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NEW LOCALITY RECORDS AND PRELIMINARY INFORMATION ON DEMERSAL FAUNAL ASSEMBLAGES IN TASMANIAN WATERS

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(with two tables and three appendices)

ABSTRACT

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A survey of demersal fish resources off the Tasmanian coast in early 1979 provided guideline information on abundance and diversity of resources and the bathymetric distribution of species.

An annotated list of new Australian records includes *Coelorinchus matamua* McCann and McKnight, *Pseudoxenomystax hirsutus* (Castle), *Physiculus marginatus* (Günther), *Pentaceros richardsoni* (Smith) and *Seriolella caerulea* (Guichenot). New Tasmanian records include *Centroscymnus crepidator* (Bocage and Capello), *Centrophorus uyato* (Rafinesque), *Etmopterus lucifer* (Jordan and Snyder), *Dalatias licha* (Bonnaterre), *Raja gudgeri* Whitley, *Harriotta raleighana* Goode and Bean, *Neoscopelus macrolepidotus* Johnson, *Euclichthys polynemus* McCulloch, *Tripterophycis gilchristi* Boulenger, *Neocyttus rhomboidalis* Gilchrist *Cyttosoma boops* Gilchrist, *Lepidotrigla mulhalli* (Macleay), *Platycephalus conatus* Waite and McCulloch, *Neophrynichthys marcidus* McCulloch, *Epigonus denticulatus* Dieuzeide and *Parika scaber* (Forster).

Two skates (*Raja* spp) are new to science, and four other species (*Raja spp.*, *Hydrolagus* sp. and *Pleuroscopus* sp.) have not been positively identified and may be undescribed.

Bathymetric distributions of species sampled and a subjective evaluation of community structures of Tasmanian demersal fishes are provided.

INTRODUCTION

Accurate identification and determination of species compositions are important aspects of both academic and applied studies of animal communities. The population dynamics and natural history of commercial fish species are realised as major considerations in fishery studies but the usefulness of non-commercials in defining faunal assemblages and trophic associations is often undervalued. Such information can often be obtained incidentally from more specific studies at low additional cost. The importance of knowledge relating to interspecific relationships within communities and its application to specific fisheries studies has been discussed by Cushing (1975). The southern extremity of the Australian continental shelf occurs in Tasmanian waters, rendering the area interesting zoogeographically and providing a boundary for many commercial fish species.

Collections of demersal fish from Tasmanian waters date back to voyages of the "Erebus" and "Terror" (1844). The F.I.S. "Endeavour (1909-1914) pioneered trawl fisheries research in southern Australia and while an attempt was made to identify the catch components accurately, most subsequent surveys conducted off Tasmania (Wolfe 1970; Blackburn and Fairbridge 1946; Anon. 1977, 1979a) did not provide detailed compositional data or were basically exploratory surveys of a single species (Grant 1974). On some cruises, "Academic Berg" (Parin and Bekker 1972), "Courageous" (Anon. 1975-78), "Kaiyo Maru" (Anon 1976) "Umitaka Maru" (Scott 1969, 70, 71), more extensive collecting was

undertaken and overall species compositions were provided. Cowper and Downie (1957) provided the only summarised information on depth distribution of species but some species appear to have been confused with closely allied forms.

Prior to 1977 the most comprehensive recent trawling survey off the Tasmanian coast was undertaken by "Zeehaan" (Webb and Wolfe, 1977). In 1977 "Zeehaan" and a Lakes Entrance trawler, "Craigmin", were chartered to undertake exploratory trawling operations around southeastern Australia (Anon. 1977). A further grant allowed for the implementation of phase two of the survey and both vessels were re-chartered for a further exercise in 1978 (Anon. 1979a).

A third phase was completed in 1979. The 23 m stern trawler, "Zeehaan", was chartered for a three month survey off the Tasmanian west coast, and two shots were also completed on the slope off St. Helens. The basic aims were to map and explore uncharted grounds and secondly to obtain detailed information on the composition and bathymetric distribution of species on the continental shelf and slope. The latter objective is discussed in this paper and the former will be covered in detail in a separate report.

METHODS

A total of 57 trawls were made between January 5 and March 23, 1979. Some of the trawls were aborted because of hookups and for a few, incomplete species listings were obtained. Data from 40 complete samples are used in this paper. Stations and their co-ordinates and depth ranges are listed in Appendix 1.

Five trawl nets were used in the survey. These nets and their headline lengths (H.L.) are: Cosalt Three Bridle (36.6 m H.L.), Bridport Gundry 480 (24.4 m H.L.), Cosalt Aquarius (47 m H.L.), Cosalt U.R.I. (36.6 m H.L.) and Cosalt Box Trawl (24.4 m H.L.).

Species compositions for each trawl were obtained and the results plotted in the appropriate subjectively determined depth range; 0-15 (0-27 m), 15-50 (27-91 m), 50-150 (91-274 m), 150-250 (274-457 m), 250-350 (457-640 m) or greater than 350 (640 m) fathoms (Appendix 2). Mean depths were used to categorise trawls where the net operating depths overlapped two depth ranges.

Catch weight estimates for each species were obtained for each trawl and the relative abundances by weight for the ten major species in each depth range given (Appendix 3).

An annotated list of new records and a list of localities is presented. Explanatory notes are given where widely used scientific names for Australian species have been replaced by senior synonyms. Specimens are currently held at the T.F.D.A. Taroona Laboratory but eventually will be distributed between the Australian, Queen Victoria and Tasmanian Museums. New records have been lodged at the Tasmanian Museum; registration numbers (Tas. Mus. No.) are provided.

RESULTS AND DISCUSSION

Taxonomic Notes

SQUALIDAE

Deania calcea (Lowe, 1839)
S22, 24, 28, 33, 35, 37, 38, 39, 40.
This species is listed from Tasmania (Cowper and Downie 1957; Munro 1956) as a junior synonym *D. kaikourae* (Whitley) (Garrick, 1960a)

Centrophorus uyato (Rafinesque, 1810)
S24, 29. (Tas. Mus. No. D 1610).
Superficially resembles the other *Centrophorus* species and was only recently recorded from Australia (Gorman and Graham 1976). The specimens above represent the first record, of the species for Tasmania.

Centroscymnus crepidator (Bocage and Capello, 1864).
S37, 40. (Tas. Mus. No. D 1611)
Recorded from Australia by Gorman and Graham (1978); two specimens above are the first for Tasmania.

Etmopterus lucifer (Jordan and Snyder, 1902).
S25, 27, 29, 32, 36, 39, 40. (Tas. Mus. No. D 1612).
New record for Tasmanian waters.

Squalus blainvillei Risso, 1826).
S17, 23, 25, 27, 29, 30, 31, 32, 36. (Tas. Mus. No. D 1613).
Garrick (1960b), although unable to procure specimens from Australian waters, listed *S. tasmaniensis* Rivero from Tasmania as a junior synonym of this species. Material referred to by Gorman and Graham (1976) and herein confirms the occurrence of this species in Australian waters.

Squalus acanthias (Linnaeus, 1758).
S1.
A cosmopolitan species, commonly found in Tasmanian waters but known by the junior synonym *S. kirki* Phillipps.

DALATIIDAE

Dalatias licha (Bonnaterre, 1788).
S31, 33, 34, 36, 38, 40. (Tas. Mus. No. D 1614).
First record for Tasmania; assumed to be conspecific with *D. phillippsi* (Whitley) which has been recorded from southern Australia (Munro 1956).

RAJIDAE

Raja sp. 1
S7. (Tas. Mus. No. D 1615).
The taxonomy of Australian rajids is confused owing to extreme intraspecific, ontogenetic and sexual variation for fishes that are very similar interspecifically. This species is similar to *R. lemprieri*; although herein discriminated it may eventually be found conspecific with that species.

Raja sp 2
S19, 21, 22, 23, 24, 25, 29, 31, 35, 36, 37, 39. (Tas. Mus. No. D 1616).
Appears to be a valid undescribed species.

Raja sp. 3
S19, 21, 22, 23, 24, 28, 29, 30, 33, 34, 36, 37. (Tas. Mus. No. D 1617).
Appears to be a valid undescribed species.

Raja gudgeri Whitley, 1940.
S29, 36, 37, 39. (Tas. Mus. No. D 1618)
Holotype collected from Great Australian Bight. New Tasmanian record.

Raja sp. 4
S19, 35, 37. (Tas. Mus. No. D 1619)
Similar to and possibly juvenile form of *R. gudgeri*.

CHIMAERIDAE

Hydrolagus sp. 1
S19, 20, 21, 22, 23, 24, 25, 26, 28, 30, 31, 32, 35, 36, 37, 39, 40. (Tas. Mus. No. D 1620).
Allied to *H. lemures* Whitley but differs in some features; may prove to be conspecific with that species.

RHINOCHIMAERIDAE

Harriotta raleighana Goode and Bean, 1894
S33, 34, 37, 39. (Tas. Mus. No. D 1621).
New record for Tasmanian waters.

CONGRIDAE

Pseudoxenomystax hirsutus Castle, 1960
S35, 38. (Tas. Mus. No. D 1622).
Previously known only from New Zealand, the above specimens are the first recorded from Australian waters.

ARGENTINIDAE

Argentina australiae Cohen, 1958
S11, 12.
This species was first described as a subspecies of *A. elongata* Hutton and is now recognised as a valid species (Cohen 1969). Previous Tasmanian records of *A. elongata* are most likely attributable to *A. australiae*.

NEOSCOPELIDAE

Neoscopelus macrolepidotus Johnson, 1863

S38. (Tas. Mus. No. D 1623).
New record for Tasmanian waters.

MORIDAE

Physiculus marginatus (Gunther, 1878)
S23, 24, 32, 36, 37. (Tas. Mus. No. D 1624).
Previously known only from Patagonian waters (Norman 1937); specimens above represent first Australian records for the species.

Euclichthys polynemus McCulloch, 1926
S20, 22, 24, 26, 35. (Tas. Mus. No. D 1625).
A new record for Tasmanian waters. This species is not really a morid, but its true taxonomic position has not been ascertained (Svetovidov 1969).

Tripterophycis gilchristi Boulenger, 1904
S26, 32, 35, 37. (Tas. Mus. No. D 1626).
A new record for Tasmanian waters.

MACROURIDAE

Coelorinchus matamua McCann and McKnight, 1980
S21, 27, 30, 36, 38, 39, 40. (Tas. Mus. No. D 1627).
This species was recently described from New Zealand (McCann and McKnight 1980) and is hereby first recorded for Australia.

Ventrifossa nigromaculatus (McCulloch, 1907)
S22, 26, 28, 35, 37, 40.
Some specimens were collected by "Courageous" (1976) in Storm Bay. This record is now substantiated.

TRACHICHTHYIDAE

Hoplostethus intermedius (Hector, 1875)
S31, 33, 36.
Also collected by "Courageous" (1976) from Tasmanian waters but not recorded as new.

BERYCIDAE

Beryx splendens Lowe, 1833
S21, 23, 30, 32, 33, 34, 35, 36.
Collected in Storm Bay by "Courageous". Appears to be our most common deep water berycid.

ZEIDAE

Cyttus traversi (Hutton, 1872)
S20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 31, 32, 33, 34, 35, 36, 37, 39, 40.
The only Tasmanian record of this common commercial species is in catch data from a previous "Zeehaan" cruise (Anon. 1979a).

OREOSOMATIDAE

Neocyttus rhomboidalis Gilchrist, 1906
S23, 25, 27, 29, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40. (Tas. Mus. No. D 1628).
The species has been recorded from southeastern Australia but not specifically from the Tasmanian shelf where it is extremely abundant.

Cyttosoma boops Gilchrist, 1904
S37, 39, 40. (Tas. Mus. No. D 1629).
New record for Tasmanian waters.

MACRORHAMPHOSIDAE

Centriscops obliquus Waite, 1911
S20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 39.
Recognised by some authors (McCulloch 1929; Munro 1958) as a junior synonym of *C. humerosus* (Richardson). However, the true identity of Richardson's species remains unknown.

Macrorhamphosus scolopax (Linnaeus, 1758)
S11.
The specific status of *M. scolopax* and *M elevatus* Waite is subject to differing schools of thought and requires further taxonomic attention (Scott 1961). The authors are in agreement with Mohr (1937) so only a single cosmopolitan species is listed.

TRIGLIDAE

Lepidotrigla mulhalli (Macleay, 1884)
S2, 3, 5, 6, 7, 8. (Tas. Mus. No. D 1630).
New record for Tasmania. This species and *L. modesta* Waite appear in the past to have been confused with *Paratrigla vanessa* (Richardson).

PLATYCEPHALIDAE

Platycephalus conatus Waite and McCulloch, 1915
S8, 10, 11, 12, 13, 15, 16, 17, 19. (Tas. Mus. No. D 1631).
This species has been previously recorded as *P. speculator* Klunzinger. *P. speculator* most closely resembles *P. richardsoni* Castelnau, but, unlike both other species, lacks a swim bladder.

PSYCHROLUTIDAE

Neophrynichthys marcidus McCulloch, 1926
S36, 37, 39. (Tas. Mus. No. D 1632).
Exact locality of the type unknown (Nelson 1977) but samples collected during recent trawling by the "Courageous" have extended its distribution around southern Australia. The above specimens constitute first records for Tasmania.

APOGONIDAE

Epigonus denticulatus Dieuzeide, 1950
S23, 24, 26, 28, 31, 35, 36, 37. (Tas. Mus. No. D 1633).
A cosmopolitan species (Mayer 1974) not previously recorded from Tasmanian waters.

PENTACEROTIDAE

Pentaceros richardsoni (Smith, 1849)
S32. (Tas. Mus. No. D 1634).
A specimen collected from 550 m (300 ftms) represents the first Australian record. The species is apparently rare in New Zealand and South Africa but is caught in commercial quantities in the North Pacific (James 1978) with exceptional catches reported from Hawaiian waters (Anon. 1979b).

Pleuroscopus sp.
S24, 28, 29, 35. (Tas. Mus. No. D 1636).
A South African species *P. pseudodorsalis* Barnard was recently collected (Anon 1979c) in the Western Great Australian Bight. These are the only records of the genus from Australian waters. Tasmanian specimens differ morphometrically and meristically from the holotype but more specimens need to be examined before their relationship can be determined.

CENTROLOPHIDAE

Seriolella Caerulea Guichenot, 1848
S24, 28, 29, 32, 33, 35, 36, 37. (Tas. Mus. No. D 1637).
First Australian record of adults. Juveniles may have been recorded as a separate species. Known from Patagonia (Norman 1937), and New Zealand (Paul 1978).

MONACANTHIDAE

Parika scaber (Forster, 1801)
S2, 5, 6,. (Tas. Mus. No. D 1638).
Originally figured by Scott (1962) incorrectly as *Navodon australis* (Donovan). Although *P. scaber* has been recorded previously as *Navodon setosus* from deep water in Bass Strait (Scott 1960; Waite and McCulloch 1915; Whitley 1931), it was omitted from the Tasmanian records (Hutchins 1977; Last 1975) because of confusion with *Meuschenia australis*.

FAUNAL ASSEMBLAGES

Methods of examining species groupings in some marine studies have been outlined by Sheard (1965). Statistical analyses can only be used with data containing adequate numbers of replicates, hence many (Fish 1925; Sheard 1949; Baker 1954 and Glover 1957) have not attempted to give objective expression to their observations.

Fager and Longhurst (1968) used recurrent group analysis (Fager 1957, 1963) to examine demersal fish assemblages in the tropical eastern Atlantic. They found that where practicable the method can be a useful tool in resource evaluation. However, they highlighted the importance of good subjective techniques when more refined methods cannot be applied to the data. Owing to the low number of sampling replicates, the data obtained in this survey were not analysed statistically.

Subjective analysis indicates the presence of two major distributional zones exhibiting only minor faunal overlap; these are defined by the continental shelf (shallower than 275 m - 150 fathoms) and slope (deeper than 275 m). Interpretation of structuring from a direct comparison of species numbers in the similarity matrix (Table 1) was occluded by the presence of twelve eurybathic species (*Cephaloscyllium laticeps*, *Galeus boardmani*, *Galeorhinus australis*, *Squalus megalops*, *Squalus blainvillei*, *Chlorophthalmus nigripinnis*, *Genypterus blacodes*, *Macruronus novaezelandiae*, *Lepidorhynchus denticulatus*, *Helicolenus papillosus*, *Rexea solandri*, and *Seriolella punctata*) that occurred both on the shelf and below 460 m (250 ftms). Removal of these species from the matrix (Table 2) provided a better picture of the infra-structure within each zone.

TABLE 1

PERCENTAGE SIMILARITY MATRIX GIVING SPECIES NUMBERS (n) AND OVERLAPPING OCCURRENCE AT EACH DEPTH RANGE

	Depth range (fathoms) [m]	0-15[27]	15-50[91]	50-150[275]	150-250[457]	250-350[640]	>350[640]	n
SHELF	0-15[27]	100	72	33	6	11	0	18
	15-50[91]	20	100	38	9	11	5	65
	50-150[275]	13	53	100	28	28	11	47
SLOPE	150-250[457]	4	24	52	100	84	52	25
	250-350[640]	4	16	29	47	100	69	45
	>350[640]	0	8	14	36	86	100	36

TABLE 2

PERCENTAGE SIMILARITY MATRIX AS IN TABLE 1 BUT WITH THE TWELVE EURYBATHIC SPECIES REMOVED

	Depth range (metres)	0-27	27-91	91-275	275-457	457-640	>690	n
SHELF	0-27	100	69	25	0	0	0	16
	27-91	19	100	31	2	0	0	58
	91-275	11	51	100	11	3	0	35
SLOPE	275-457	0	6	25	100	75	56	16
	457-640	0	0	3	36	100	84	33
	>640	0	0	0	29	84	100	31

Three faunal assemblages appear to be evident on the shelf and upper slope. Although only one sample was taken in less than 27.5 m (15 ftms), elements of a shallow water inshore fauna are apparent. These observations are substantiated by unpublished studies being currently undertaken in the bays and estuaries around Tasmania and in essence are similar to the findings of Walker (1979).

The second, an inner shelf assemblage (27.5 m - 90 m), is well defined, consisting of a fauna which is more diverse than and differs in composition from the outer shelf and slope edge (90-275m). Although these faunas are rather different it is not suggested that the 90 m contour is their "limiting line". Discrete boundaries in faunal distributions are mythical features that are more idealistic than realistic. It is likely that these communities are more complex than indicated in this study and may be further subdivided. Examples of those species most indicative of the inner shelf are *Pristiophorus nudipinnis*, *Lepidotrigla mulhalli* and *Thamnoconus degini* while *Raja nitida*, *Hydrolagus ogilbyi*, *Coelorinchus australis* and *Notopogo lillei* are typical outer shelf species.

The trawled area of slope appears to possess at least two assemblages. An upper slope fauna is well defined with many species occurring down to 730 m (=400 fthms). The best indicators of this community are: *Oxynotus bruniensis*, *Raja* sp. 3, *Euclichthys polynemus*, *Beryx splendens* and *Zenopsis nebulosus*. Suggestions of a fifth assemblage appear with the fringe occurrence, at depths above 550 m, of some species recorded by previous authors (Cowper and Downie 1957; Garrick 1960) as having extended distributions down the slope and probably form part of a mid-slope fauna. Best indicators of this assemblage are: *Mora dannevigi*, *Daenia calcea*, *Scymnodon plunketi*, *Centroscymnus crepidater* and *Dalatias licha* and possibly *Cyttosoma boops*, *Neophrynichthys marcidus* and *Coelorinchus innotabilis*

Problems in viewing all communities as highly stable co-adapted groups in equilibrium have been discussed by Mills (1969). Depth occurrence of some species are further complicated by variations in the physical environment. Work by Fager and Longhurst (1968) support comments by Smith (1950) on the heterogeneity of deep water fish faunas but the importance of temperature in the bathymetric distribution of species is stressed. Newell (1974), in the study of southern Tasmanian water masses, found that waters below the shelf edge were of one type but on the shelf they became complex and exhibited marked seasonal changes. Thermal stratification and shifts in the thermocline in summer may not affect all species, but the distribution of stenothermal species may be slightly deeper at this time of year.

Clearly many questions need answering before community structure in this region is fully understood. Primarily there is a need to establish a better picture of depth distributions of each species and simultaneously examine coexistence patterns to see if the shelf assemblages can be further sub-divided. Bennett and Pope (1953) have shown the presence of distinct faunal provinces on southern Australian shores and there appears to be a similar structuring of reef fish populations (Last 1979). Fager and Longhurst (1968) have shown that inner shelf faunas can sometimes be split into a number of subcommunities. Complex shelf areas such as Bass Strait may possess complex community structures, as indicated by recent Tasmanian studies (unpublished data).

It is well established that the number of fish species is higher in the more ecologically diverse littoral zone than in deeper offshore waters (Smith 1950). This hypothesis is supported by results from this survey. From a total of 129 species, numbers on the shelf and slope totalled 90 and 54 respectively, sample numbers in each zone were almost equal.

Abundance data for each depth range (Appendix 3) suggested a reversal of the above trends. High total catch rates (weight of fish caught/hour) for each of the three slope depth ranges were experienced; similarly, commercial catch rates were higher for the slope samples. However, relative abundance data only provide an approximation to the real situation, as many variables (i.e. tide, net type and time of day) were not constant throughout the sampling. The dangers of using trawl data as an absolute measure of demersal fish abundances are evident from the work of Fenaughty and O'Sullivan (1978).

Faunal lists of littoral fishes from south-eastern Australia (Winstanley 1979) and New Zealand (Webb 1972) are essentially similar in composition to the fauna of Tasmanian waters. Several species appear to be endemic to the southern Australian region (i.e. some rajid, urolophid, platycephalid, pleuronectid, bothid and monacanthid species)

although some are represented by congeners in other seas.

Briggs (1974) regarded the degree of endemism of Tasmanian fishes as lying between 10 and 30 percent, with the Clinidae, Rajidae, Ostraciontidae and Bovichthyidae as major groups. Apart from some rajid species, all members of these families are confined to the shelf, with the possible exception of *Raja* sp. 1, none of the shelf species taken in this survey is endemic to Tasmanian waters. Endemism appears to be greatest in the intertidal and shallow subtidal zones (unpublished data), but the degree is certainly much less than 10 percent.

The slope fauna is widely distributed with several species either antitropically (i.e *Squalus blainvillei*, *Centrophorus uyato* and *Pentaceros richardsoni*) or circumglobally (i.e. *Etmopterus lucifer*, *Coelorinchus fasciatus*) distributed and some may be cosmopolitan. Many species, at this stage, are only "superficial" endemics and increased knowledge of these fishes will result in a reduction in endemism (Smith 1950).

Some features of community compositions require brief discussion. Eight families of elasmobranchs, most of which are commercially important, comprise over 30 percent of the total complement of trawl species compared with about 5 percent in shallow inshore waters. The most diverse of these were the squalids, represented by ten species, which were most numerous on the continental slope. Although most species are widely distributed outside Australian waters, in contrast, all members of two rajiform families, Rajidae (10 species) and Urolophidae (4 species) are endemic to the Australian/New Zealand region. Urolophids, being both viviparous and confined to the shelf, experience only localised dispersal. The more homogeneous physical environment of deep water skates is less restricting, geographically, than for shelf species. However behavioural (in low activity benthics) and reproductive (production of demersal eggs) characteristics are possibly major factors in causing the marked endemism exhibited by the group in different marine provinces throughout the world.

The macrourids are the most diverse family of demersal teleosts in this area. Such findings are in accordance with Pearcy and Ambler (1974), who rank the group as the dominant fishes on the slopes and adjoining abyssal plains of the world. In addition, many species still possibly remain unrecorded in Australian waters (McCann and McKnight 1980). The group is very important commercially (Pechenik and Troyanovskii 1970) and although Tasmanian species are not exploited, a close relative, the merlucciid, *Macruronus novaezelandiae* is potentially Tasmania's most important trawl species. Speciose teleost groups of commercial interest include the morids, triglids, uranoscopids and zeids, while some other less diverse families, such as the ophidiids, platycephalids, cheilodactylids, gempylids, centrolophids and pleuronectids, contain important commercial species.

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APPENDIX 1

TRAWL STATIONS

DEPTH CODE	CRUISE/STATION CODE	START		FINISH		DEPTH RANGE (metres)
		Lat.	Long.	Lat.	Long.	
1	C07 - 10	42°00'S	145°14'E	42°04'S	145°13'E	22
2	C10 - 01	40°20'S	145°25'E	40°23'S	145°20'E	45
3	C12 - 04	39°55'S	144°52'E	39°53'S	145°00'E	46
4	C12 - 03	39°59'S	145°03'E	39°57'S	144°59'E	49
5	C12 - 01	40°04'S	145°07'E	40°06'S	145°09'E	51
6	C12 - 02	39°59'S	145°08'E	39°59'S	145°07'E	51
7	C07 - 01	42°09'S	145°08'E	42°08'S	145°05'E	64
8	C07 - 09	41°56'S	145°00'E	42°00'S	145°02'E	70
9	C11 - 01	40°47'S	144°16'E	40°42'S	144°15'E	90-93
10	C06 - 03	43°18'S	145°33'E	43°15'S	145°31'E	157-159
11	C06 - 01	43°18'S	135°32'E	43°15'S	145°26'E	159
12	C06 - 02	43°15'S	145°26'E	43°20'S	145°31'E	159
13	C06 - 04	43°14'S	145°26'E	43°17'S	145°32'E	159-163
14	C04 - 02	44°03'S	146°55'E	41°01'S	147°07'E	165
15	C09 - 05	40°57'S	143°49'E	40°58'S	143°54'E	183
16	C09 - 06	40°50'S	143°53'E	40°53'S	143°47'E	183
17	C11 - 02	40°46'S	143°42'E	-	-	183-220
18	C04 - 01	44°03'S	146°53'E	-	-	238-265
19	C07 - 03	42°06'S	144°43'E	42°00'S	144°40'E	366-420
20	C07 - 07	42°05'S	144°41'E	42°07'S	144°41'E	455-457
21	C07 - 08	42°07'S	144°41'E	42°08'S	144°43'E	457
22	C09 - 02	41°14'S	144°08'E	41°17'S	144°12'E	457-494
23	C07 - 06	42°08'S	144°41'E	42°03'S	144°39'E	485-547
24	C09 - 04	41°01'S	143°51'E	40°54'S	143°44'E	494
25	C07 - 05	42°12'S	144°43'E	42°08'S	144°40'E	530-567
26	C02 - 01	40°48'S	143°36'E	40°41'S	143°31'E	550
27	C03 - 01	42°20'S	144°47'E	-	-	550
28	C09 - 01	41°19'S	144°11'E	41°14'S	144°05'E	550
29	C11 - 04	40°43'S	143°33'E	40°47'S	143°36'E	550
30	C15 - 01	40°32'S	143°27'E	40°39'S	143°30'E	550
31	C15 - 02	40°55'S	143°55'E	-	-	550
32	C15 - 03	41°05'S	143°54'E	-	-	550
33	C17 - 01	41°33'S	148°38'E	41°36'S	148°38'E	550
34	C17 - 02	42°23'S	148°33'E	42°17'S	148°39'E	550
35	C09 - 03	41°10'S	144°01'E	41°02'S	143°52'E	530-640
36	C06 - 05	42°14'S	144°43'E	42°21'S	144°47'E	622-658
37	C08 - 03	41°20'S	144°12'E	41°15'S	144°03'E	622-722
38	C08 - 02	42°15'S	144°43'E	42°19'S	144°46'E	680-710
39	C11 - 03	40°40'S	143°29'E	-	-	677-750
40	C08 - 01	42°21'S	144°45'E	42°15'S	144°43'E	732

DEPTH DISTRIBUTIONS OF FISH SPECIES COLLECTED BY 'ZEEHAAN', JANUARY TO MARCH 1979

Depth (m)	< 27	27 - 91								91 - 275								275 - 457										457 - 640										> 640			
SPECIES Code	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
HETERODONTIDAE																																								
Port Jackson shark																																								
Heterodontus portusjacksoni			x	x	x																																			
HEXANCHIDAE																																								
seven-gilled shark																																								
Notorhynchus cepedianus	x																																							
ORECTOLOBIDAE																																								
rusty catshark																																								
Parascyllium ferrugineum	x	x	x			x	x																																	
SCYLIORHINIDAE																																								
draughtboard shark																																								
Cephaloscyllium laticeps		x	x	x		x			x			x	x	x	x	x			x		x	x	x					x			x	x	x	x		x				
spotted catshark																																								
Asymbolis analis		x			x				x		x	x	x	x	x																									
sawtail shark																																								
Galeus boardmani												x			x		x	x		x	x		x	x	x	x			x			x	x			x				
CARCHARHINIDAE																																								
gummy shark																																								
Mustelus antarcticus	x	x	x	x		x	x		x		x	x																												
school shark																																								
Galeorhinus australis		x					x		x	x	x	x			x	x	x		x	x					x															
SQUALIDAE																																								
prickly dogfish																																								
Oxynotus bruniensis																			x			x		x	x			x		x		x		x	x				x	
long snouted dogfish																																								
Deania quadrispinosa																																							x	
brier shark																																								
Deania calcea																						x		x				x					x		x		x	x	x	x
southern dogfish																																								
Centrophorus uyato																								x					x											
Lord Plunket's shark																																								
Scymnodon plunketi																																					x			
Mollers deepsea shark																																								
Etmopterus lucifer																									x		x		x			x				x			x	x
spiked dogfish																													x											
Squalus megalops	x					x	x	x	x		x	x	x	x		x	x	x	x																					
green-eyed dogfish																																								
Squalus blainvillei																		x					x		x		x		x	x	x	x			x					
white-spotted dogfish																																								
Squalus acanthias	x																																							
golden dogfish																																								
Centroscymnus crepidator																																					x			x

DEPTH DISTRIBUTIONS OF FISH SPECIES COLLECTED BY 'ZEEHAAN', JANUARY TO MARCH 1979

Depth (m)	< 27	27 - 91								91 - 275									275 - 457										457 - 640										> 640			
SPECIES																																										
Code	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
DALATIIDAE																																										
black shark																																									
Dalatias licha																														x		x	x		x		x		x	
PRISTIOPHORIDAE																																										
southern saw shark																																									
Pristiophorus nudipinnis	x	x	x	x	x	x		x																																	
common saw shark																																									
P. cirratus			x	x		x	x		x		x	x	x	x																											
SQUATINIDAE																																									
angel shark																																									
Squatina australis	x		x		x	x																																			
RAJIDAE																																									
thornback skate																																									
Raja lemprieri					x			x	x	x	x	x	x	x																											
brown blotched skate																																									
Raja sp. 1							x																																		
white spotted skate																																									
Raja cerva		x		x		x					x	x	x		x	x	x	x																							
long-nosed skate																																									
Raja nasuta					x	x							x																												
grey skate																																									
Raja sp. 2																			x		x	x	x	x	x				x		x				x	x	x			x	
Melbourne skate																																									
Raja whitleyi				x			x						x																												
green bight skate																																									
Raja sp.3																			x		x	x	x	x				x	x	x			x	x		x	x				
brown bight skate																																									
Raja gudgeri																													x							x	x		x	
blotched bight skate																																									
Raja sp. 4																			x																x		x				
peacock skate																																									
Raja nitida											x	x	x	x																											
UROLOPHIDAE																																									
banded stingaree																																									
Urolophus cruciatus	x	x		x	x		x	x	x			x		x																											
stingaree																																									
Urolophus paucimaculatus	x																																								
sandy-backed stingaree																																									
Urolophus bucculentus						x	x	x	x																																
green back stingaree																																									
Urolophus viridis		x	x	x	x	x	x	x	x																																
MYLIOBATIDAE																																									
eagle ray																																									
Myliobatis australis			x																																					

APPENDIX 2 DEPTH DISTRIBUTIONS OF FISH SPECIES COLLECTED BY 'ZEEHAAN', JANUARY TO MARCH 1979

Depth (m)	< 27	27 - 91								91 - 275								275 - 457									457 - 640									> 640			
SPECIES Code	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
TORPEDINIDAE																																								
torpedo ray																																								
Narcine tasmaniensis				x	x	x	x	x	x		x	x		x																										
electric ray																																								
Torpedo macneilli				x																																			
RHINOBATIDAE																																								
fiddler ray																																								
Trygonorhina fasciata			x																																				
CALLORHYNCHIDAE																																								
elephant fish																																								
Callorhynchus milii	x						x	x	x																															
CHIMAERIDAE																																								
Ogilby's ghost shark																																								
Hydrolagus ogilbyi													x		x	x		x																						
ghost shark																																								
Hydrolagus sp. 1																			x	x	x	x	x	x	x	x	x	x		x	x	x	x			x	x	x	x	x
RHINOCHIMAERIDAE																																								
spookfish																																								
Harriotta raleighana																																	x	x			x		x	
CONGRIDAE																																								
little conger eel																																								
Gnathophis habenata							x																																	
deepsea conger eel																																								
Pseudoxenomystax hirsutus																																			x			x		
ARGENTINIDAE																																								
silverside																																								
Argentina australiae											x	x																												
CHLOROPTHALMIDAE																																								
cucumber fish																																								
Chloropthalmus nigripinnis										x	x	x	x	x	x	x		x	x	x	x	x	x	x				x	x	x	x	x			x					
NEOSCOPELIDAE																																								
large-scaled lantern fish																																								
Neoscopelus macrolepidotus																																						x		
MORIDAE																																								
red cod																																								
Pseudophycis bachus	x	x					x	x	x	x	x		x																											
deep sea cod																																								
Mora dannevigi																						x	x		x		x			x	x	x	x	x	x		x	x	x		x

APPENDIX 2 DEPTH DISTRIBUTIONS OF FISH SPECIES COLLECTED BY 'ZEEHAAN', JANUARY TO MARCH 1979

Depth (m)	< 27	27 - 91								91 - 275									275 - 457														457 - 640														> 640			
SPECIES Code	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Tasmanian cod																																								
Physiculus marginatus																							x	x								x				x	x			
Eucla cod																																								
Euclichthys polynemus																				x		x		x		x									x						
grenadier cod																																								
Tripterophycis gilchristii																										x						x			x		x				
OPHIDIIDAE																																								
rock ling																																								
Genypterus blacodes		x				x			x	x	x	x				x	x						x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
MACROURIDAE																																								
southern whiptail																																								
Coelorinchus australis										x	x	x	x		x	x	x	x	x																						
banded whiptail																																								
Coelorinchus fasciatus																			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x
large headed whiptail																																								
Coelorinchus matamua																					x						x			x						x		x	x	x
innotable whiptail																																								
Coelorinchus innotabilis																																				x	x	x	x	
toothed whiptail																																								
Lepidorhynchus denticulatus																x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x
blackspot whiptail																																								
Ventrifossa nigromaculata																						x				x		x							x		x				
MERLUCCIIDAE																																								
blue grenadier																																								
Macruronus novaezelandiae																	x		x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x		x	x
TRACHICHTHYIDAE																																								
New Zealand sawbelly																																								
Hoplostethus intermedius																															x		x		x					
sandpaper fish																																								
Paratrachichthys trailli							x																																	
BERYCIDAE																																								
alfonsin																																								
Beryx splendens																					x		x							x		x	x	x	x	x				
ZEIDAE																																								
king dory																																								
Cytus traversi																				x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x		x	x
silver dory																																								
Cyttus australis		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x																						
mirror dory																																								
Zenopsis nebulosus																		x	x	x	x	x																		
John dory																																								
Zeus faber			x		x	x																																		

APPENDIX 2 DEPTH DISTRIBUTIONS OF FISH SPECIES COLLECTED BY 'ZEEHAAN', JANUARY TO MARCH 1979

Depth (m)	< 27	27 - 91								91 - 275								275 - 457																457 - 640																> 640			
SPECIES Code	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
New Zealand dory																																								
Cyttus novaezelandiae										x	x	x		x			x	x																						
OREOSOMATIDAE																																								
spiky dory																																								
Neocyttus rhomboidalis																							x		x		x		x		x	x	x	x	x	x	x	x	x	x
ox-eyed dory																																								
Cyttosoma boops																																					x		x	x
MACRORHAMPHOSIDAE																																								
banded bellows fish																																								
Centriscops obliquus																				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	
common bellows fish																																								
Macrorhamphosus scolopax											x																													
crested bellows fish																																								
Notopogon lillei											x	x			x	x		x																						
SCORPAENIDAE																																								
red gurnard perch																																								
Helicolenus papillosus									x	x	x	x	x		x		x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x
thetis fish																																								
Neosebastes thetidis		x	x	x		x			x	x	x	x	x		x	x	x																						
common gurnard perch																																								
Neosebastes scorpaenoides					x																																		
goblin fish																																								
Glyptauchen panduratus		x				x																																		
TRIGLIDAE																																								
red gurnard																																								
Chelidonichthys kumu							x		x																															
latchet																																								
Pterygotrigla polyommata	x					x	x	x	x	x	x	x	x	x	x	x	x																								
butterfly gurnard																																								
Paratrigla vanessa	x	x	x	x	x	x																																		
round snouted gurnard																																								
Lepidotrigla mulhalli		x	x		x	x	x	x																																
grooved gurnard																																								
Lepidotrigla modesta				x	x	x	x	x	x	x	x	x	x	x																										
PLATYCEPHALIDAE																																								
tiger flathead																																								
Platycephalus richardsoni		x	x	x	x	x	x		x		x	x																												
deep-water flathead																																								
Platycephalus conatus								x		x	x	x	x		x	x	x		x																					

APPENDIX 2 DEPTH DISTRIBUTIONS OF FISH SPECIES COLLECTED BY 'ZEEHAAN', JANUARY TO MARCH 1979

Depth (m)	< 27	27 - 91								91 - 275								275 - 457																457 - 640																> 640			
SPECIES Code	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
toothed whiptail																																								
Lepidorhynchus denticulatus																x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x		x
blackspot whiptail																																								
Ventrifossa nigromaculata																						x				x		x							x		x			
sand flathead	x		x	x	x	x		x																																
Platycephalus bassensis	x		x	x	x	x		x																																
HOPLICHTHYIDAE																																								
deep sea flathead																																								
Hoplichthys haswelli																			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x
PSYCHROLUTIDAE																																								
blobfish																																								
Neophrynichthys marcidus																																			x	x		x		
CALLIONYMIDAE																																								
common stinkfish																																								
Callionymus calauropomus			x																																				
long spined stinkfish																																								
Callionymus phasis											x																													
SERRANIDAE																																								
rosy perch																																								
Callanthias allporti																	x																							
orange perch																																								
Anthias pulchellus																	x	x																						
hapuku																																								
Polyprion oxygeneios															x																									
CARANGIDAE																																								
jack mackerel																																								
Trachurus declivis			x																																				
EMMELICHTHYIDAE																																								
redbait																																								
Emmelichthys nitidus				x																																			
APOGONIDAE																																								
big-eye cardinal fish																																								
Epigonus lenimen																							x		x						x			x		x	x	x	x	x
white cardinal fish																																								
Epigonus denticulatus																							x	x	x	x		x			x					x	x	x		
GERREIDAE																																								
silverbelly																																								
Parequula melbournensis		x	x																																				

APPENDIX 2 DEPTH DISTRIBUTIONS OF FISH SPECIES COLLECTED BY 'ZEEHAAN', JANUARY TO MARCH 1979

	Depth (m)	< 27	27 - 91							91 - 275								275 - 457			457 - 640												> 640			
SPECIES	Code	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
gemfish																																									
Rexea solandri								x			x	x	x	x		x	x	x	x	x				x	x	x	x		x	x	x	x	x	x	x		x			x	x
CENTROLOPHIDAE																																									
deep sea trevalla																																									
Hyperoglyphe antarctica																				x																				
spotted trevalla																																									
Seriolella punctata		x	x		x			x		x														x	x	x					x	x	x				x				
white trevalla																																									
Seriolella caerulea																									x				x	x			x	x		x	x	x			
PLEURONECTIDAE																																									
long-snouted flounder																																									
Ammotretis rostratus		x																																						
spotted flounded																																									
Ammotretis lituratus				x																																				
greenback flounder																																									
Rhombosolea tapirina		x																																						
BOTHIDAE																																									
Andrew's flounder																																									
Arnoglossus andrewsi				x																																				
TETRAODONTIDAE																																									
ringed toadfish																																									
Arothron armilla			x	x																																				
OSTRACIONTIDAE																																									
Shaws cowfish																																									
Aracana aurita			x	x	x	x	x																																		
MONACANTHIDAE																																									
cosmopolitan leatherjacket																																									
Parika scaber			x			x	x																																		
Degen's leatherjacket																																									
Thamnaconus degeni			x		x	x	x			x																															
mosaic leatherjacket																																									
Eubalichthys mosaicus			x	x			x																																		
DIODONTIDAE																																									
porcupine fish																																									
Allomycterus pilatus									x	x		x	x	x			x																								
globe fish																																									
Diodon nichthemerus		x		x	x																																				

DEPTH DISTRIBUTIONS OF FISH SPECIES COLLECTED BY 'ZEEHAAN', JANUARY TO MARCH 1979

Depth (m)	< 27	27 - 91								91 - 275								275 - 457			457 - 640													> 640			
SPECIES Code	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
SPARIDAE																																								
snapper																																								
Chrysophrys auratus				x																																			
MULLIDAE																																								
red mullet																																								
Upeneichthys lineatus		x																																					
PENTACEROTIDAE																																								
giant boarfish																																								
Paristiopterus labiosus								x																																
black-spotted boarfish																																								
Zanclistius elevatus											x				x	x	x																							
pelagic armourhead																																								
Pentaceros richardsoni																																x								
long-snouted boarfish																																								
Pentaceropsis recurvirostris		x	x		x	x			x																															
OPLEGNATHIDAE																																								
knife jaw																																								
Oplegnathus woodwardi															x	x																								
CHEILODACTYLIDAE																																								
morwong																																								
Nemadactylus macropterus							x		x		x	x	x	x				x																						
PARAPERCIDAE																																								
barred grubfish																																								
Parapercis allporti											x	x																												
CREEDIDAE																																								
Haswells sandfish																																								
Creedia haswelli			x																																				
URANASCOPIDAE																																								
bulldog stargazer																																								
Gnathagnus innotablis										x																														
barred stargazer																																								
Kathetostoma laeve		x	x	x	x	x		x																																
speckled stargazer																																								
Kathetostoma giganteum								x		x	x	x	x	x	x			x	x																					
scaled stargazer																																								
Pleuroscopus sp.																								x					x	x					x					
GEMPYLIDAE																																								
snoek																																								
Thyrsites atun			x																																				

APPENDIX 3

RELATIVE ABUNDANCE BY WEIGHT FOR EACH DEPTH RANGE (METRES) OF THE TEM MAJOR SPECIES GIVING THEIR PERCENTAGE CONTRIBUTION (p) TO THE TOTAL CATCH WEIGHT (w) AT THAT DEPTH FROM n SAMPLES. TOTAL (C_T) AND COMMERCIAL (C_c) CATCH RATES ARE ALSO GIVEN.

1. 0-29 metres

	% weights
Elephant fish	33.5
Sand Flathead	12.9
Banded Stingaree	8.4
Bearded Rock Cod	8.4
Butterfly Gurnard	8.4
Latchet	8.4
Spiked Dogfish	4.5
Southern Sawshark	4.5
Rusty Catshark	2.2
Gummy Shark	2.2

p = 93.4%
w = 179 kg C_T = 119.4 kg/hr
n = 1 C_c = 67.9 kg/hr

2. 27-91 metres

	% weights
Green Back Stingaree	32.1
Bearded Rock Cod	24.5
Rounded Snouted Gurnard	8.3
Latchet	3.6
Banded Stingaree	3.4
Thetis Fish	3.2
Gummy Shark	1.9
Angel Shark	1.8
Arrow Squid	1.6
Elephant Fish	1.6

p = 82.0
w = 3359 C_T = 207.6 kg/hr
n = 8 C_c = 84.45 kg/hr

3. 91-275 metres

	% weights
Jackass Fish	22.1
Latchet	12.5
Porcupine Fish	7.7
Cucumber Fish	6.7
School Shark	6.3
Speckled Stargazer	5.1
Ogilby's Ghost Shark	5.0
Spiked Dogfish	4.5
Denticulated Skate	3.8
Southern Calamary	2.9

p = 76.6%
w = 4826 kg C_T = 181.9 kg/hr
n = 9 C_c = 104.19 kg/hr

4. 275-457 metres

	% weights
Toothed Whiptail	65.8
Blue Grenadier	14.2
Mirror Dory	7.5
Green Bight Skate	2.5
Banded Whiptail	2.1
Deepwater Ghost Shark	1.3
School Shark	1.3
Draughtboard Shark	1.1
Red Gurnard Perch	1.1
Spiny Flathead	1.1

p = 98.0%
w = 1800 kg C_T = 502.3 kg/hr
n = 3 C_c = 129.2 kg/hr

5. 457-640 metres

	% weights
King Dory	35.4
Toothed Whiptail	18.2
Blue Grenadier	16.6
Red Gurnard Perch	9.7
Banded Bellows Fish	4.5
Spiky Dory	2.8
Deepwater Ghost Shark	1.8
Gemfish	1.7
Deep Sea Cod	1.5
Rockling	1.4

p = 92.6%
w = 24760 kg C_T = 342.32 kg/hr
n = 15 C_c = 243.6 kg/hr

6. Greater than 640 metres

	% weights
Spiky Dory	58.3
Toothed Whiptail	11.3
Deep Sea Cod	3.6
King Dory	3.3
Red Gurnard Perch	2.9
Banded Bellows Fish	2.7
Southern Whiptail	2.7
Brier Shark	2.5
Rockling	2.4
Deepwater Ghost Shark	1.9

p = 91.6%
w = 5646 kg C_T = 442.8 kg/hr
n = 4 C_c = 333.7 kg/hr