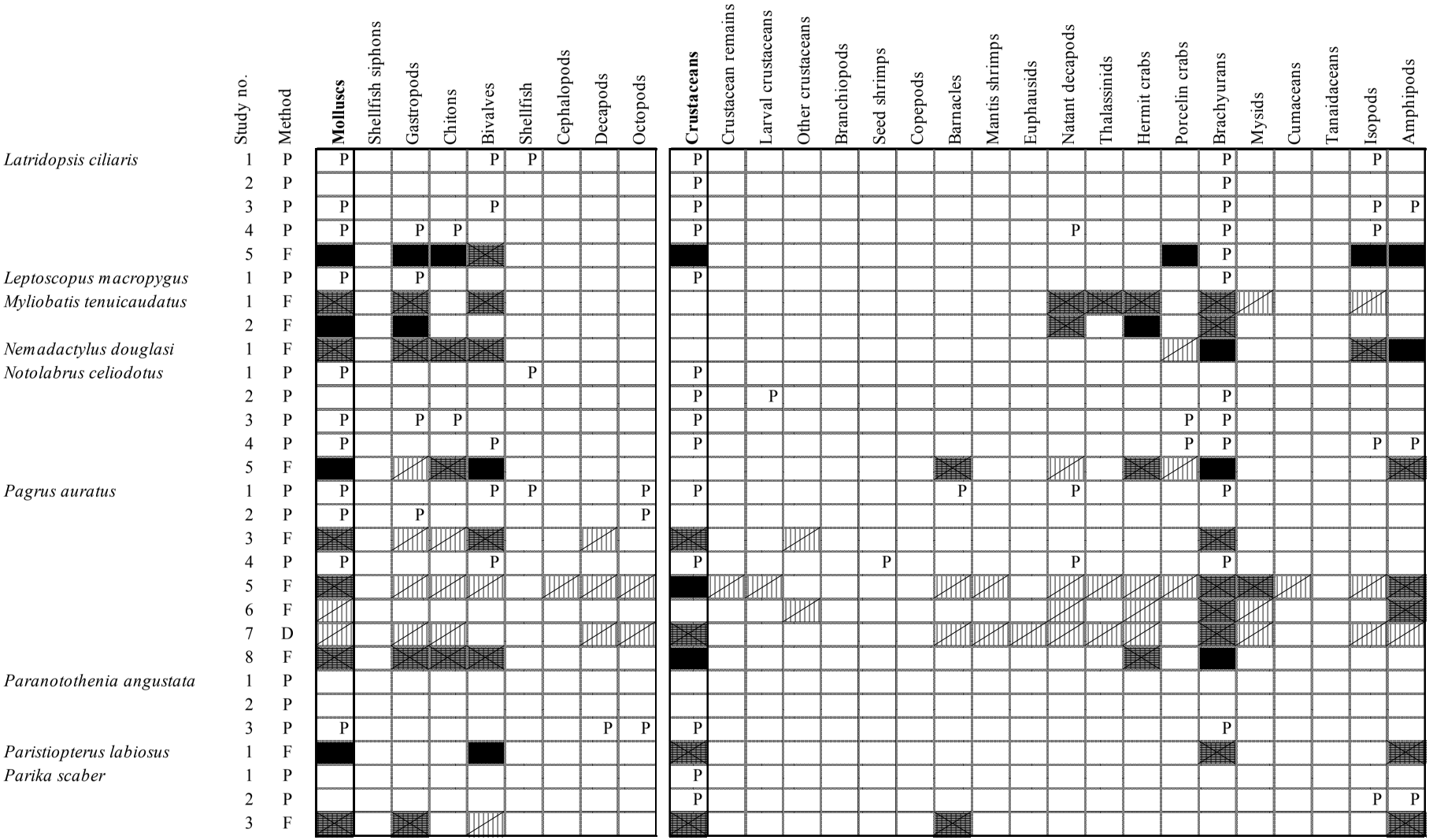

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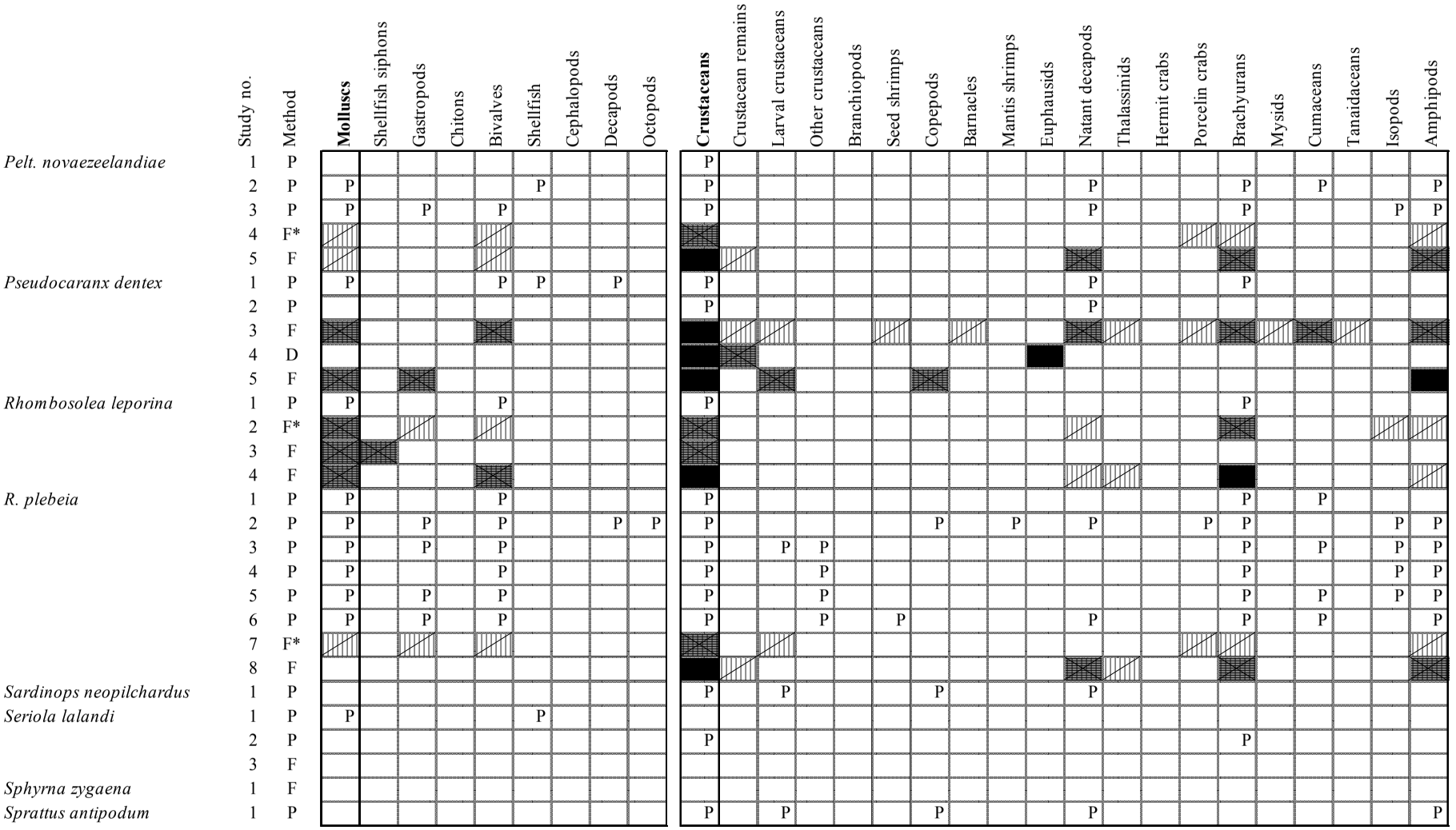

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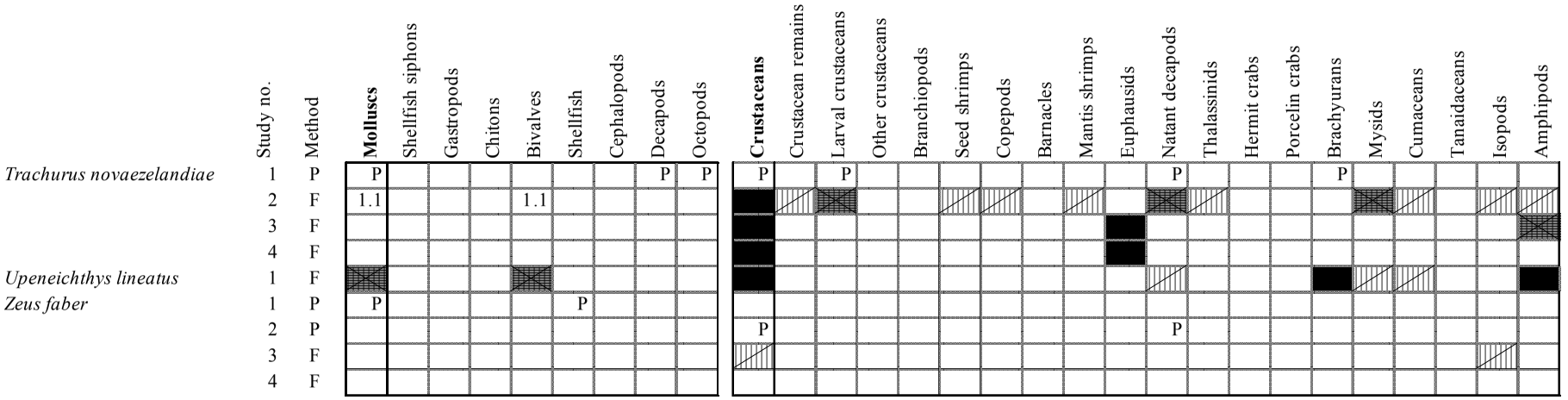

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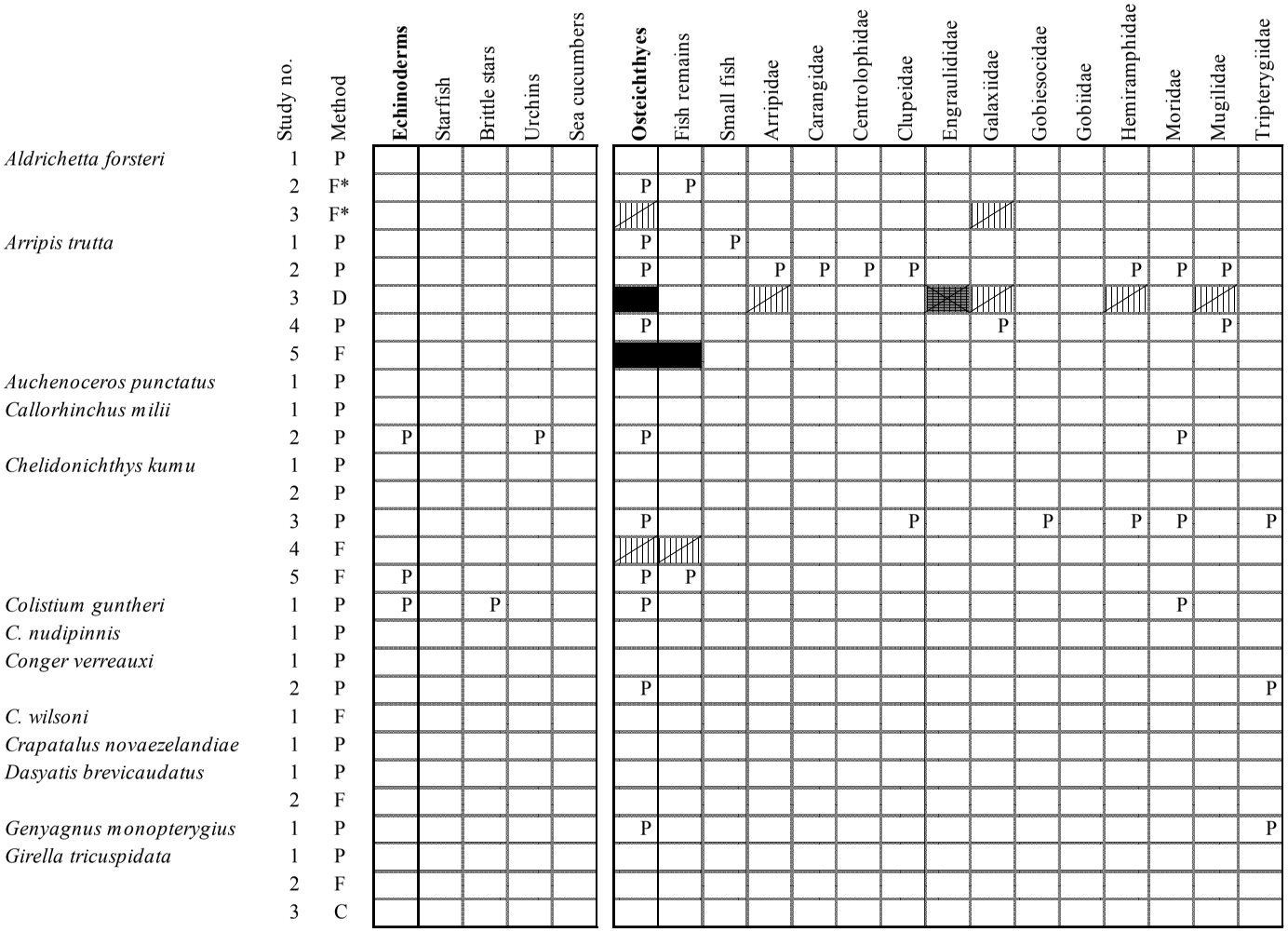

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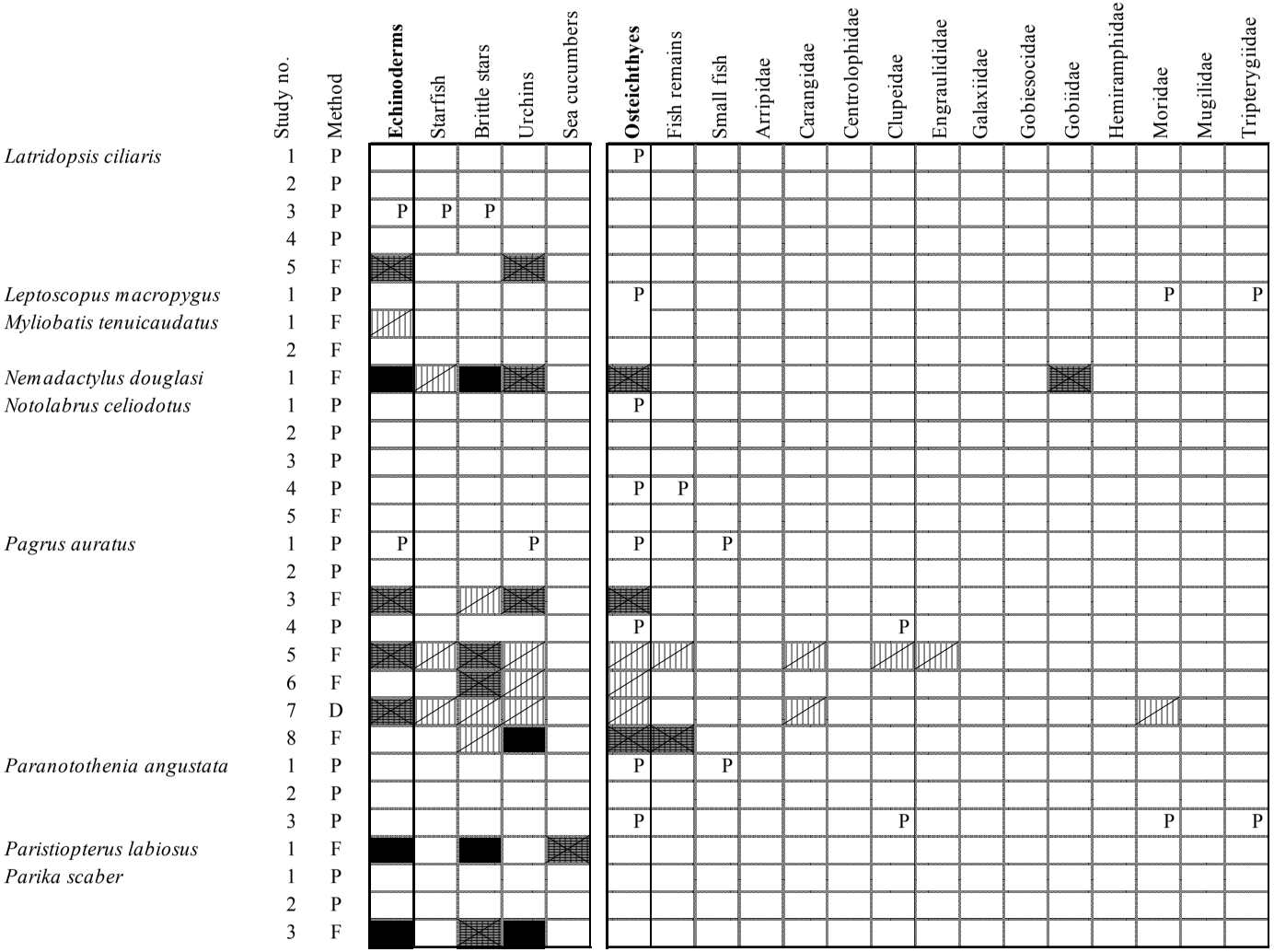

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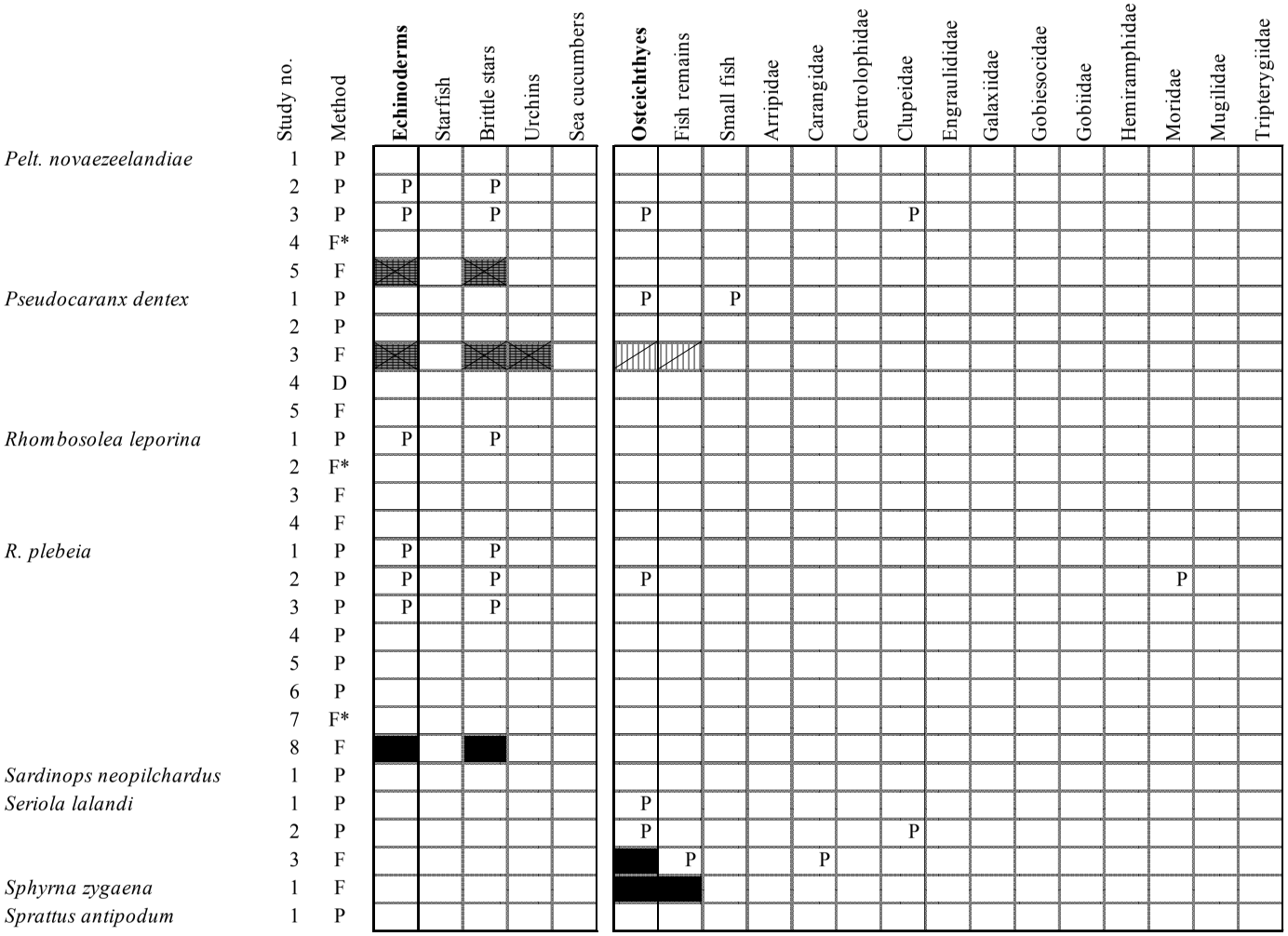


Table A1a (continued)

	Study no.	Method	**Echinoderms**	Starfish	Brittle stars	Urchins	Sea cucumbers	**Osteichthyes**	Fish remains	Small fish	Arripidae	Carangidae	Centrolophidae	Clupeidae	Engraulididae	Galaxiidae	Gobiesocidae	Gobiidae	Hemiramphidae	Moridae	Mugilidae	Tripterygiidae
Trachurus novaezelandiae	1	P						P				P		P								
	2	F							P					P								
	3	F																				
	4	F																				
Upeneichthys lineatus	1	F																				
Zeus faber	1	P						P														
	2	P																				
	3	F												P	P							
	4	F							P			P										P

Table A1b: Southern Hemisphere inshore (0–100 m). n, numbers of stomachs examined; P, presence of a food item in the stomach; , ≤ 10% importance in diet; , 11 to 50 % importance in diet; , >51 % importance in diet.

	Study no.	Study area	No. stomachs	No. empty (%)	Fish length (cm)	Method	Unidentified	Eggs	Extraneous matter	Algae	Seaweeds	Coelenterates	Polychaetes	Molluscs	Crustaceans	Insects	Echinoderms	Osteichthyes	Reference
Aldrichetta forsteri	1	W Australia	127		12–23	P	P		P	P				P	P				Thomson 1954
	2	W Australia	488	37		F													Thomson 1957
	3	W Australia	20		3–5	F													Lenanton, et al. 1982
	4	S Australia	472			B													Edgar & Shaw 1995
Arripis trutta	1	S Australia	40			B													Edgar & Shaw 1995
Callorhinchus milii	1	S Australia	86			B													Edgar & Shaw 1995
Engraulis australis	1	S Australia	23			B													Edgar & Shaw 1995
Girella tricuspidata	1	E Australia	9	33	>15	C													Clements & Choat 1997
Pseudocaranx dentex	1	S Australia	105			B													Edgar & Shaw 1995
Sardinops neopilchardus	1	S Australia	964	6	9–21	F													Stevens et al 1984
	2	S Australia	14			B													Edgar & Shaw 1995
Scomber australasicus	1	S Australia	536	35		F													Stevens et al 1984
Sphyrna zygaena	1	central Pacific	1			F													Strasburg 1958*
	2	E Australia	48	13	151–312	F													Stevens et al 1984
	3	S Africa	144		< 200	F													Smale 1991
	4	S Africa	5		> 200	F													Smale 1991
	5	S Africa	4			IRI													Sauer and Smale 1991*
Trachurus novaezelandiae	1	S Australia	240	9		F													Stevens et al 1984
Upeneichthys lineatus	2	SW Australia	382	35	6–26	F													Platell et al. 1998

Table A1b (continued)

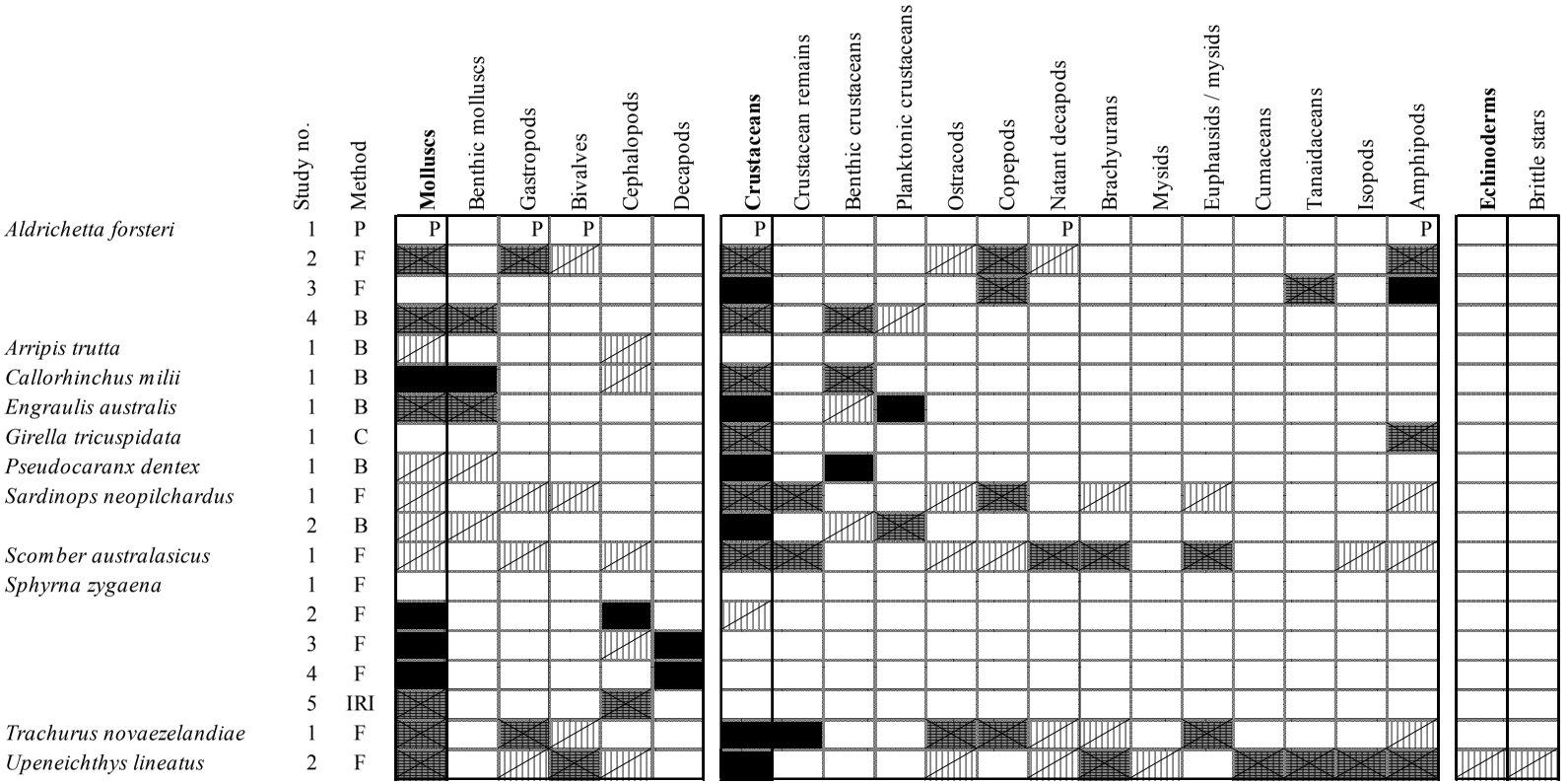


Table A1b (continued)

	Study no.	Method	**Osteichthyes**	Fish remains	Other fish	Berycidae	Carangidae	Cheilodactylidae	Clupeidae	Congiopodidae	Congridae	Engraulididae	Macrouridae	Merlucciidae	Scombridae	Sparidae
Aldrichetta forsteri	1	P														
	2	F														
	3	F														
	4	B														
Arripis trutta	1	B	■													
Callorhinchus milii	1	B														
Engraulis australis	1	B														
Girella tricuspidata	1	C														
Pseudocaranx dentex	1	B														
Sardinops neopilchardus	1	F	▨													
	2	B														
Scomber australasicus	1	F	▨													
Sphyrna zygaena	1	F	■													
	2	F	▨	▨	▨	▨	▨		▨			▨		▨	▨	
	3	F	▨	▨	▨		▨		▨		▨	▨		▨	▨	▨
	4	F	■	▨			▨	▨	▨	▨	▨		▨	■		▨
	5	IRI	■													
Trachurus novaezelandiae	1	F	▨													
Upeneichthys lineatus	2	F	▨													

Table A1c: Northern Hemisphere inshore (0–100 m). n, numbers of stomachs examined; P, presence of a food item in the stomach; , ≤ 10% importance in diet; , 11 to 50 % importance in diet; , >51 % importance in diet.

	Study no.	Study area	No. stomachs	No. empty (%)	Fish length (cm)	Method	**Molluscs**	Cephalopods	**Crustaceans**	Crustacean remains	Euphausids	Mysids	**Chondrichthyes**	**Osteichthyes**	Other fish	Callionymidae	Cepolidae	Gobiidae	Gonostomatidae	Reference
Sphyrna zygaena	1	Mediterranean	25	20		F														Capape 1975*
	2	Mexico	27	0		IRI														Galvan-Magana et al. 1989*
Zeus faber	1	Mediterranean	48	17	5–14	F														Stergiou & Fourtouni 1991
	2	Mediterranean	133	35	14–51	F														Stergiou & Fourtouni 1991

Table A2a: New Zealand shelf (100–400 m). n, numbers of stomachs examined; P, presence of a food item in the stomach; , ≤ 10% importance in diet; , 11 to 50 % importance in diet; , >51 % importance in diet.

	Study no.	Study area	No. stomachs	No. empty (%)	Fish length (cm)	Method	Unidentified	Extraneous matter	Algae	Seaweeds	Coelenterates	Tunicates	Bryozoans	Echiurans	Polychaetes	Chaetognaths	Molluscs	Crustaceans	Echinoderms	Osteichthyes	Reference
Alopias vulpinus	1	Otago			< 290	P														P	Graham 1938, 1953
Arnoglossus scapha	1	Otago				P									P		P				Thomson & Anderton 1921
	2	Otago				P									P		P	P	P	P	Graham 1938, 1953
	3	Wellington Harbour	103	43	20–35	F															Livingston 1987
Caelorinchus biclinozonalis	1	Otago	2			P												P			Graham 1953
Caesioperca lepidoptera	1	NE North Island	30	13	16–27	F															Russell 1983
Cephaloscyllium isabellum	1	Otago				P												P		P	Graham 1938, 1953
Congiopodus leucopaecilus	1	Otago	12	100		P		P													Thomson 1891
	2	Otago				P									P		P	P			Graham 1938, 1953
Cyttus novaezelandiae	1	Otago				P												P			Graham 1938, 1953
Galeorhinus galeus	1	Otago	24			P														P	Graham 1938, 1953
Gonorynchus gonorynchus	1	Otago				P		P							P			P	P	P	Graham 1938, 1953
Hemerocoetes sp.	1	Otago				P												P			Graham 1938
Kathetostoma giganteum	1	Otago	1			P											P	P			Thomson & Anderton 1921
	2	Otago				P						P			P			P		P	Graham 1938, 1953
Latris lineata	1	New Zealand	573	>90		P		P												P	Thomson 1891
	2	Otago				P												P			Thomson & Anderton 1921
	3	Otago				P											P	P		P	Graham 1938, 1953
Lepidopus caudatus	1	New Zealand				P														P	Sherrin 1886
	2	New Zealand	31	97		P														P	Thomson 1891
	3	Otago		>95		P														P	Graham 1953
Lepidotrigla brachyoptera	1	Otago				P												P			Graham 1938
Mustelus lenticulatus	1	Otago	100's			P									P		P	P			Thomson & Anderton 1921
	2	Otago	400+			P									P		P	P		P	Graham 1938, 1953
	3	Hauraki Gulf	12	0	50–95	F															Godfriaux 1968
	4	Golden Bay	25	♀	juv. ♂	F															King & Clark 1984
	5	Golden Bay	148	♂	mat. ♂	F															King & Clark 1984
	6	Golden Bay	49		juv. ♀	F															King & Clark 1984
	7	Golden Bay	206		mat. ♀	F															King & Clark 1984
	8	Golden Bay	428			P								P	P		P	P		P	King & Clark 1984

Table A2a (continued)

	Study no.	Study area	No. stomachs	No. empty (%)	Fish length (cm)	Method	Unidentified	Extraneous matter	Algae	Seaweeds	Coelenterates	Tunicates	Bryozoans	Echiurans	Polychaetes	Chaetognaths	Molluscs	Crustaceans	Echinoderms	Osteichthyes	Reference
Nemadactylus macropterus	1	New Zealand	108			P									P		P	P		P	Thomson 1891
	2	Otago				P												P			Thomson & Anderton 1921
	3	Palliser Bay & Cook Strait	20	0		P		P	P						P		P	P			Phillipps 1926
	4	Otago				P									P		P	P			Graham 1938, 1953
	5	Cape Campbell & Castlepoint	50			P	P								P		P	P	P	P	Marwick 1942
	6	W Bay of Plenty	1420		15–40	D															Godfriaux 1974a
	7	Tasman Bay	154		15–40	D															Godfriaux 1974a
Notolabrus cintus	1	Otago				P									P		P	P			Graham 1938, 1953
Notorynchus cepedianus	1	Otago	1	0	135	P											P			P	Graham 1938, 1953
Parapercis colias	1	New Zealand	6286			P		P		P					P		P	P	P		Thomson 1891
	2	Otago				P			P	P							P	P		P	Thomson & Anderton 1921
	3	Otago	400+			P				P					P		P	P		P	Graham 1938, 1953
	4	Chatham Islands	250			W															Rapson 1956
	5	Malborough Sounds	530	47		F															Rapson 1956
	6	Cook Strait	800	~50		P					P				P			P			Rapson 1956
	7	Auckland	400		10–30	P									P		P	P	P	P	Mutch 1983
	8	NE North Island	14	14	17–31	F															Russell 1983
Pelotretis flavilatus	1	Otago				P						P			P		P	P	P		Thomson & Anderton 1921
	2	Otago				P									P		P	P	P	P	Graham 1938, 1953
	3	Tasman Bay, Marlb. Sounds				P									P				P		Rapson 1940
	4	Wellington Harbour	130	13	20–39	F															Livingston 1987
Polyprion americanus	1	Otago				P											P			P	Graham 1938, 1953
P. oxygeneios	1	New Zealand	141			P											P			P	Thomson 1891
	2	Otago	160+			P						P					P	P		P	Thomson & Anderton 1921
	3	Otago	800+			P		P									P	P		P	Graham 1938, 1953
	4	Runder Point, Cook Strait	85			F*															Johnston 1983
	5	Cook Strait	2 536	~47		F*															Johnston 1983
	6	Cape Campbell	61			F*															Johnston 1983
Pseudolabrus miles	1	Otago				P											P	P			Graham 1938, 1953
	2	NE North Island	10	10	20–35	F															Russell 1983

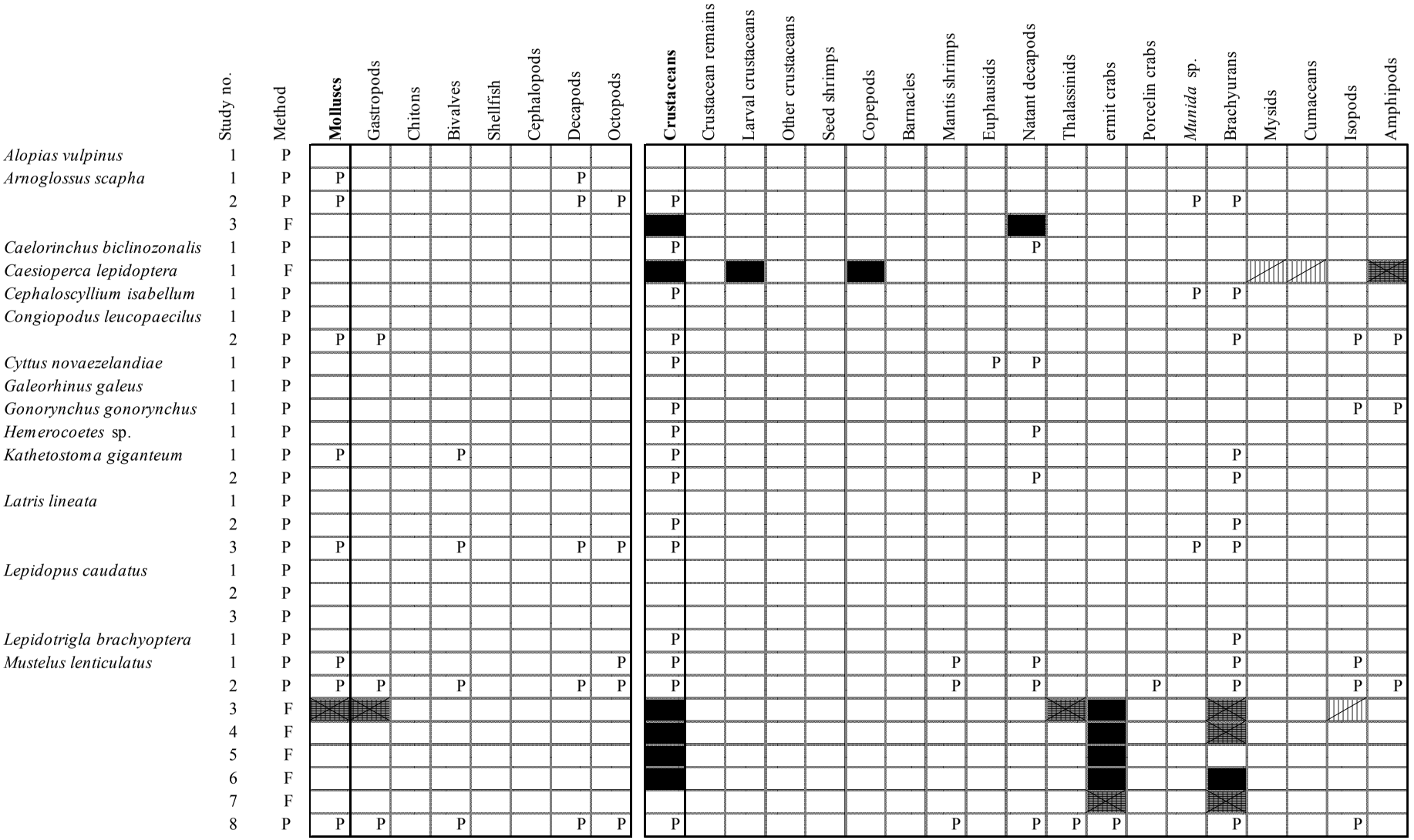
Table A2a (continued)

	Study no.	Study area	No. stomachs	No. empty (%)	Fish length (cm)	Method	Unidentified	Extraneous matter	Algae	Seaweeds	Coelenterates	Tunicates	Bryozoans	Echiurans	Polychaetes	Chaetognaths	Molluscs	Crustaceans	Echinoderms	Osteichthyes	Reference
Pseudophycis bachus	1	South Island	372			P											P	P		P	Thomson 1891
	2	Otago	100's			P											P	P		P	Thomson & Anderton 1921
	3	Cook Strait	2	0		P									P					P	Phillipps 1926
	4	Otago	1000+			P		P			P	P			P		P	P	P	P	Graham 1938, 1953
	5	Rangitikei River to Wellington	203		12–69	F															Habib 1975
	6	Whakatane R. to Cape Palliser	51		12–47	F															Habib 1975
	7	west coast South Island	210		10–57	F															Habib 1975
	8	Cloudy Bay to Cape Campbell	219		8–70	F															Habib 1975
	9	Canterbury	2294		2–75	V															Habib 1975
	10	Otago	258		5–71	F															Habib 1975
	11	Southland	122		48–73	F															Habib 1975
P. breviuscula	1	Otago				P												P			Graham 1938
	2	NE North Island	6	50	6–13	F															Russell 1983
Raja nasuta	1	Southland	19			P											P	P		P	Thomson 1891
	2	Otago				P												P			Thomson & Anderton 1921
	3	Otago				P									P		P	P		P	Graham 1938, 1953
Rexea solandri	1	Cook Strait	20			P											P			P	Phillipps 1926
	2	Otago				P											P			P	Thomson & Anderton 1921
	3	Otago	350+			P											P	P		P	Graham 1938, 1953
Rhombosolea tapirina	1	Otago				P									P		P	P		P	Graham 1938, 1953
Seriolella brama	1	Portland Island	59			P														P	Thomson 1891
	2	Otago				P									P			P			Thomson & Anderton 1921
	3	Otago				P									P		P	P		P	Graham 1938, 1953
	4	South Island	270		38–68	W															Gavrilov & Markina 1979
Seriolella punctata	1	Otago	4		28–35	P											P				Graham 1938, 1953
	2	South Island	1371		12–18	F															Gavrilov & Markina 1979
	3	South Island	1371		24–31	P												P			Gavrilov & Markina 1979
	4	South Island	1371		32–67	?W															Gavrilov & Markina 1979
Squalus acanthias	1	Otago				P									P		P	P		P	Thomson & Anderton 1921
	2	Otago	350+			P									P		P	P		P	Graham 1938, 1953
	3	east coast South Island	7283	29		F															Hanchet 1991

Table A2a (continued)

	Study no.	Study area	No. stomachs	No. empty (%)	Fish length (cm)	Method	Unidentified	Extraneous matter	Algae	Seaweeds	Coelenterates	Tunicates	Bryozoans	Echiurans	Polychaetes	Chaetognaths	Molluscs	Crustaceans	Echinoderms	Osteichthyes	Reference
Thyrsites atun	1	New Zealand	39	0		P											P	P		P	Thomson 1891
	2	Otago				P												P		P	Thomson & Anderton 1921
	3	Cook Strait	12			P									P		P	P		P	Phillipps 1926
	4	Otago	400+			P									P		P	P		P	Graham 1938, 1953
	5	Castlepoint to Point Gibson	244	58	36–92	P												P		P	Mehl 1969
	6	west coast South Island	225	47		F												■		▒	Hurst 1980
	7	NE South Island	516	26		F												■		▒	Hurst 1980
	8	Otago - non-schooling	86	3	64–88	W											▨	■		▒	O'Driscoll 1998
	9	Otago - schooling	29	41	64–88	W												■		▨	O'Driscoll 1998
	10	NE North Island	3	0	99–135	F														■	Russell 1983
Trachurus declivis	1	Bay Of Plenty	49	61		F												■			Hurst 1980
	2	North Cape	16	0		F												■			Hurst 1980
	3	west coast South Island	301	75		F												■		▨	Hurst 1980
Typhlonarke aysoni	1	Otago				P												P		P	Graham 1938, 1953

Table A2a (continued)



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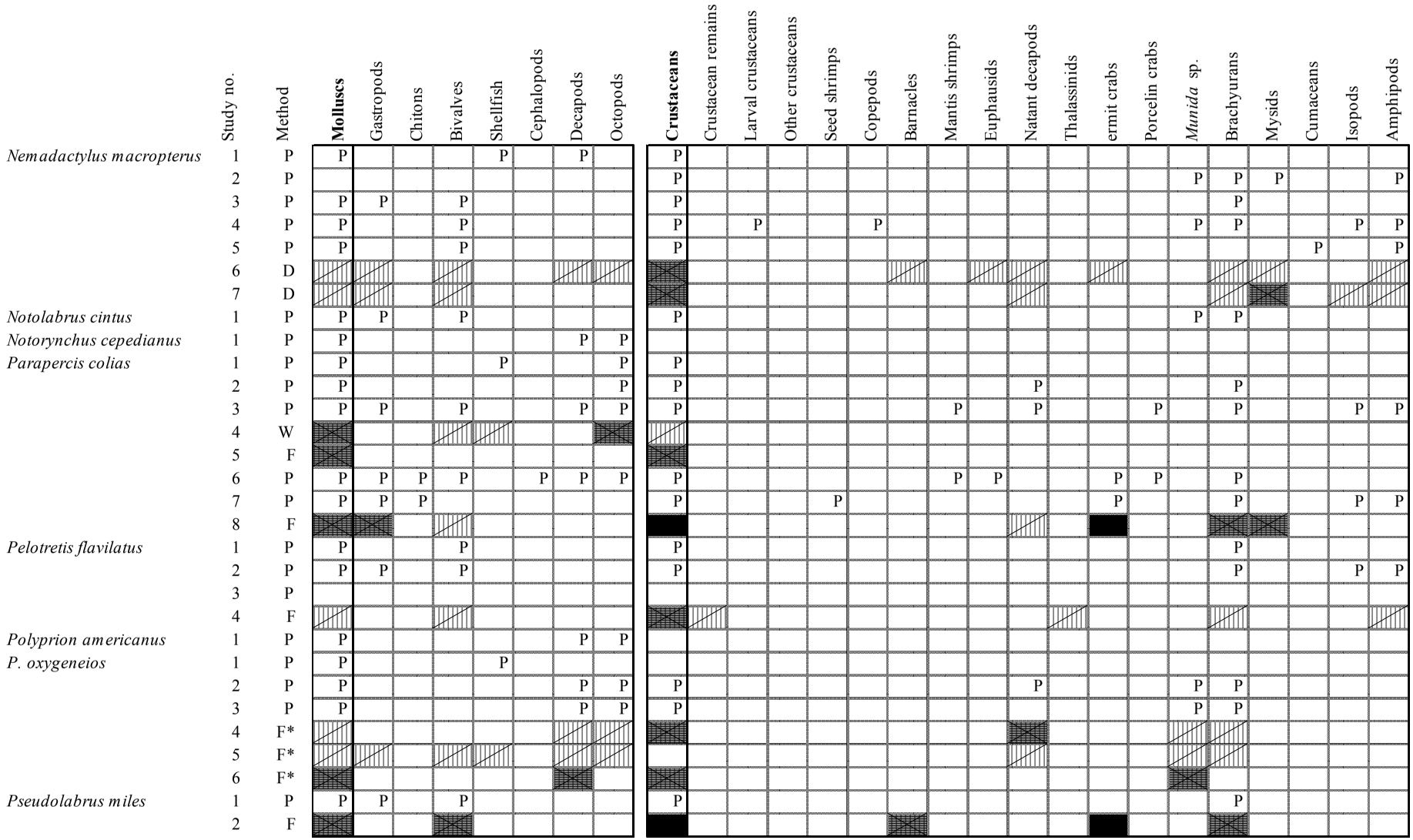

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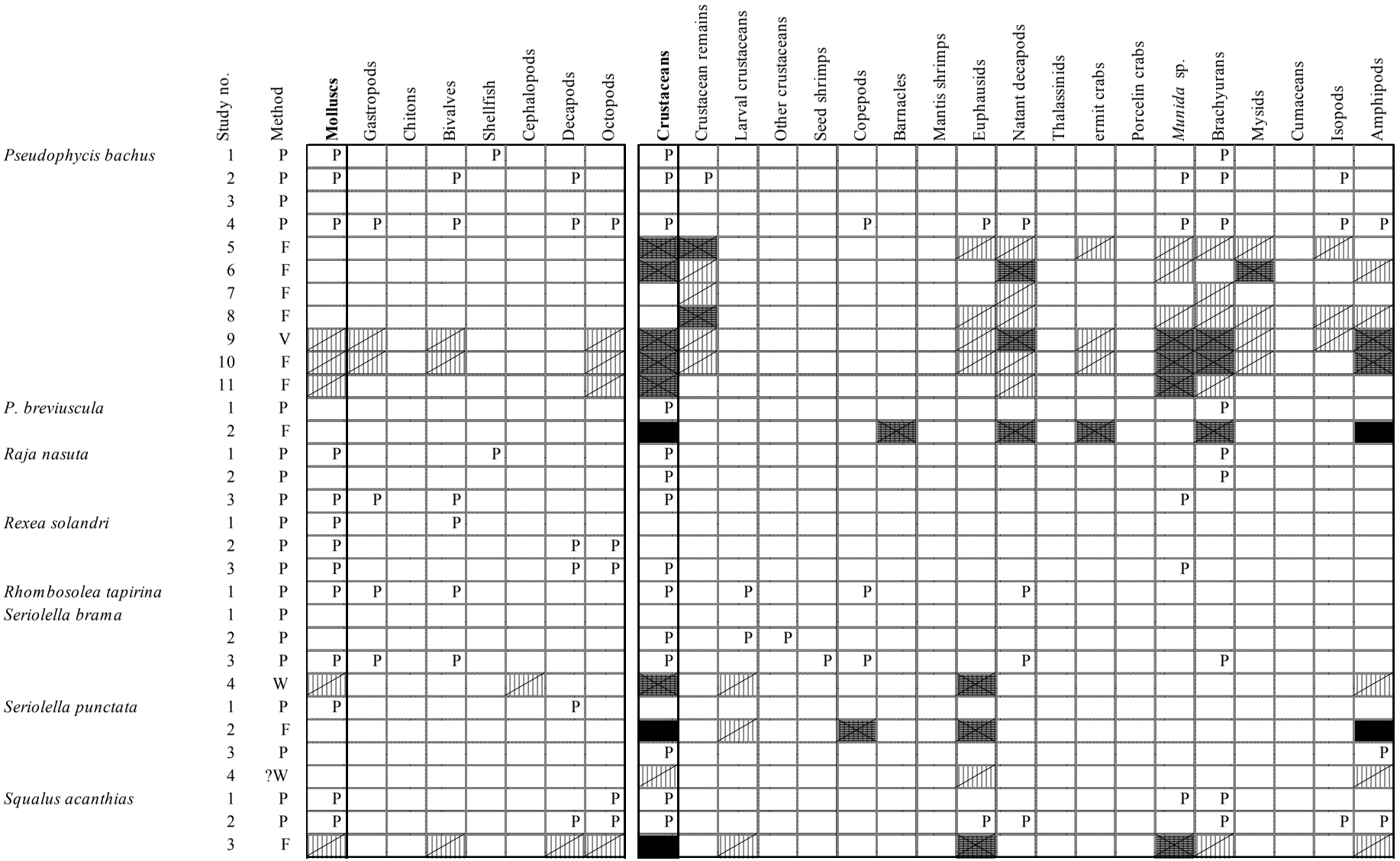

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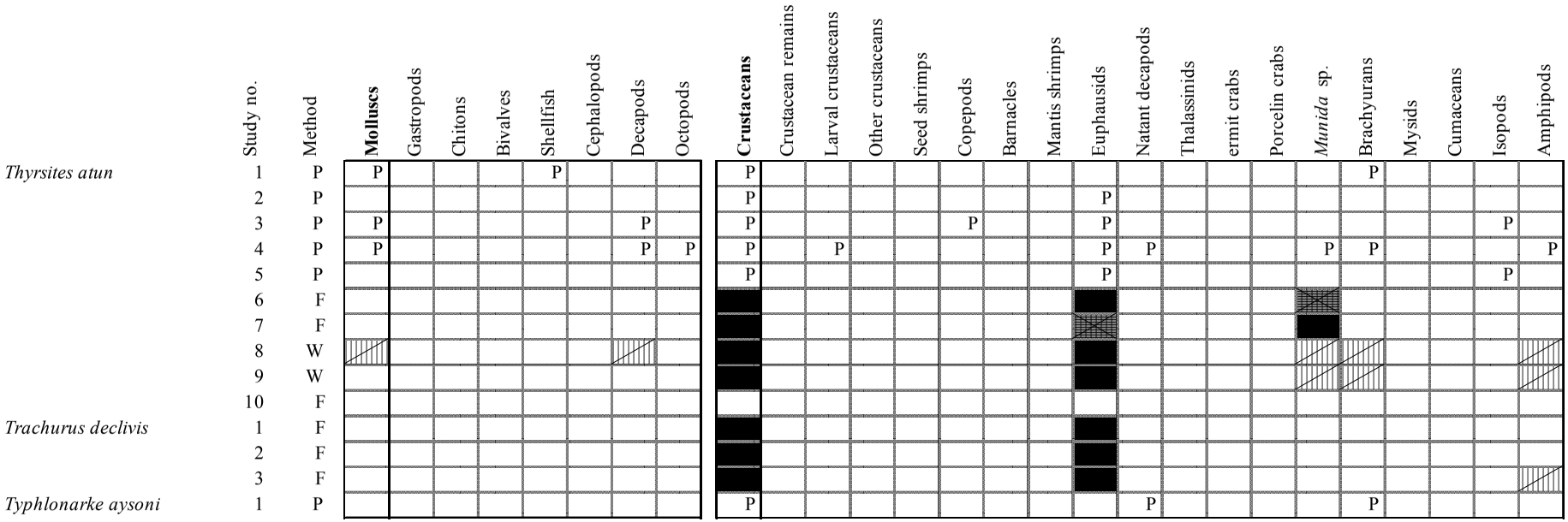
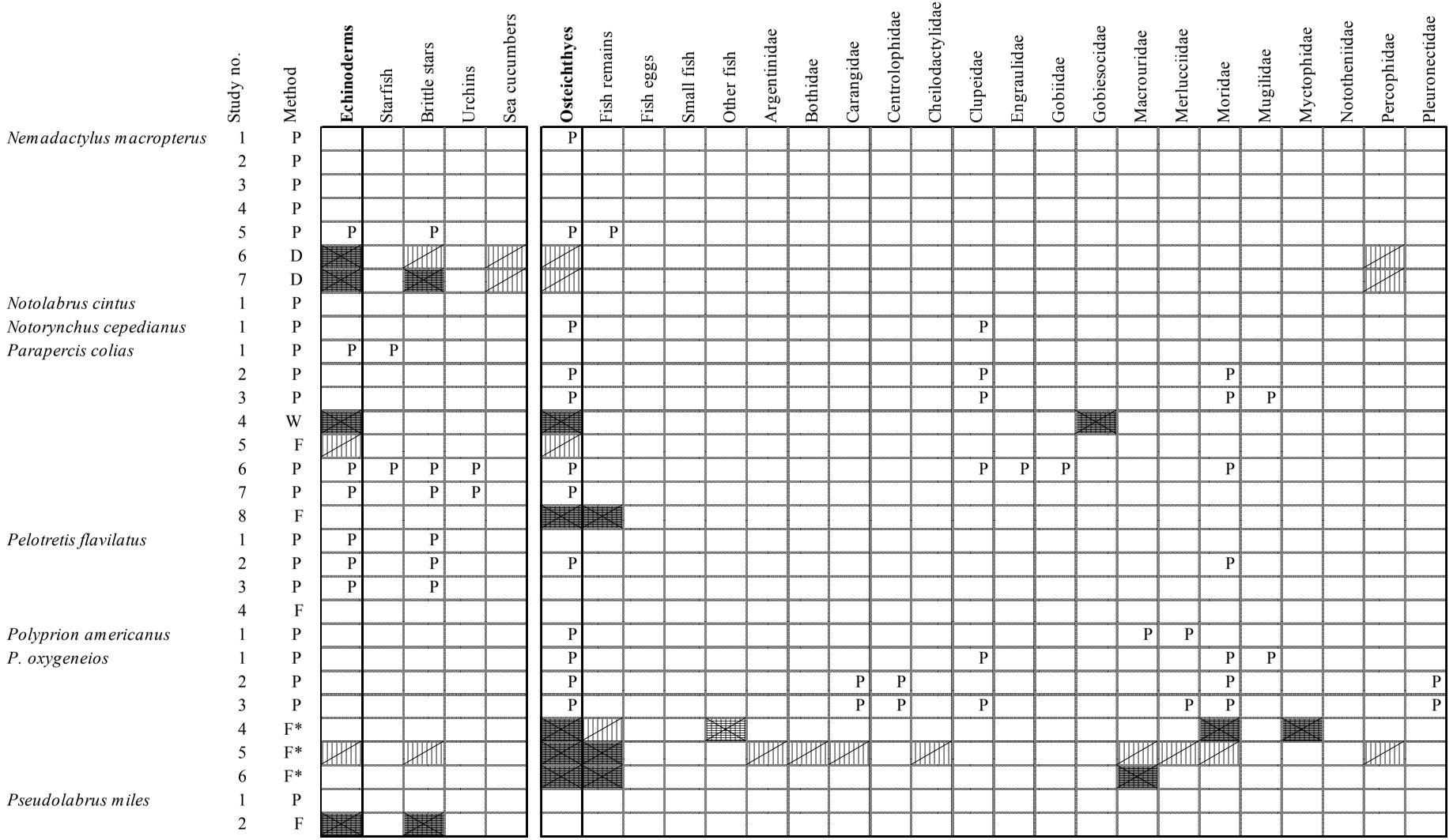


	Study no.	Method	**Molluscs**	Gastropods	Chitons	Bivalves	Shellfish	Cephalopods	Decapods	Octopods	**Crustaceans**	Crustacean remains	Larval crustaceans	Other crustaceans	Seed shrimps	Copepods	Barnacles	Mantis shrimps	Euphausids	Natant decapods	Thalassinids	ermit crabs	Porcelin crabs	*Munida* sp.	Brachyurans	Mysids	Cumaceans	Isopods	Amphipods
Thyrsites atun	1	P	P				P				P														P				
	2	P									P								P										
	3	P	P						P		P					P			P									P	
	4	P	P						P	P	P		P						P	P				P	P				P
	5	P									P								P									P	
	6	F																											
	7	F																											
	8	W																											
	9	W																											
	10	F																											
Trachurus declivis	1	F																											
	2	F																											
	3	F																											
Typhlonarke aysoni	1	P									P									P					P				

Table A2a (continued)

	Study no.	Method	**Echinoderms**	Starfish	Brittle stars	Urchins	Sea cucumbers	**Osteichthyes**	Fish remains	Fish eggs	Small fish	Other fish	Argentinidae	Bothidae	Carangidae	Centrolophidae	Cheilodactylidae	Clupeidae	Engraulidae	Gobiidae	Gobiesocidae	Macrouridae	Merlucciidae	Moridae	Mugilidae	Myctophidae	Nototheniidae	Percophidae	Pleuronectidae
Alopias vulpinus	1	P						P							P			P						P					
Arnoglossus scapha	1	P																											
	2	P	P		P		P	P										P						P					
	3	F						■										■											▨
Caelorinchus biclinozonalis	1	P																											
Caesioperca lepidoptera	1	F						▨		▨																			
Cephaloscyllium isabellum	1	P						P																					
Congiopodus leucopaecilus	1	P																											
	2	P																											
Cyttus novaezelandiae	1	P																											
Galeorhinus galeus	1	P						P										P						P					P
Gonorynchus gonorynchus	1	P	P		P			P																					
Hemerocoetes sp.	1	P																											
Kathetostoma giganteum	1	P																											
	2	P						P																P	P				P
Latris lineata	1	P						P																					
	2	P																											
	3	P						P										P											
Lepidopus caudatus	1	P						P										P											
	2	P						P										P											
	3	P						P	P																				
Lepidotrigla brachyoptera	1	P																											
Mustelus lenticulatus	1	P																											
	2	P						P										P											
	3	F																											
	4	F																											
	5	F																											
	6	F																											
	7	F																											
	8	P						P																					

Table A2a (continued)



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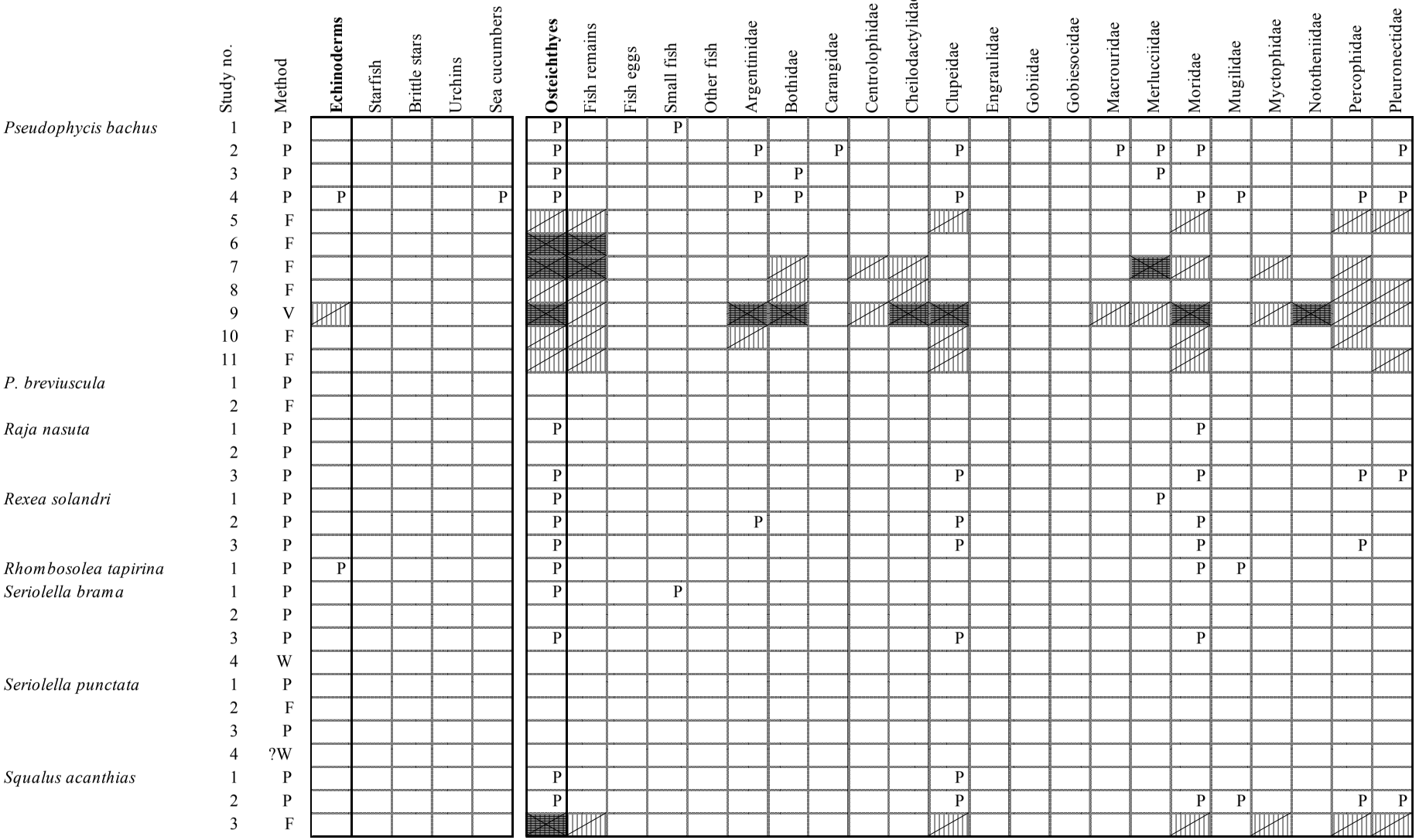

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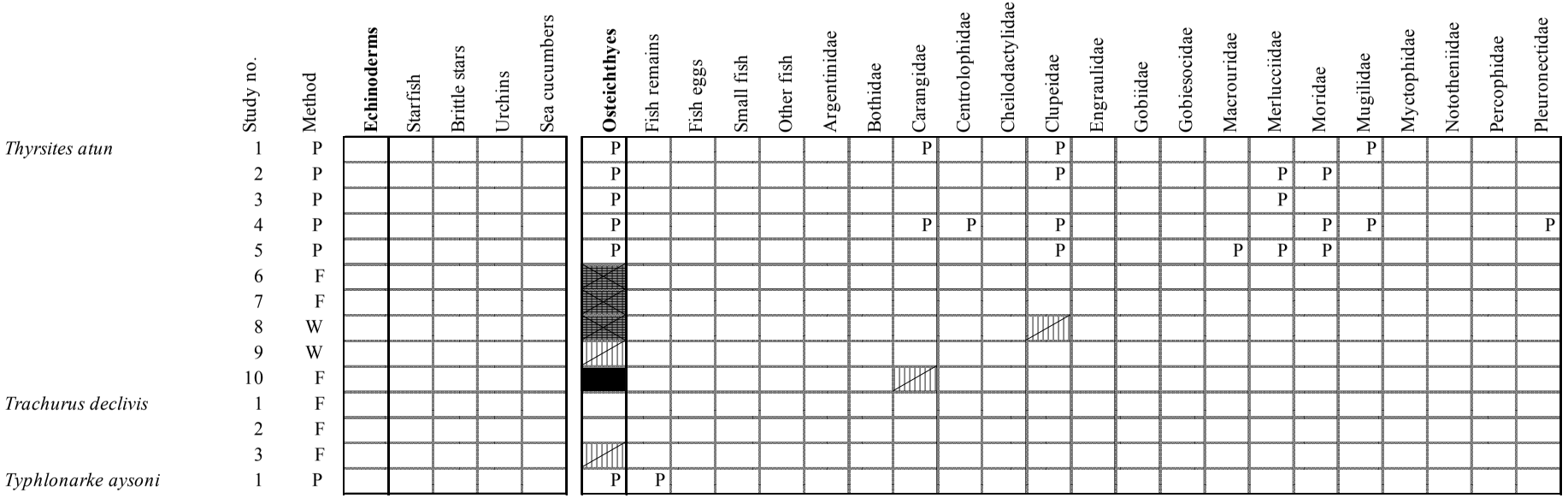


Table A2a (continued)

	Study no.	Method	Pomacentridae	Retropinnidae	Scorpaenidae	Triglidae	Tripterygiidae
Alopias vulpinus	1	P					
Arnoglossus scapha	1	P					
	2	P					
	3	F					
Caelorinchus biclinozonalis	1	P					
Caesioperca lepidoptera	1	F					
Cephaloscyllium isabellum	1	P					P
Congiopodus leucopaecilus	1	P					
	2	P					
Cyttus novaezelandiae	1	P					
Galeorhinus galeus	1	P					
Gonorynchus gonorynchus	1	P			P		
Hemerocoetes sp.	1	P					
Kathetostoma giganteum	1	P					
	2	P					P
Latris lineata	1	P					
	2	P					
	3	P					
Lepidopus caudatus	1	P					
	2	P					
	3	P					
Lepidotrigla brachyoptera	1	P					
Mustelus lenticulatus	1	P					
	2	P					
	3	F					
	4	F					
	5	F					
	6	F					
	7	F					
	8	P					

Table A2a (continued)

	Study no.	Method	Pomacentridae	Retropinnidae	Scorpaenidae	Triglidae	Tripterygiidae
Nemadactylus macropterus	1	P					
	2	P					
	3	P					
	4	P					
	5	P					
	6	D					
	7	D					
Notolabrus cintus	1	P					
Notorynchus cepedianus	1	P					
Parapercis colias	1	P					
	2	P					P
	3	P					P
	4	W					
	5	F					
	6	P					P
	7	P					
	8	F					
Pelotretis flavilatus	1	P					
	2	P					
	3	P					
	4	F					
Polyprion americanus	1	P					
P. oxygeneios	1	P					
	2	P					
	3	P			P		
	4	F*					
	5	F*					
	6	F*					
Pseudolabrus miles	1	P					
	2	F					

Table A2a (continued)

	Study no.	Method	Pomacentridae	Retropinnidae	Scorpaenidae	Triglidae	Tripterygiidae
Pseudophycis bachus	1	P					
	2	P			P		
	3	P			P		
	4	P		P	P		P
	5	F					
	6	F					
	7	F					
	8	F					
	9	V					
	10	F					
	11	F					
P. breviuscula	1	P					
	2	F					
Raja nasuta	1	P					
	2	P					
	3	P					
Rexea solandri	1	P					
	2	P					
	3	P			P		
Rhombosolea tapirina	1	P					
Seriolella brama	1	P					
	2	P					
	3	P					
	4	W					
Seriolella punctata	1	P					
	2	F					
	3	P					
	4	?W					
Squalus acanthias	1	P					
	2	P					
	3	F					

Table A2a (continued)

	Study no.	Method	Pomacentridae	Retropinnidae	Scorpaenidae	Triglidae	Tripterygiidae
Thyrsites atun	1	P					
	2	P					
	3	P					
	4	P			P	P	
	5	P					
	6	F					
	7	F					
	8	W					
	9	W					
	10	F					
Trachurus declivis	1	F					
	2	F					
	3	F					
Typhlonarke aysoni	1	P					

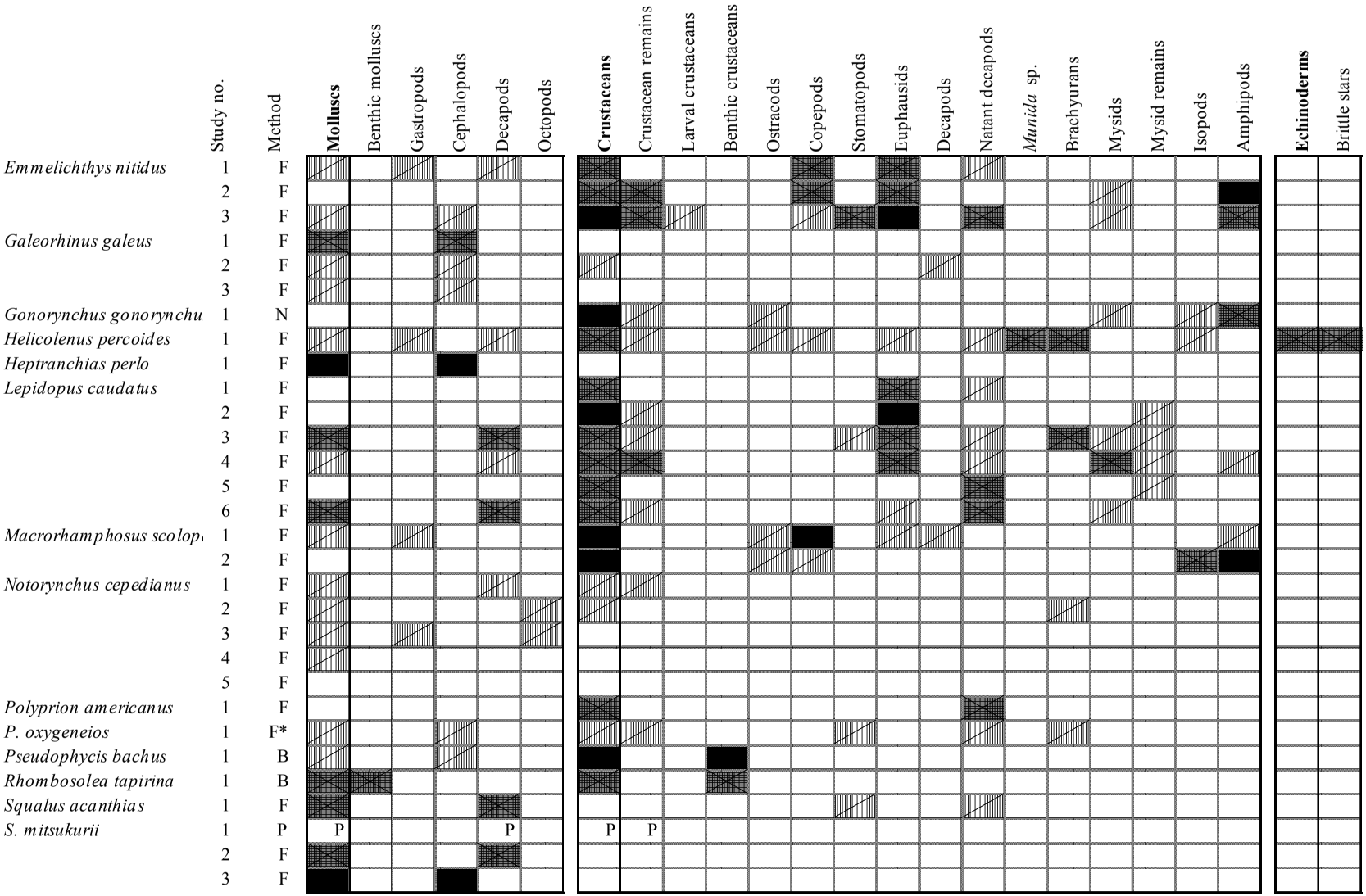
Table A2b: Southern Hemisphere shelf (100–400 m). n, numbers of stomachs examined; P, presence of a food item in the stomach; , ≤ 10% importance in diet; , 11 to 50 % importance in diet; , >51 % importance in diet.

	Study no.	Study area	No. stomachs	No. empty (%)	Fish length (cm)	Method	Extraneous matter	Foraminiferans	Coelenterates	Tunicates	Bryozoans	Polychaetes	Chaetognaths	Molluscs	Crustaceans	Echinoderms	Chondrichthyes	Osteichthyes	Cetacean remains	Pinniped remains	Reference
Emmelichthys nitidus	1	WC S Africa	1615		12–36	F															Roshchin 1986
	2	WC S Africa	48	8	14–49	F															Meyer & Smale 1991a
	3	WC S Africa	82	8	14–49	F															Meyer & Smale 1991a
Galeorhinus galeus	1	Argentina	12	17		F															Menni et al. 1982*
	2	Argentina	18	33		F															Menni et al. 1982*
	3	S Africa	5	40		F															Sauer & Smale 1991*
Gonorynchus gonorynchu	1	S Africa	62	21	31–42	N															Meyer & Smale 1991b
Helicolenus percoides	1	E Tasmania	948	28	8–38	F															Blaber & Bulman 1987
Heptranchias perlo	1	S Africa	10	40		F															Bass et al. 1975*
Lepidopus caudatus	1	E Tasmania	78	24	97–149	F															Blaber & Bulman 1987
	2	SC, S Africa	75	18	24–60	F															Meyer & Smale 1991a
	3	SC, S Africa	40	18	85–134	F															Meyer & Smale 1991a
	4	WC, S Africa	66	18	34–60	F															Meyer & Smale 1991a
	5	WC, S Africa	19	18	60–85	F															Meyer & Smale 1991a
	6	WC, S Africa	37	18	85–124	F															Meyer & Smale 1991a
Macrorhamphosus scolop	1	SE Australia - plank. prey	111			F															Clarke 1985
	2	SE Australia - benthic prey	71			F															Clarke 1985
Notorynchus cepedianus	1	E Cape, S Africa	91	30		F															Ebert 1991
	2	W Cape, S Africa	103	29		F															Ebert 1991
	3	Namibia	94	32		F															Ebert 1991
	4	Namibia	46	33		F															Ebert 1991
	5	Argentina	5			F															Menni et al. 1982*
Polyprion americanus	1	Argentina	20	60	59–79	F															Menni & Lopez 1979
P. oxygeneios	1	SE Pacific	138	13	65–115	F*															Rojas et al. 1985
Pseudophycis bachus	1	S Australia	69			B															Edgar & Shaw 1995
Rhombosolea tapirina	1	S Australia	43			B															Edgar & Shaw 1995
Squalus acanthias	1	S Africa	176	31	32–91	F															Ebert et al. 1992
S. mitsukurii	1	SE Pacific	110	66		P								P	P		P	P			Litvinov 1990
	2	S Africa	271	22	23–102	F															Ebert et al. 1992
	3	S Africa	1			F															Lipinsky et al. 1992*

Table A2b (continued)

	Study no.	Study area	No. stomachs	No. empty (%)	Fish length (cm)	Method	Unidentified	Extraneous matter	Coelenterates	Polychaetes	Chaetognaths	Molluscs	Crustaceans	Echinoderms	Osteichthyes	Reference
Trachurus declivis	1	S Australia - summer	550	24	11–35	F										Stevens et al 1984
	2	S Australia - spring	143	48	11–35	F										Stevens et al 1984
	3	S Australia - winter	485	31	11–35	F										Stevens et al 1984
	4	E Tasmania	169	7	21–37	F										Blaber & Bulman 1987
T. murphyi	1	Peru	92	11	32–38	F										Konchina 1978
	2	Peru	280	10	22–62	F										Konchina 1979
	3	Peru	2381	45	23–64	F										Konchina 1980
Zenopsis nebulosus	1	SE Pacific	20		25–46	F										Parin et al. 1988
	2	SE Pacific	36		27–33	F										Parin et al. 1988
	3	SE Pacific	11		26–40	F										Parin et al. 1988
	4	SE Pacific	5		26–41	F										Parin et al. 1988

Table A2b (continued)



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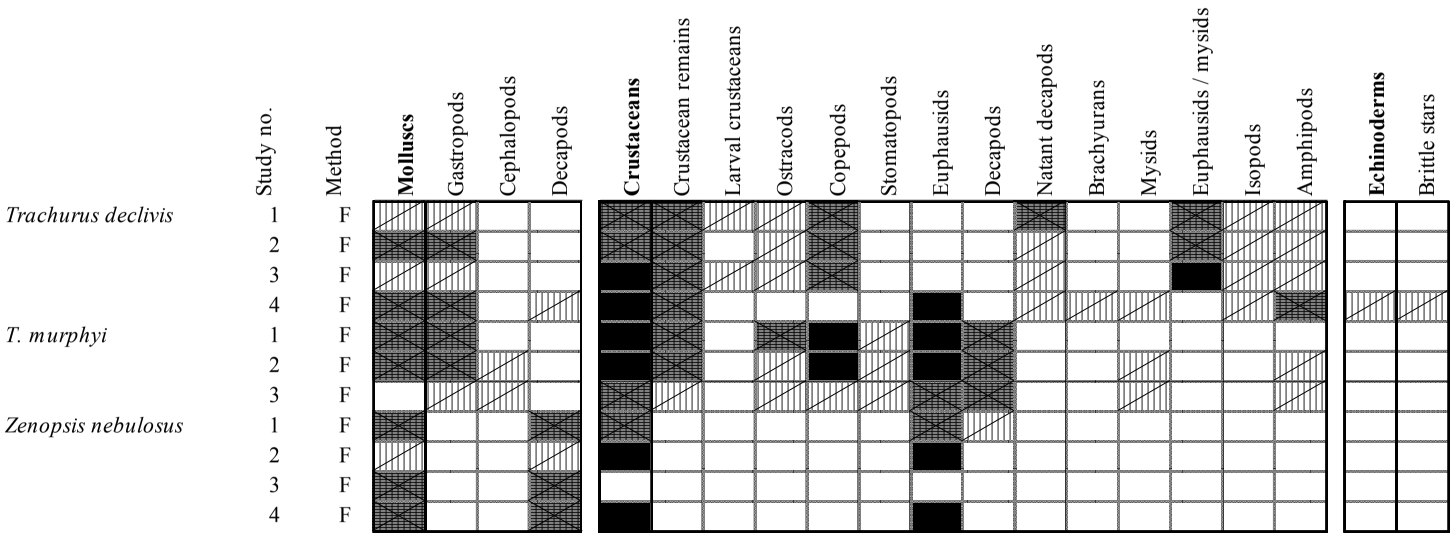

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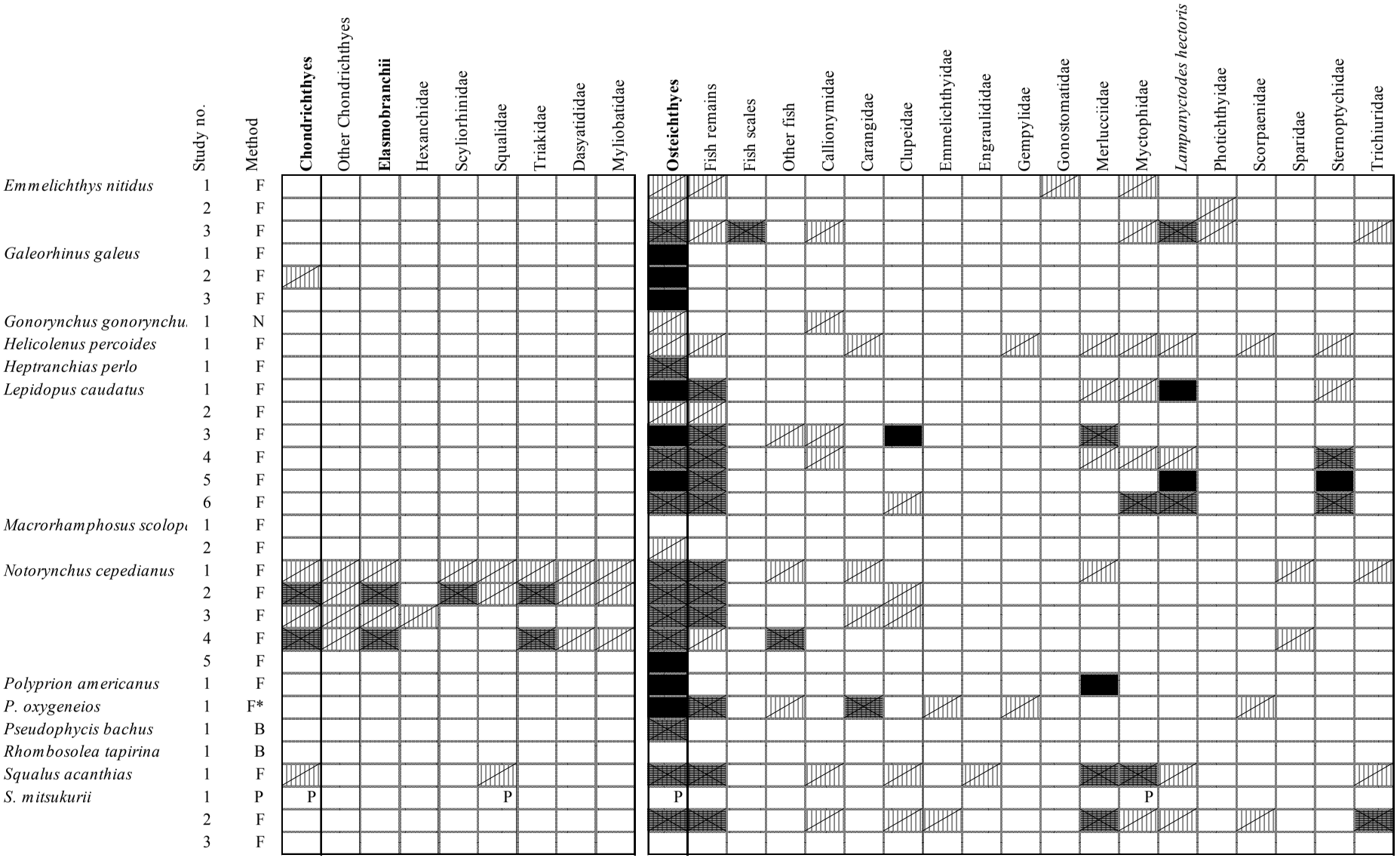

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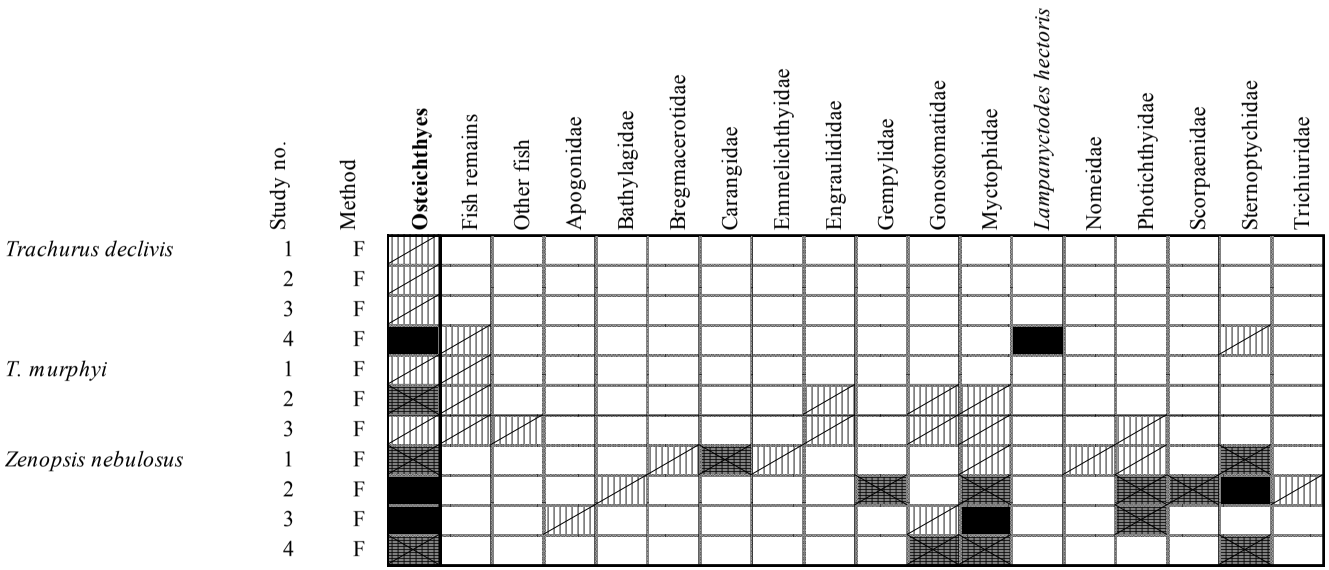


Table A2c: Northern Hemisphere shelf (100–400 m). n, numbers of stomachs examined; P, presence of a food item in the stomach; , ≤ 10% importance in diet; , 11 to 50 % importance in diet; , >51 % importance in diet.

	Study no.	Study area	No. stomachs	No. empty (%)	Fish length (cm)	Method	Unidentified	Molluscs	Crustaceans	Chondrichthyes	Osteichthyes	Marine mammals	Reference
Alopias vulpinus	1	Mediterranean	4			F							Capape 1975*
	2	NE Atlantic	1			F							Pascoe 1986*
	3	Mexico	926	59		F							Castillo et al. 1992*
Cephaloscyllium isabellum	1	NW Pacific	356	28		F							Taniuchi 1988
Galeorhinus galeus	1	Mediterranean	1			F							Capape 1975*
	2	NE Atlantic	169		< 105	F							Gomes et al. 1998
	3	N Atlantic	46	9		F							Ellis et al. 1996*
Heptranchias perlo	1	Mediterranean	9	22		F							Capape 1975*
Lepidopus caudatus	1	Mediterranean	145		20–69	W							Macpherson 1981
	2	NE Atlantic	70		74–173	F							Gomes et al. 1998
Notorynchus cepedianus	1	NE Pacific	38			F							Ebert 1989*
Polyprion americanus	1	N Atlantic				P					P		Vinnichenko 1997
Squalus mitsukurii	1	C Pacific	293	66		F							Wilson & Seki 1994

Table A2c (continued)

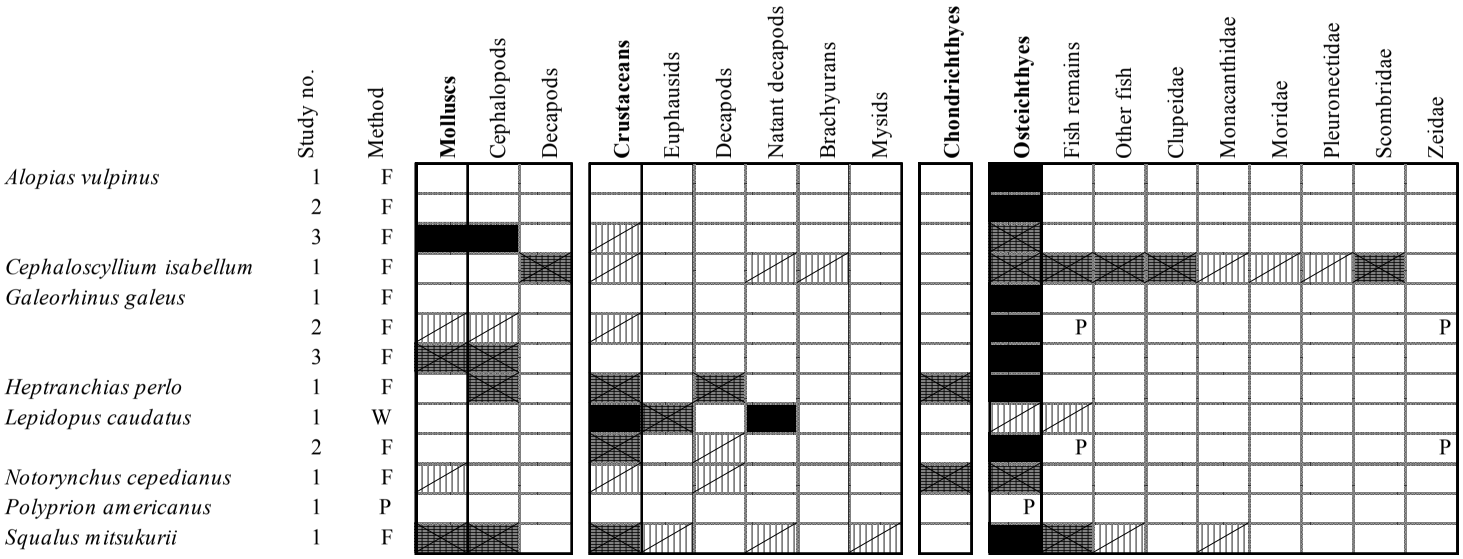


Table A3a: New Zealand upper slope (400–700 m). n, numbers of stomachs examined; P, presence of a food item in the stomach; ▨, ≤ 10% importance in diet; ▩, 11 to 50 % importance in diet; ■, >51 % importance in diet.

	Study no.	Study area	No. stomachs	No. empty (%)	Fish length (cm)	Method	Unidentified	Extraneous matter	Tunicates	Polychaetes	Chaetognaths	Molluscs	Crustaceans	Echinoderms	Osteichthyes	Reference
Argentina elongata	1	Otago				P				P			P		P	Graham 1938, 1953
	2	Campbell Plateau	132			F	▩		■	▨		▨	▨	▨		Clark 1985
Caelorinchus aspercephalus	1	Campbell Plateau	46		21–60	F			▩	▩	▩	▨	▩		▩	Clark 1985
C. oliverianus	1	SW Chatham Rise	10			F							■			Clark et al 1989
Centriscops humerosus	1	Otago				P							P			Graham 1938, 1953
Genypterus blacodes	1	Otago, Milford Sound	6	83		P									P	Thomson 1891
	2	Otago	100's			P						P	P		P	Thomson & Anderton 1921
	3	CKST	6	17		P									P	Phillipps 1926
	4	Otago	500+			P		P		P		P	P		P	Graham 1938, 1953
	5	North Island	57	30	40–160	F							■		■	Mitchell 1984
	6	Chatham Rise	300	34	30–140	F						▨	■		■	Mitchell 1984
	7	WCSI	56	36	60–150	F						▨	▩		■	Mitchell 1984
	8	Campbell Plat./Pukaki Rise	126	34	40–120	F						▨	▩		■	Mitchell 1984
	9	Campbell Plateau	50		70–130	F						▨	▩		▩	Clark 1985
Gollum attenuatus	1	New Zealand	747	33		IRI	▩	▨				▩	▩		■	Yano 1993
Helicolenus percoides	1	Otago				P							P			Thomson & Anderton 1921
	2	Otago	300+			P				P			P		P	Graham 1938, 1953
Hoplostethus mediterraneus	1	northern New Zealand	173		5–18	F							▩		▩	Kerstan 1989
Hyperoglyphe antarctica	1	Otago	200+			P			P			P	P		P	Graham 1938, 1953
Lepidorhynchus denticulatus	1	Campbell Plateau	82		26–50	F	▨		▨		▩	▩	■		▨	Clark 1985
	2	SW Chatham Rise	40			F					▩		■		▩	Clark et al 1989
Macruronus novaezelandiae	1	Otago				P									P	Thomson & Anderton 1921
	2	CKST	5			P									P	Phillipps 1926
	3	Otago	4		25–125	P						P			P	Graham 1938, 1953
	4	East region	507	50*		F	▩	▩					▩		▩	Kuo & Tanaka 1984
	5	Northwest region	207	60*		F		▩	▨				▩		▩	Kuo & Tanaka 1984
	6	South region	451			F		▨	▨				▩		▩	Kuo & Tanaka 1984
	7	Campbell Plateau	544		40–100	F			▩		▨		▩		▩	Clark 1985
Merluccius australis	1	Otago				P						P	P		P	Graham 1938, 1953

Table A3a (continued)

	Study no.	Study area	No. stomachs	No. empty (%)	Fish length (cm)	Method	Unidentified	Extraneous matter	Tunicates	Polychaetes	Chaetognaths	Mollusks	Crustaceans	Echinoderms	Osteichthyes	Reference
Micromesistius australis	1	Bounty Rise	101		♂	F										Shpak 1976
	2	Bounty Rise			♀♂	F										Shpak 1976
	3	Pukaki Rise	110		♂	F										Shpak 1976
	4	Pukaki Rise			♀	F										Shpak 1976
	5	Campbell Plateau	231		♂	F										Shpak 1976
	6	Campbell Plateau			♀	F										Shpak 1976
	7	Campbell Plateau	65		15–20	F										Shpak 1976
	8	Campbell Plateau	475		16–54	F										Clark 1985
Neophrynichthys latus	1	Otago				P				P			P		P	Graham 1938, 1953
Paranotothenia microlepidota	1	Snares Islands	3	0	juv.	F										Fenwick 1978
	2	Campbell Plateau	56		20–70	F										Clark 1985
Seriolella caerulea	1	South Island	224		30–64	W										Gavrilov & Markina 1979

Table A3a (continued)

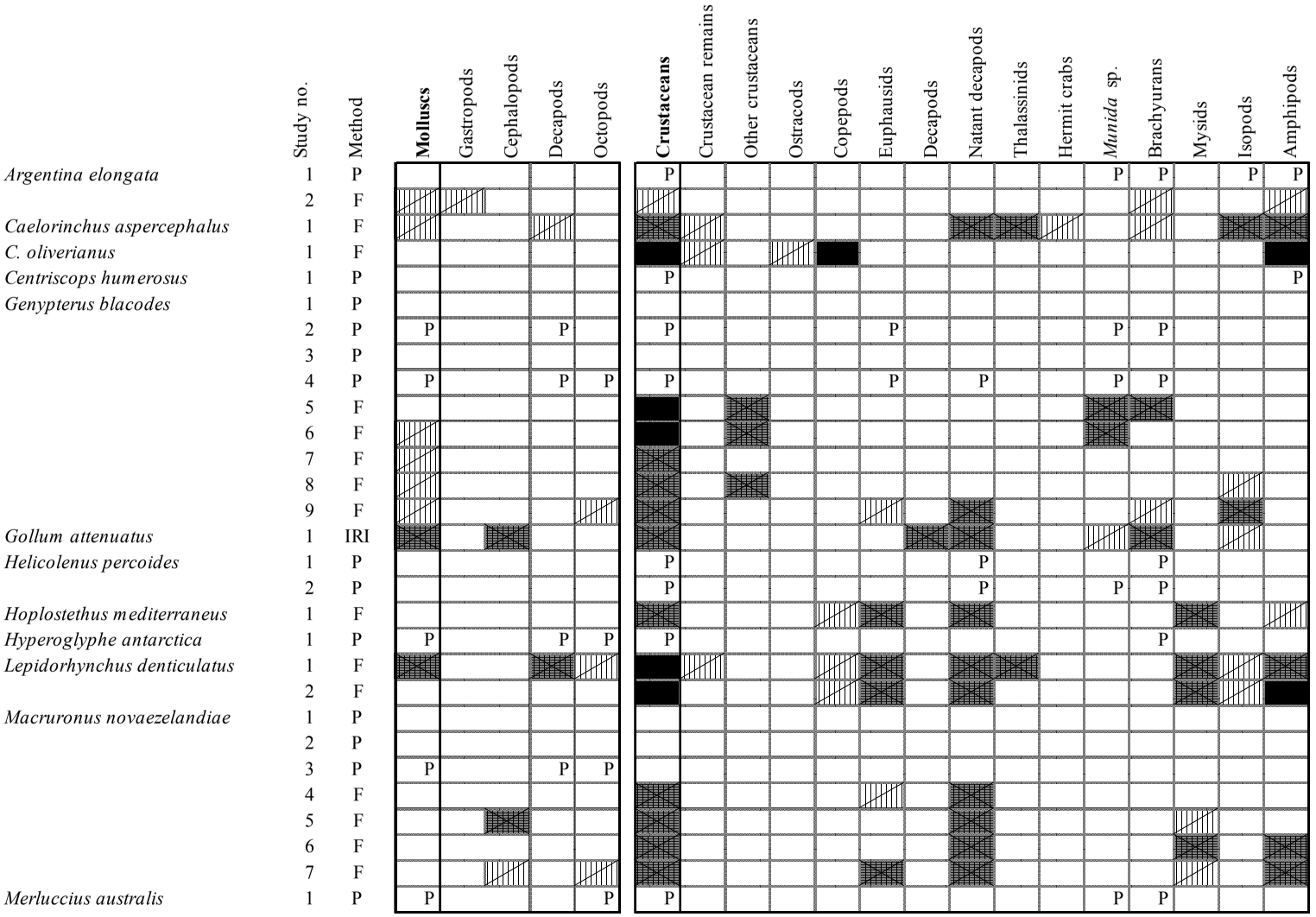
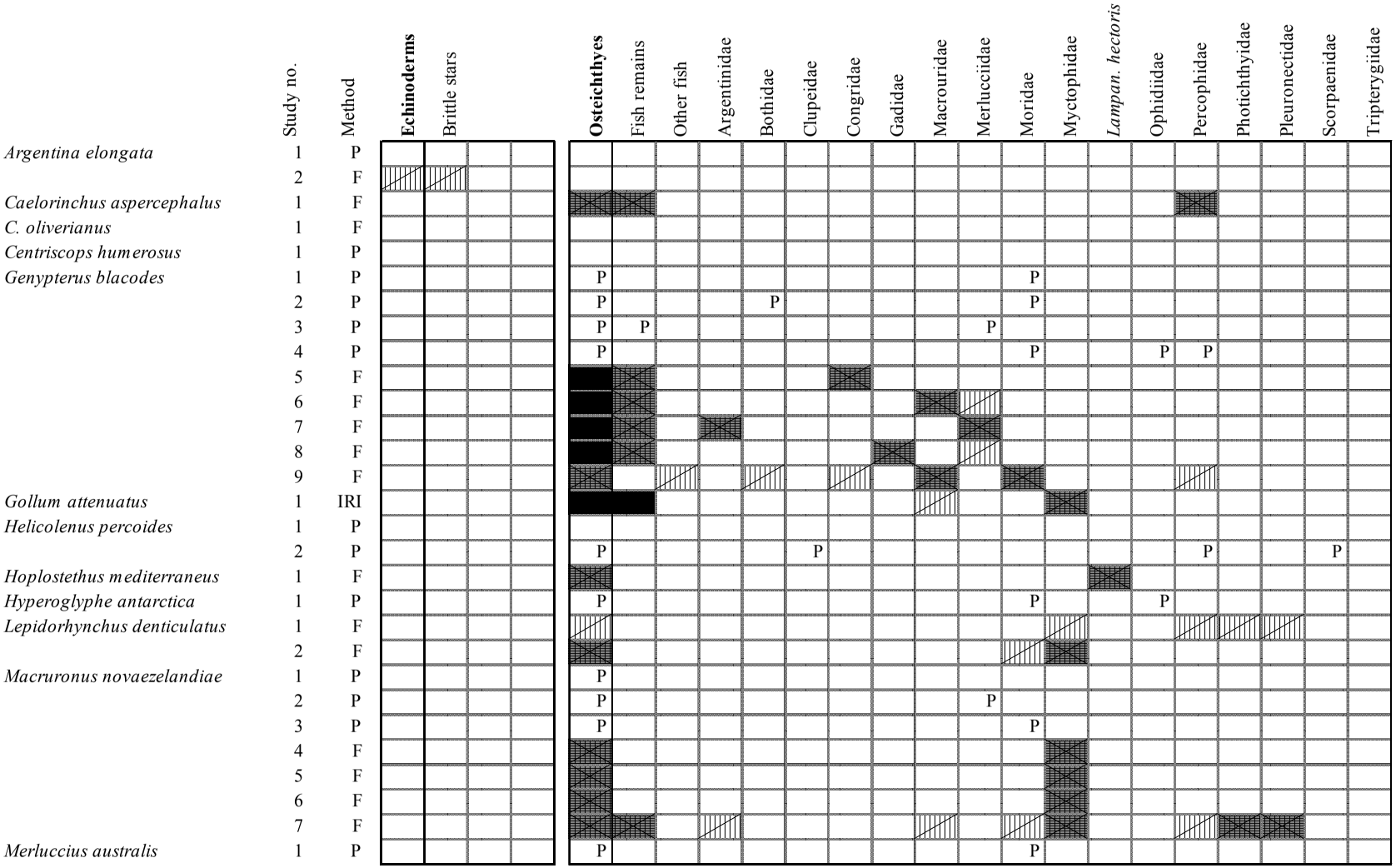


Table A3a (continued)

	Study no.	Method	**Molluscs**	Gastropods	Cephalopods	Decapods	Octopods	**Crustaceans**	Crustacean remains	Other crustaceans	Ostracods	Copepods	Euphausids	Decapods	Natant decapods	Thalassinids	Hermit crabs	*Munida* sp.	Brachyurans	Mysids	Isopods	Amphipods
Micromesistius australis	1	F																				
	2	F																				
	3	F																				
	4	F																				
	5	F																				
	6	F																				
	7	F																				
	8	F																				
Neophrynichthys latus	1	P						P											P			
Paranotothenia microlepidota	1	F																				
	2	F																				
Seriolella caerulea	1	W																				

Table A3a (continued)



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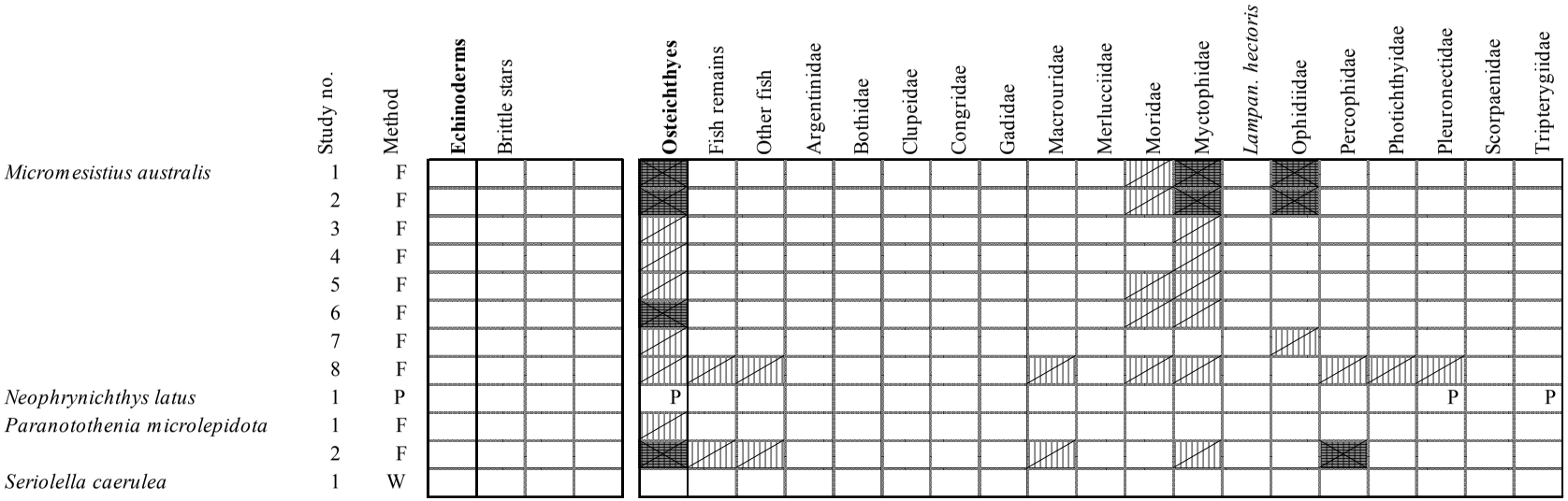


Table A3b: Southern Hemisphere upper slope (400–700 m). n, numbers of stomachs examined; P, presence of a food item in the stomach; , ≤ 10% importance in diet; , 11 to 50 % importance in diet; , >51 % importance in diet.

	Study no.	Study area	No. stomachs	No. empty (%)	Fish length (cm)	Method	Unidentified	Coelenterates	Tunicates	Polychaetes	Chaetognaths	Molluscs	Crustaceans	Osteichthyes	Reference
B. splendens	1	SE Pacific	59		15–31	W									Dubochkin & Kotlyar 1989
Brama brama	1	E Tasmania	129	7	24–48	F									Blaber & Bulman 1987
Cyttus traversi	1	E Tasmania	433	43	9–56	F									Blaber & Bulman 1987
Epigonus denticulatus	1	S Africa	59	12	10–18	F									Meyer & Smale 1991a
	2	S Africa	49	12	18–22	F									Meyer & Smale 1991a
Genypterus blacodes	1	E Tasmania	449	46	45–130	F									Blaber & Bulman 1987
Hyperoglyphe antarctica	1	SE Australia	78	45		F									Winstanley 1978
Lampanyctodes hectoris	1	E Tasmania	975	19	3–7	F									Young & Blaber 1986
Lepidorhynchus denticulatus	1	E Tasmania	655	15	8–51	F									Blaber & Bulman 1987
Macruronus novaezelandiae	1	E Tasmania	243	8	15–29	F									Bulman & Blaber 1986
	2	E Tasmania	841	32	30–120	F									Bulman & Blaber 1986
	3	Bass Strait	452	38	30–120	F									Bulman & Blaber 1986
	4	WC Tasmania	303	42	30–120	F									Bulman & Blaber 1986
Maurolicus muelleri	1	E Tasmania	719	22	2–6	F									Young & Blaber 1986
	2	SE Pacific	59	0		F									Gorelova & Krasil'nikova 1990
	3	S Africa	57	0	3–4	F									Gorelova & Krasil'nikova 1990
Merluccius australis	1	Chile, S Pacific			51–60	W									Paya 1992
	2	Chile, S Pacific			61–70	W									Paya 1992
	3	Chile, S Pacific			71–80	W									Paya 1992
	4	Chile, S Pacific			81–90	W									Paya 1992
	5	Chile, S Pacific			91–100	W									Paya 1992

Table A3b (continued)

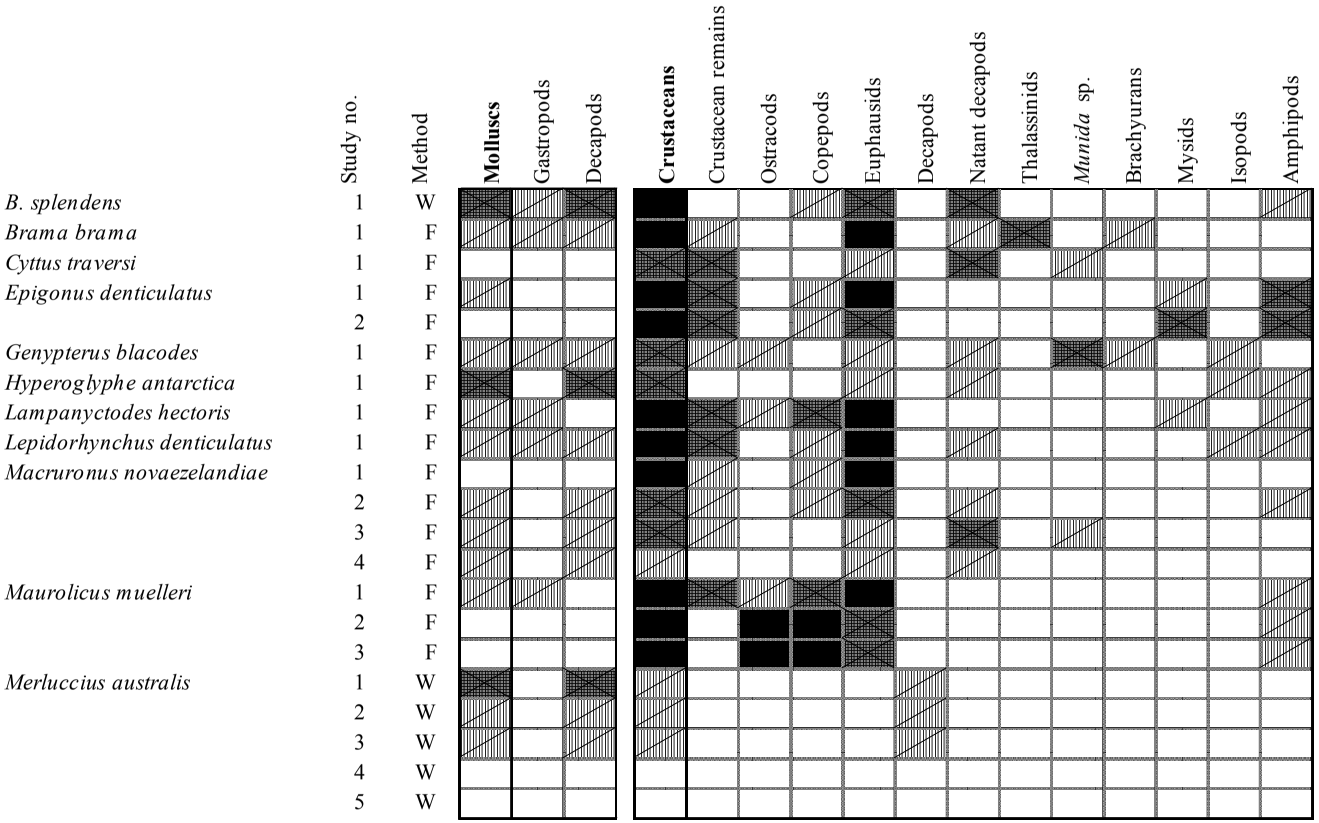


Table A3b (continued)

	Study no.	Method	**Osteichthyes**	Fish remains	Fish eggs	Callionymidae	Gadidae	Macrouridae	*Coelorinchus* spp.	*Lepidorhynchus denticulatus*	Merlucciidae	Moridae	*Diaphus spp.*	*Lampanyctodes hectoris*	Scorpaenidae	Sternoptychidae
B. splendens	1	W														
Brama brama	1	F														
Cyttus traversi	1	F														
Epigonus denticulatus	1	F														
	2	F														
Genypterus blacodes	1	F														
Hyperoglyphe antarctica	1	F														
Lampanyctodes hectoris	1	F														
Lepidorhynchus denticulatus	1	F														
Macruronus novaezelandiae	1	F														
	2	F														
	3	F														
	4	F														
Maurolicus muelleri	1	F														
	2	F														
	3	F														
Merluccius australis	1	W														
	2	W														
	3	W														
	4	W														
	5	W														

Table A3c: Northern Hemisphere upper slope (400–700 m). n, numbers of stomachs examined; P, presence of a food item in the stomach; ▨, ≤ 10% importance in diet; ▩, 11 to 50 % importance in diet; ■, >51 % importance in diet.

	Study no.	Study area	No. stomachs	No. empty (%)	Fish length (cm)	Method	Unidentified	Extraneous matter	Coelenterates	Tunicates	Polychaetes	Chaetognaths	Molluscs	Crustaceans	Osteichthyes	Reference
Beryx decadactylus	1	NE Atlantic	1		25	P								P		Mauchline & Gordon 1984a
	2	NE Atlantic	46		23–48	F							▩	▩	■	Gomes et al. 1998
B. splendens	1	Atlantic	67		16–33	W				▩			▨	▩	▩	Dubochkin & Kotlyar 1989
	2	NE Atlantic	294		18–39	F				▩			▩	▩	■	Gomes et al. 1998
	3	NW Atlantic				P							P	P	P	Vinnichenko 1997
Caelorinchus fasciatus	1		6		< 31	P					P		P	P		McLellan 1977
Centrolophus niger	1	Irish Sea	1		47	P			P					P	P	McKee 1981
Etmopterus lucifer	1	NW Pacific	230			F							■	▩	▩	Baba et al. 1987*
Hoplostethus mediterraneus	1	NE Atlantic	23		5–24	P								P		Marshall & Merrett 1977
	2	NE Atlantic	51	20	25–43	F								■	▩	Du Buit 1978
	3	NW Atlantic				P								P	P	Vinnichenko 1997
Lepidorhynchus denticulatus	1	Atlantic	4			P								P		McLellan 1977
Malacocephalus laevis	1	NW Pacific	9		< 52	P		P					P			McLellan 1977
	2	N Atlantic				P							P			McLellan 1977
	3	NE Atlantic	24	38	33–54	F	▩					▨	▨	■	■	Mauchline & Gordon 1984b
Maurolicus muelleri	1	NE Atlantic	180	27	1–5	F	▩		▨				▨	■		Mauchline & Gordon 1983b

Table A3c (continued)

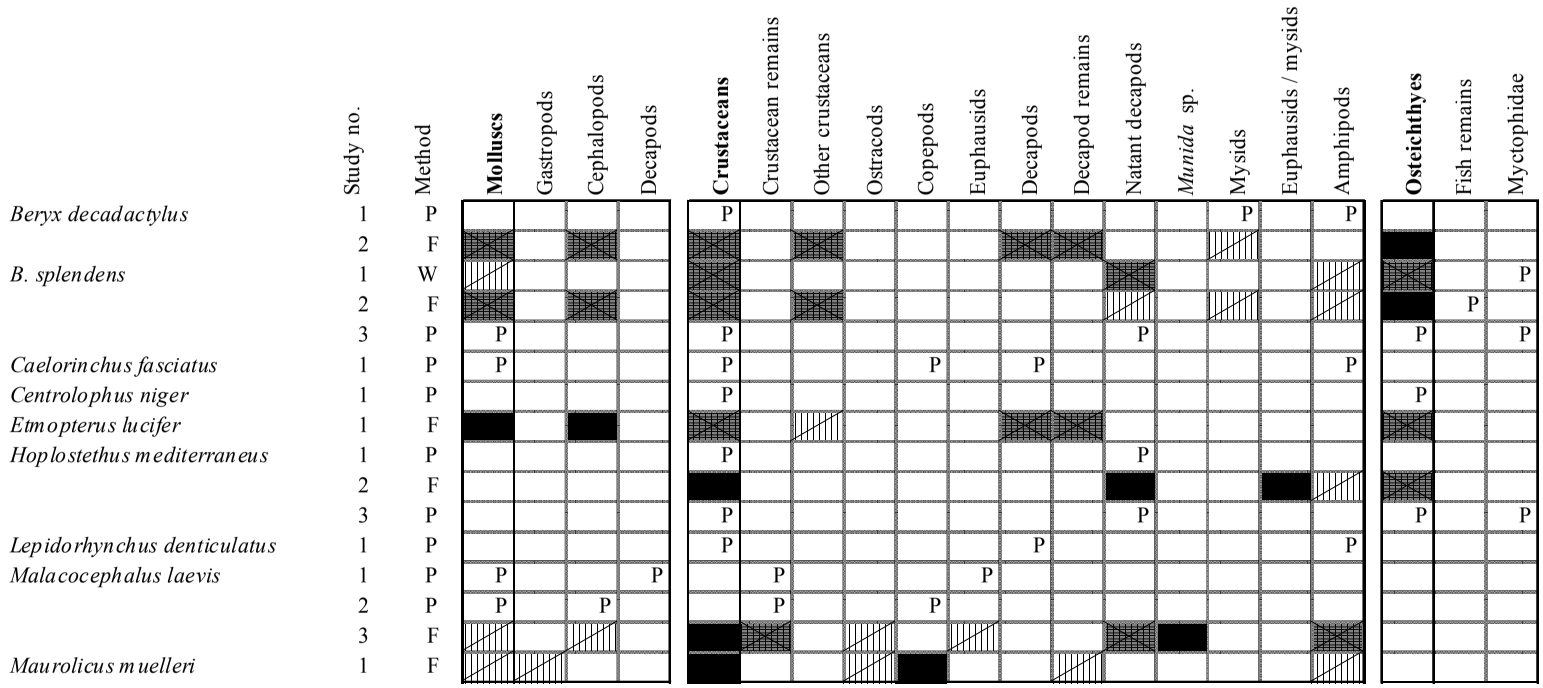


Table A4a: New Zealand mid slope (> 700 m). n, numbers of stomachs examined; P, presence of a food item in the stomach; , ≤ 10% importance in diet; , 11 to 50 % importance in diet; , >51 % importance in diet.

	Study no.	Study area	No. stomachs	No. empty (%)	Fish length (cm)	Method	Coelenterates	Tunicates	Polychaetes	Molluscs	Crustaceans	Echinoderms	Osteichthyes	Reference
Alepocephalus australis	1	SW Chatham Rise	26			F								Clark et al 1989
Allocyttus niger	1	SW Chatham Rise	329			F								Clark et al 1989
Caelorinchus fasciatus	1	SW Chatham Rise	21			F								Clark et al 1989
Coryphaenoides subserrulatus	1	SW Chatham Rise	23			F								Clark et al 1989
Deania calcea	1	North Island	63			F								Clark & King 1989
Diastobranchus capensis	1	SW Chatham Rise	10			F								Clark et al 1989
Etmopterus baxteri	1	SW Chatham Rise	117			F								Clark et al 1989
Hoplostethus atlanticus	1	Chatham Rise	33			N								Rosecchi et al 1988
	2	Challenger - March	210	~42		F								Rosecchi et al 1988
	3	Challenger - July	392	~60		F								Rosecchi et al 1988
	4	Challenger - Nov.	85	~38		F								Rosecchi et al 1988
	5	Challenger - Total	687		9–40	N								Rosecchi et al 1988
Macrourus carinatus	1	SW Chatham Rise	34			F								Clark et al 1989
Pseudocyttus maculatus	1	SW Chatham Rise	242			F								Clark et al 1989

Table A4a (continued)

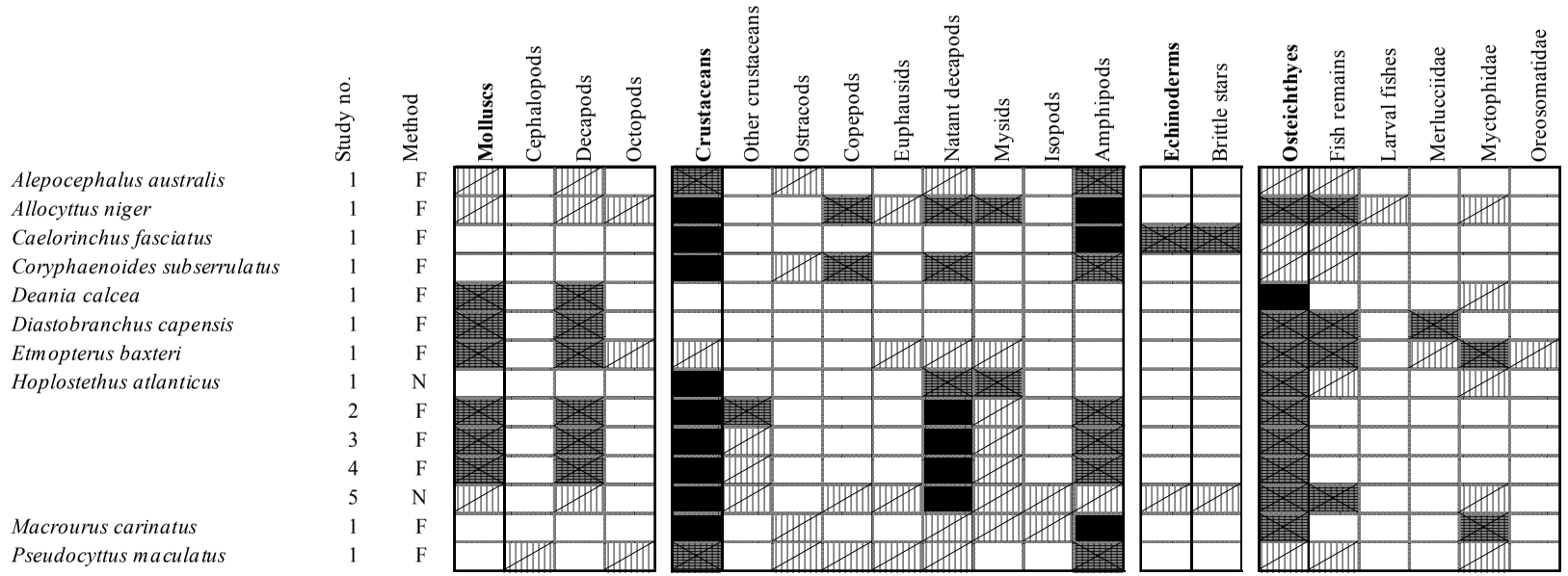


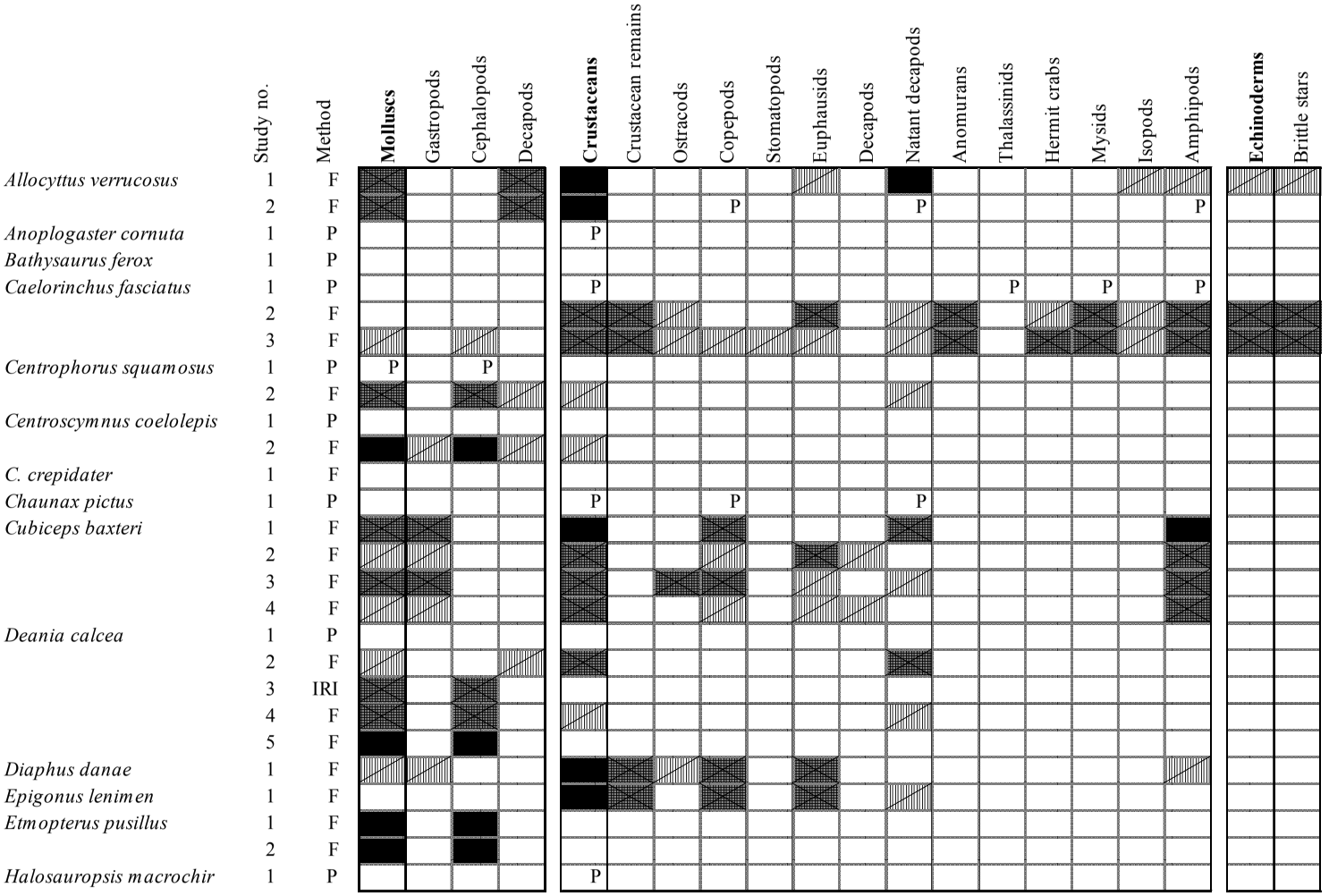
Table A4b: Southern Hemisphere mid slope (> 700 m). n, numbers of stomachs examined; P, presence of a food item in the stomach; , ≤ 10% importance in diet; , 11 to 50 % importance in diet; , >51 % importance in diet.

	Study no.	Study area	Nio. Stomachs	No. empty (%)	Fish length (cm)	Method	Unidentified	Coelenterates	Tunicates	Polychaetes	Chaetognaths	Molluscs	Crustaceans	Echinoderms	Chondrichthyes	Osteichthyes	Cetacean remains	Reference
Allocyttus verrucosus	1	S Africa	1802		10–42	F												Mel'nikov 1981
	2	SE Australia	3173	50	10–38	F												Lyle & Smith 1997
Anoplogaster cornuta	1	W Africa				P							P			P		Daveport 1993
Bathysaurus ferox	1	NW Africa	1	0	50	P										P		Marshall & Merrett 1977
Caelorinchus fasciatus	1	Namibia	714		15–29	P				P			P					Macpherson 1985
	2	S Africa	61	26	small	F												Meyer & Smale 1991b
	3	S Africa	110	26	large	F												Meyer & Smale 1991b
Centrophorus squamosus	1	NW Africa	1		121	P						P						Marshall & Merrett 1977
	2	S Africa	21	14	43–131	F												Ebert et al. 1992
Centroscymnus coelolepis	1	NW Africa	4		66–102	P										P		Marshall & Merrett 1977
	2	S Africa	93	24	32–110	F												Ebert et al. 1992
C. crepidater	1	S Africa	6	33	53–88	F												Ebert et al. 1992
Chaunax pictus	1	NW Africa	5		5–21	P							P					Marshall & Merrett 1977
Cubiceps baxteri	1	WC S America, EC Aust.	40	3	4–9	F												Gorelova et al 1994
	2	WC S America, EC Aust.	50	8	10–19	F												Gorelova et al 1994
	3	WC S America, S Africa	56	50	4–9	F												Gorelova et al 1994
	4	WC S America, S Africa			16–23	F												Gorelova et al 1994
Deania calcea	1	NW Africa	8		66–94	P										P		Marshall & Merrett 1977
	2	E Tasmania	64	57	42–105	F												Blaber & Bulman 1987
	3	Namibia	61			IRI												Yano 1991*
	4	S Africa	81	23	56–108	F												Ebert et al. 1992
	5	Southern Africa	2			F												Lipinski et al. 1992*
Diaphus danae	1	E Tasmania	538	7	3–12	F												Young & Blaber 1986
Epigonus lenimen	1	E Tasmania	597	40	10–19	F												Blaber & Bulman 1987
Etmopterus pusillus	1	S Africa	5		39–46	F												Ebert et al. 1992
	2	S Africa	7			F												Bass et al. 1976*
Halosauropsis macrochir	1	NW Africa	5		15–27	P				P			P					Marshall & Merrett 1977

Table A4b (continued)

	Study no.	Study area	Nio. Stomachs	No. empty (%)	Fish length (cm)	Method	Unidentified	Coelenterates	Tunicates	Polychaetes	Chaetognaths	Molluscs	Crustaceans	Echinoderms	Chondrichthyes	Osteichthyes	Cetacean remains	Reference
Hoplostethus atlanticus	1	SE Aust - 88 juv	3157	57	<30	W												Bulman & Koslow 1992
	2	SE Aust - 88 adults	1416	51	>30	W												Bulman & Koslow 1992
	3	SE Aust - 89 juv	1929	65	<30	W												Bulman & Koslow 1992
	4	SE Aust - 89 adults	984	68	>30	W												Bulman & Koslow 1992
Malacocephalus laevis	1	S Africa	54	39	small	F												Meyer & Smale 1991b
	2	S Africa	14	39	large	F												Meyer & Smale 1991b
Neocyttus rhomboidalis	1	E Tasmania	165	61	24–37	F												Blaber & Bulman 1987
	2	SE Australia	1427	96	9–41	F												Lyle & Smith 1997

Table A4b (continued)



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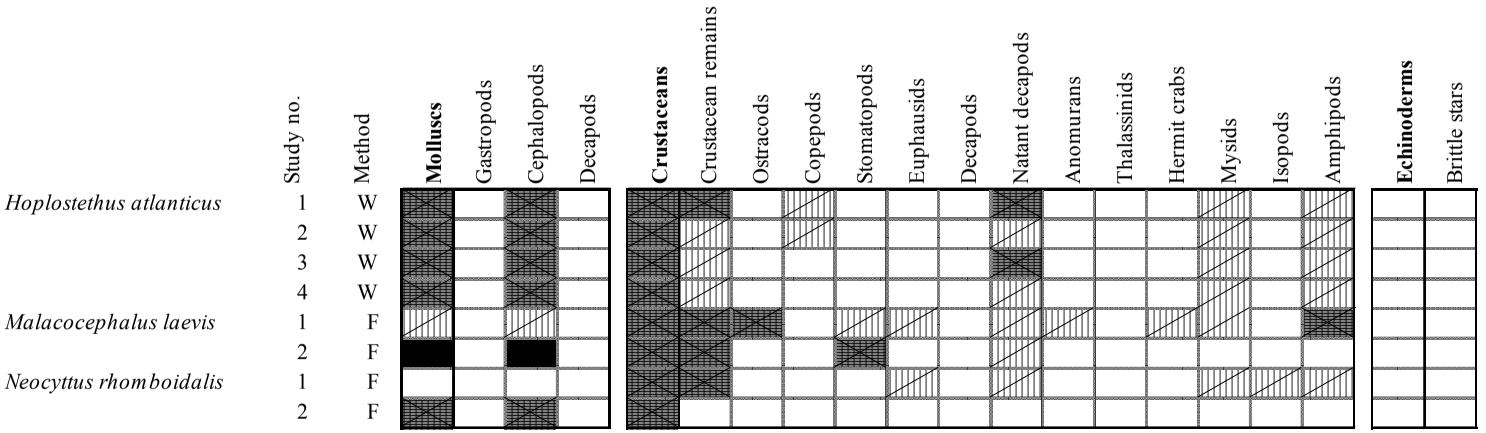

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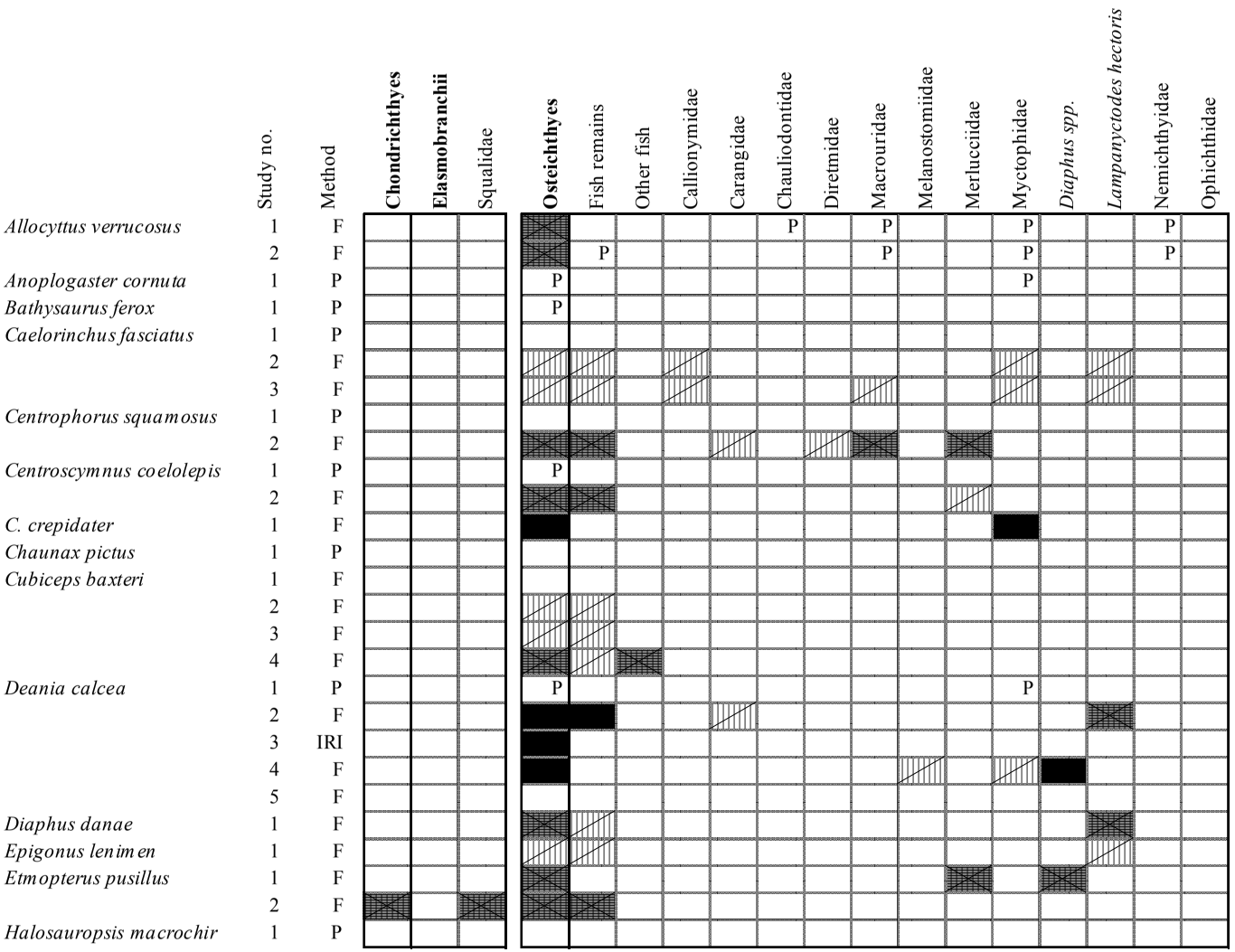

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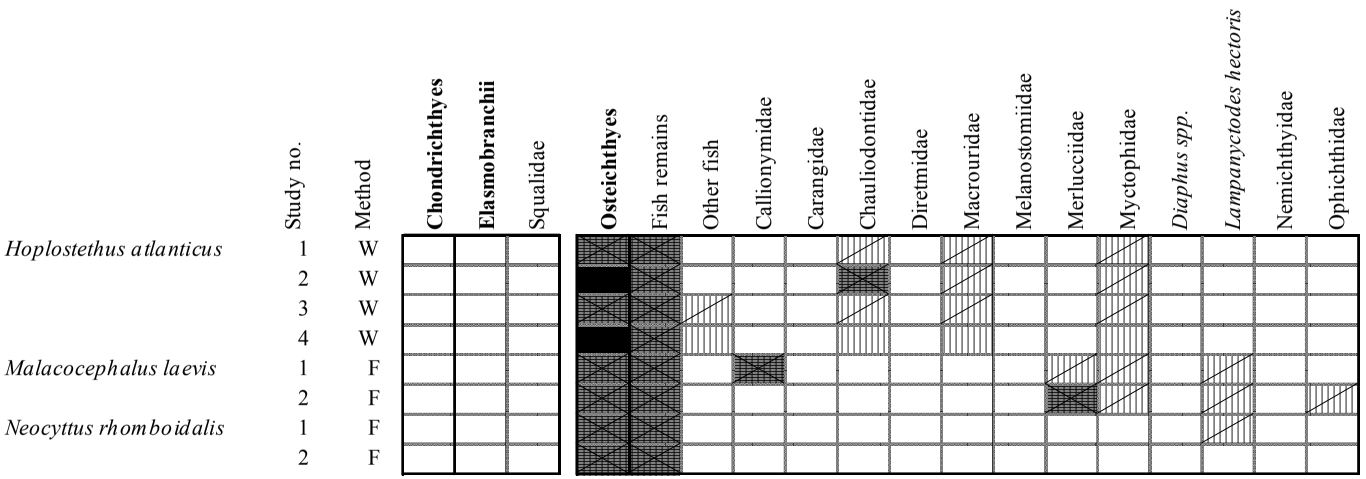


Table A4c: Northern Hemisphere mid slope (> 700 m). n, numbers of stomachs examined; P, presence of a food item in the stomach; ▨, ≤ 10% importance in diet; ▩, 11 to 50 % importance in diet; ■, >51 % importance in diet.

	Study no.	Study area	No. stomachs	No. empty (%)	Fish length (cm)	Method	Unidentified	Extraneous matter	Foraminiferans	Coelenterates	Tunicates	Polychaetes	Chaetognaths	Molluscs	Crustaceans	Echinoderms	Chondrichthyes	Osteichthyes	Cetacean remains	Reference
Alepisaurus ferox	1	NW Pacific	73	1		N		▩			▩	▨		▨	▩			▩		Kubota 1977
	2	C Pacific	42			F						▩		■	■			■		Moteki et al. 1992
	3	C Pacific	24			F					▨	▨		▩	▨			■		Moteki et al. 1992
Antimora rostrata	1	W Atlantic	10	30	29–50	P								P	P					Sedberry & Musick 1978
	2	NE Atlantic	153	89	8–46	F	■							▩	▨			▩		Mauchline & Gordon 1984c
Aristomias spp.	1	C Pacific	17	71	33–140	I												▨		Clarke 1982
Astronesthes indicus	1	C Pacific	154	75	2–6	I									■					Clarke 1982
	2	C Pacific	18	83	6–15	I												▨		Clarke 1982
A. splendidus	1	C Pacific	61	0	2–10	I									▨			▩		Clarke 1982
Bathysaurus ferox	1	SE Atlantic	1	0	50	P												P		Marshall & Merrett 1977
	2	W Atlantic	14	50	17–61	F	▩	▩							▩			■		Sedberry & Musick 1978
	3	W Atlantic	30	53		F						▨			▨			■		Sulak et al. 1985
Caelorinchus innotabilis	1		3		< 28	P						P		P						McLellan 1977
Centrophorus squamosus	1	SE Atlantic	1		121	P								P						Marshall & Merrett 1977
	2	NE Atlantic	18	50	111–148	F												■		Mauchline & Gordon 1983a
	3	NE Atlantic	1			F								■						Lipinski et al. 1992*
Centroscymnus coelolepis	1	NE Atlantic	12		67–106	F	▨	▨						■			▨		▩	Clarke & Merrett 1972
	2	SE Atlantic	4		66–102	P												P		Marshall & Merrett 1977
	3	W Atlantic	5	40	37–50	F								▩				■		Sedberry & Musick 1978
	4	NE Atlantic	18	72	88–149	F	▩			▩				▩			▩	■		Mauchline & Gordon 1983a
	5	NW Pacific	64	~80	64–109	P		P						P				P		Yano & Tanaka 1984
	6	Mediterranean	69	36	19–39	F	▨	▨						■	▩			▩		Carrasson et al. 1992
	7	Mediterranean	17	41	40–75	F			▨					■				▩	▨	Carrasson et al. 1992
	8	NE Atlantic	2			F								■						Lipinski et al. 1992*
C. crepidater	1	NE Atlantic	23	48	26–79	F								▩	▨			▩		Mauchline & Gordon 1983a
C. owstoni	1	NW Pacific	336	~80	38–117	P		P						P				P		Yano & Tanaka 1984

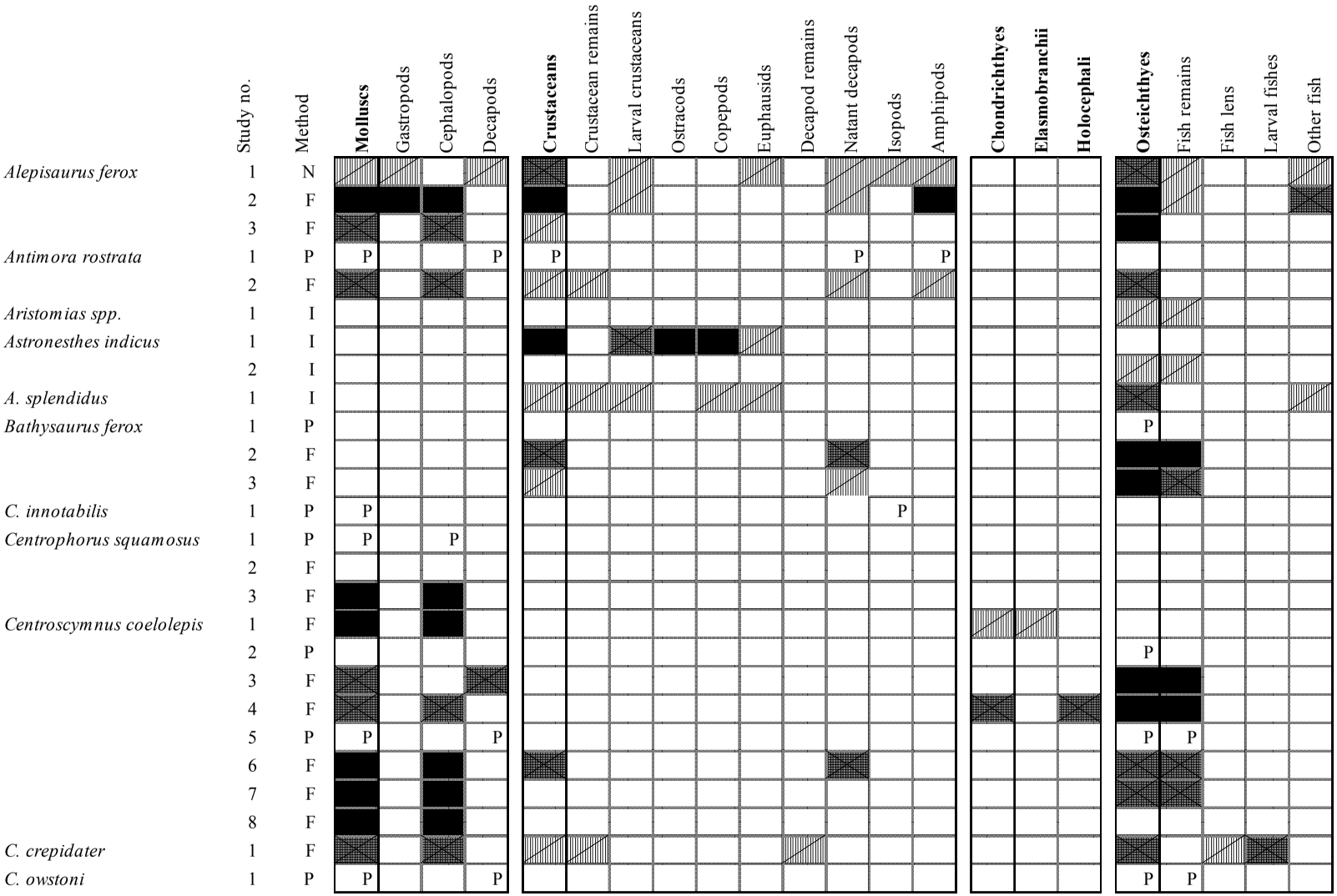
Table A4c (continued)

	Study no.	Study area	No. stomachs	No. empty (%)	Fish length (cm)	Method	Unidentified	Extraneous matter	Foraminiferans	Coelenterates	Tunicates	Polychaetes	Chaetognaths	Molluscs	Crustaceans	Echinoderms	Chondrichthyes	Osteichthyes	Cetacean remains	Reference
Chauliodus sloani	1	NE Atlantic	151	56	2–26	I														Clarke 1982
	2	NE Atlantic	2	100	5–22	F														Mauchline & Gordon 1983b
Chlamydoselachus anguineus	1	NW Pacific	139	73	118–177	F														Kubota et al 1991
Cryptopsaras couesi	1	NE Atlantic	1	0	35	P												P		Minchin 1988
Dalatias licha	1	Mediterranean	4			F														Capape 1975*
	2	Mediterranean	31			F														Macpherson 1980*
	3	Mediterranean	31			W														Macpherson 1981
	4	Mediterranean	97	18	23–101	F														Matallanas 1982
Deania calcea	1	NE Atlantic	2		99–147	F														Clarke & Merrett 1972
	2	SE Atlantic	8		66–94	P												P		Marshall & Merrett 1977
	3	NE Atlantic	65	69	79–98	F														Mauchline & Gordon 1983a
	4	NE Atlantic	46	59	99–111	F														Mauchline & Gordon 1983a
Epigonus telescopus	1	NE Atlantic	40	88	27–60	F														Du Buit 1978
	2	Mediterranean	311		5–19	W														Macpherson 1981
	3	NE Atlantic	525	31	8–34	F														Mauchline & Gordon 1984a
	4	NW Atlantic				P								P	P			P		Vinnichenko 1997
Gonostoma elongatum	1	W Pacific	347	48	2–22	N														Gorelova 1981
	2	C Pacific	77		3–21	I														Clarke 1982
	3	NE Atlantic	1	0	16	F														Mauchline & Gordon 1983b
	4	Gulf of Mexico	114		3–5	N														Lancraft et al. 1988
	5	Gulf of Mexico	121		8–10	N														Lancraft et al. 1988
	6	Gulf of Mexico	31		11–13	N														Lancraft et al. 1988
Halargyreus johnsonii	1	NE Atlantic	573	94	8–27	F														Mauchline & Gordon 1984c
Halosauropsis macrochir	1	SE Atlantic	5		15–27	P						P			P					Marshall & Merrett 1977
	2	W Atlantic	83	19	13–38	F														Sedberry & Musick 1978

Table A4c (continued)

	Study no.	Study area	No. stomachs	No. empty (%)	Fish length (cm)	Method	Unidentified	Extraneous matter	Foraminiferans	Coelenterates	Tunicates	Polychaetes	Chaetognaths	Molluscs	Crustaceans	Echinoderms	Chondrichthyes	Osteichthyes	Cetacean remains
Harriotta raleighana	1	W Atlantic	10	0	25–91	P	P	P						P	P				
	2	NE Atlantic	10	20		F	■			▩		▩		▩	■				
Hoplostethus atlanticus	1	NE Atlantic	53	28	14–30	F	■					▨		▩	▩			▩	
Idiacanthus fasciola	1	C Pacific	291	82	5–38	I									▨			▩	
Lampanyctus alatus	1	Gulf of Mexico	84			N					▨	▨			■			▨	
L. nobilis	1	C Pacific	183		4–9	I									■				
Malacosteus niger	1	C Pacific	100	80	2–19	I									P			P	
Mora moro	1	Mediterranean	93	97		P									P			P	
Odontomacrurus murrayi	1	N Atlantic	1		50	P												P	
Photostomias, 2 spp.	1	C Pacific	189	74	3–14	I									▩				
Raja hyperborea	1	NE Atlantic	31	16	23–84	F	▩					▨			▩			■	
Scopelogadus beanii	1	W Atlantic	106	29	4–11	F	▩					▨		▨	■			▨	
Simenchelys parasiticus	1	W Atlantic	23	0	14–46	P	■												
Stomias boa ferox	1	NE Atlantic	8	100	3–28	F													
Xenodermichthys copei	1	NE Atlantic - pelagic	22	23	1–14	F	■							▨	▩				
	2	NE Atlantic - demersal	36	22	5–11	F	▩				▩		▨	▨	▩				
	3	NE Atlantic - demersal	62	47	11–14	F	■				▨	▨			▩				
	4	NE Atlantic - demersal	64	42	14–17	F	▩				▨		▨		▩			▨	

Table A4c (continued)



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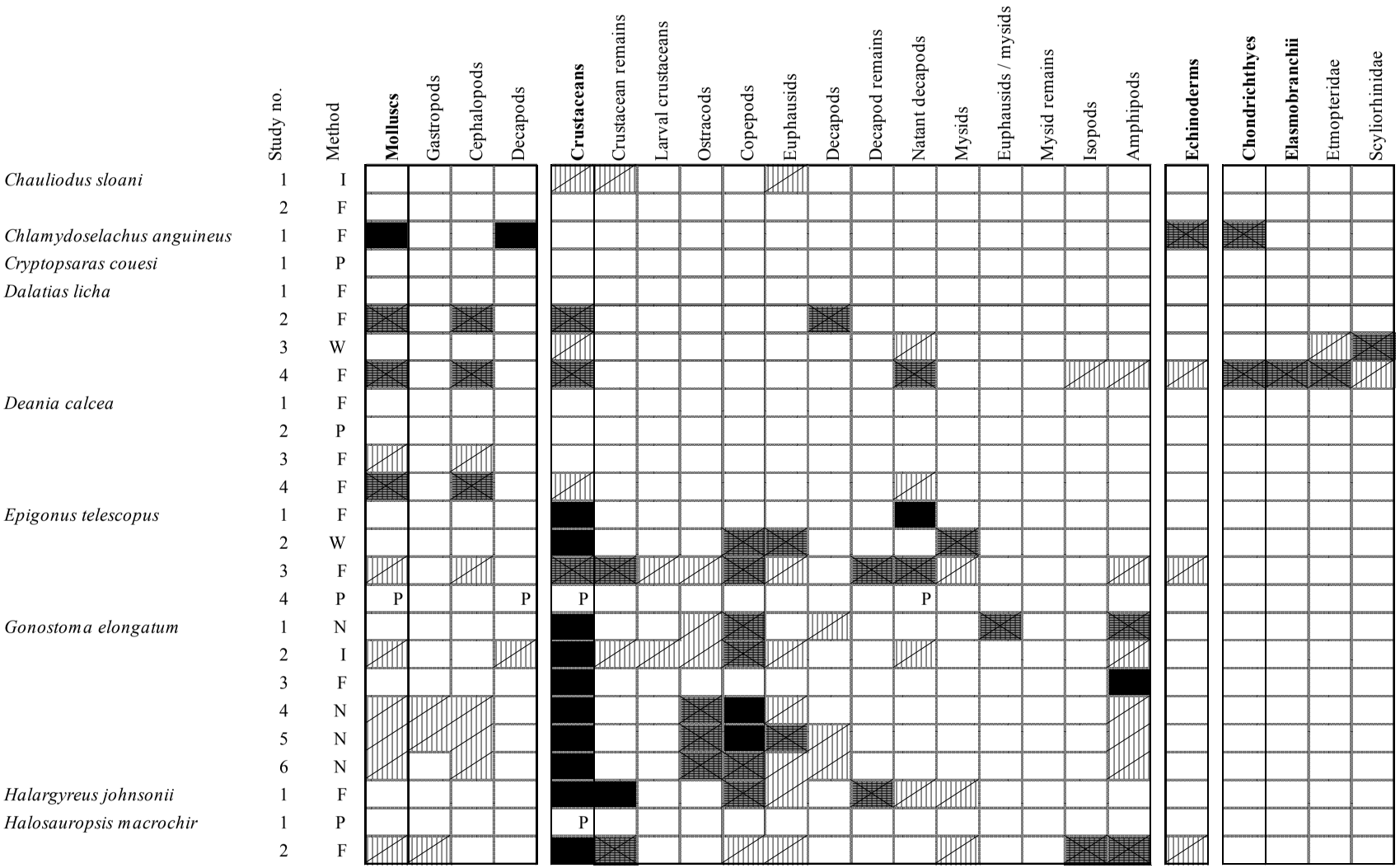

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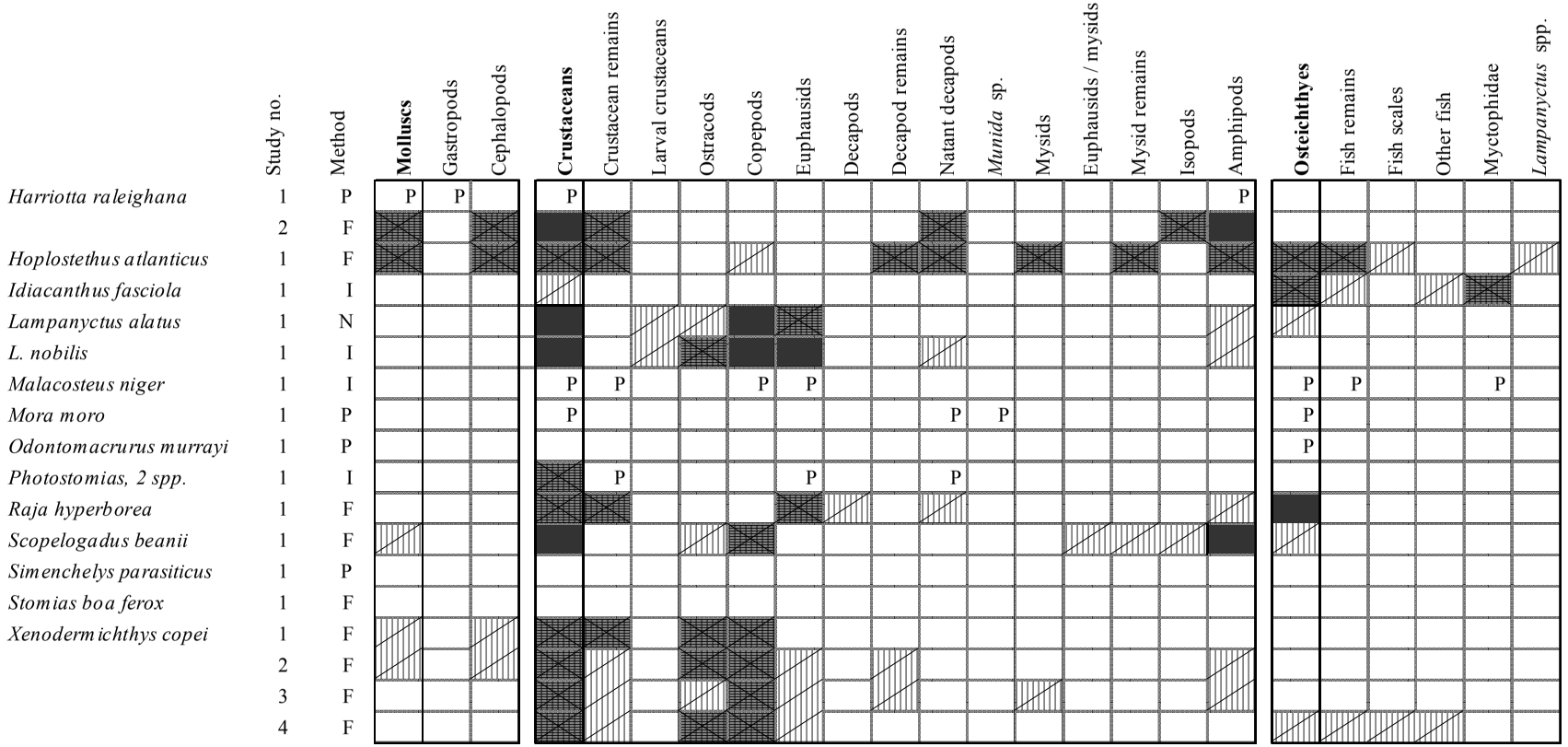

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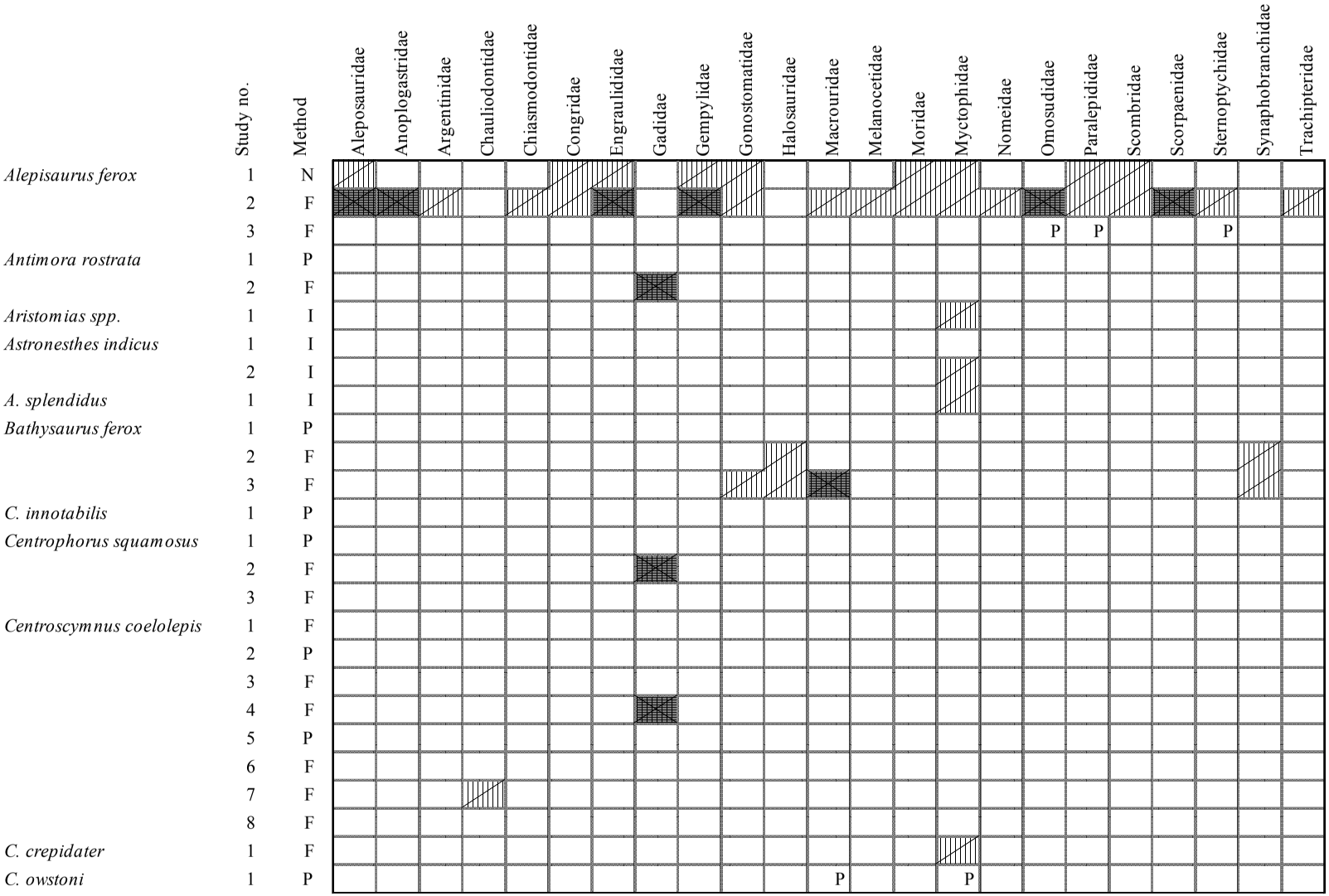

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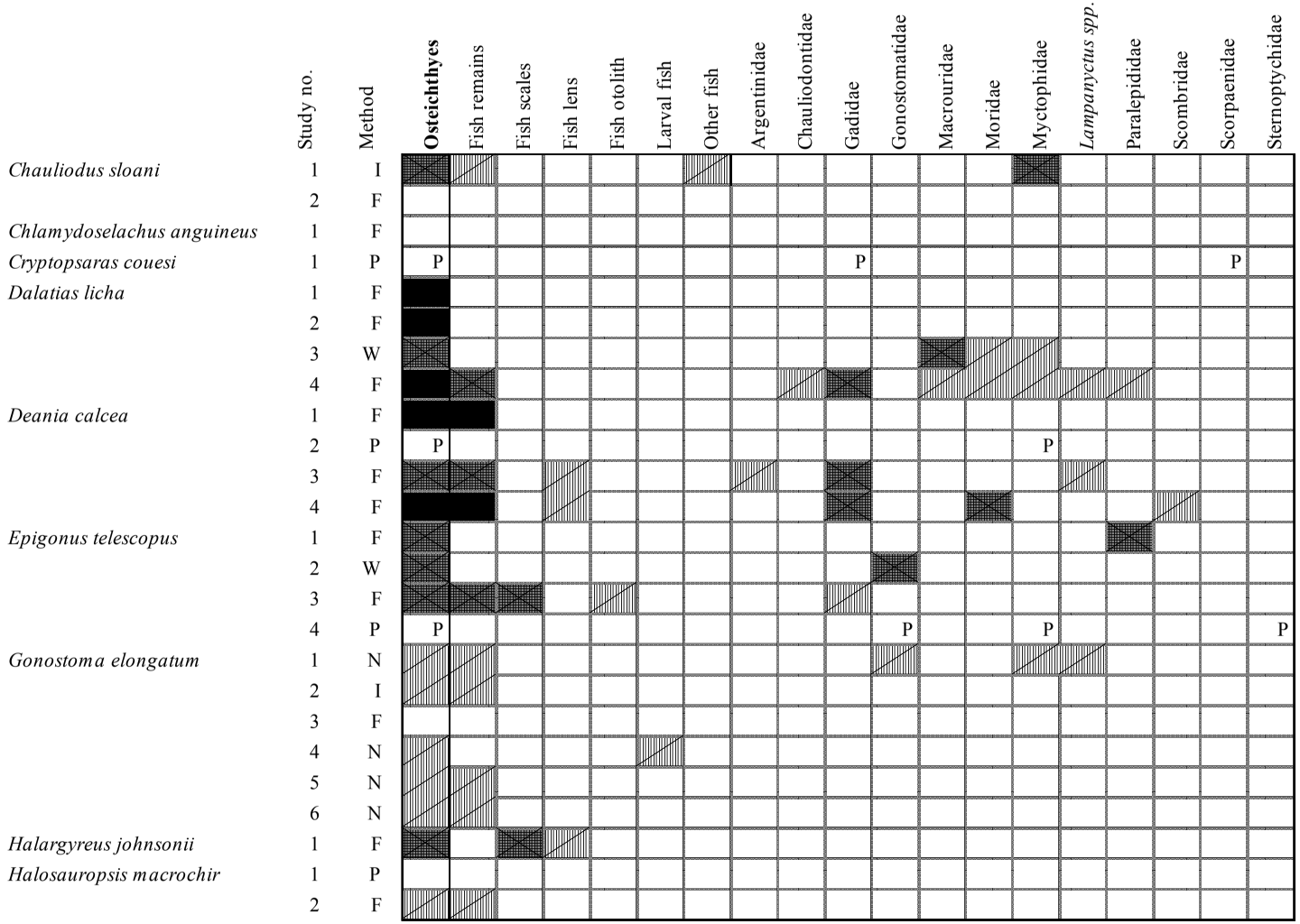

APPENDIX B: Fish species catch and stomach content sampling distribution maps, and ontological diet change (MFish Research Trawl Database 1960-2000).

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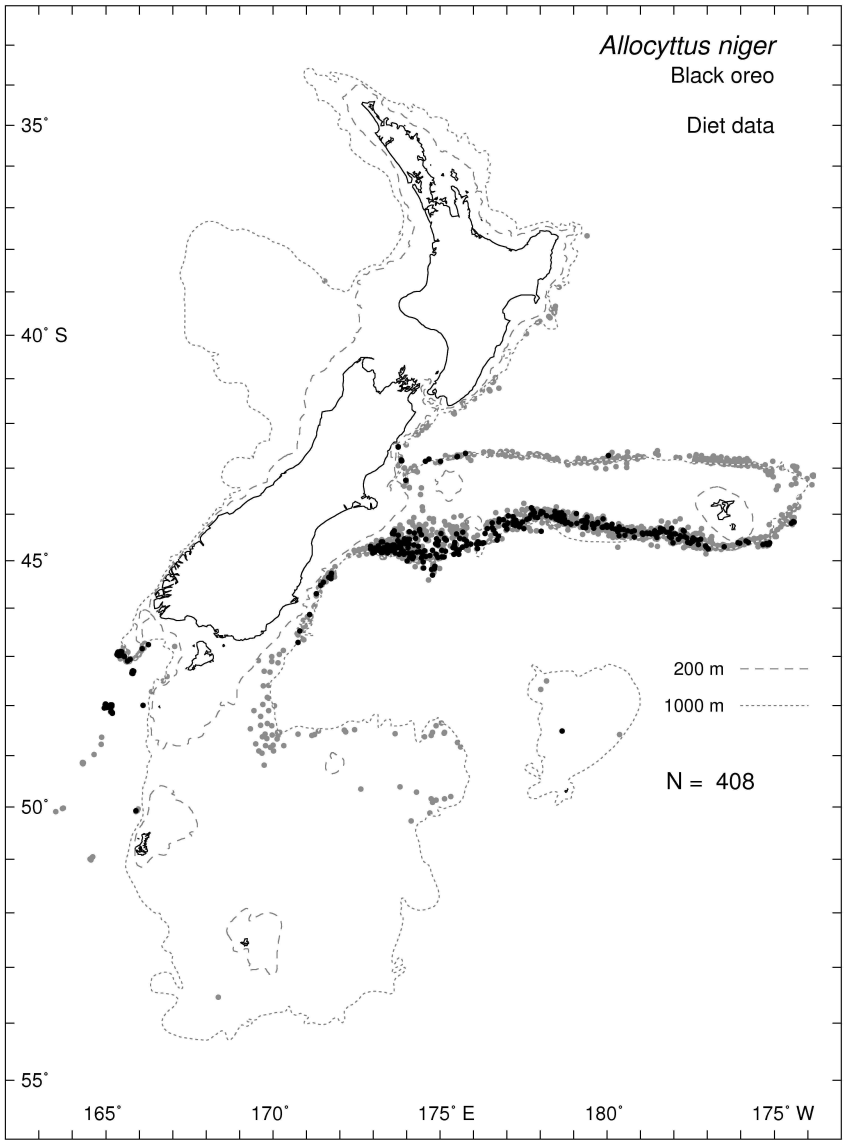

Figure B1a. The distribution of all black oreo (left panel) caught (grey dots) and those examined for diet (black dots) in research trawls 1960–2000. N, number of fish examined for diet.

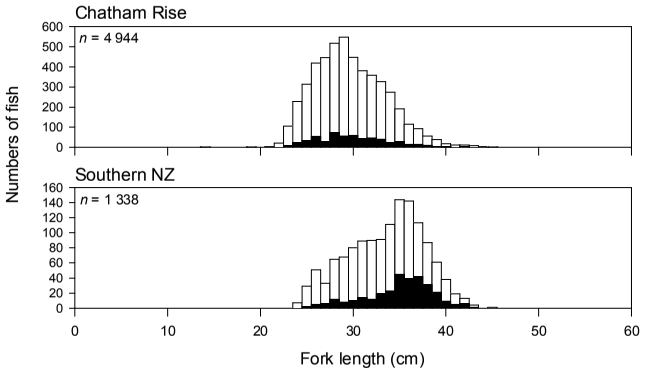

Figure B1b. The length frequency of black oreo where feeding data was recorded. Fish with empty stomachs are presented as white bars and fish containing prey items as black bars. Areas are defined on p. 9. *n*, number of fish examined for diet.

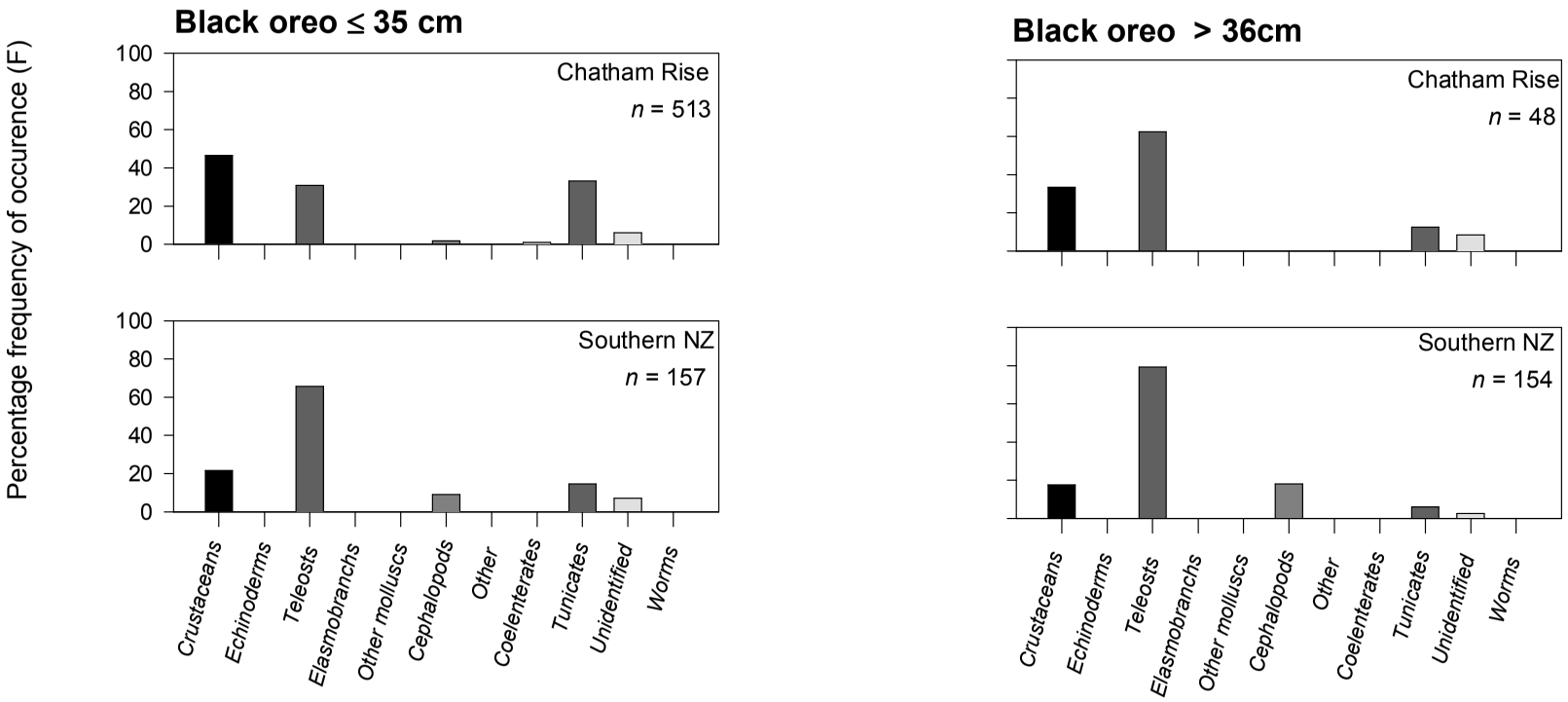

Figure B1c. The importance of major prey groups in the diet of black oreo examined on research trawl surveys. Fish size groups are arbitrary designations. Areas are defined on p. 9. *n*, number of fish examined for diet.

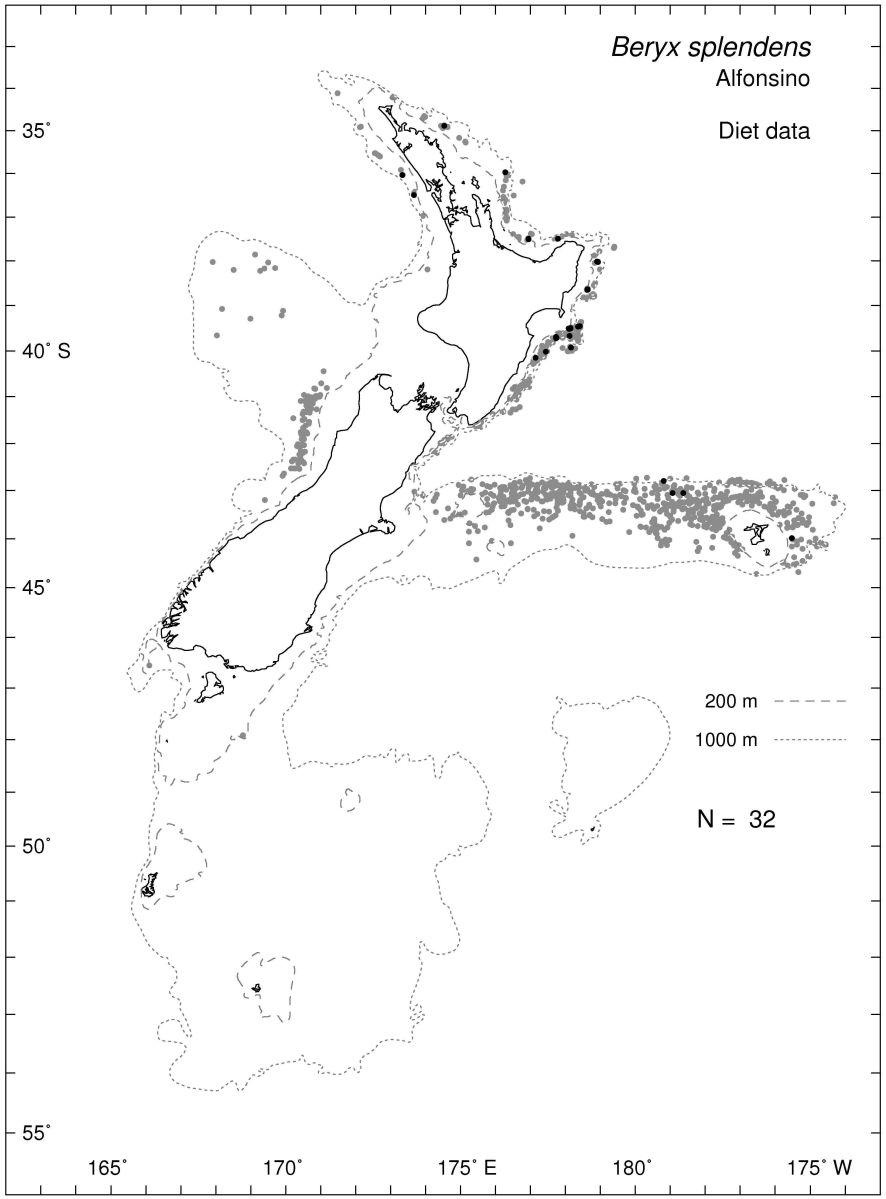

Figure B2a. The distribution of all alfonsino (left panel) caught (grey dots) and those examined for diet (black dots) in research trawls 1960–2000. N, number of fish examined for diet.

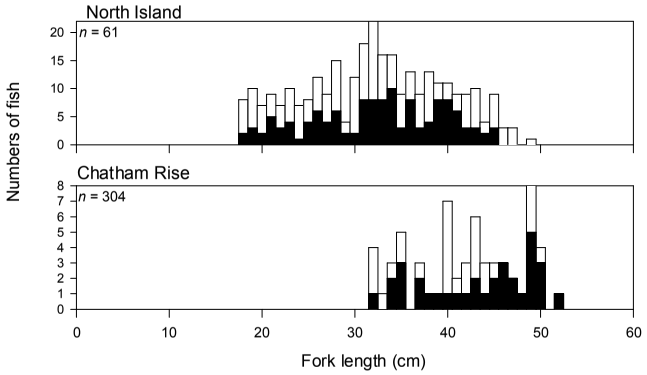

Figure B2b. The length frequency of alfonsino where feeding data was recorded. Fish with empty stomachs are presented as white bars and fish containing prey items as black bars. Areas are defined on p. 9. *n*, number of fish examined for diet.

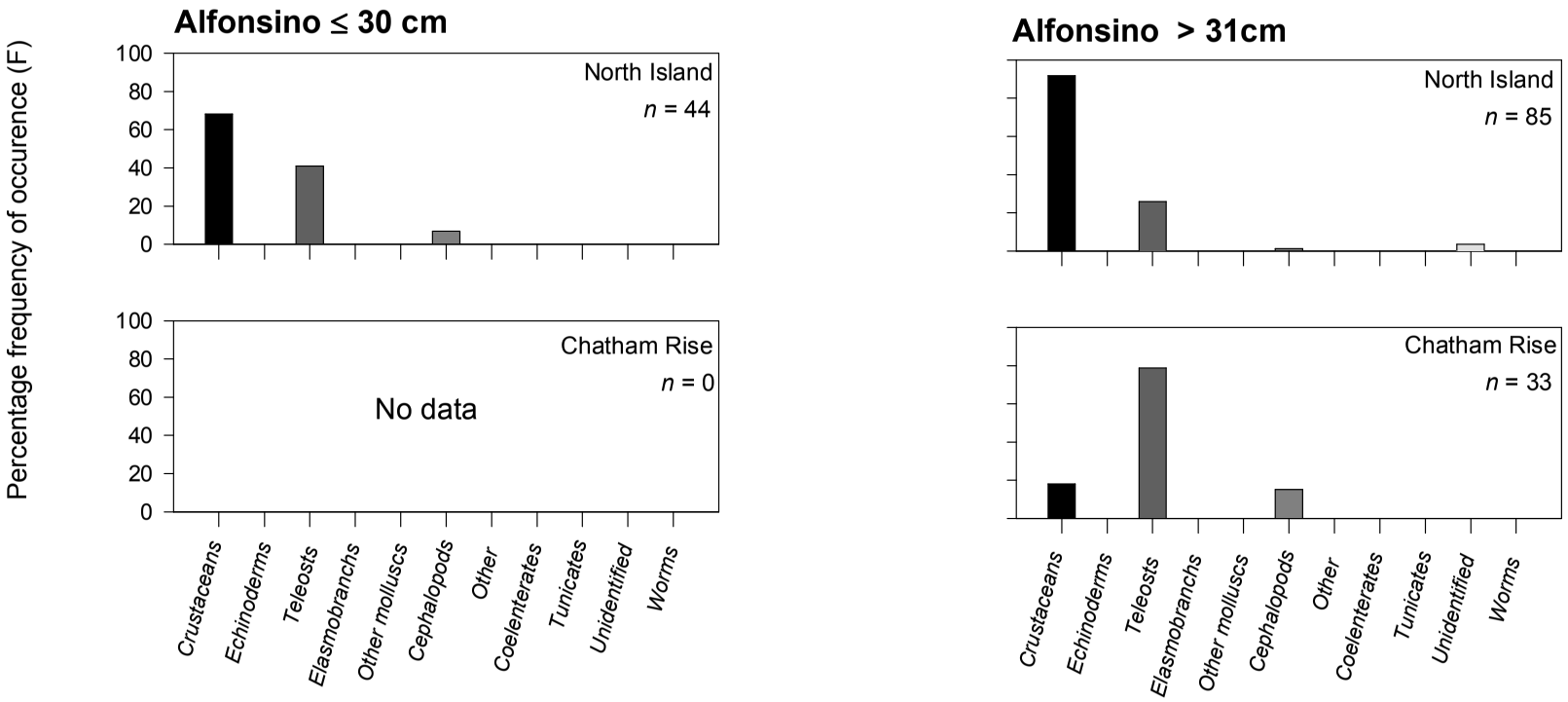

Figure B2c. The importance of major prey groups in the diet of alfonsino examined on research trawl surveys. Fish size groups are arbitrary designations. Areas are defined on p. 9. *n*, number of fish examined for diet.

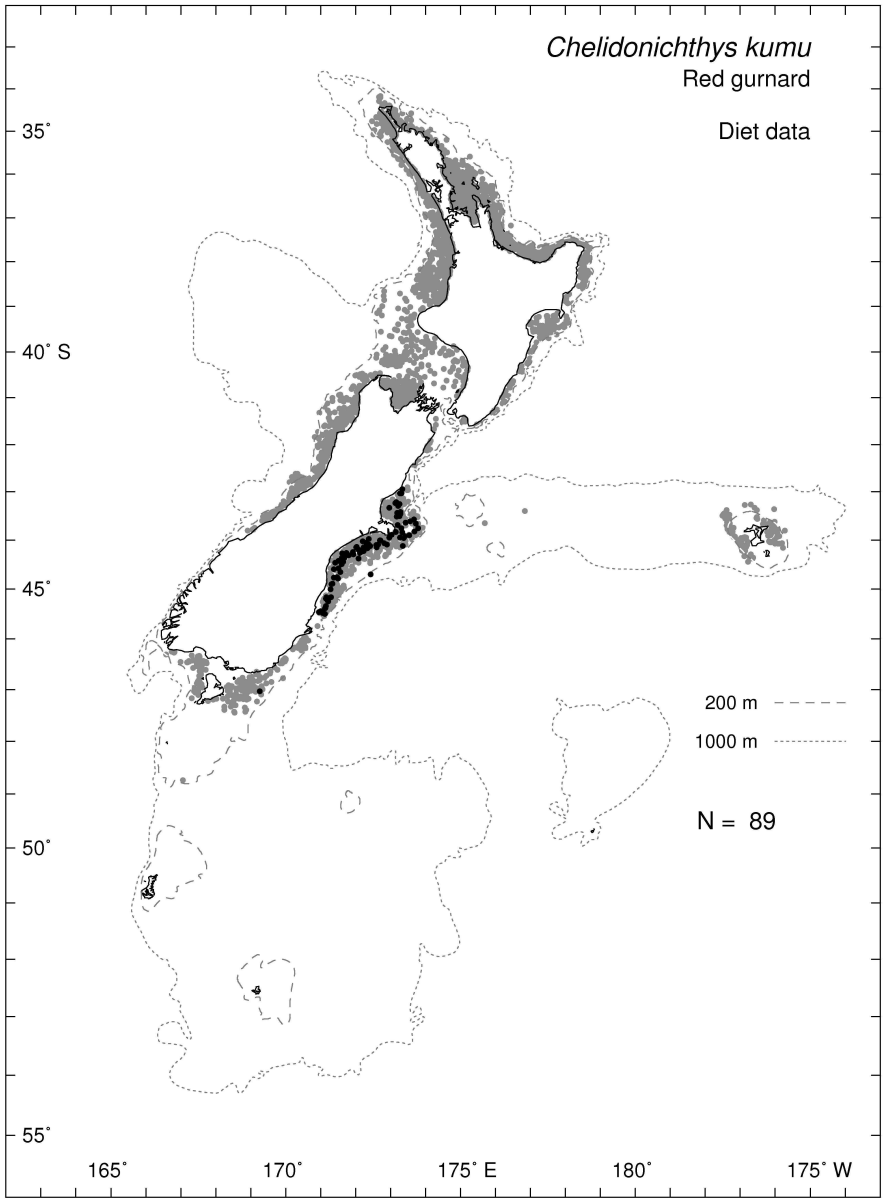

Figure B3a. The distribution of all red gurnard (left panel) caught (grey dots) and those examined for diet (black dots) in research trawls 1960–2000. N, number of fish examined for diet.

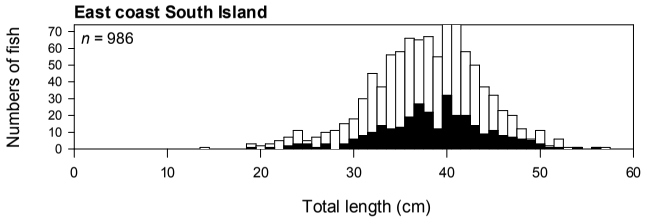

Figure B3b. The length frequency of red gurnard where feeding data was recorded. Fish with empty stomachs are presented as white bars and fish containing prey items as black bars. Areas are defined on p. 9. *n*, number of fish examined for diet.

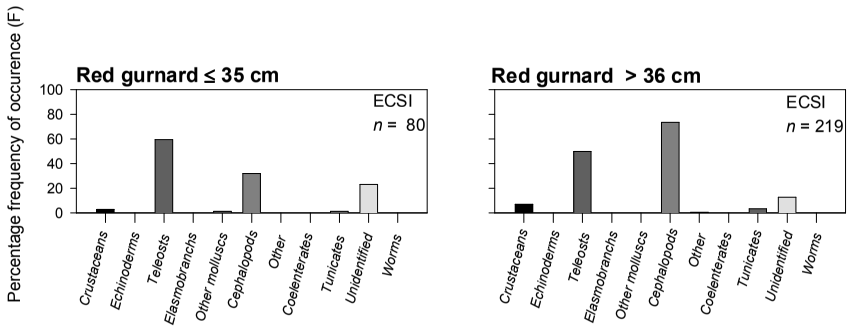

Figure B3c. The importance of major prey groups in the diet of red gurnard examined on research trawl surveys. Fish size groups are arbitrary designations. Areas are defined on p. 9. *n*, number of fish examined for diet.

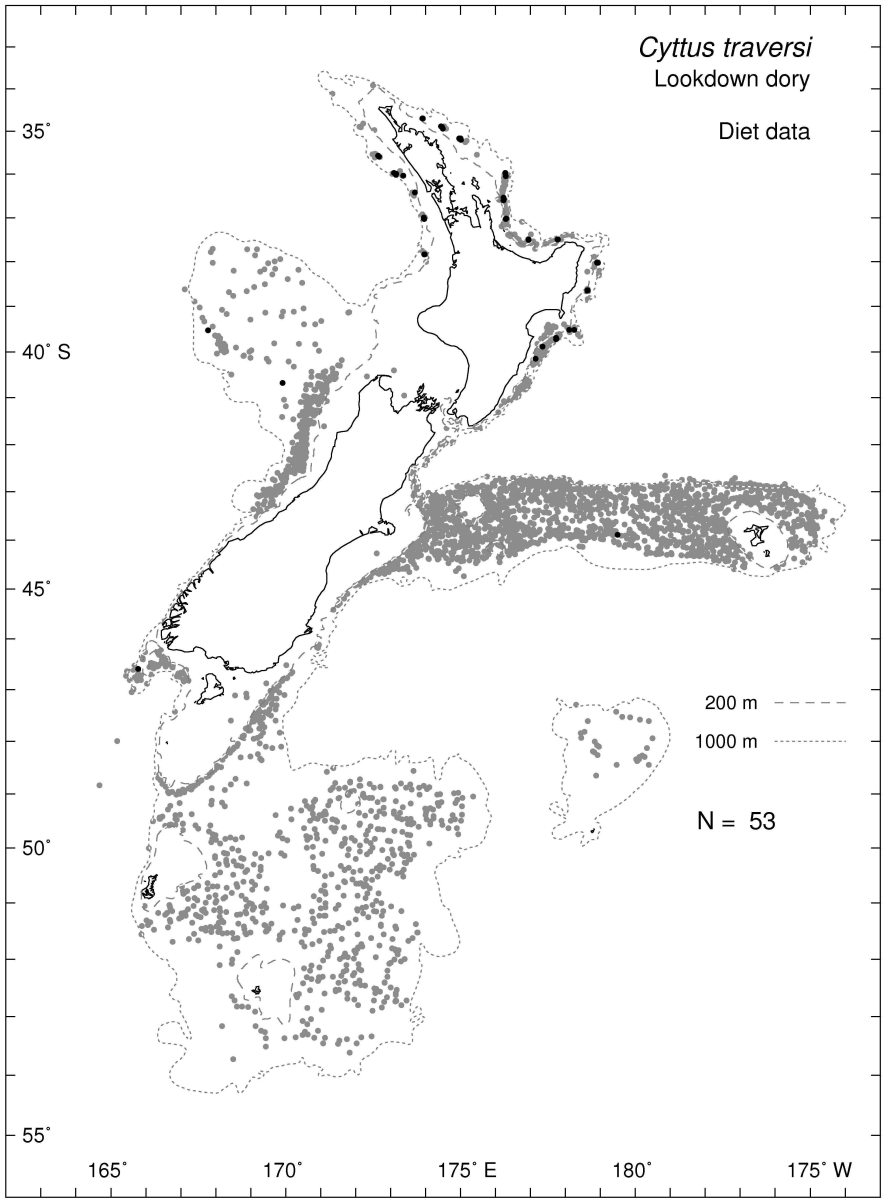

Figure B4a. The distribution of all lookdown dory (left panel) caught (grey dots) and those examined for diet (black dots) in research trawls 1960–2000. N, number of fish examined for diet.

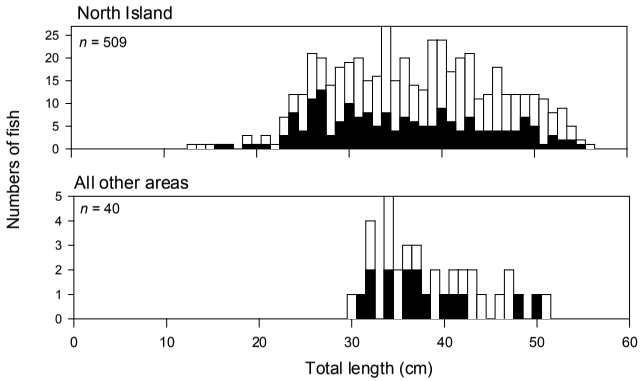

Figure B4b. The length frequency of lookdown dory where feeding data was recorded. Fish with empty stomachs are presented as white bars and fish containing prey items as black bars. Areas are defined on p. 9. *n*, number of fish examined for diet.

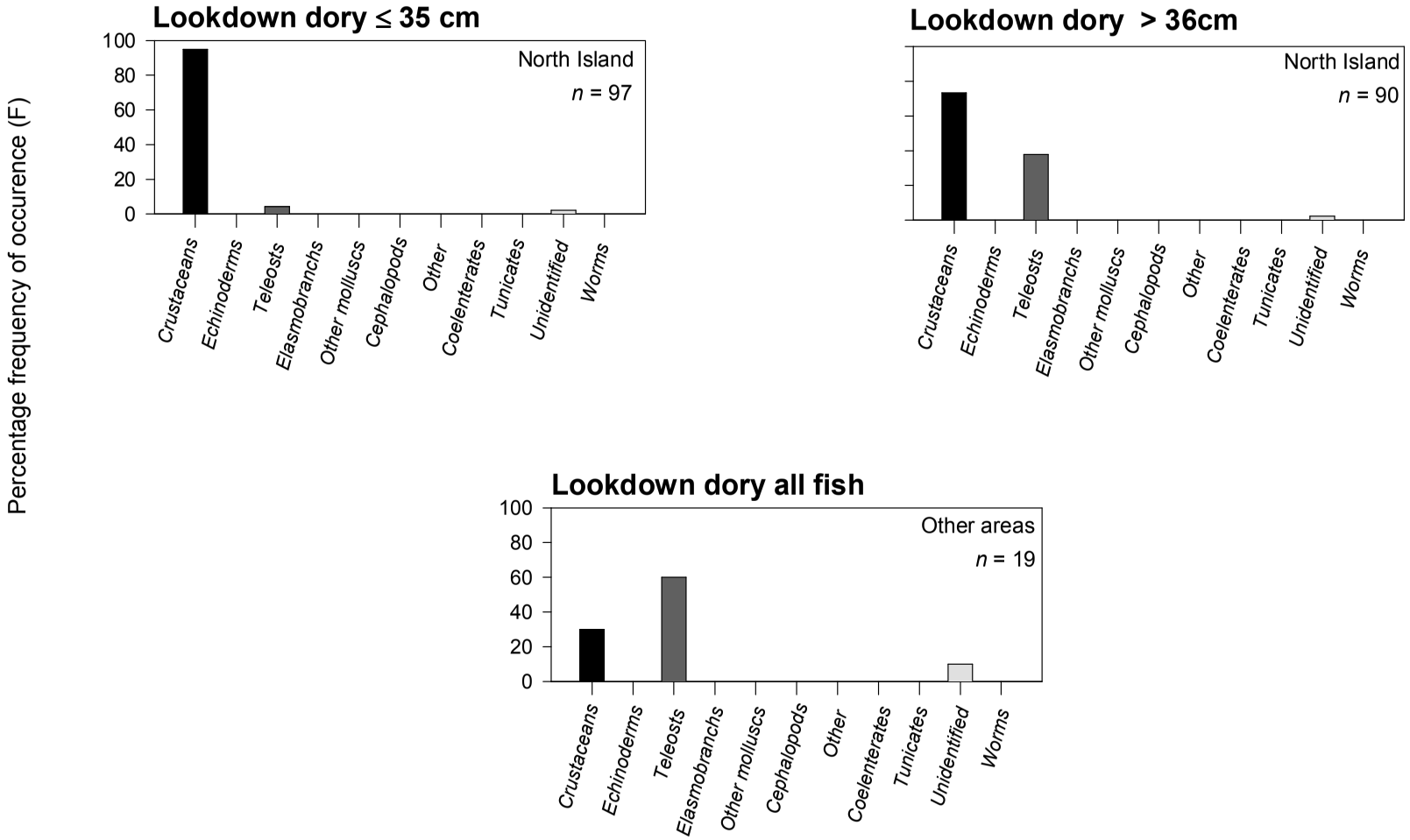

Figure B4c. The importance of major prey groups in the diet of lookdown dory examined on research trawl surveys. Fish size groups are arbitrary designations. Areas are defined on p. 9. *n*, number of fish examined for diet.

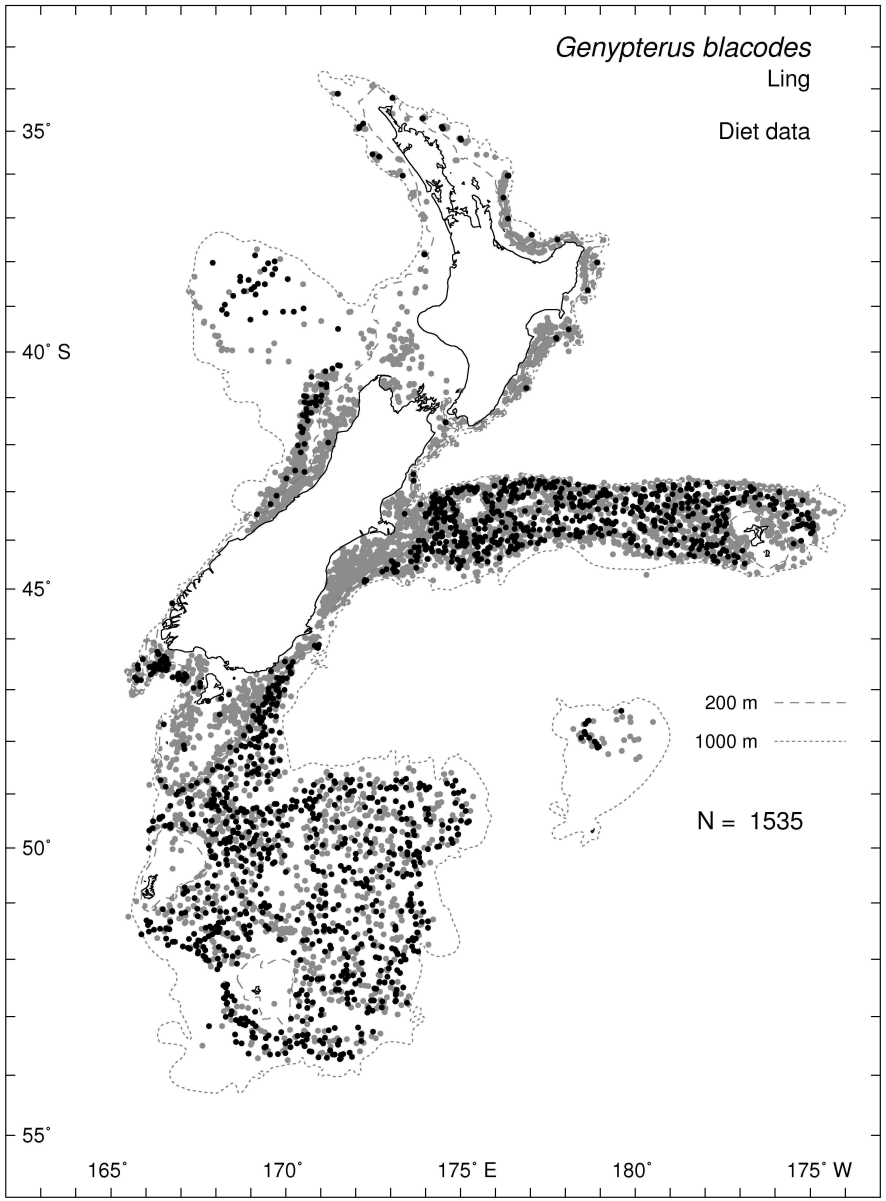

Figure B5a. The distribution of all ling (left panel) caught (grey dots) and those examined for diet (black dots) in research trawls 1960–2000. N, number of fish examined for diet.

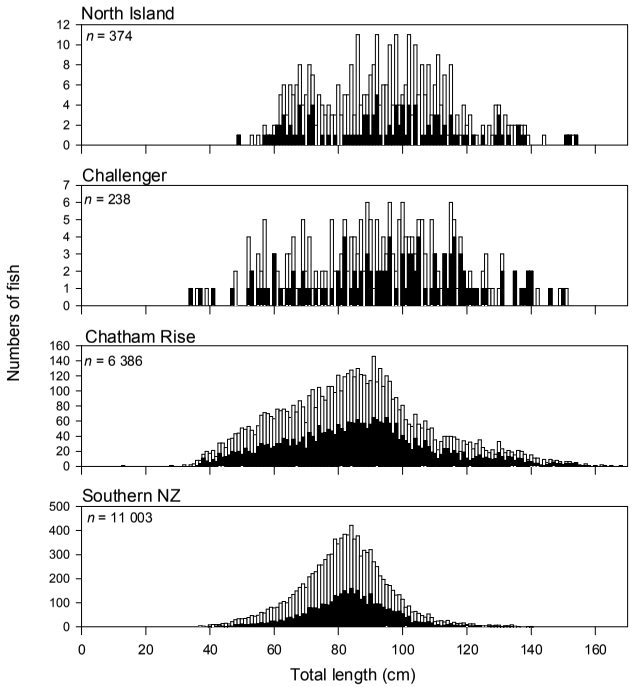

Figure B5b. The length frequency of ling where feeding data was recorded. Fish with empty stomachs are presented as white bars and fish containing prey items as black bars. Areas are defined on p. 9. *n*, number of fish examined for diet.

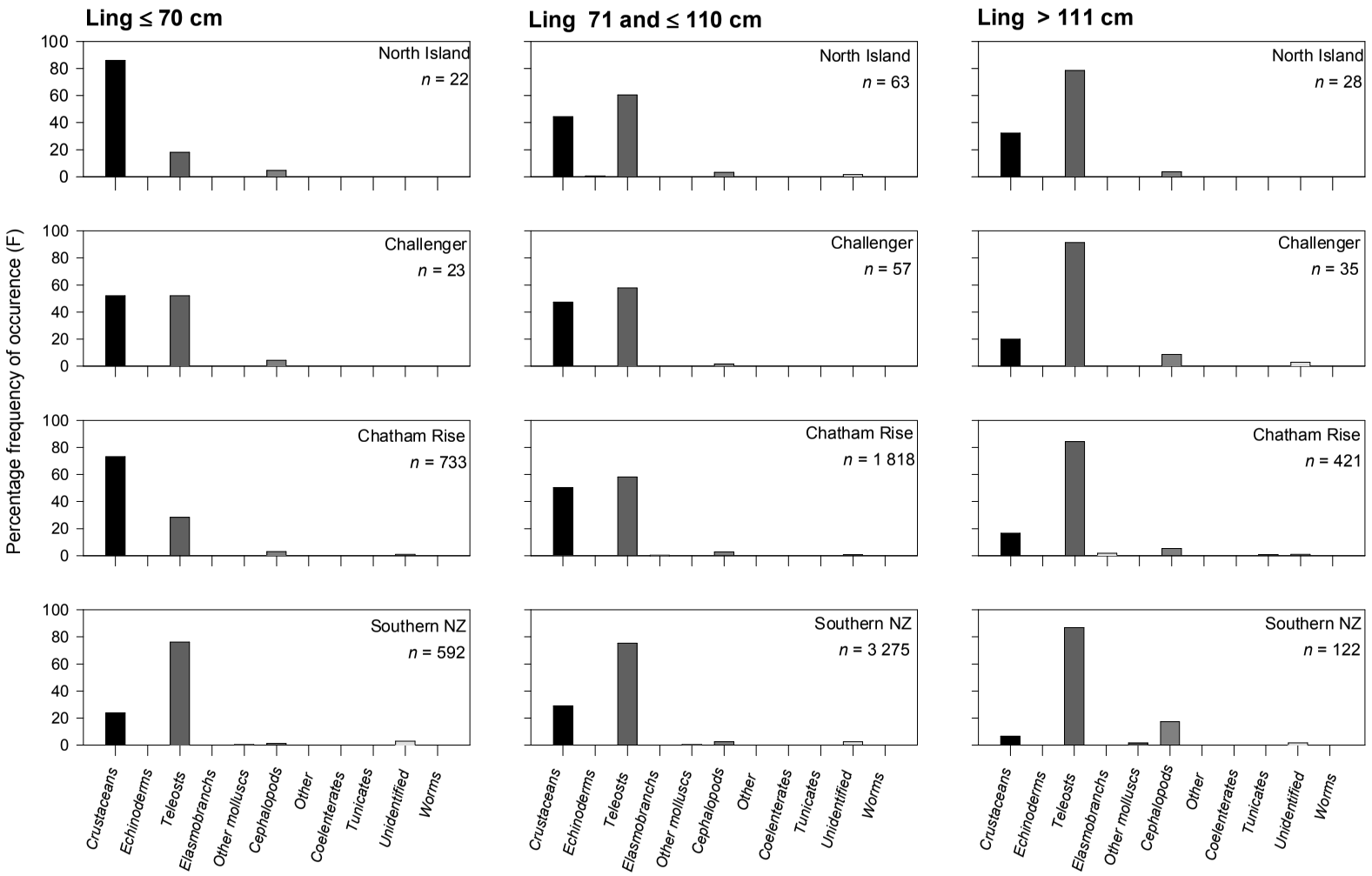

Figure B5c. The importance of major prey groups in the diet of ling examined on research trawl surveys. Fish size groups are arbitrary designations. Areas are defined on p. 9. *n*, number of fish examined for diet.

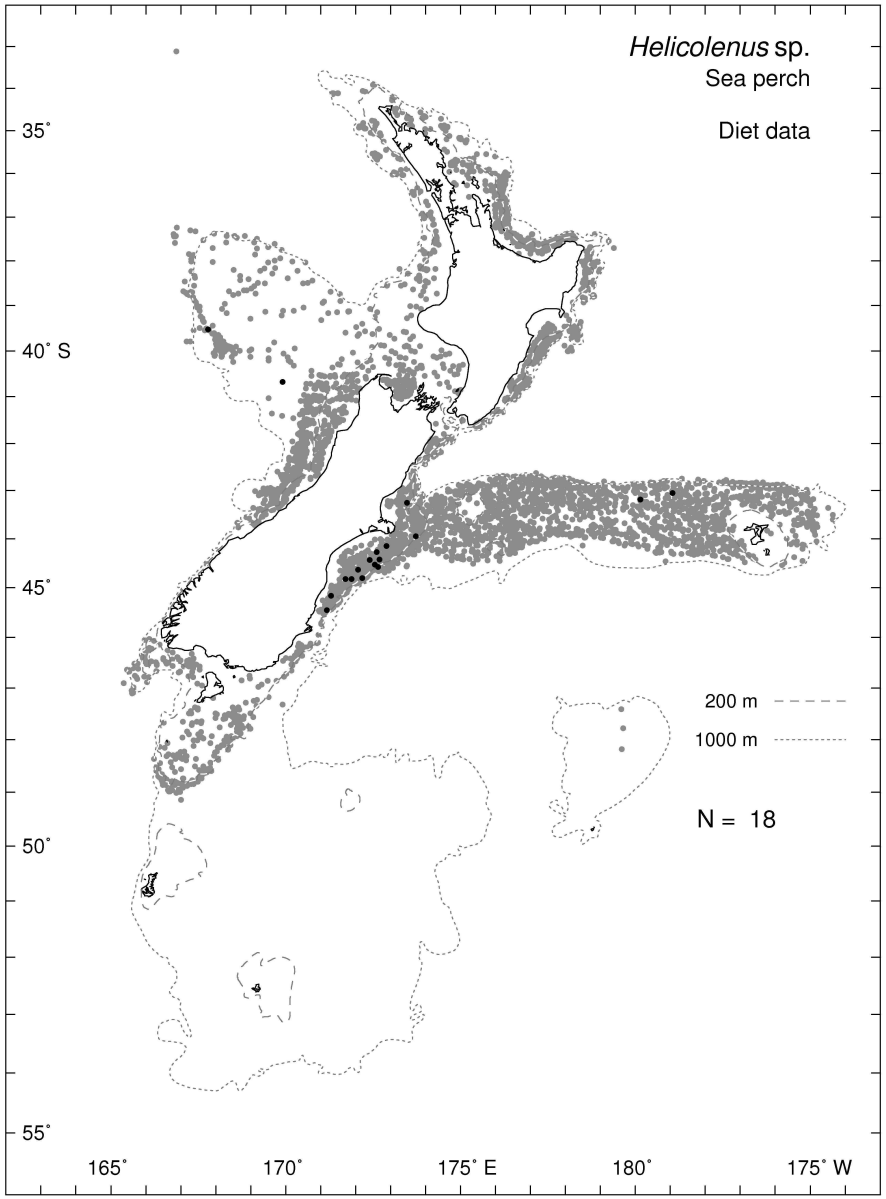

Figure B6a. The distribution of all sea perch (left panel) caught (grey dots) and those examined for diet (black dots) in research trawls 1960–2000. N, number of fish examined for diet.

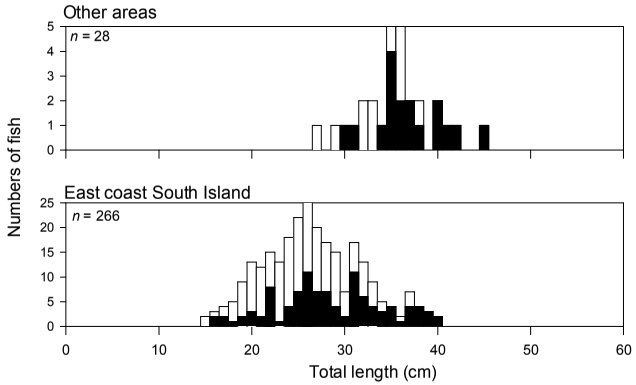

Figure B6b. The length frequency of sea perch where feeding data was recorded. Fish with empty stomachs are presented as white bars and fish containing prey items as black bars. Areas are defined on p. 9. *n*, number of fish examined for diet.

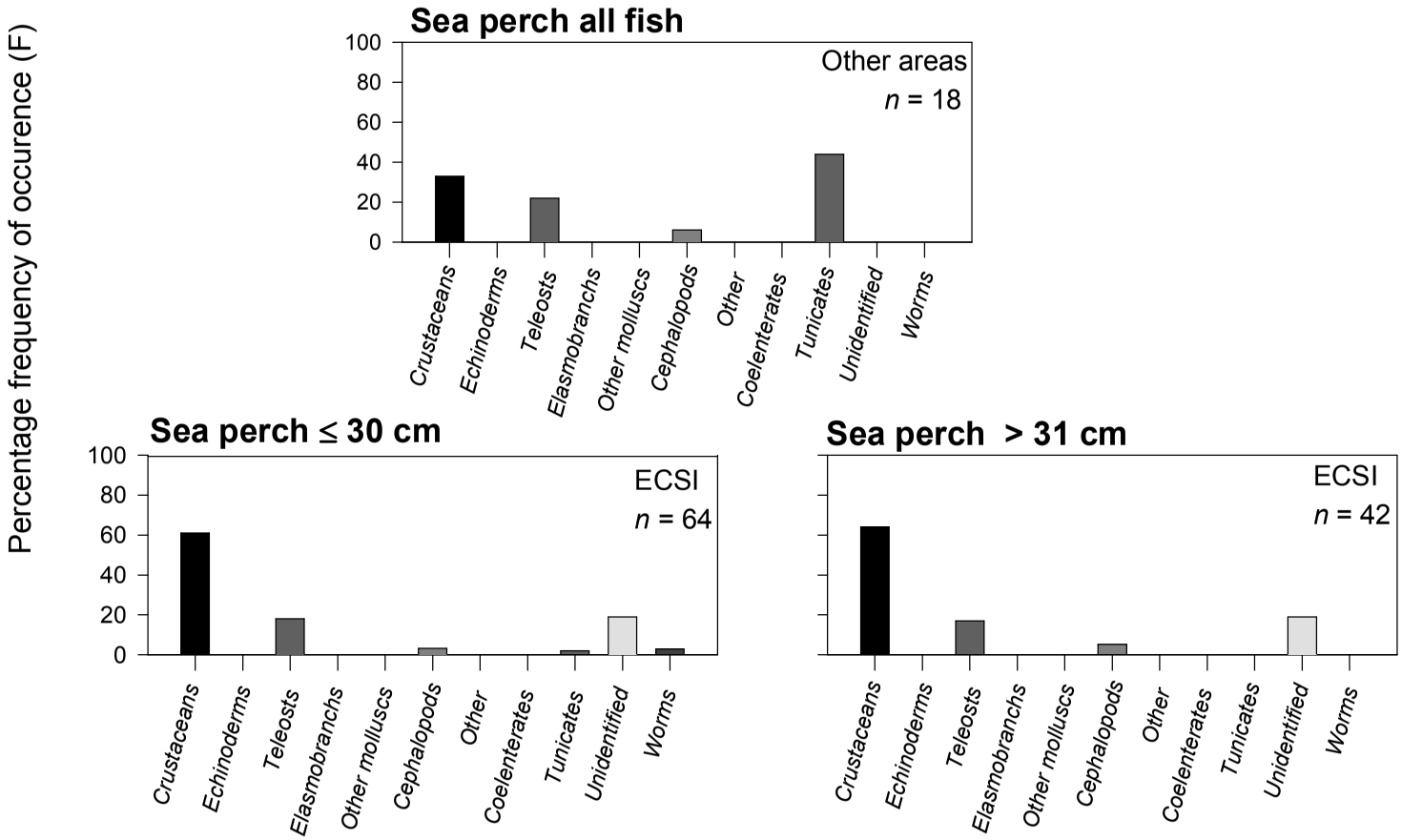

Figure B6c. The importance of major prey groups in the diet of sea perch examined on research trawl surveys. Fish size groups are arbitrary designations. Areas are defined on p. 9. *n*, number of fish examined for diet.

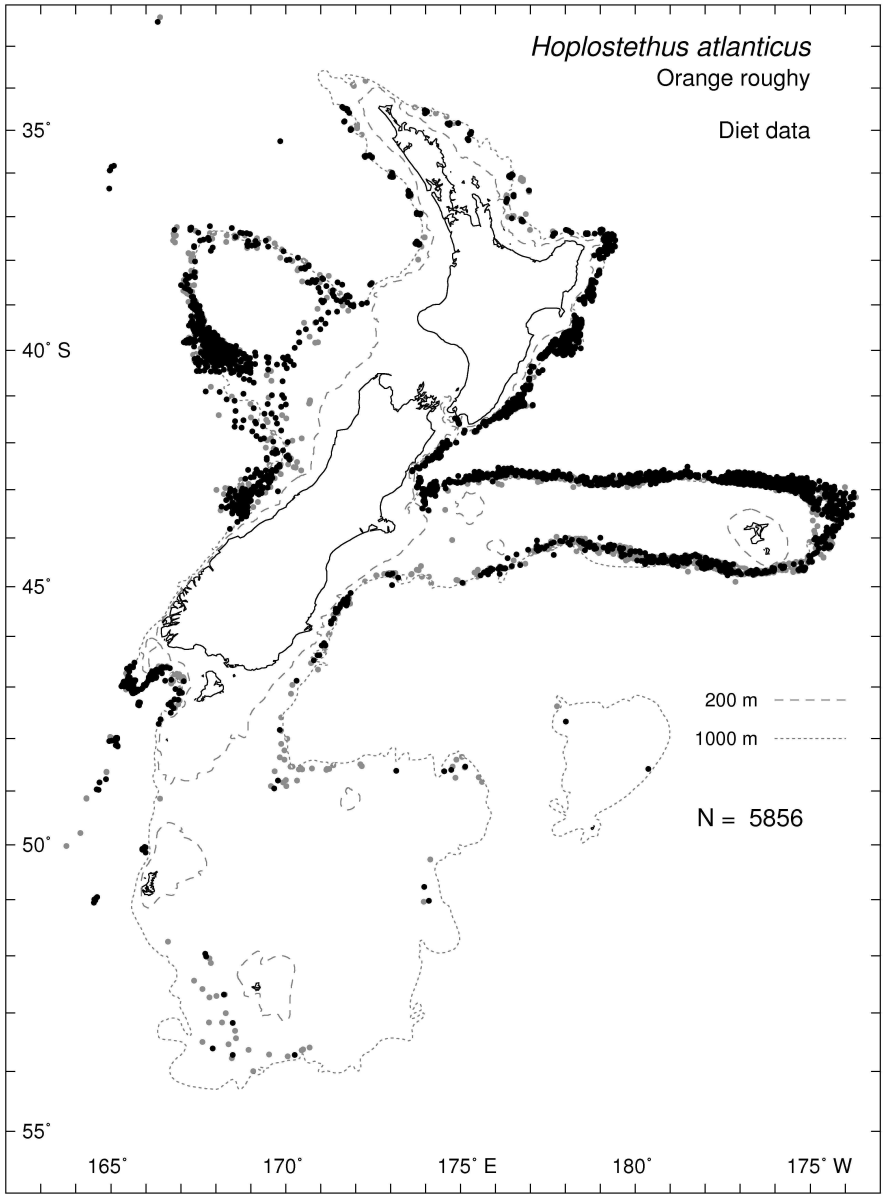

Figure B7a. The distribution of all orange roughy (left panel) caught (grey dots) and those examined for diet (black dots) in research trawls 1960–2000. N, number of fish examined for diet.

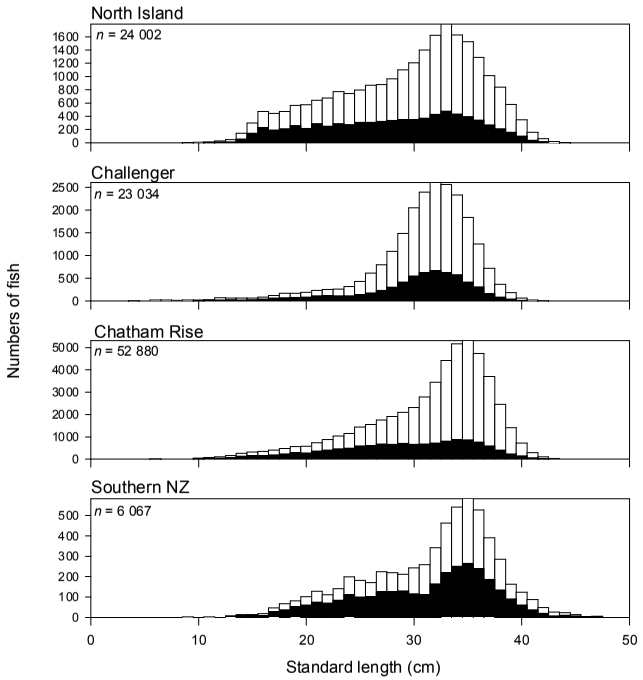

Figure B7b. The length frequency of orange roughy where feeding data was recorded. Fish with empty stomachs are presented as white bars and fish containing prey items as black bars. Areas are defined on p. 9. *n*, number of fish examined for diet.

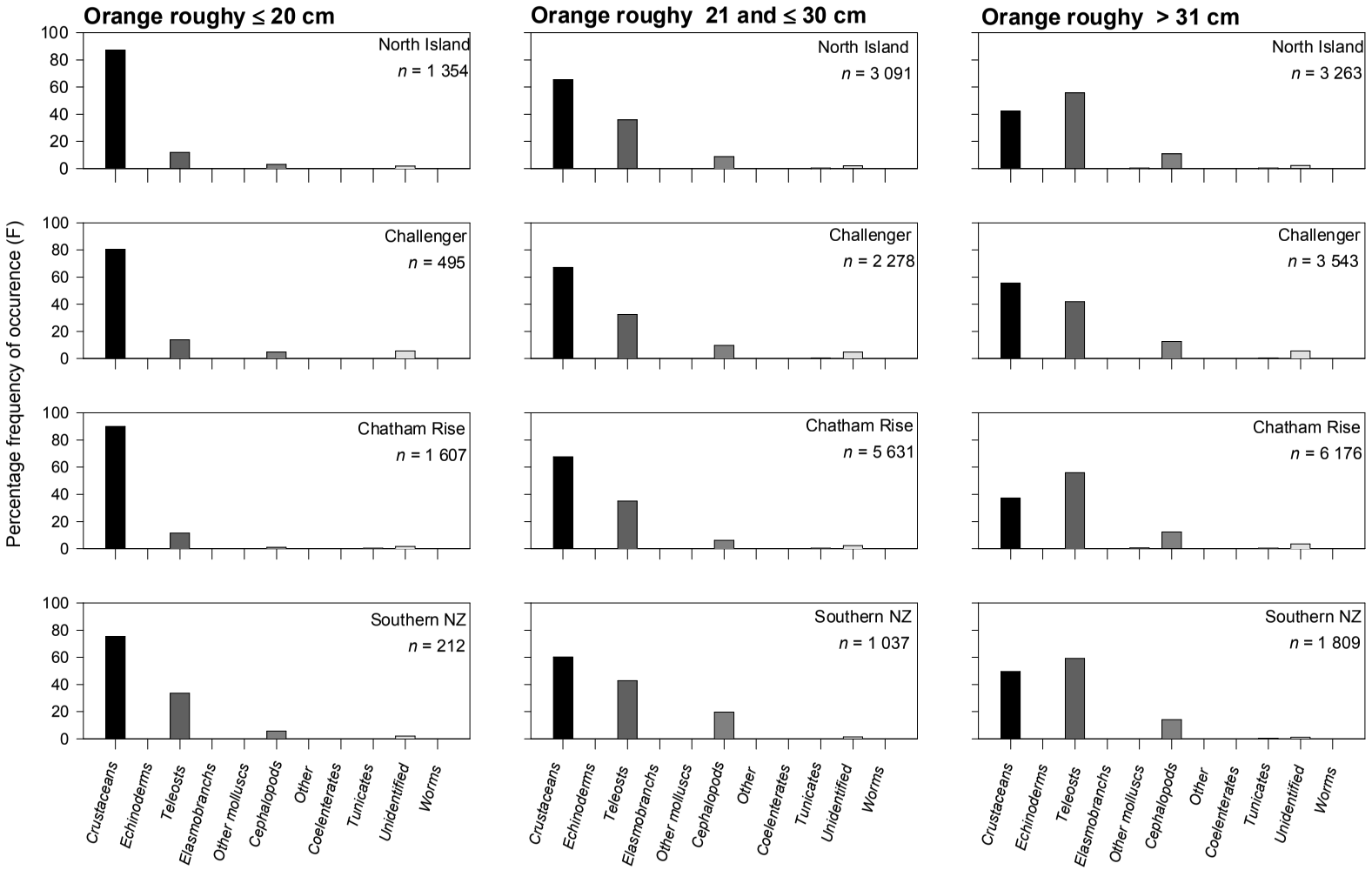

Figure B7c. The importance of major prey groups in the diet of orange roughy examined on research trawl surveys. Fish size groups are arbitrary designations. Areas are defined on p. 9. *n*, number of fish examined for diet.

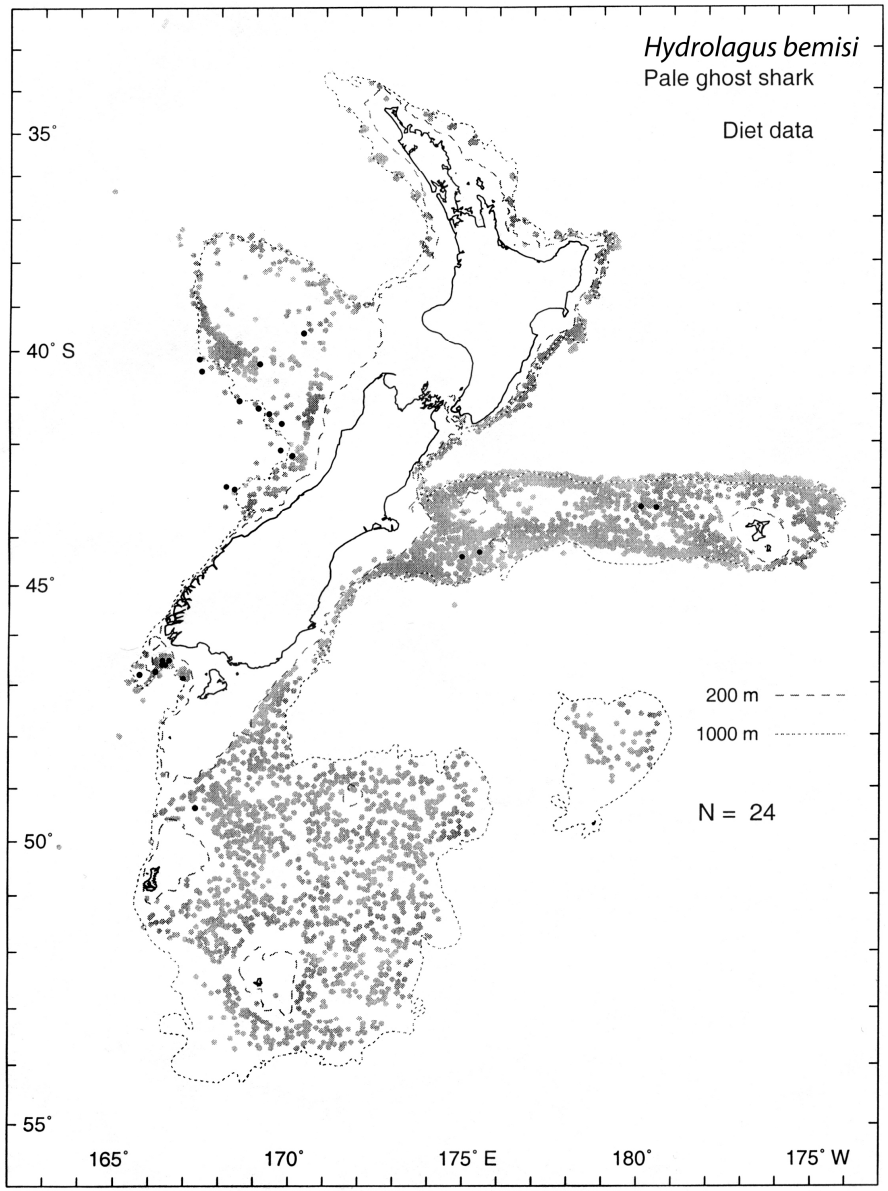

Figure B8a. The distribution of all pale ghost shark (left panel) caught (grey dots) and those examined for diet (black dots) in research trawls 1960–2000. N, number of fish examined for diet.

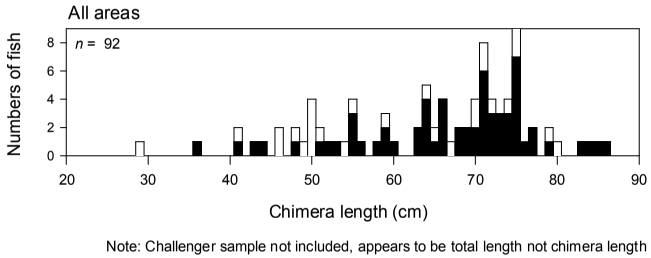

Figure B8b. The length frequency of pale ghost shark where feeding data was recorded. Fish with empty stomachs are presented as white bars and fish containing prey items as black bars. Areas are defined on p. 9. *n*, number of fish examined for diet.

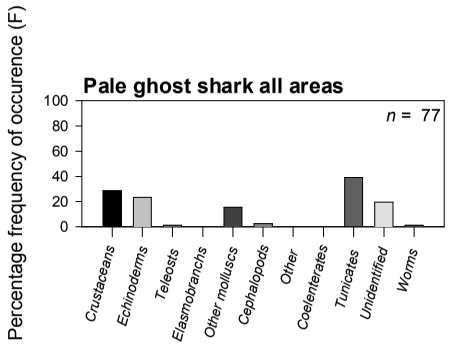

Figure B8c. The importance of major prey groups in the diet of pale ghost shark examined on research trawl surveys. Fish size groups are arbitrary designations. *n*, number of fish examined for diet.

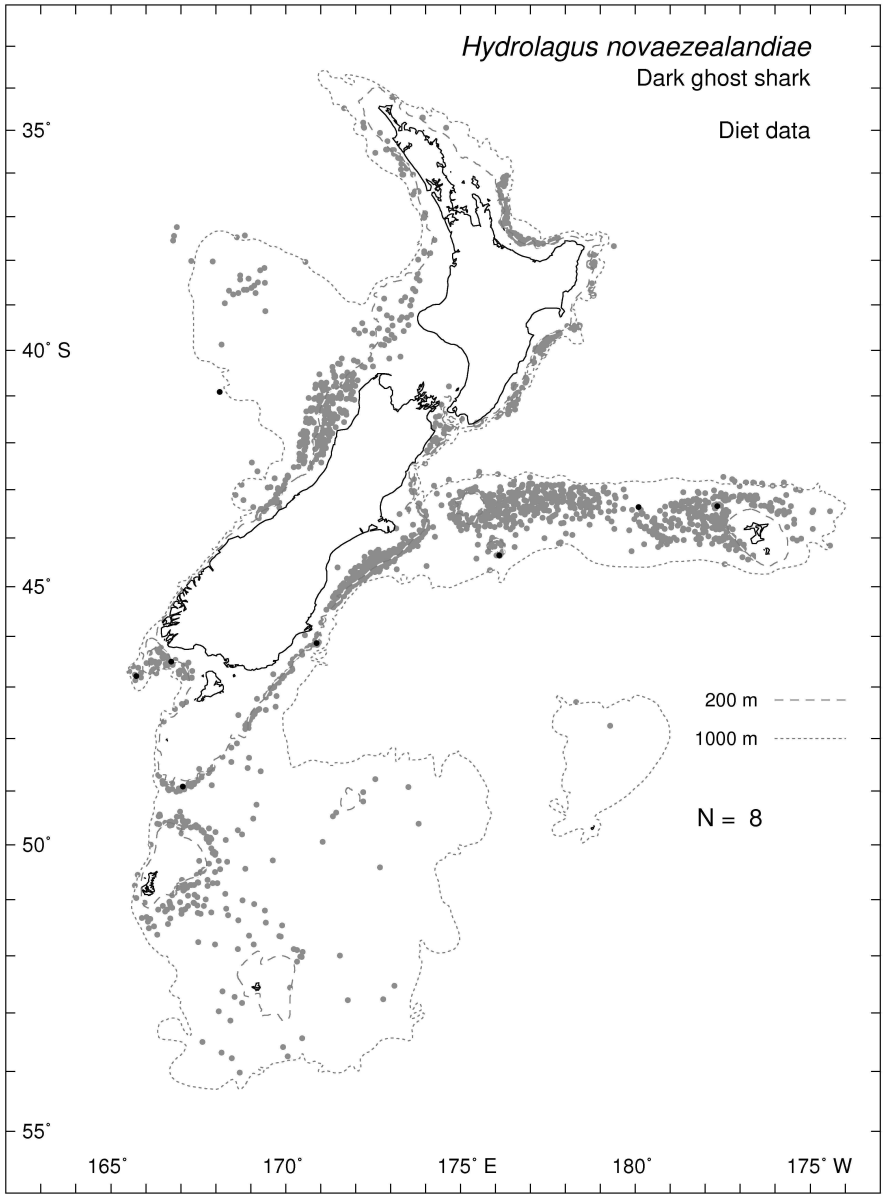

Figure B9a. The distribution of all dark ghost shark (left panel) caught (grey dots) and those examined for diet (black dots) in research trawls 1960–2000. N, number of fish examined for diet.

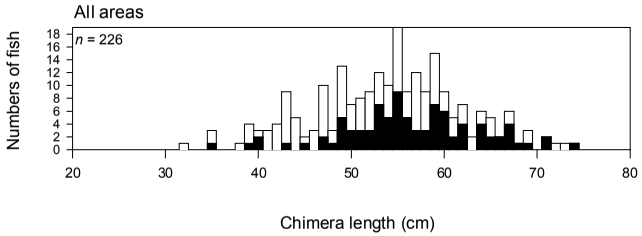

Figure B9b. The length frequency of dark ghost shark where feeding data was recorded. Fish with empty stomachs are presented as white bars and fish containing prey items as black bars. Areas are defined on p. 9. *n*, number of fish examined for diet.

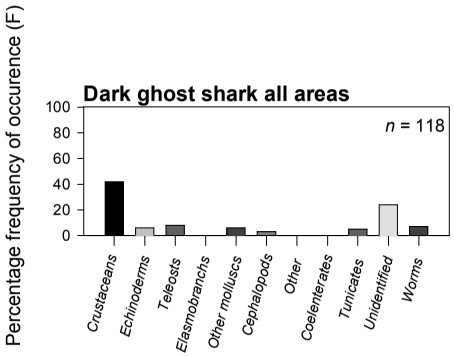

Figure B9c. The importance of major prey groups in the diet of dark ghost shark examined on research trawl surveys. Fish size groups are arbitrary designations. *n*, number of fish examined for diet.

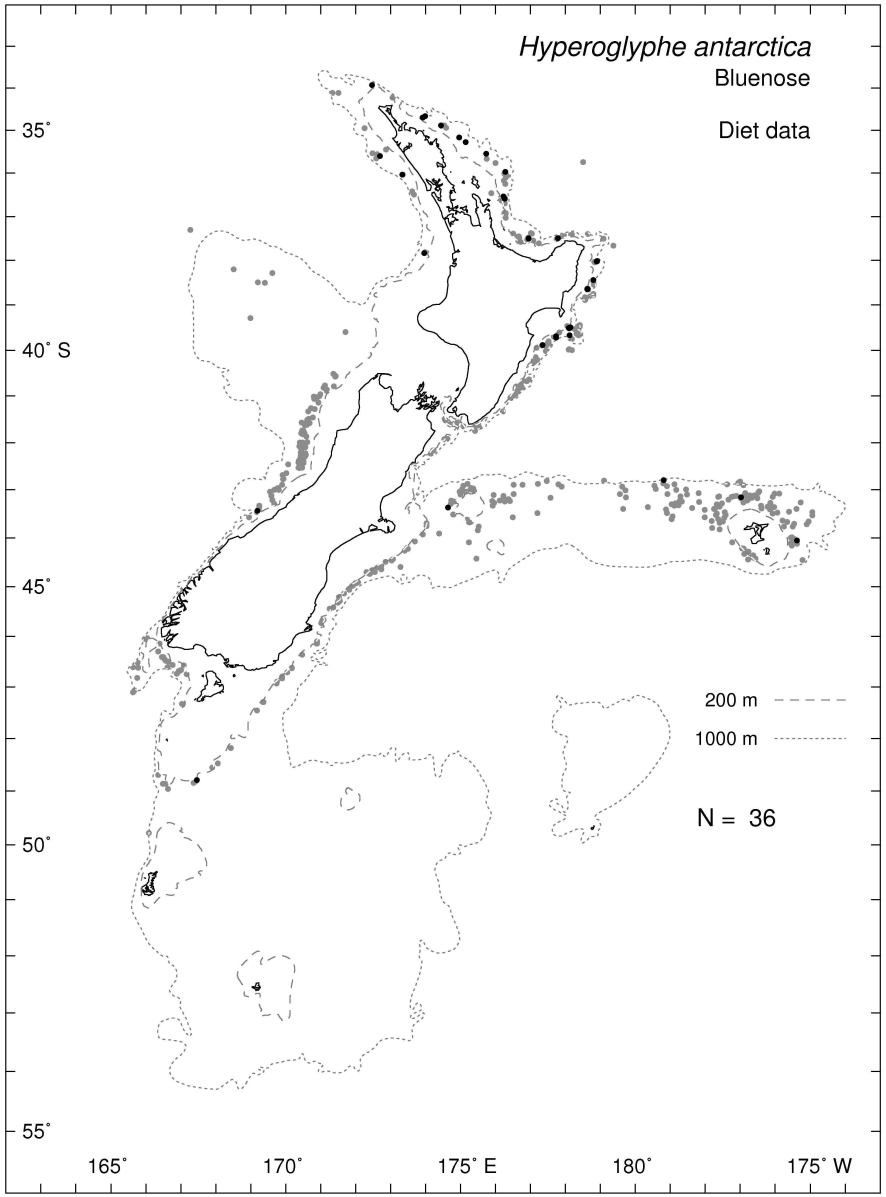

Figure B10a. The distribution of all bluenose (left panel) caught (grey dots) and those examined for diet (black dots) in research trawls 1960–2000. N, number of fish examined for diet.

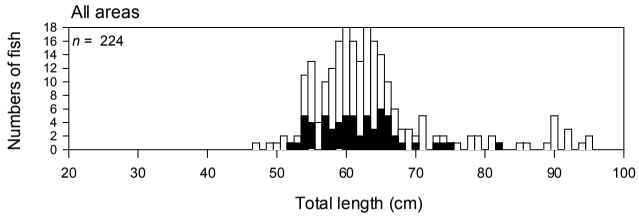

Figure B10b. The length frequency of bluenose where feeding data was recorded. Fish with empty stomachs are presented as white bars and fish containing prey items as black bars. Areas are defined on p. 9. *n*, number of fish examined for diet.

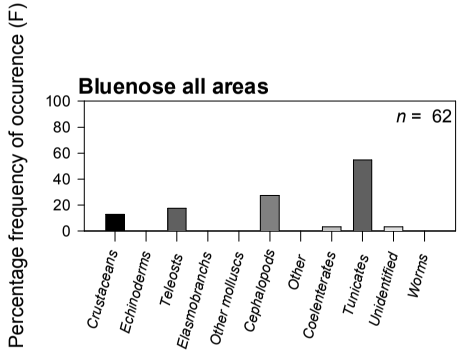

Figure B10c. The importance of major prey groups in the diet of bluenose examined on research trawl surveys. Fish size groups are arbitrary designations. *n*, number of fish examined for diet.

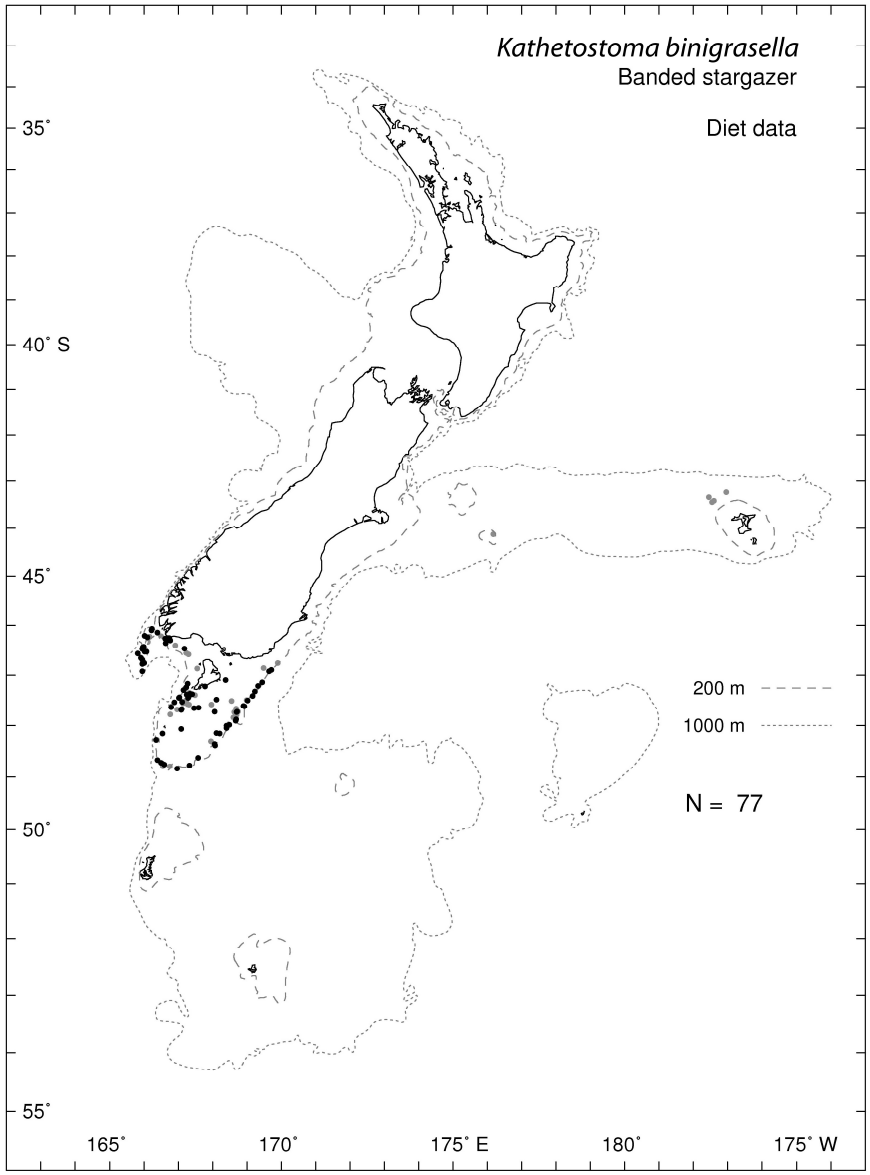

Figure B11a. The distribution of all banded stargazer (left panel) caught (grey dots) and those examined for diet (black dots) in research trawls 1960–2000. N, number of fish examined for diet.

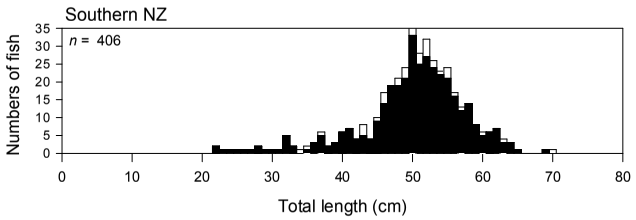

Figure B11b. The length frequency of banded stargazer where feeding data was recorded. Fish with empty stomachs are presented as white bars and fish containing prey items as black bars. Areas are defined on p. 9. *n*, number of fish examined for diet.

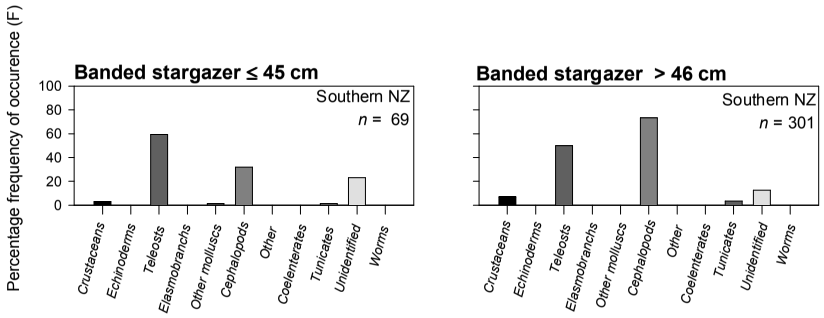

Figure B11c. The importance of major prey groups in the diet of banded stargazer examined on research trawl surveys. Fish size groups are arbitrary designations. Areas are defined on p. 9. *n*, number of fish examined for diet.

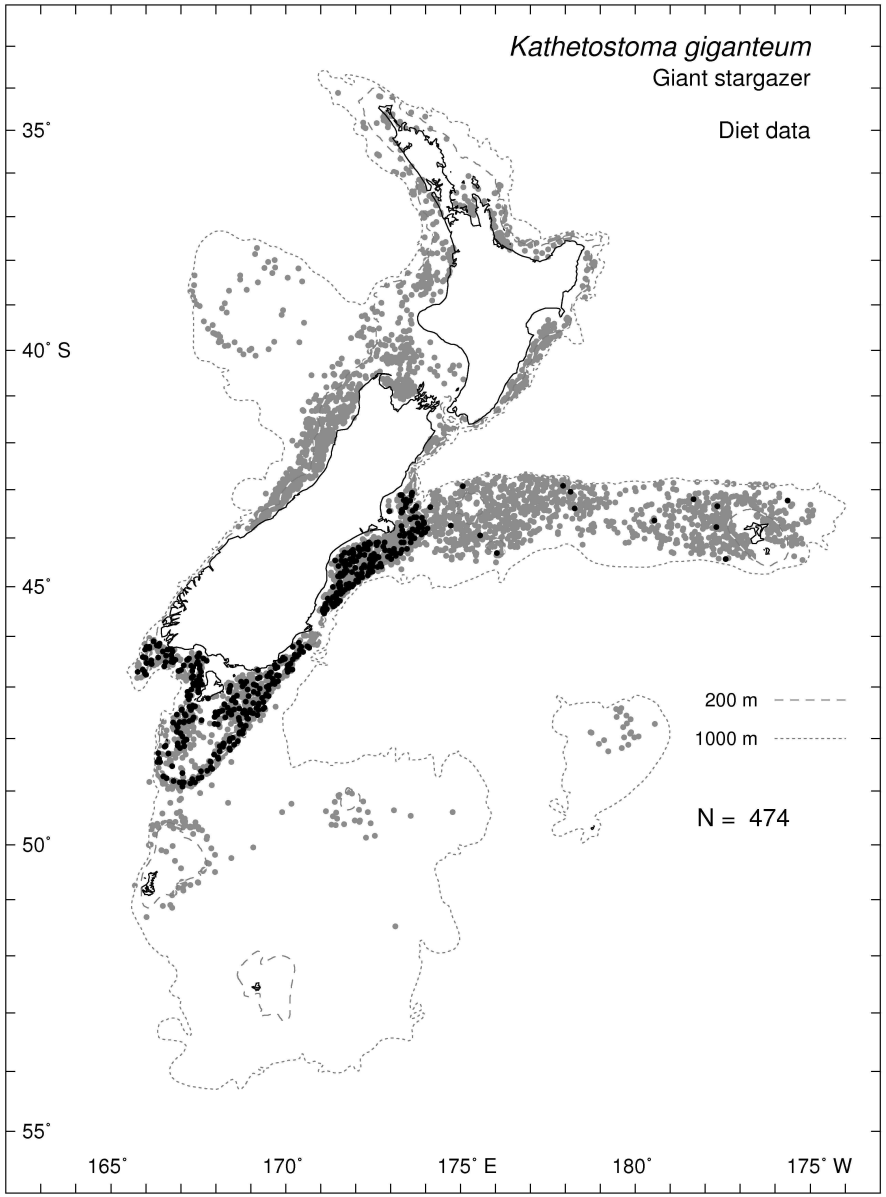

Figure B12a. The distribution of all giant stargazer (left panel) caught (grey dots) and those examined for diet (black dots) in research trawls 1960–2000. N, number of fish examined for diet.

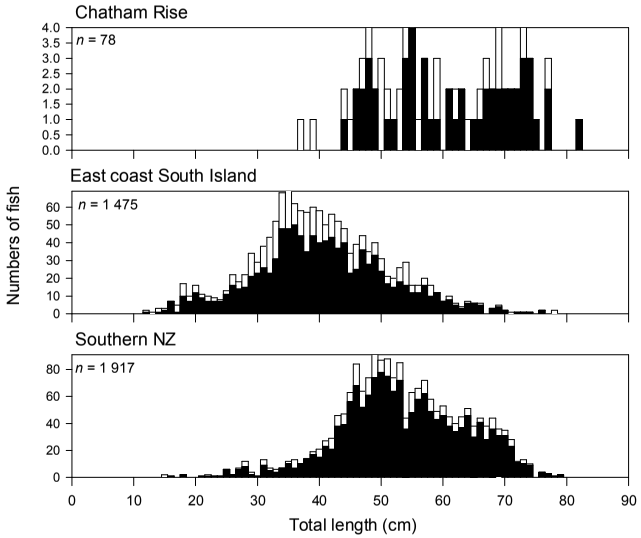

Figure B12b. The length frequency of giant stargazer where feeding data was recorded. Fish with empty stomachs are presented as white bars and fish containing prey items as black bars. Areas are defined on p. 9. *n*, number of fish examined for diet.

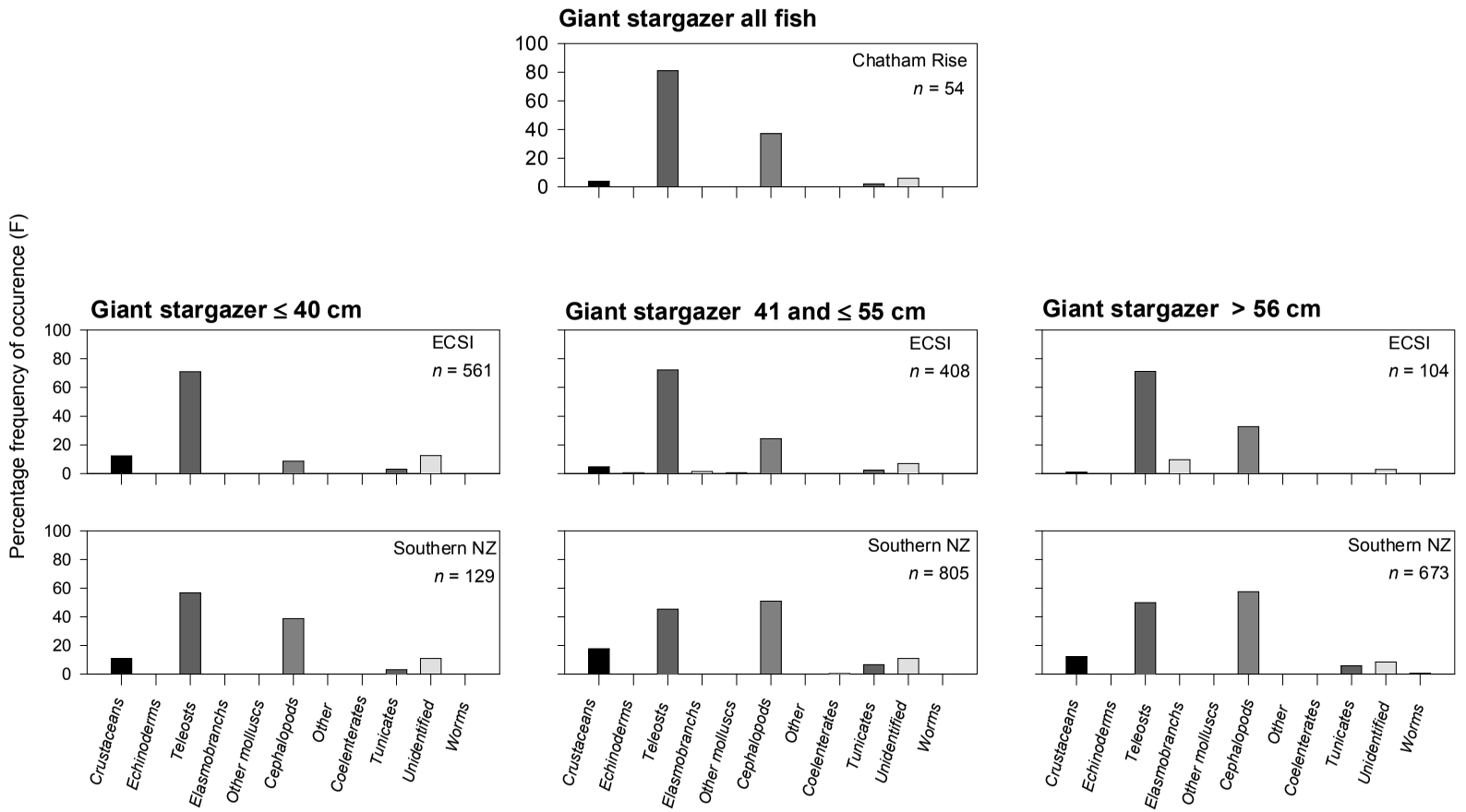

Figure B12c. The importance of major prey groups in the diet of giant stargazer examined on research trawl surveys. Fish size groups are arbitrary designations. Areas are defined on p. 9. *n*, number of fish examined for diet.

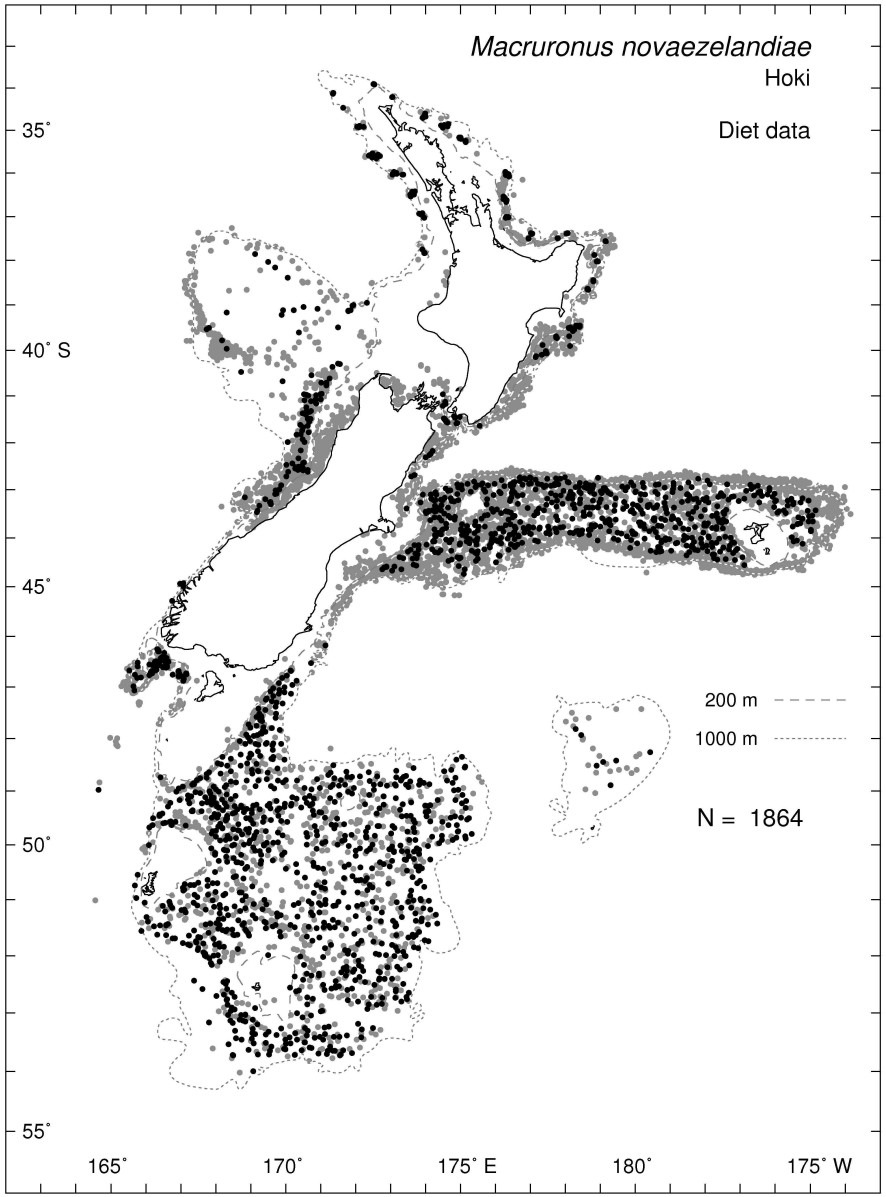

Figure B13a. The distribution of all hoki (left panel) caught (grey dots) and those examined for diet (black dots) in research trawls 1960–2000. N, number of fish examined for diet.

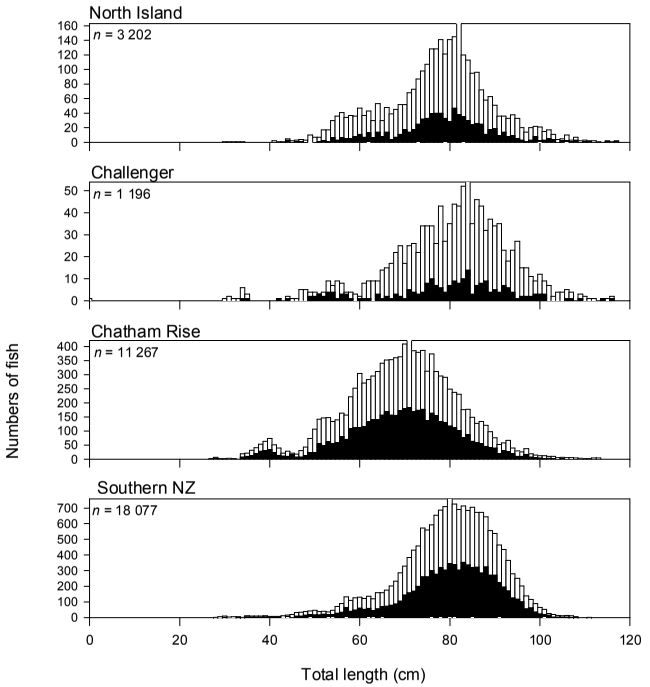

Figure B13b. The length frequency of hoki where feeding data was recorded. Fish with empty stomachs are presented as white bars and fish containing prey items as black bars. Areas are defined on p. 9. *n*, number of fish examined for diet.

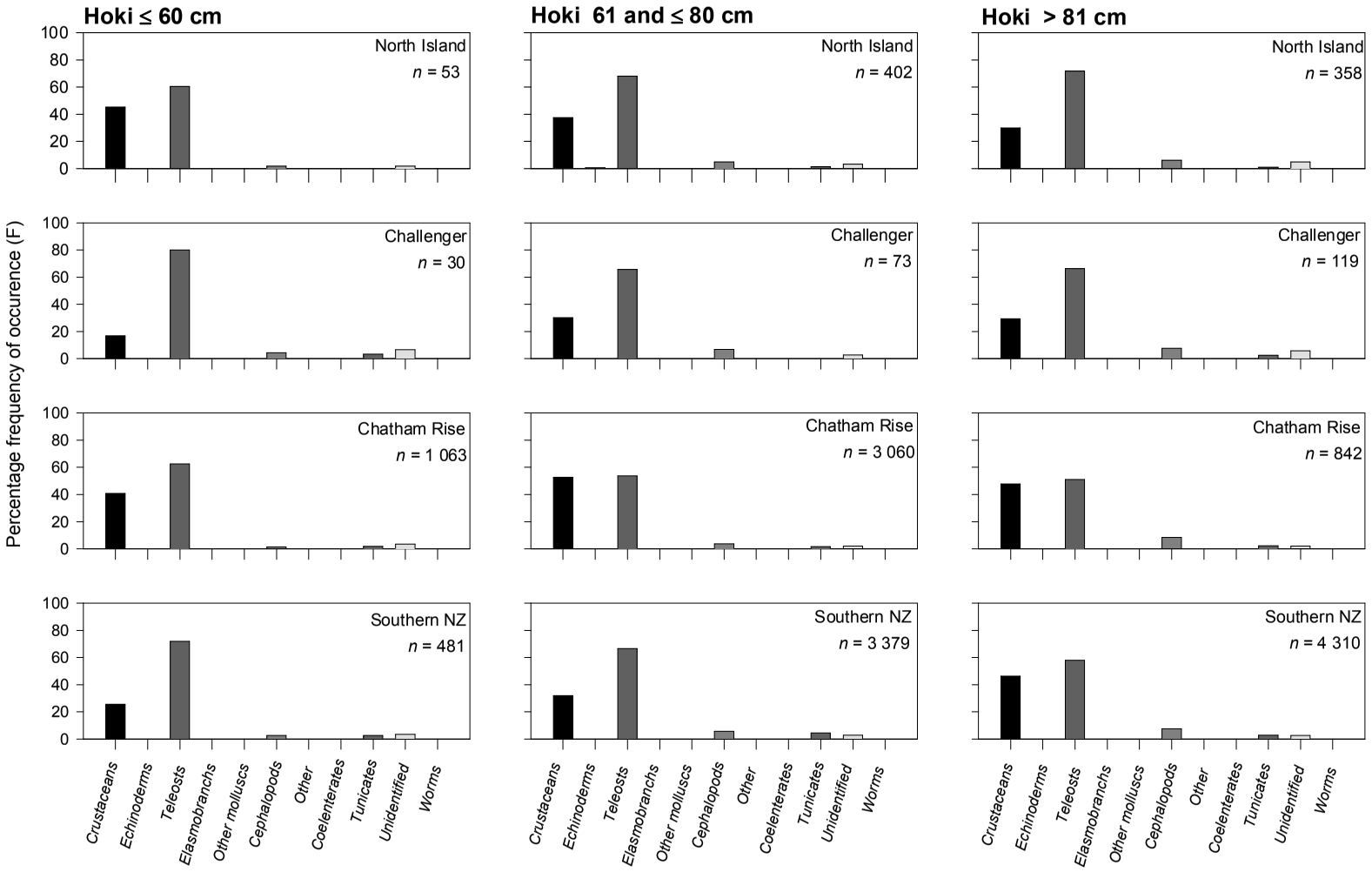

Figure B13c. The importance of major prey groups in the diet of hoki examined on research trawl surveys. Fish size groups are arbitrary designations. Areas are defined on p. 9. *n*, number of fish examined for diet.

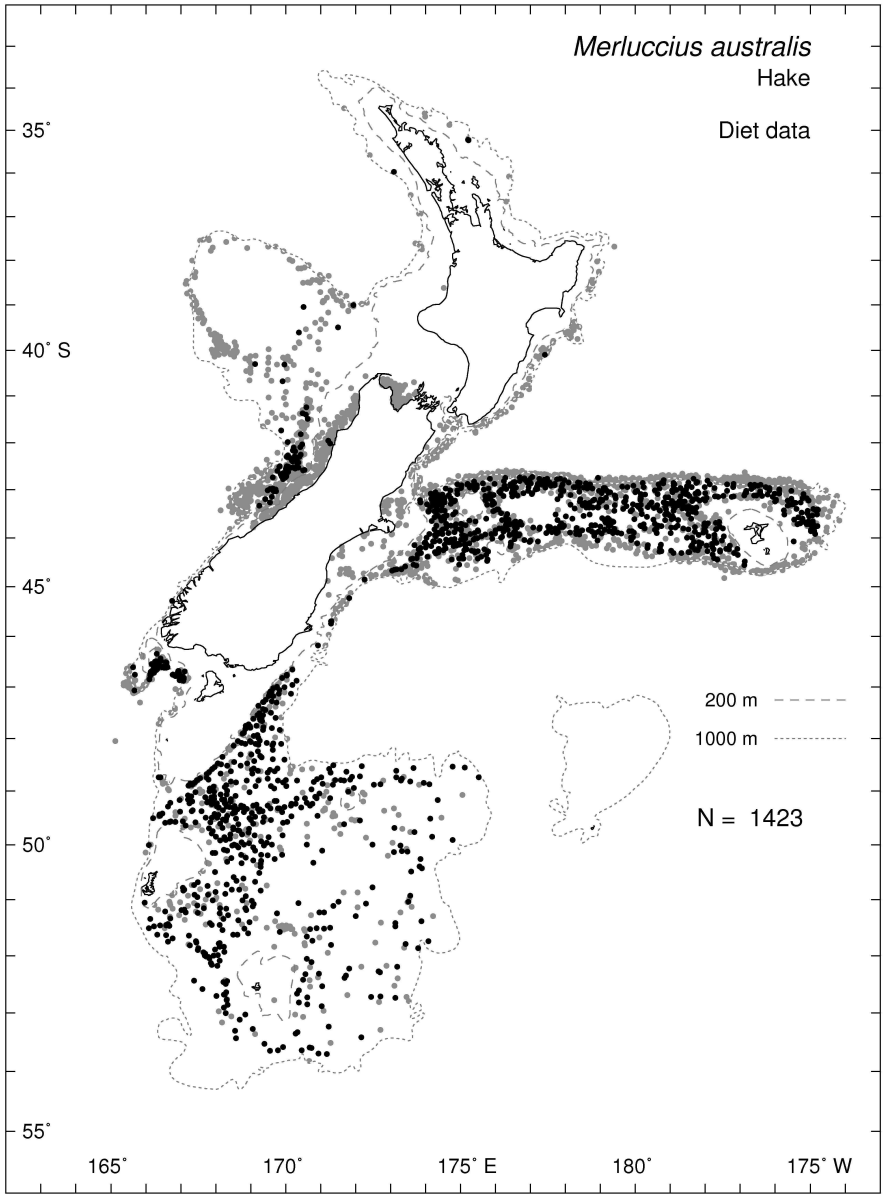

Figure B14a. The distribution of all hake (left panel) caught (grey dots) and those examined for diet (black dots) in research trawls 1960–2000. N, number of fish examined for diet.

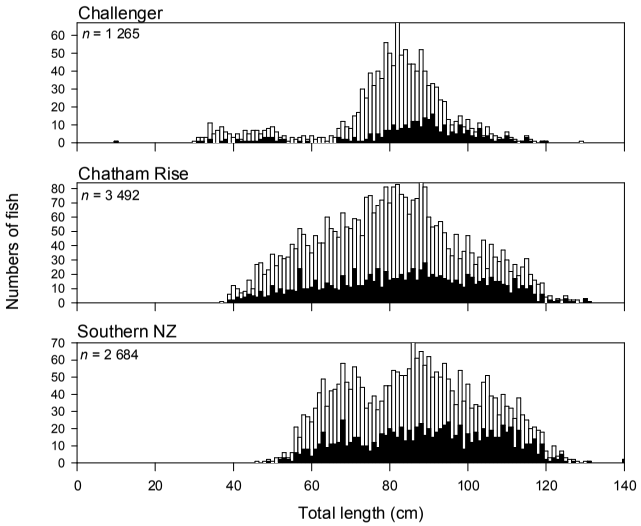

Figure B14b. The length frequency of hake where feeding data was recorded. Fish with empty stomachs are presented as white bars and fish containing prey items as black bars. Areas are defined on p. 9. *n*, number of fish examined for diet.

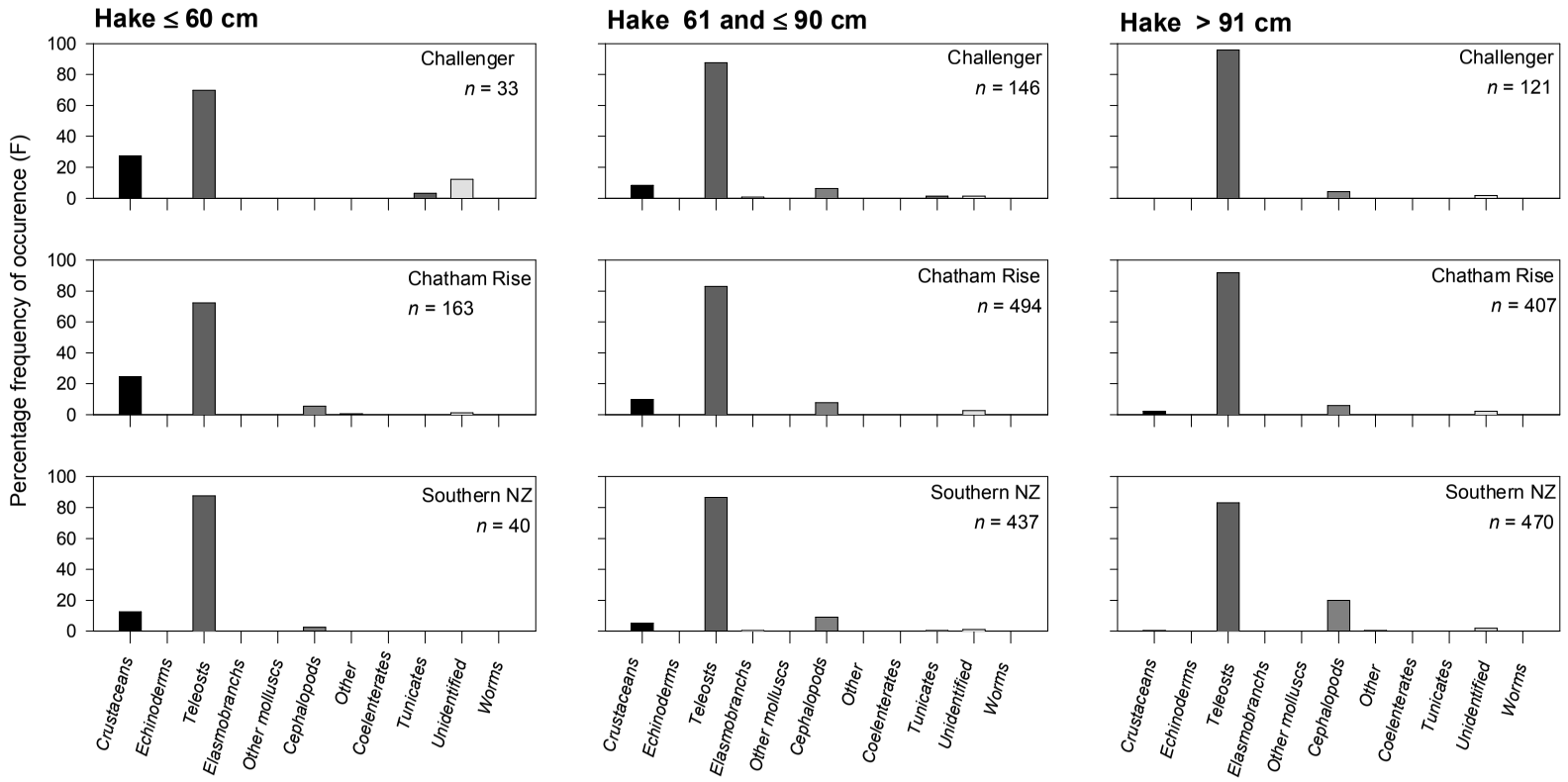

Figure B14c. The importance of major prey groups in the diet of hake examined on research trawl surveys. Fish size groups are arbitrary designations. Areas are defined on p. 9. *n*, number of fish examined for diet.

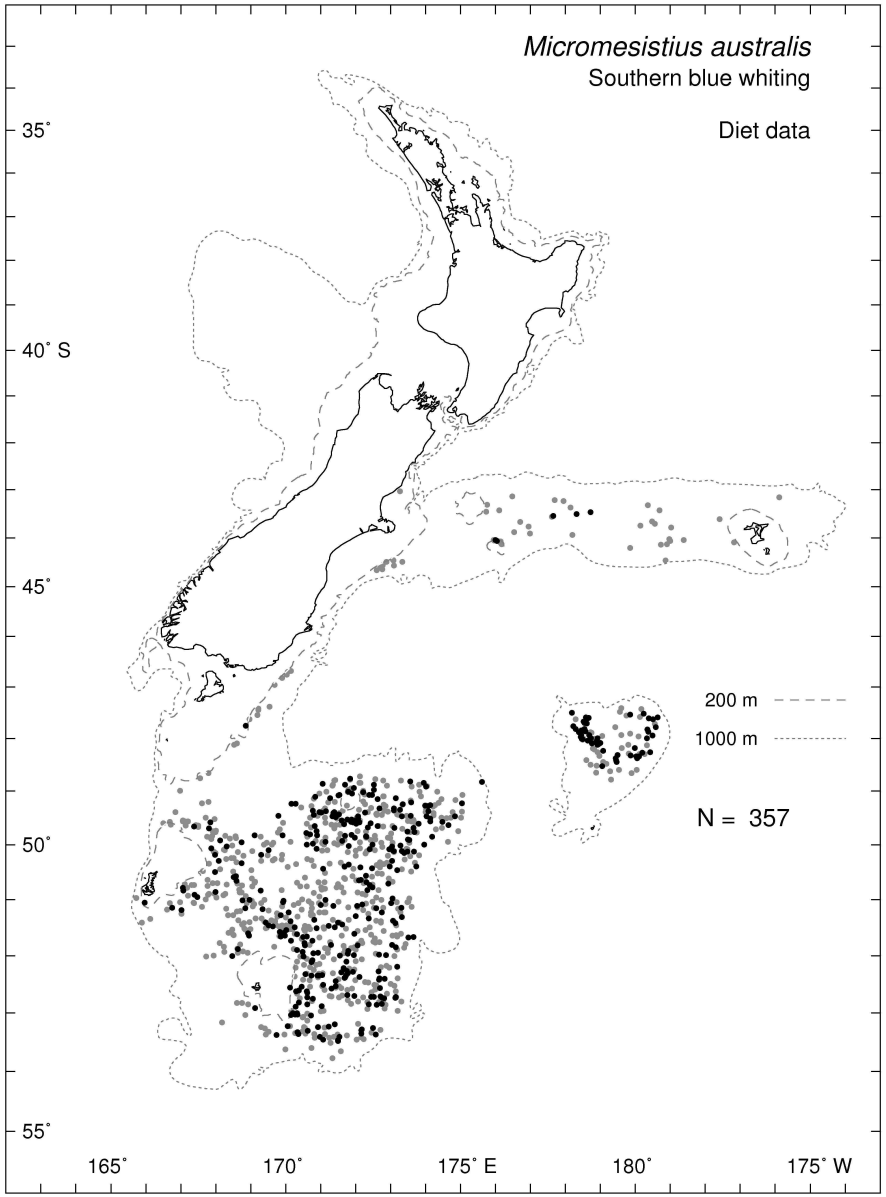

Figure B15a. The distribution of all southern blue whiting (left panel) caught (grey dots) and those examined for diet (black dots) in research trawls 1960–2000. N, number of fish examined for diet.

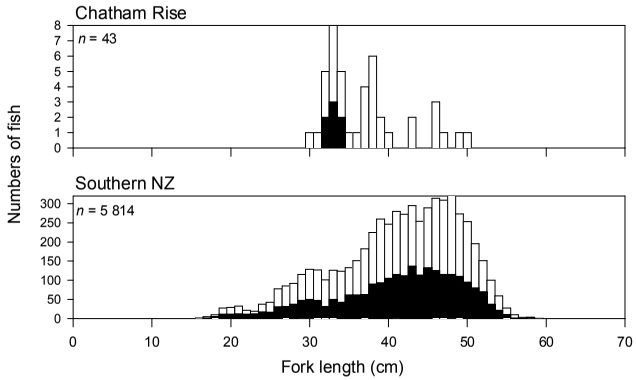

Figure B15b. The length frequency of southern blue whiting where feeding data was recorded. Fish with empty stomachs are presented as white bars and fish containing prey items as black bars. Areas are defined on p. 9. *n*, number of fish examined for diet.

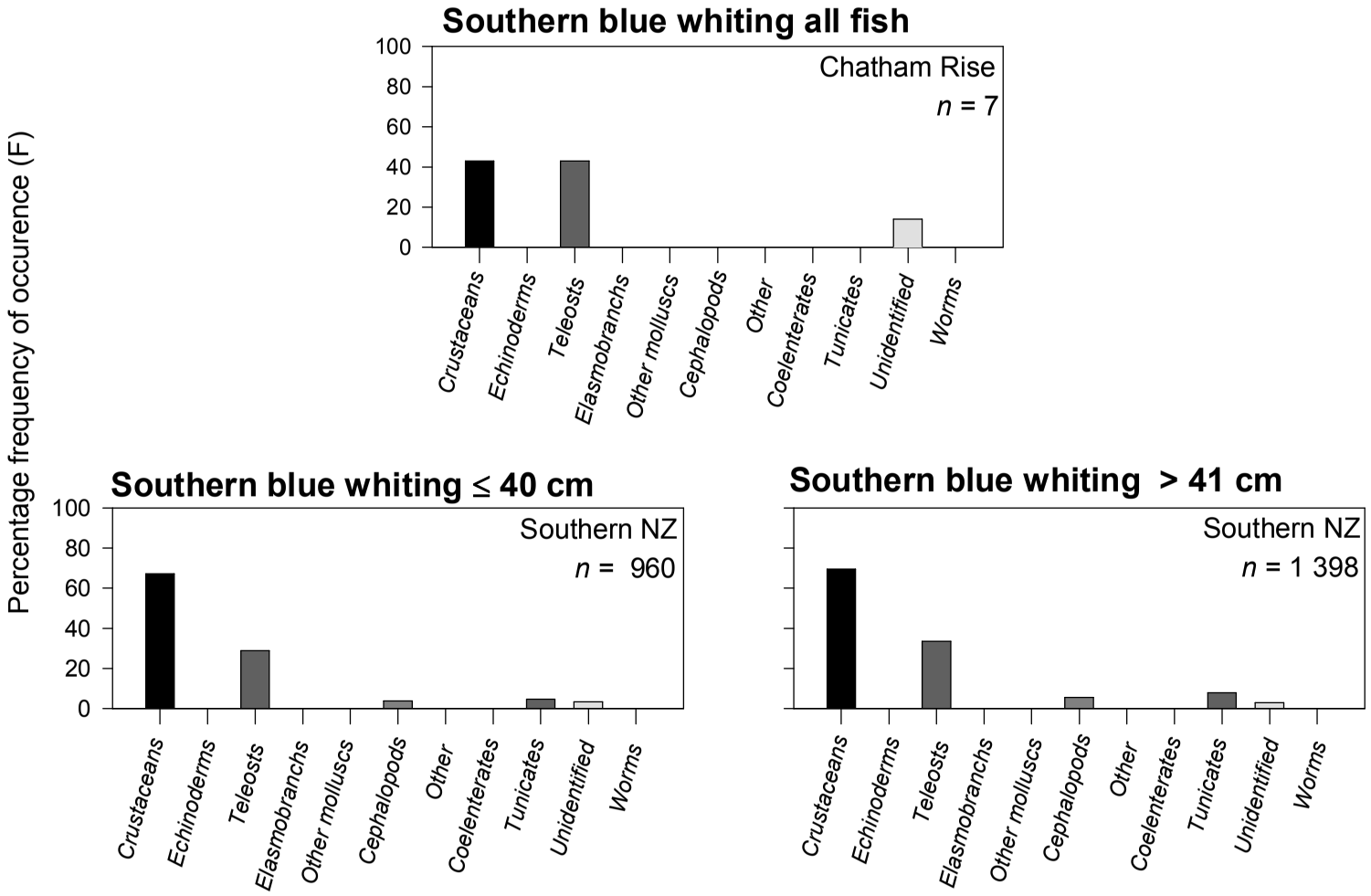

Figure B15c. The importance of major prey groups in the diet of southern blue whiting examined on research trawl surveys. Fish size groups are arbitrary designations. Areas are defined on p. 9. *n*, number of fish examined for diet.

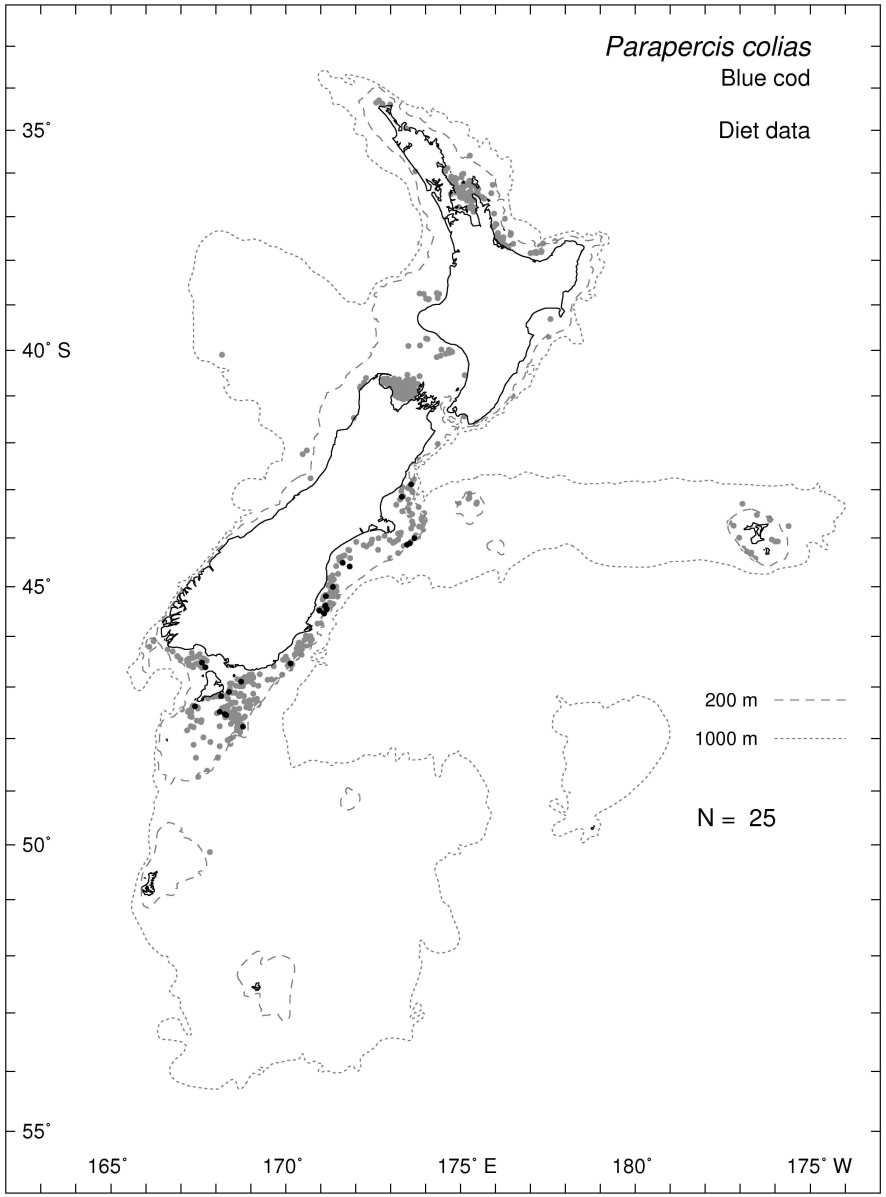

Figure B16a. The distribution of all blue cod (left panel) caught (grey dots) and those examined for diet (black dots) in research trawls 1960–2000. N, number of fish examined for diet.

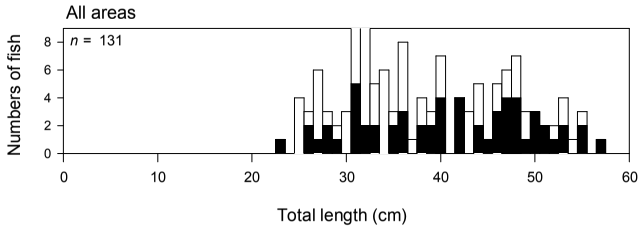

Figure B16b. The length frequency of blue cod where feeding data was recorded. Fish with empty stomachs are presented as white bars and fish containing prey items as black bars. Areas are defined on p. 9. *n*, number of fish examined for diet.

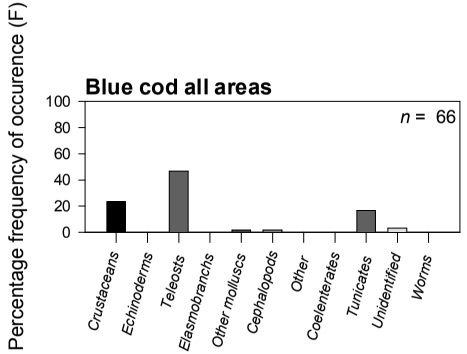

Figure B16c. The importance of major prey groups in the diet of blue cod examined on research trawl surveys. Fish size groups are arbitrary designations. *n*, number of fish examined for diet.