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A guide to the fish otoliths from waters off the Australian Antarctic Territory, Heard and Macquarie Islands

R. Williams and A. McEldowney

ANTARCTIC DIVISION
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A GUIDE TO THE FISH OTOLITHS FROM WATERS OFF THE AUSTRALIAN ANTARCTIC TERRITORY, HEARD AND MACQUARIE ISLANDS

by

R. Williams and A. McEldowney

Antarctic Division
Department of the Arts, Sport, the Environment,
Tourism and Territories
Kingston, Tasmania, Australia

ABSTRACT

Otoliths from 76 fish species are illustrated and described as an aid to the identification of stomach contents of Antarctic birds and mammals. Material was obtained from waters off Australian Antarctic Territory and from around Macquarie and Heard Islands. Information is also given on the distribution, habits and known predators of the fish species.

1. INTRODUCTION

This guide is intended primarily as a reference work for scientists studying the diets of vertebrate predators in the area covered by Australian antarctic and subantarctic operations. Considerable work has been done in recent years in this field (see Williams 1989 for a summary), and given the requirements of work associated with the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR), it is likely to continue in the future. In response to the requirement for identification of prey species from usually highly-digested remains, the authors have built up a large reference collection of sagittal otolith material from fish acquired during programmes of fisheries research, and have presented it here in what is hoped is a convenient format.

This guide does not cover all fish species known from the area; only those for which otolith material exists in the Australian Antarctic Division's collections. However, nearly all species which are either commonly caught by fishing gear or which are known to be important in the diets of predators are included. In view of the possibility of further species occurring in a predator's diet, and the known variability in the form of the otoliths of some species, it is recommended that this guide is used in conjunction with other works, notably Hecht (1987).

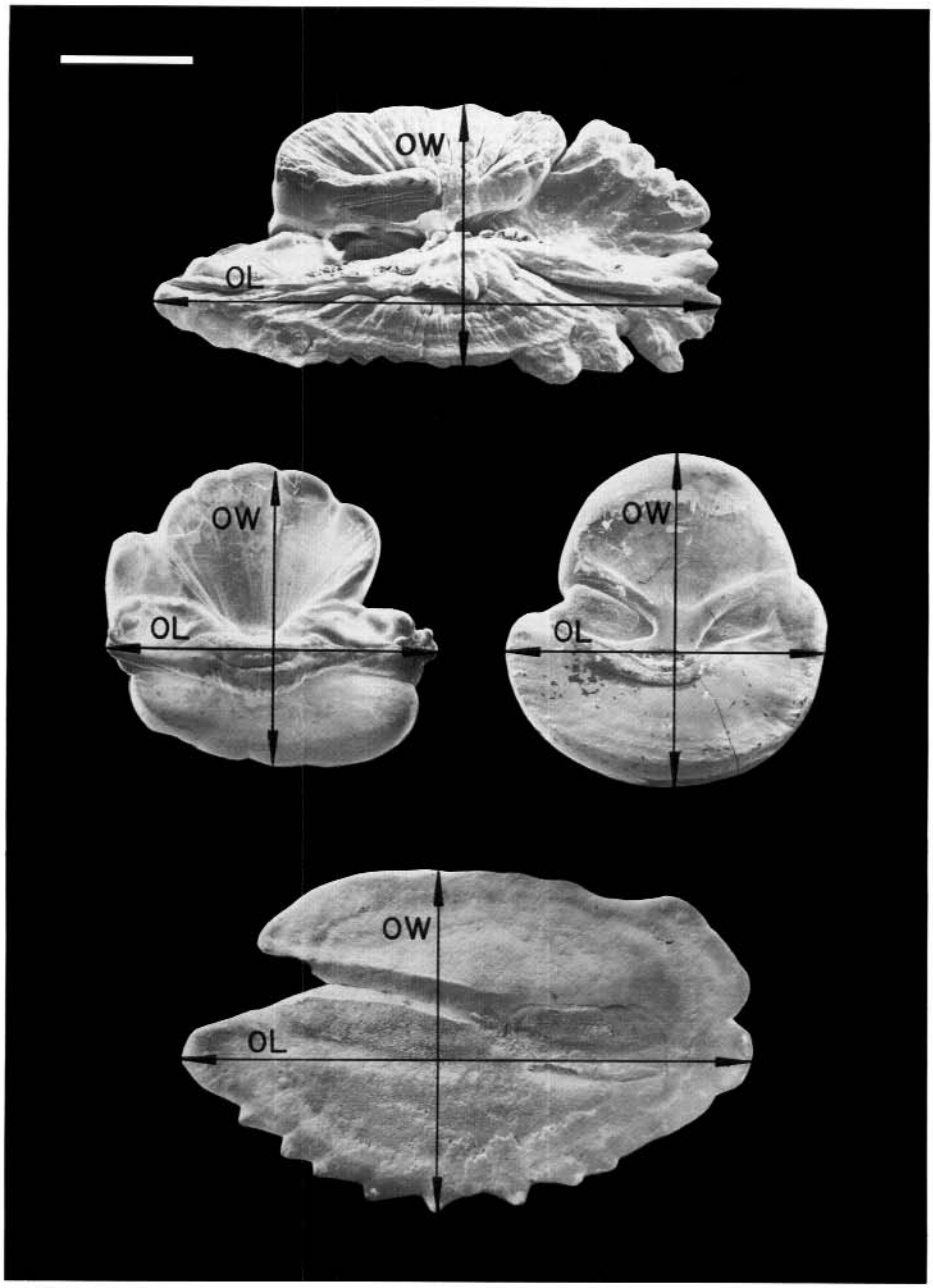

Figure 1. Examples of measurement of otolith length (OL) and otolith width (OW) for otoliths of different shape. Clockwise from top: *Notothenia (N.) coriiceps, Pleuragramma antarcticum, Gymnoscopelus (G.) nicholsi* and *Champsocephalus gunnari*.

2. MATERIALS AND METHODS

Otoliths were cleaned by soaking in distilled water for 1 week and then in 5-10% household bleach for 1.5 hours. They were gently rubbed between the fingers to remove tissue and sonicated in fresh bleach solution for 30 seconds. They were then washed in three changes of distilled water, then acetone, and finally left to dehydrate in 100% dry acetone for 1 hour.

The otoliths were mounted on brass stubs with copper conducting paint and coated with a 30 nm thick layer of gold. They were observed with a JEOL JSM 840 scanning electron microscope at 15 kvolts and 10^{-9}A probe current and a working distance of 25 mm (except for larger otoliths).

Measurements were made to the nearest 0.001 mm with a Nikon digital counter CM6S and data processor DP-851 connected to the micrometer stage of profile projector. Otolith length was measured across the greatest diameter parallel or sub-parallel to the sulcus acusticus. Otolith width was measured across the greatest diameter perpendicular to the otolith length. Examples of otolith length and width for different shaped otoliths are given in Figure 1. Measurements of the fish were made on fresh specimens at sea to the nearest millimetre below, although weights were ascertained from thawed specimens in the laboratory after having been frozen as soon as possible after capture.

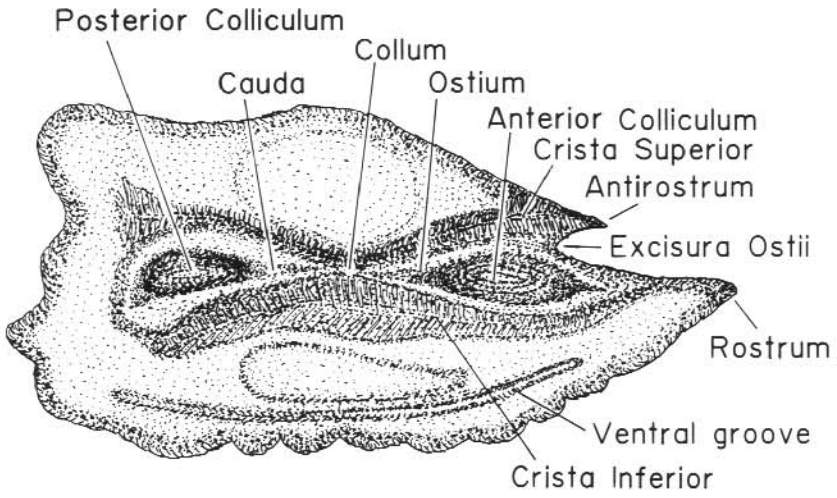

Figure 2. Terminology used in otolith description (after Hecht 1987).

3. GUIDE TO OTOLITHS

Otoliths are arranged in alphabetical order of genera and species within families (except for Myctophidae, where the order of genera is that of Hulley 1981). The order of families follows the arrangement of Nelson (1976). As the general structure of otoliths is usually fairly consistent within families, this arrangement is the most efficient for identification.

For most species, three otoliths representing the range of sizes available are illustrated and accompanied by a page of data summarising the information relevant to that species. In some cases the available material only allows one or two illustrations, whereas in other species which are abundant or known to be important in predators' diets, six specimens are illustrated. The scale bar in all illustrations represents one millimetre.

The authors have not given a detailed description of each species' otolith because the illustrations achieve that purpose much better. Rather, they highlight any diagnostic characters, especially those which help to differentiate similar otoliths. Technical terms used in these descriptions are explained in Figure 2. The data on otolith length:width and maximum size are useful in diagnosis, as species with similar otoliths can often be differentiated using these parameters.

Regression formulae for obtaining standard length of the fish from either otolith length or width are also given. These should be used judiciously because some species (e.g. *Zanclorhynchus spinifer* and *Pagothenia bernacchii*) have a very poor relationship between these parameters. Values of R and n are given for these regressions to help the user decide on their validity. Where insufficient specimens were available to produce a realistic regression (generally when there were less than ten specimens) the data for individual specimens are given in full, so that some approximation of otolith size to fish size is possible. Coefficients for the log/log regression of fish mass on standard length are also given to allow the conversion of otolith length or width to fish mass.

Abbreviations used in the data sheets and elsewhere are as follows:

SL	standard length
OL	otolith length
OW	otolith width
R	regression coefficient
n	number of observations
OL/OW	otolith length/width
SD	standard deviation
AAT	Australian Antarctic Territory
Scotia Arc	S Shetland, S Orkney and S Sandwich Islands

General data on the species' distribution, habitat and known predators are also given and can be used to corroborate decisions based on the other information.

Figure 3. Otoliths of *Bathylagus antarcticus* from fish of standard length 115 mm (top), 162 mm and 190 mm.

FAMILY BATHYLAGIDAE

Bathylagus antarcticus Gunther

Remarks

A distinctive otolith with a very pronounced pointed rostrum, antirostrum absent and high length:width ratio. Unlikely to be confused with any other otolith except possibly *Photichthys argenteus* which has a shorter rostrum, a small antirostrum and lower length:width ratio.

Conversion factors

SL = 56.16975 OL - 39.7831	R = 0.875	n = 17
SL = 115.7744 OW - 47.0855	R = 0.950	n = 17
Mass = 1.05×10^{-6} $SL^{3.446}$	R = 0.993	n = 196
mean OL/OW = 1.980	SD = 0.171	Range = 1.676-2.243

Largest otolith size recorded (mm): OL 4.025 OW 2.025

Size range of fish in otolith sample 55 - 174 mm SL

Distribution

Within AAT

Oceanic waters from north of the Antarctic Convergence south to the Antarctic continent, including waters around Heard and Macquarie Islands, but not on the continental shelf. ANARE records show it occurring between 48°S and 68°S in waters off AAT.

Elsewhere

Circumglobal from north of the Antarctic Convergence south to the Antarctic continent, but not on the continental shelf (Gon 1987).

Habitat

One of the commonest pelagic fish, encountered from the surface to very deep waters. ANARE records indicate a depth distribution between 100 m and 1500 m, but Gon (1987) records a depth range from the surface to 4000 m.

Known predators

A minor constituent of the diet of fur seals (*Arctocephalus* spp.) at Macquarie Island (Green et al. 1990).

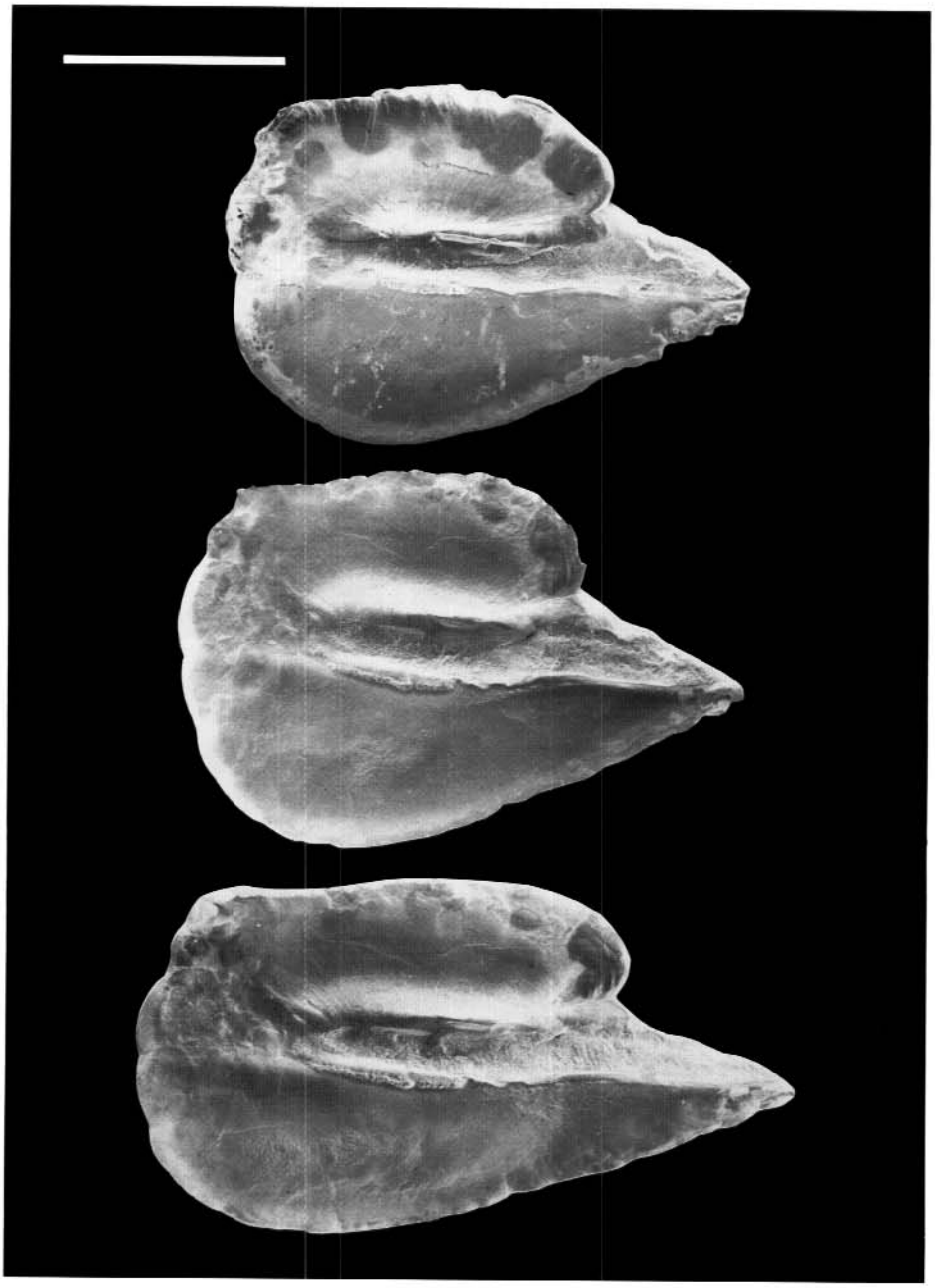

Figure 4. Otoliths of *Photichthys argenteus* from fish of standard length 116 mm (top), 123 mm and 125 mm.

FAMILY GONOSTOMATIDAE

Photichthys argenteus Andriashev

Remarks

Another very distinctive otolith with prominent pointed rostrum and a small rounded antirostrum. Somewhat similar to *Bathylagus antarcticus*, but the latter has a higher OL:OW ratio.

Conversion factors

SL	Mass	Otolith mean length	Otolith mean width	Otolith mean length/width
68	2.75	2.650	1.750	1.514
116	7.18	2.523	1.860	1.356
125	8.71	2.750	1.750	1.571
123	8.10	2.750	1.750	1.571

Distribution

Within AAT
Probably throughout the area in a zone astride the Subtropical Convergence. Positive records from 50°30', 154°50'E and 46°50'S, 131°38'S (ANARE records).

Elsewhere
Probably circumglobal within the above latitude zone. Observed from New Zealand and South Africa (Grey 1960).

Habitat

A pelagic fish. ANARE records indicate a depth distribution below 250 m.

Known predators

None observed.

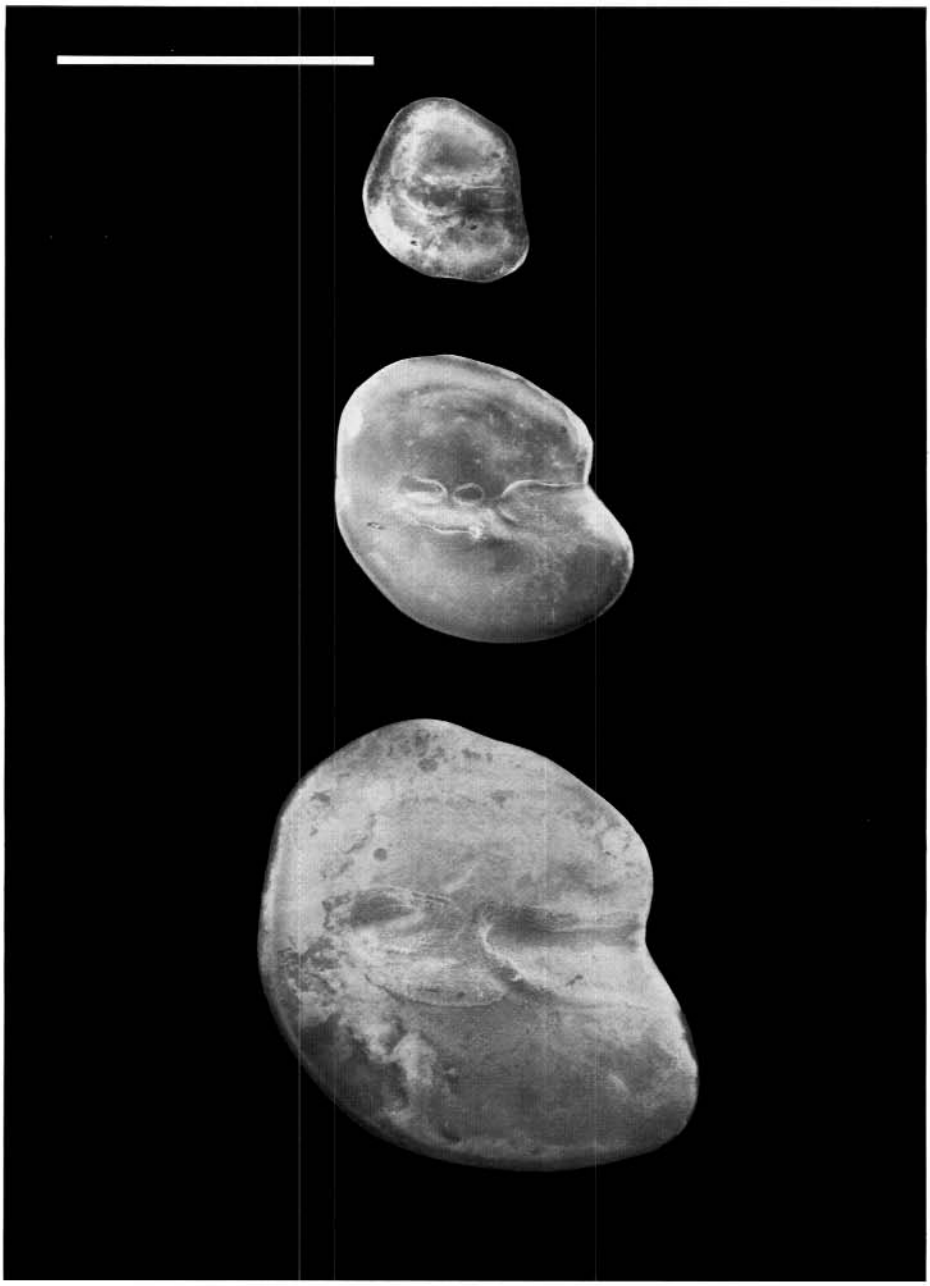

Figure 5. Otoliths of *Krefftichthys anderssoni* from fish of standard length 19 mm (top), 38 mm and 62 mm.

FAMILY MYCTOPHIDAE

Krefftichthys anderssoni (Lonnberg)

Remarks

This species belongs to a myctophid group with very similar, more or less discoid small otoliths of low relief which are difficult to tell apart. This species can be distinguished from other members of this group (*Protomyctophum* spp., *Electrona antarctica, Gymnoscopelus braueri* and *G. hintonoides*) by its more quadrate shape and weakly marked excisura ostii. There is also a pseudo colliculum present below the posterior colliculum which is often difficult to see.

Conversion factors

SL = 41.21040 OL - 13.8900	R = 0.962	n = 28
SL = 47.28366 OW - 9.10800	R = 0.940	n = 28
Mass = 3.220×10^{-6} $SL^{3.296}$	R = 0.981	n = 28
mean OL/OW = 1.101	SD = 0.097	Range = 0.930-1.291

Largest otolith size recorded (mm): OL 1.697 OW 1.638

Size range of fish in otolith sample 19 - 66 mm SL

Distribution

Within AAT

Waters around Heard and Macquarie Islands, and oceanic waters between 55°S and 65°S throughout the area (ANARE records).

Elsewhere

Circumglobal in a broad latitudinal band astride the Antarctic Convergence (Hulley 1981).

Habitat

A very common myctophid, and one of the commonest of all pelagic species in antarctic oceanic waters. Frequently caught in the top 200 m, but can be encountered down to 1500 m (ANARE records).

Known predators

A major diet component of many predators, especially those on subantarctic islands, e.g. king, royal/macaroni, rockhopper and gentoo penguins at Macquarie and Heard Islands (Williams 1989, Klages et al. 1989). It is also taken occasionally by antarctic fur seals at Heard Island (Green et al. 1989).

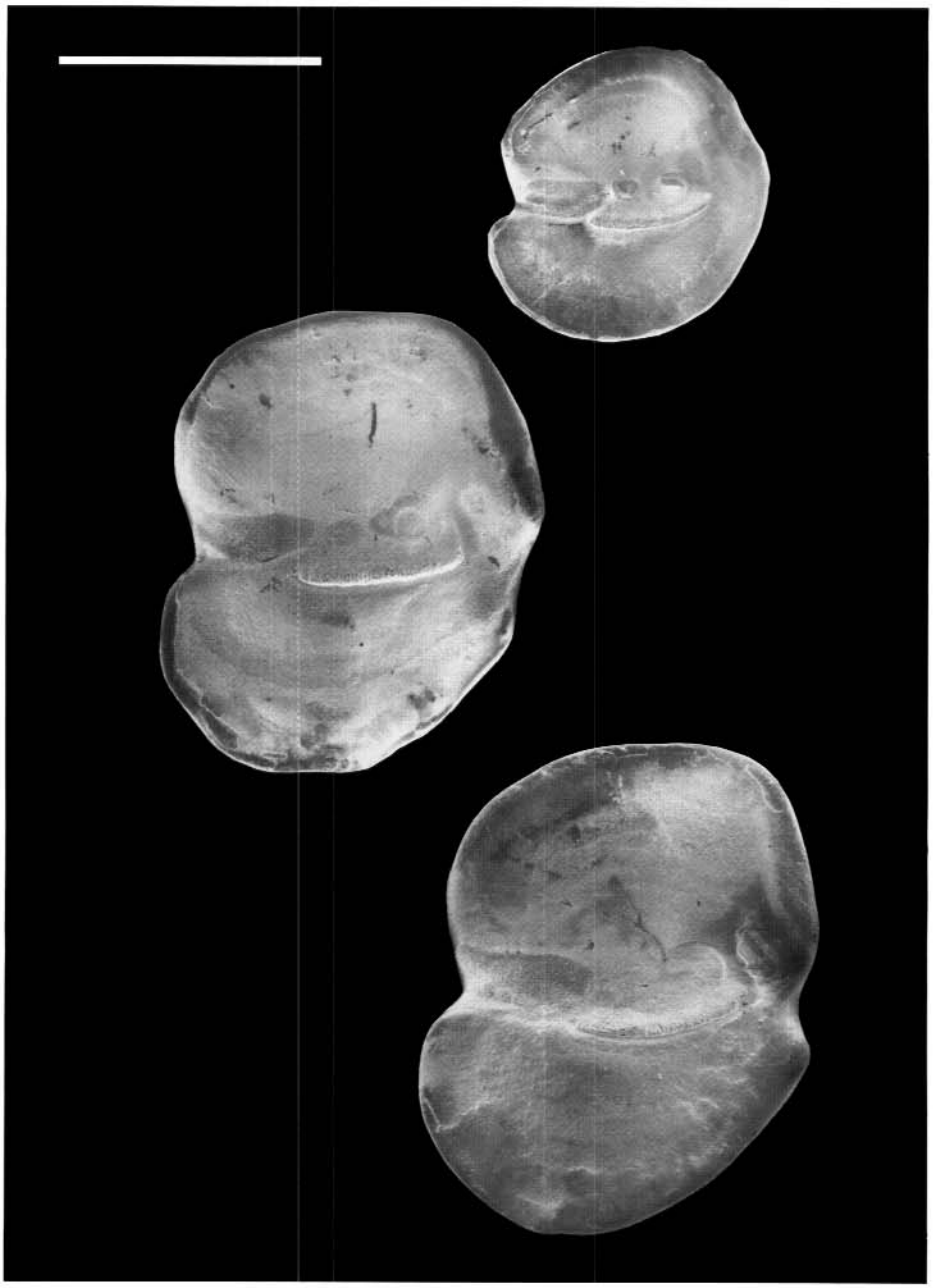

Figure 6. Otoliths of *Protomyctophum (P.) bolini* from fish of standard length 23 mm (top), 44 mm and 58 mm.

Protomyctophum (Protomyctophum) bolini (Fraser-Brunner)

Remarks

Another of the low relief discoid group of myctophid otoliths (see under *K. anderssoni* for general notes). Within this group, it is characterised by being the most dorso-ventrally elongate, with the dorsal half about the same length as the ventral half, and most specimens have a characteristic notch in the posterior margin.

Conversion factors

SL = 26.90736 OL - 5.68285	R = 0.733	n = 31
SL = 27.02152 OW - 6.38535	R = 0.880	n = 31
Mass = 2.34×10^{-5} $SL^{2.859}$	R = 0.981	n = 36
mean OL/OW = 1.015	SD = 0.184	Range = 0.723-1.308

Largest otolith size recorded (mm): OL 2.344 OW 2.339

Size range of fish in otolith sample 22 - 58 mm SL

Distribution

Within AAT

Oceanic waters from north of the Antarctic Convergence south to the Antarctic Divergence (about 65°S) throughout the area, including waters around Heard and Macquarie Islands.

Elsewhere

Circumglobal with a wide latitudinal distribution from north of the Antarctic Convergence (temperature about 7°C) to the Antarctic Divergence (Hulley 1981).

Habitat

A widespread myctophid, but not usually encountered in great abundance. Usually in oceanic waters, migrating from below 600 m depth in the daytime to 300-400 m at night (Hulley 1981). This is corroborated by ANARE records, which show captures betwen 200 and 1000 m, with most around 500 m.

Known predators

A common, although usually not a major diet component of several predators on subantarctic islands, for example antarctic fur seals at Heard Island (Green et al. 1989), and royal/macaroni, rockhopper and gentoo penguins at Macquarie and Heard Islands (Williams 1989, Klages et al. 1989).

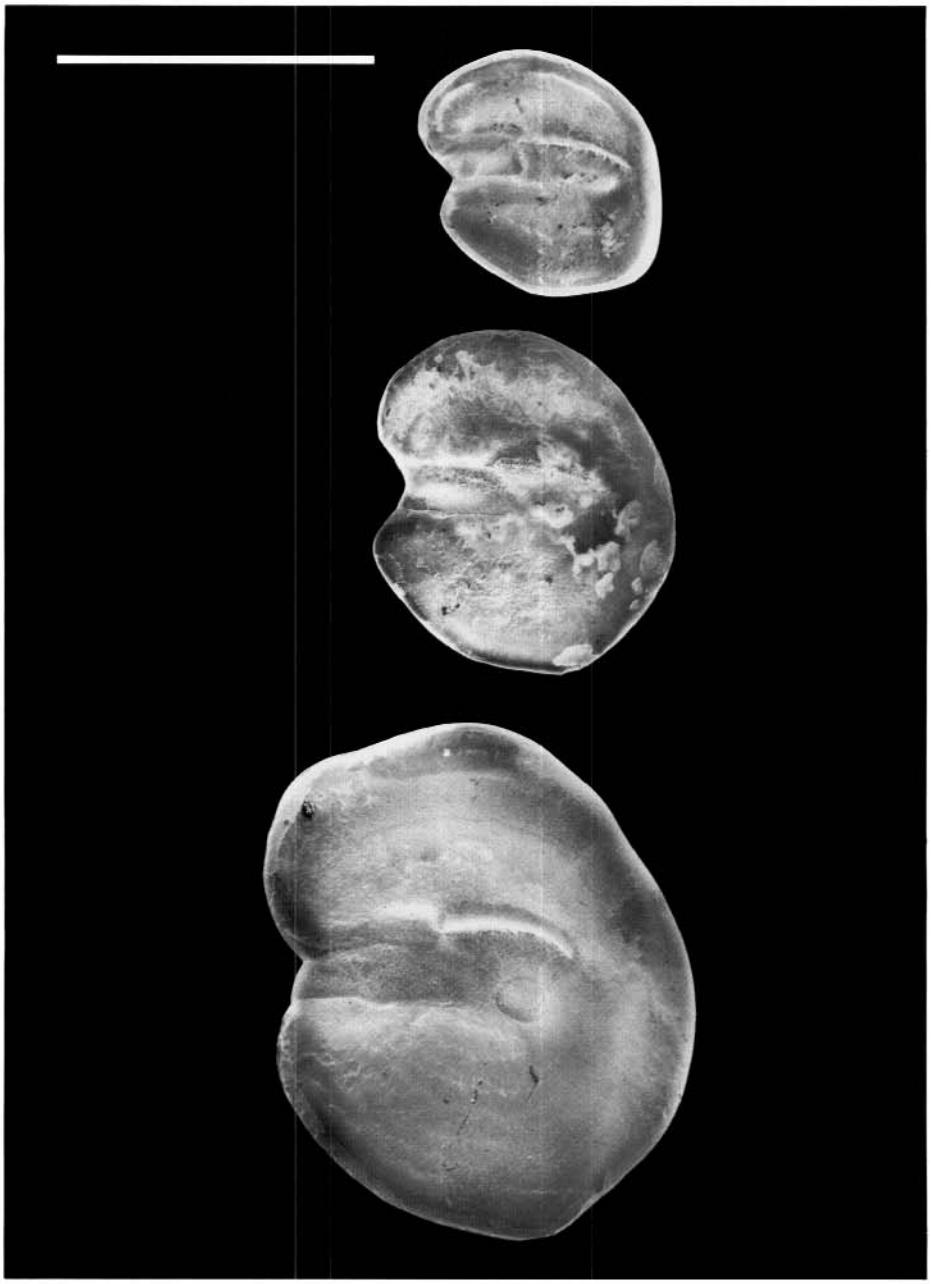

Figure 7. Otoliths of *Protomyctophum (H.) parallelum* from fish of standard length 19 mm (top), 26 mm and 40 mm.

Protomyctophum (Hierops) parallelum (Lonnberg)

Remarks

Another of the low relief discoid group of myctophid otoliths (see under *K. anderssoni* for general notes). Within this group, it is characterised by a very rounded posterior margin, virtual absence of a rostrum and wide excisura ostii.

Conversion factors

SL	Mass	Otolith mean length	Otolith mean width	Otolith mean length/width
23	0.14	1.10	0.90	1.222
23	0.14	1.075	1.175	0.915
24	0.15	1.05	0.95	1.105
24	0.17	1.20	1.00	1.200
24	0.15	1.112	0.968	1.149
26	0.21	1.250	1.050	1.190
26	0.20	0.997	1.113	0.896
40	0.74	1.85	1.50	1.233

Distribution

Within AAT
Oceanic waters between the Subtropical and Antarctic Convergences throughout the area, including Macquarie Island.

Elsewhere
Circumglobal in a similar latitudinal range (Hulley 1981)

Habitat

A mesopelagic myctophid usually found below 450 m, but with juveniles occurring in depths as shallow as 150 m (Hulley 1981). This depth range is confirmed at Macquarie Island where one adult male and fourteen juveniles were caught in 250-500 m depth (Williams 1988a), and at three sites between 46°50'S, 131°38'E and 49°51'S, 131°20'E in 845 to 1500 m.

Known predators

None observed.

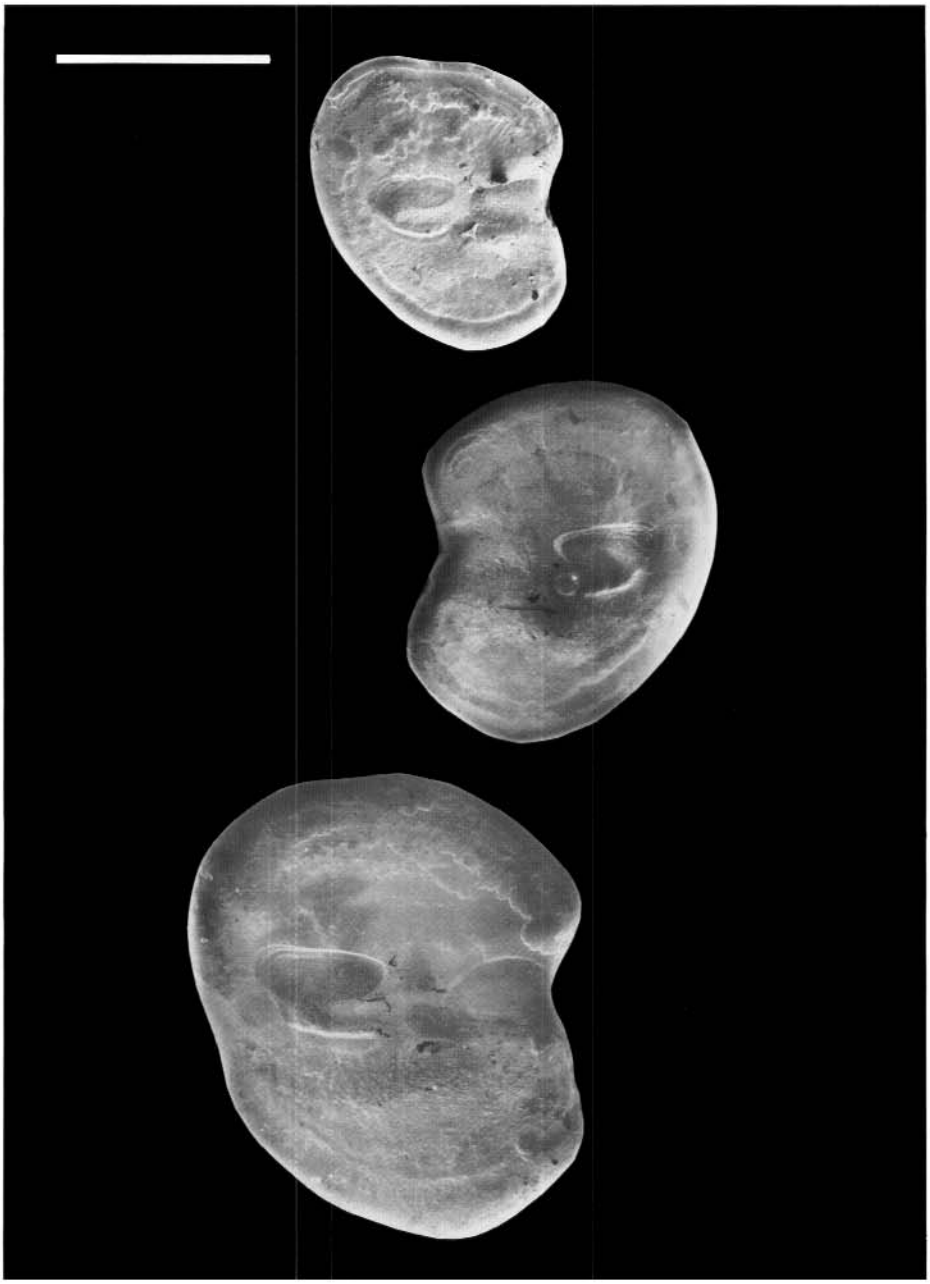

Figure 8. Otoliths of *Electrona antarctica* from fish of standard length 21 mm (top), 58 mm and 99 mm.

Electrona antarctica (Gunther)

Remarks

Another of the low relief discoid group of myctophid otoliths (see under *K. anderssoni* for general notes). Within this group it is characterised by the comma-shaped outline with poorly developed rostrum, and on the lateral face (the reverse of the one pictured) the growth rings can usually be distinctly seen and the face has a sharp relief rising to a distinct central peak. The OL:OW ratio is much lower in this species than in others of the group.

Conversion factors

SL = 42.69686 OL + 0.278033	R = 0.984	n = 86
SL = 33.30505 OW + 2.023806	R = 0.988	n = 85
Mass = 9.53×10^{-6} $SL^{3.080}$	R = 0.988	n = 227
mean OL/OW = 0.813	SD = 0.069	Range = 0.604-1.004

Largest otolith size recorded (mm): OL 2.086 OW 2.725

Size range of fish in otolith sample 20 - 96 mm SL

Distribution

Within AAT

Oceanic waters between Antarctic Convergence and Antarctic Continental Shelf throughout the area, including waters around Heard and Macquarie Islands.

Elsewhere

Circumpolar between Antarctic Convergence and Antarctic Continental Shelf. Some specimens have been recorded to the north of the convergence in water temperatures up to 3°C (Hulley 1981).

Habitat

The commonest myctophid, and one of the commonest of all pelagic species in antarctic oceanic waters. Only very rarely encountered over the shelf (ANARE records). Usually found in the upper 100 m (Hulley 1981), but can be caught from as deep as 1300 m (ANARE records).

Known predators

A common, although usually not a major diet component of many predators, especially those on subantarctic islands, for example all species of fur seals on Macquarie Island (Green et al. 1990) and on Heard Island (Green et al. 1989), emperor penguins in the Mawson area (G. Robertson, pers. comm.), king penguins at Heard Island (Klages et al. 1989) and snow petrels at Casey (J. van Franeker, pers. comm.).

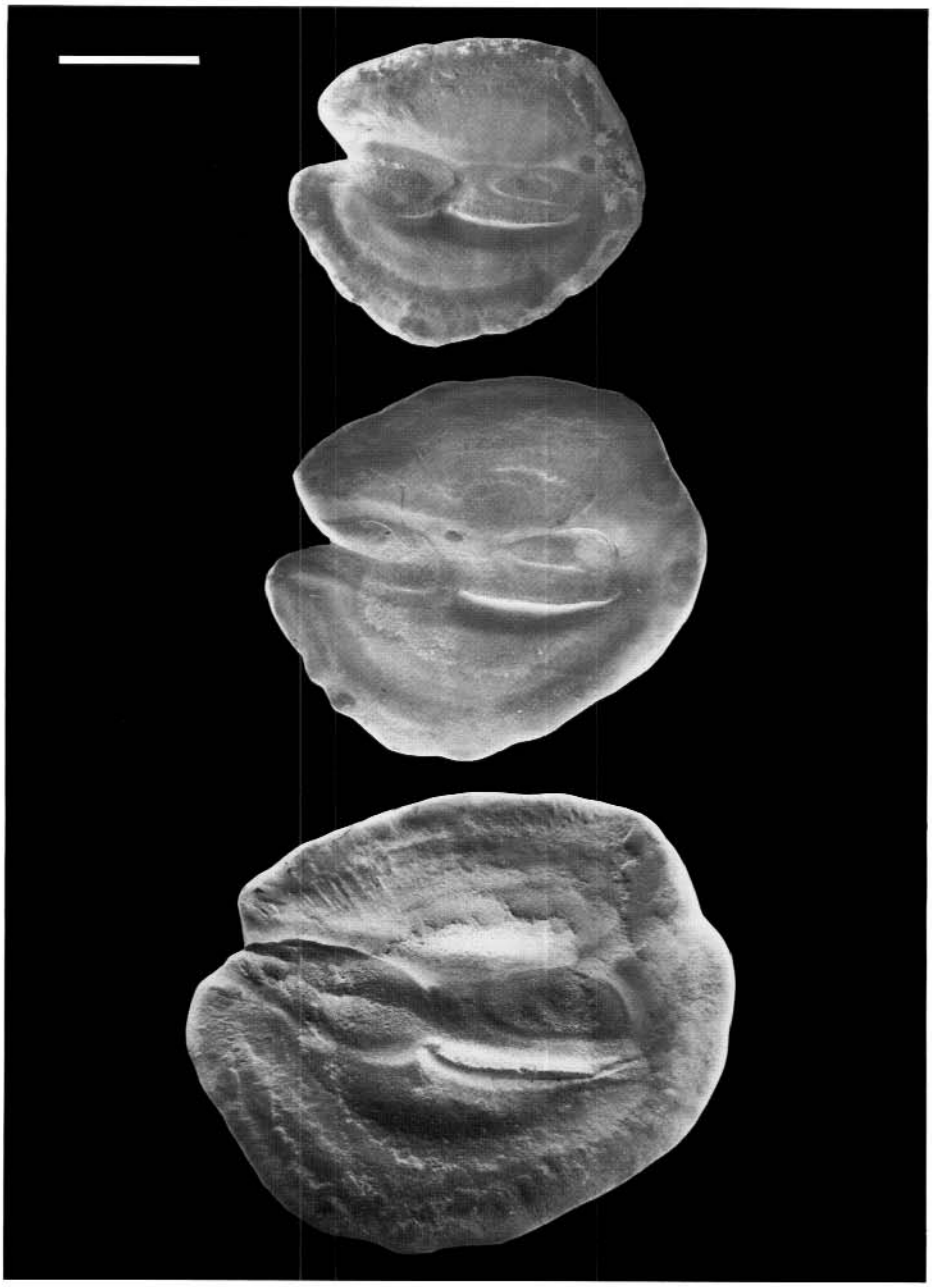

Figure 9. Otoliths of *Electrona carlsbergi* from fish of standard length 58 mm (top), 78 mm and 104 mm.

Electrona carlsbergi (Taning)

Remarks

This species belongs to a myctophid group with rather similar discoid, medium sized otoliths with fairly strong patterning and relief. This species can be distinguished from other members of this group (*E. paucirastra, E. subaspera, Metelectrona ventralis*) by the approximately equal length of the rostrum and antirostrum, the acute angle of the excisura ostii, and the smooth rounded posterior margin, giving the otolith a generally symmetrical appearance.

Conversion factors

SL = 24.25848 OL - 2.49594	R = 0.960	n = 20
SL = 23.38342 OW + 8.686356	R = 0.917	n = 20
Mass = 5.314×10^{-5} $SL^{2.737}$	R = 0.970	n = 20
mean OL/OW = 1.101	SD = 0.042	Range.1.040 - 1.194

Longest otolith size recorded (mm): OL 4.200 OW 3.916

Size range of fish in otolith sample 58 - 104 mm SL

Distribution

Within AAT

Oceanic waters in the vicinity of the Antarctic Convergence north to the Subtropical Convergence, including waters around Heard and Macquarie Islands.

Elsewhere

Circumglobal from the vicinity of the Antarctic Convergence north to the Subtropical Convergence (Hulley 1981).

Habitat

A common pelagic fish, with the centre of its distribution astride the Antarctic Convergence. Usually associated with Antarctic Intermediate Water to a maximum temperature of about 5°C, which results in a depth range near the Antarctic Convergence centred on 100 m, while further north the depth range increases to about 600 m (Hulley 1981). This species has been observed to be the major constituent of a scattering layer between 60 and 120 m near the Antarctic Convergence in the Atlantic Sector (Linkowski 1983). However at Macquarie Island, which is usually less than 50 km north of the Antarctic Convergence, the few records to date have been from the depth range 250 to 500 m.

Known predators

A major constituent of the diet of several predators, including king penguins at Macquarie (Hindell 1988a) and Heard (Klages et al. 1989) Islands; gentoo penguins at Macquarie (Hindell 1989) and Heard (Klages et al. 1989) Islands. Also a minor constituent of the diets of all fur seal species on Macquarie (Green et al. 1990) and Heard (Green et al. 1989) Islands, chinstrap penguins at Bouvet Island (Cooper et al.1984), royal/macaroni penguins at Heard and Macquarie Islands (Williams 1989), and rockhopper penguins at Macquarie Island (Hindell 1988c).

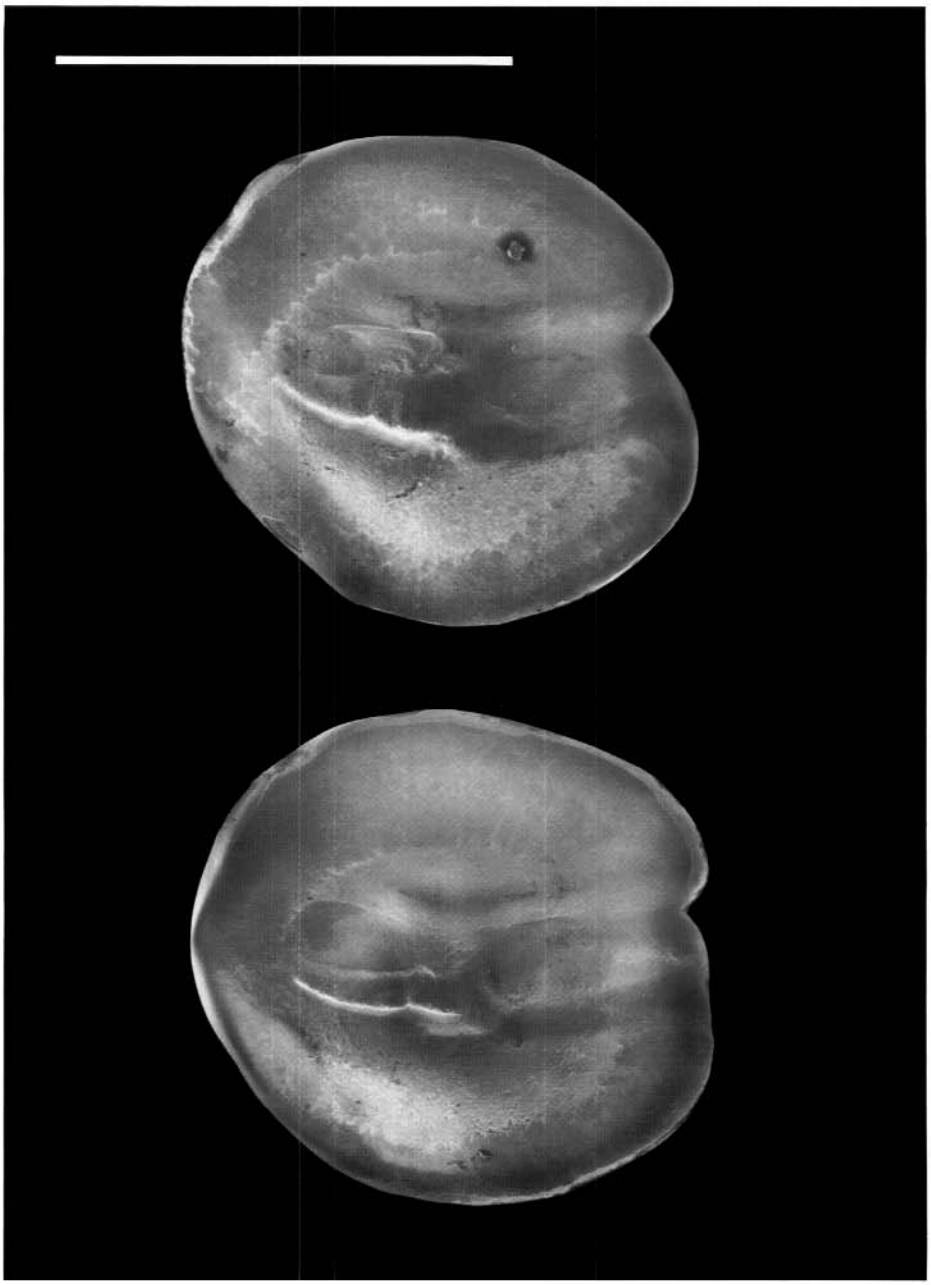

Figure 10. Otoliths of *Electrona paucirastra* from fish of standard length 24 mm (top) and 27 mm.

Electrona paucirastra Bolin

Remarks

Another of the high relief large discoid group of myctophid otoliths (see under *E. carlsbergi* for general notes). Within this group, it is hard to characterise because only otoliths from small specimens are available. Figure 10 indicates, however, that otoliths in larger specimens would be similar to those of *E. subaspera*, but perhaps more asymmetrical.

Conversion factors

SL	Mass	Otolith mean length	Otolith mean width	Otolith mean length/width
24	0.21	1.300	1.100	1.182
25	0.23	1.3	1.175	1.106
26	0.25	1.2	1.05	1.143
27	0.25	1.275	1.125	1.333

Distribution

Within AAT
Oceanic waters in the vicinity of the Subtropical Convergence throughout the area, including waters around Heard and Macquarie Islands. Records from 50°30'S, 154°E show that this species can extend close to the Antarctic Convergence in the vicinity of Macquarie Island.

Elsewhere
Probably circumglobal in the vicinity of the Subtropical Convergence (Hulley 1981).

Habitat

A pelagic myctophid in the upper waters, commonly to 100 m depth (Hulley 1981) but ANARE records show this fish can be taken as deep as 250 to 500 m.

Known predators

A rare constituent of the diet of antarctic fur seals at Macquarie Island (Green et al. 1990).

Figure 11. Otoliths of *Electrona subaspera* from fish of standard length 24 mm (top), 91 mm and 102 mm.

Electrona subaspera (Gunther)

Remarks

Another of the high relief large discoid group of myctophid otoliths (see under *E. carlsbergi* for general notes). Within this group, it is characterised by the rostrum being significantly larger than the antirostrum, the excisura ostii being a right angle or larger, and the posterior margin having a bulge on the ventral part, giving the otolith an asymmetrical appearance. It can be distinguished from the similar otoliths of *Metelectrona ventralis* by the more or less smooth, convex dorsal margin and less prominent cristae.

Conversion factors

SL = 29.00713 OL - 9.04409	R = 0.997	n = 17
SL = 30.94086 OW - 8.10739	R = 0.996	n = 17
Mass = 7.98×10^{-6} $SL^{3.190}$	R = 0.999	n = 21
mean OL/OW = 1.095	SD = 0.051	Range = 1.000-1.211

Largest otolith size recorded (mm): OL 3.823 OW 3.563

Size range of fish in otolith sample 24 - 102 mm SL

Distribution

Within AAT

Waters between the Subtropical Convergence and the Antarctic Convergence throughout the area, including Heard and Macquarie Islands.

Elsewhere

Circumglobal between Subtropical Convergence and Antarctic Convergence (Hulley 1981).

Habitat

A common myctophid in the upper waters, especially at night, within its range (Hulley 1981), but can be caught from as deep as 500 m (ANARE records).

Known predators

A major diet component of all fur seal species on Macquarie Island (Green et al. 1990) and gentoo penguins in summer (Williams 1988a), but only a minor constituent in the antarctic fur seal at Heard Island (Green et al. 1989).

Figure 12. Otoliths of *Metelectrona ventralis* (Bekker) from fish of standard length 73 mm (top), and 91 mm.

Metelectrona ventralis (Bekker)

Remarks

Another of the high relief large discoid group of myctophid otoliths (see under *E. carlsbergi* for general notes). Within this group, it is very similar to otoliths of *E. subaspera* in possessing a rostrum significantly larger than the antirostrum and an excisura ostii with a relatively large angle, but can be distinguished from this species by the more or less straight but crenulated dorsal margin, more prominent cristae and lack of a postero-ventral bulge.

Conversion factors

SL	Mass	Otolith mean length	Otolith mean width	Otolith mean length/width
73	4.71	2.950	2.700	1.093
79	6.15	3.151	2.904	1.085
81	7.07	3.320	2.978	1.115
81	7.43	3.379	3.023	1.118
85	8.80	3.552	3.216	1.105
91	11.46	3.700	3.500	1.057

Distribution

Within AAT
Only recorded from the stomachs of *Dissostichus eleginoides* from the vicinity of Heard Island (ANARE records). This is the first record of this species from south of the Antarctic Convergence.

Elsewhere
Hulley (1981) describes the distribution of this species as subantarctic, with a southern limit well to the north of the Antarctic Convergence, and suggested limiting temperatures of 5°C and 15°C. Hulley, Camus and Duhamel (1989), however, record its presence in stomachs of *D. eleginoides* and *C. gunnari* from the vicinity of Kerguelen Island, which would probably be right on the Convergence. Therefore, the chance of finding this fish just south of the Convergence is not impossible.

Habitat

A pelagic myctophid in the upper waters, recorded from the surface to depths of 350 m (Hulley 1981), while Hulley, Camus and Duhamel (1989) extend the depth range to 810 m and state that it has an epibenthic distribution during the day, with the implication that it migrates to the upper waters at night.

Known predators

Known from the stomachs of the fish *Dissostichus eleginoides* and *Champsocephalus gunnari* around Kerguelen, but its importance in the diet of these predators is not known (Hulley, Camus and Duhamel 1989). Also found in *D. eleginoides* stomachs around Heard Island. These otoliths may have been mistaken in the past with the very similar otoliths of *Electrona subaspera*, and known predators of *E. subaspera* (fur seals and gentoo penguins) therefore may take some *M. ventralis*. The comparative rarity of *M. ventralis*, particularly near the Antarctic Convergence, means that such an error would probably be small.

Figure 13. Otoliths of *Gymnoscopelus (G.) braueri* from fish of standard length 52 mm (top), 109 mm and 128 mm.

Gymnoscopelus (Gymnoscopelus) braueri (Lonnberg)

Remarks

Another of the low relief discoid group of myctophid otoliths (see under *K. anderssoni* for general notes). Within this group, it is characterised by being the most square-looking with a moderately well developed rostrum in larger specimens and a very wide excisura ostii. This species has the highest OL:OW ratio of the group.

Conversion factors

SL = 43.34839 OL - 0.73401	R = 0.904	n = 41
SL = 50.27563 OW - 4.40964	R = 0.943	n = 41
Mass = 5.639×10^{-6} $SL^{3.102}$	R = 0.986	n = 41
mean OL/OW = 1.127	SD = 0.121	Range = 0.761-1.423
Largest otolith size recorded (mm):	OL 2.879	OW 2.536
Size range of fish in otolith sample	32 - 128 mm SL	

Distribution

Within AAT
Oceanic waters from the Antarctic Convergence south to the Antarctic Continent, but not on the continental shelf, including waters around Heard and Macquarie Islands. ANARE records show it is distributed between 55°S and 66°S in waters off AAT.

Elsewhere
Circumglobal between the Antarctic Convergence and the Antarctic Continental Shelf. Some juveniles may occur north of the Antarctic Convergence (Hulley 1981).

Habitat

One of the commonest myctophids south of the Antarctic Convergence in the upper 200 m of water (Hulley 1981). ANARE records show captures betwen 125 and 1000 m.

Known predators

An occasional diet component of several predators on subantarctic islands, for example New Zealand fur seals on Macquarie Island (Green et al. 1990) and antarctic fur seals on Heard Island (Green et al. 1989). May also be a component of 'other myctophids' cited in several diet studies.

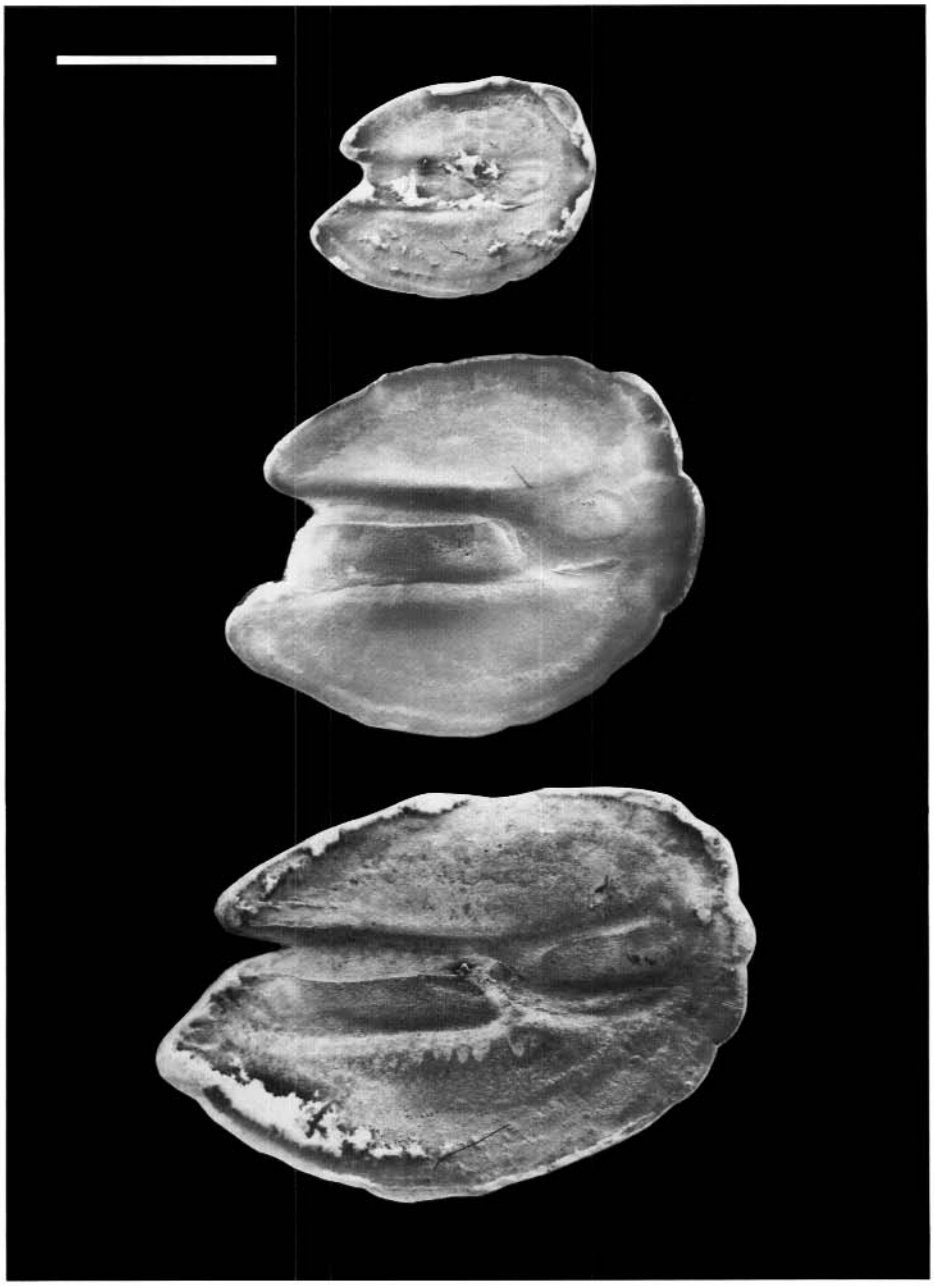

Figure 14. Otoliths of *Gymnoscopelus (G.) bolini* from fish of standard length 31 mm (top), 56 mm and 64 mm.

Gymnoscopelus (Gymnoscopelus) bolini Andriashev

Remarks

This species belongs to a myctophid group with rather similar large lozenge-shaped otoliths with fairly strong patterning and relief, the members of which are very difficult to distinguish. This species can be distinguished from most other members of this group (*G. nicholsi, G. piabilis, G. microlampas*) by the lack of crenulate ventral margin and less prominent antirostrum. It is, however, virtually indistinguishable from *G. fraseri*, although *G. bolini* otoliths tend to have a relatively longer posterior colliculum and antirostrum.

Conversion factors

SL	Mass	Otolith mean lenth	Otolith mean width	Otolith mean length/width
31	0.27	1.510	1.052	1.435
35	0.36	1.538	1.065	1.444
36	0.38	1.609	1.096	1.468
38	0.46	1.658	1.173	1.413
38	0.42	1.502	1.136	1.322
64	3.18	3.040	1.988	1.529

Distribution

Within AAT
Oceanic waters between the Subtropical Convergence and the Antarctic Convergence throughout the area, including Heard and Macquarie Islands.

Elsewhere
Circumglobal between the Antarctic Convergence and Subtropical Convergence (Hulley 1981).

Habitat

A common pelagic myctophid, usually in the top 200 m of water (Hulley 1981). ANARE records confirm this, with all records from the vicinity of Macquarie Island from the top 50 m.

Known predators

An occasional diet component of several predators on subantarctic islands, for example fur seals on Macquarie Island (Green et al. 1990) and Heard Island (Green et al. 1989). May also be a component of 'other myctophids' cited in several diet studies.

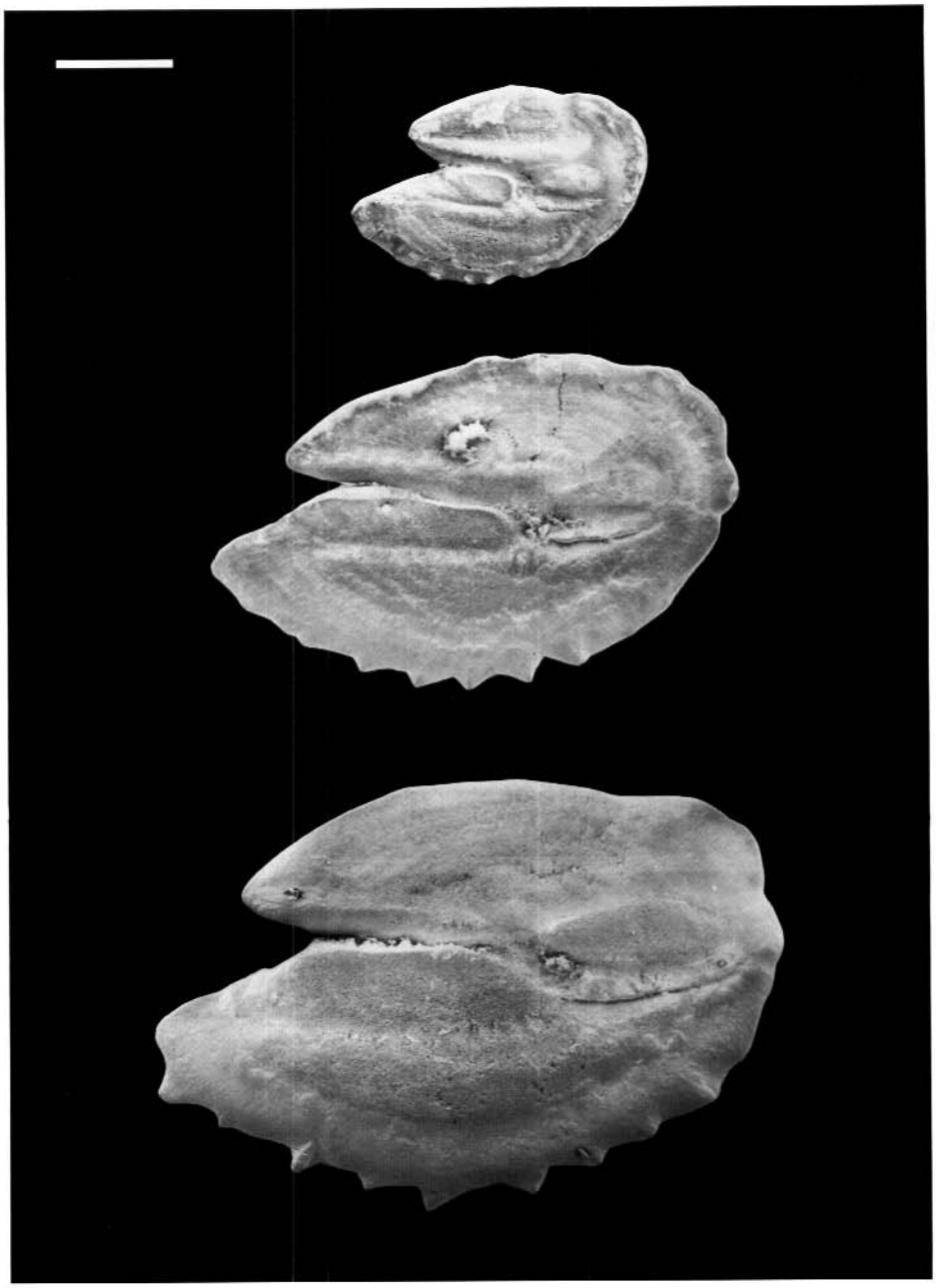

Figure 15. Otoliths of *Gymnoscopelus (G.) nicholsi* from fish of standard length 55 mm (top), 115 mm and 165 mm.

Gymnoscopelus (Gymnoscopelus) nicholsi (Gilbert)

Remarks

Another of the lozenge-shaped group of myctophid otoliths (see under *G. bolini* for general notes). Within this group, it is characterised by prominent crenulations on the ventral margin and relatively well-developed antirostrum and high length:width ratio. In all characteristics, however, it appears virtually indistinguishable from *G. piabilis*.

Conversion factors

SL = 28.61827 OL - 20.7910	R = 0.889	n = 140
SL = 46.31267 OW - 17.2168	R = 0.882	n = 140
Mass = 5.610×10^{-6} $SL^{3.153}$	R = 0.981	n = 140
mean OL/OW = 1.660	SD = 0.082	Range = 1.071-1.832
Largest otolith size recorded (mm):	OL 6.045	OW 4.372
Size range of fish in otolith sample 31 - 174 mm SL		

Distribution

Within AAT
Oceanic and shelf waters from the Antarctic Convergence south to the Antarctic Continent, including waters around Heard and Macquarie Islands.

Elsewhere
Circumpolar between the Antarctic Convergence and the Antarctic Continent, including shelf areas (Hulley 1981).

Habitat

One of the commonest myctophids south of the Antarctic Convergence. Atypical of myctophids in that it occurs on shelf areas, and is caught near the bottom as well as in pelagic habitats (Hulley 1981). Taken in the depth range 50 - 516 m (ANARE records). Linkowski (1985) found substantial near-bottom concentrations in 224 - 480 m in the S Shetlands area.

Known predators

The otoliths of *G. nicholsi* and *G. piabilis* are very hard to distinguish, particularly after even slight erosion in the predator's stomach. Otoliths of this species pair are very common in fur seals at Macquarie Island (Green et al. 1990), and Heard Island (Green et al. 1989), and gentoo penguins at Macquarie Island (Hindell 1989). Only for the case of gentoo penguins in summer at Macquarie Island is there sufficient evidence from other remains to ascribe the prey to one of the species, in this case *G. piabilis* (Williams 1988a). It is possible that most of the contribution that this species pair makes to predators' diets at Macquarie Island is in fact from *G. piabilis*, but at other localities such as Heard Island and more southerly waters, *G. nicholsi* would be the main contributor because they are outside the main distribution range of *G. piabilis*. *G. nicholsi* has been found as a minor constituent in the diets of many predators including Macquarie Island cormorants (Green et al.1990), king penguins at Heard Island (Klages et al. 1989), and antarctic fur seals at S Georgia (North et al. 1983).

Figure 16. Otoliths of *Gymnoscopelus* (*N.*) *fraseri* from fish of standard length 51 mm (top), 71 mm and 84 mm.

Gymnoscopelus (Nasolychnus) fraseri (Fraser-Brunner)

Remarks

Another of the lozenge shaped group of myctophid otoliths (see under *G. bolini* for general notes). Within this group, it is virtually indistinguishable from *G. bolini* in having smooth margins, although *G. fraseri* tends to have a relatively shorter posterior colliculum and antirostrum.

Conversion factors

SL = 21.84513 OL + 1.731671	R = 0.946	n = 17
SL = 29.47851 OW + 6.338667	R = 0.892	n = 17
Mass = 7.29×10^{-6} $SL^{3.101}$	R = 0.937	n = 17
mean = OL/OW = 1.444	SD = 0.082	Range = 1.307 - 1.583

Largest otolith size recorded (mm): OL 3.800 OW 2.570

Size range of fish in otolith sample 57 - 84 mm SL

Distribution

Within AAT

Recorded from the oceanic and shelf waters around Macquarie and Heard Islands, but is probably distributed throughout the area in the vicinity of the Antarctic Convergence.

Elsewhere

Circumglobal, principally in the region of the Antarctic Convergence, but also occurs just to the south of the Convergence, and up to 15° north of it (Hulley 1981). Has been recorded from the Ob' and Lena Banks (Hulley, Camus and Duhamel 1989).

Habitat

A moderately common myctophid in the region of the Antarctic Convergence, where it attains its greatest abundance. Occurs within the temperature range of 1.5 to 8°C (Hulley 1981). Taken in the depth range 10 m to 750 m (ANARE records).

Known predators

Not specifically identified in any diet study, but is probably a component of 'other myctophids' cited in several diet studies, for example fur seals on Macquarie Island (Green et al. 1990) and Heard Island (Green et al. 1989), where it has not been possible to differentiate otoliths of this species from eroded otoliths of *G. nicholsi* or *G. piabilis* or from *G. bolini*.

Figure 17. Otoliths of *Lampanyctus australis*, standard length 88 mm (top); *Gymnoscopelus (N.) hintonoides* standard length 137 mm; and *Gymnoscopelus (N.) microlampas*, standard length 90 mm.

Gymnoscopelus (Nasolychnus) hintonoides Hulley

Remarks

Another of the low relief discoid group of mytophid otoliths (see under *K. anderssoni* for general notes). Within this group, it is characterised by the straight anterior, posterior and dorsal margins, virtual absence of an excisura ostii and very weak rostrum, giving it an almost rectangular appearance. It has the highest OL/OW ratio of any species in this group.

SL	Mass	Otolith mean length	Otolith mean width	Otolith mean length/width
33	0.39	1.300	0.950	1.368
37	0.37	0.850	0.700	1.214
56	2.20	2.516	1.824	1.379
57	2.23	2.605	1.887	1.380
58	2.30	2.628	2.073	1.268
137	28.47	2.000	2.400	1.188

Distribution

Within AAT
Only recorded from the vicinity of Macquarie and Heard Islands.

Elsewhere
Outside the AAT, this species has only been recorded from the south Atlantic region, where it occurs between the subtropical Convergence and just south of the Antarctic Convergence (Hulley 1981).

Habitat

A pelagic myctophid in deeper waters, recorded from 328-800 m depth in the south Atlantic (Hulley 1981), at 250-500 m at Macquarie Island (Williams 1988a) and 490 m at Heard Island (ANARE records).

Known predators

None observed.

Gymnoscopelus (Nasolychnus) microlampas Hulley

Remarks

Another of the lozenge-shaped group of myctophid otoliths (see under *G. bolini* for general notes). Within this group, it is characterised by weak, rounded crenulations on the ventral margin, straight posterior margin and low length:width ratio.

Conversion factors

SL	Mass	Otolith mean length	Otolith mean width	Otolith mean length/width
90	9.07	3.70	2.95	1.254

Distribution

Within AAT
One specimen captured in the vicinity of Macquarie Island (Williams 1988a), and reported in the Australian and Indian sectors of the Southern Ocean between the Subtropical and Antarctic Convergences (Hulley 1981).

Elsewhere
Probably circumglobal between the Subtropical and Antarctic Convergences (Hulley 1981).

Habitat

A mesopelagic myctophid from depths below 650 m in the South Atlantic (Hulley 1981), but from slightly shallower waters around Macquarie Island of 250 - 500 m (Williams 1988a).

Known predators

None observed.

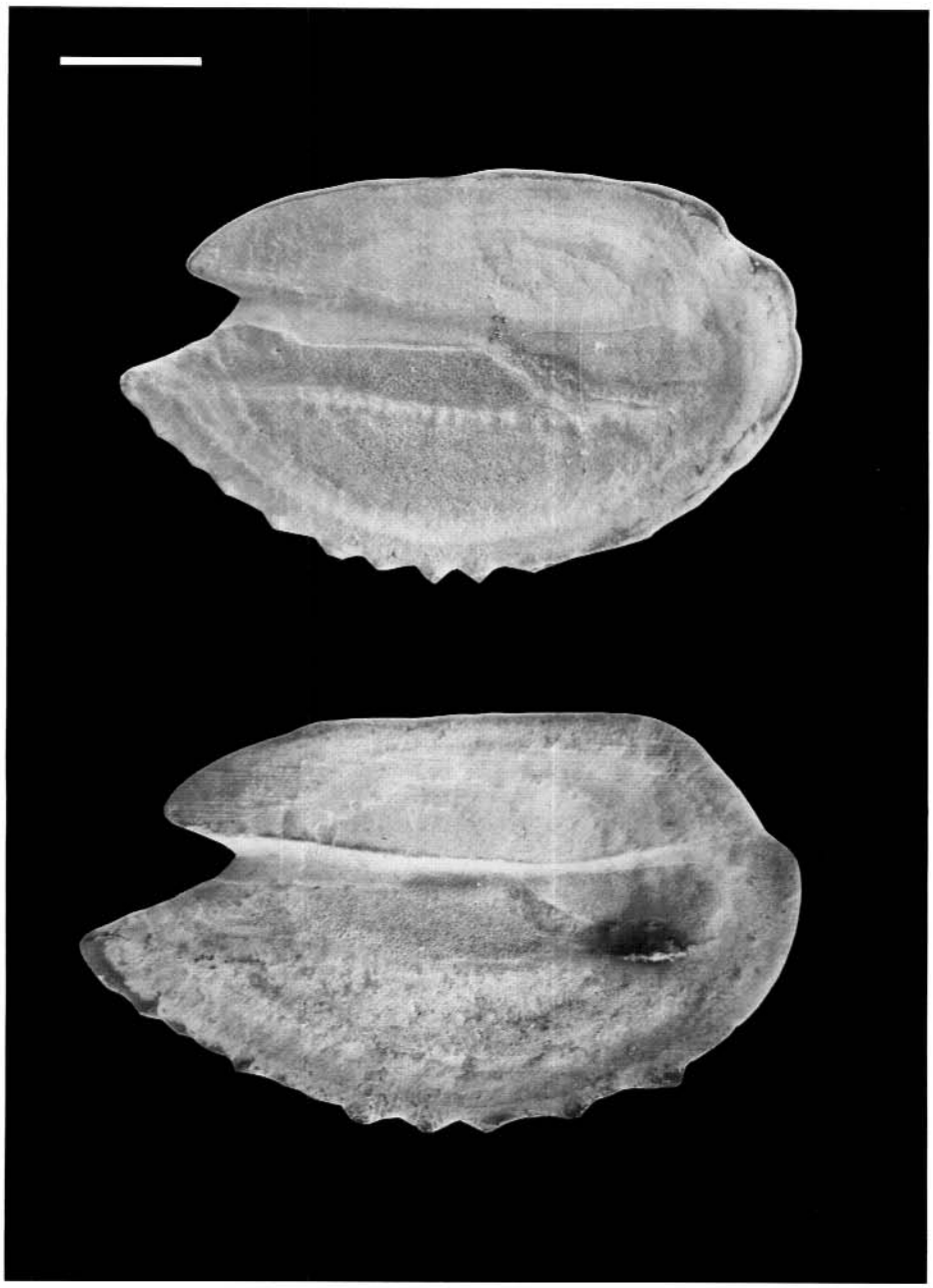

Figure 18. Otoliths of *Gymnoscopelus (N.) piabilis* from fish of standard length 121 mm (top) and 122 mm.

Gymnoscopelus (Nasolychnus) piabilis (Whitley)

Remarks

Another of the lozenge shaped-group of myctophid otoliths (see under *G. bolini* for general notes). Within this group, it is characterised by prominent crenulations on the ventral margin and relatively well-developed antirostrum and high length:width ratio. In all characteristics, however, it appears virtually indistinguishable from *G. nicholsi*.

Conversion factors

SL	Mass	Otolith mean length	Otolith mean width	Otolith mean length/width
121	18.40	5.625	3.275	1.718
122	19.32	5.625	3.225	1.744

Distribution

Within AAT
Oceanic waters from north of the Subtropical Convergence south to the Antarctic Convergence throughout the area, including waters around Heard and Macquarie Islands. Macquarie Island is the type locality for this species (Hulley 1981, Williams 1988a).

Elsewhere
Probably circumglobal in a similar latitudinal range, but may be absent from the western and central Pacific sector (Hulley 1981).

Habitat

A mesopelagic myctophid from a wide depth range, from the surface to 2000 m in both midwater and bottom trawls (Hulley 1981). At Macquarie Island it has been taken in midwater trawls at 50 m depth, and is probably quite common as it formed about 6% of a major fish-kill at the island (Williams 1988a).

Known predators

This species is most likely the *Gymnoscopelus* sp. that forms a significant part of the summer diet of gentoo penguins at Macquarie Island (Williams 1988a). For further comments, see under *G. nicholsi*.

Lampanyctus australis Taning

Remarks

The lack of features on this myctophid otolith and the geographical range of the fish should distinguish it from others.

Conversion factors

SL	Mass	Otolith mean length	Otolith mean width	Otolith mean length/width
88	8.02	2.425	1.850	1.311

Distribution

Within AAT
Oceanic waters in the vicinity of the Subtropical Convergence and occasionally to the north throughout the area.

Elsewhere
Probably circumglobal in a similar latitudinal range, but may be absent from the central Pacific sector (Hulley 1981).

Habitat

A mesopelagic myctophid from a wide depth range; 100 m to greater than 500 m (Hulley 1981).

Known predators

None observed.

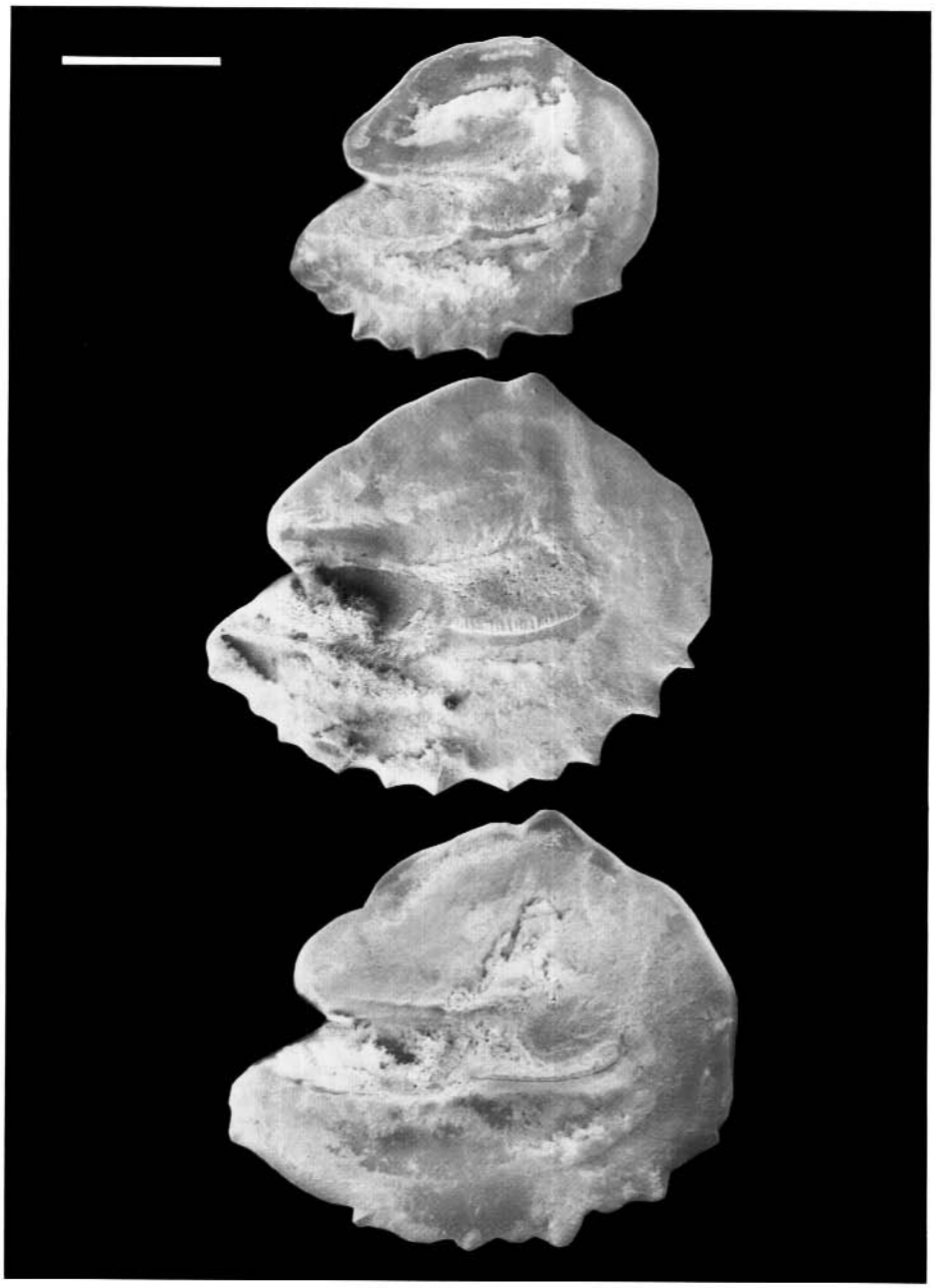

Figure 19. Otoliths of *Diaphus hudsoni* from fish of standard length 42 mm (top), 57 mm and 62 mm.

Diaphus hudsoni Zubrigg & Scott

Remarks

A distinctive myctophid otolith, not likely to be confused with any other from the region.

Conversion factors

SL	Mass	Otolith mean length	Otolith mean width	Otolith mean length/width
42	1.20	2.675	2.225	1.202
54	2.73	3.600	2.925	1.231
57	3.19	3.600	2.950	1.220
62	3.98	3.900	3.525	1.106

Distribution

Within AAT
Oceanic waters in the vicinity of the Subtropical Convergence, probably throughout the area (Hulley 1981).

Elsewhere
Probably circumglobal in the vicinity of the Subtropical Convergence (Hulley 1981).

Habitat

A deep water myctophid, occurring mainly below 250 m (Hulley 1981). ANARE records confirm this, as the only samples are from one haul at 1000 m at 46°49.7'S, 131°37.9'E.

Known predators

None observed.

Figure 20. Otolith of *Magnisudis prionosa* from fish of unknown length (taken from fur seal faeces).

FAMILY PARALEPIDIDAE

Magnisudis prionosa (Rofen)

Remarks

Easily recognisable by the large difference in size between the dorsal and ventral parts, prominent colliculi and expanded and lobed ends of the ventral part.

Conversion factors

No conversion factors are available, as all material is from stomach contents.

Distribution

Within AAT
The only positive records are from stomach contents in the vicinity of Macquarie Island (Williams 1989).

Elsewhere
Probably circumglobal in the Southern Ocean from 20° to 60°S, but not yet reported from the southern Indian Ocean (Fischer and Hureau 1985).

Habitat

A pelagic fish in the open ocean, mainly at mid depths. The adults are found near the coasts in temperate and polar zones, and generally occur in higher latitudes than the young (Rofen 1966).

Known predators

A minor constituent of the diet of fur seals (Green et al. 1990), king penguins (Hindell 1988a), royal penguins (Hindell 1988b) and gentoo penguins (Hindell 1989) at Macquarie Island, and king and gentoo penguins at Heard Island (Klages et al. 1989).

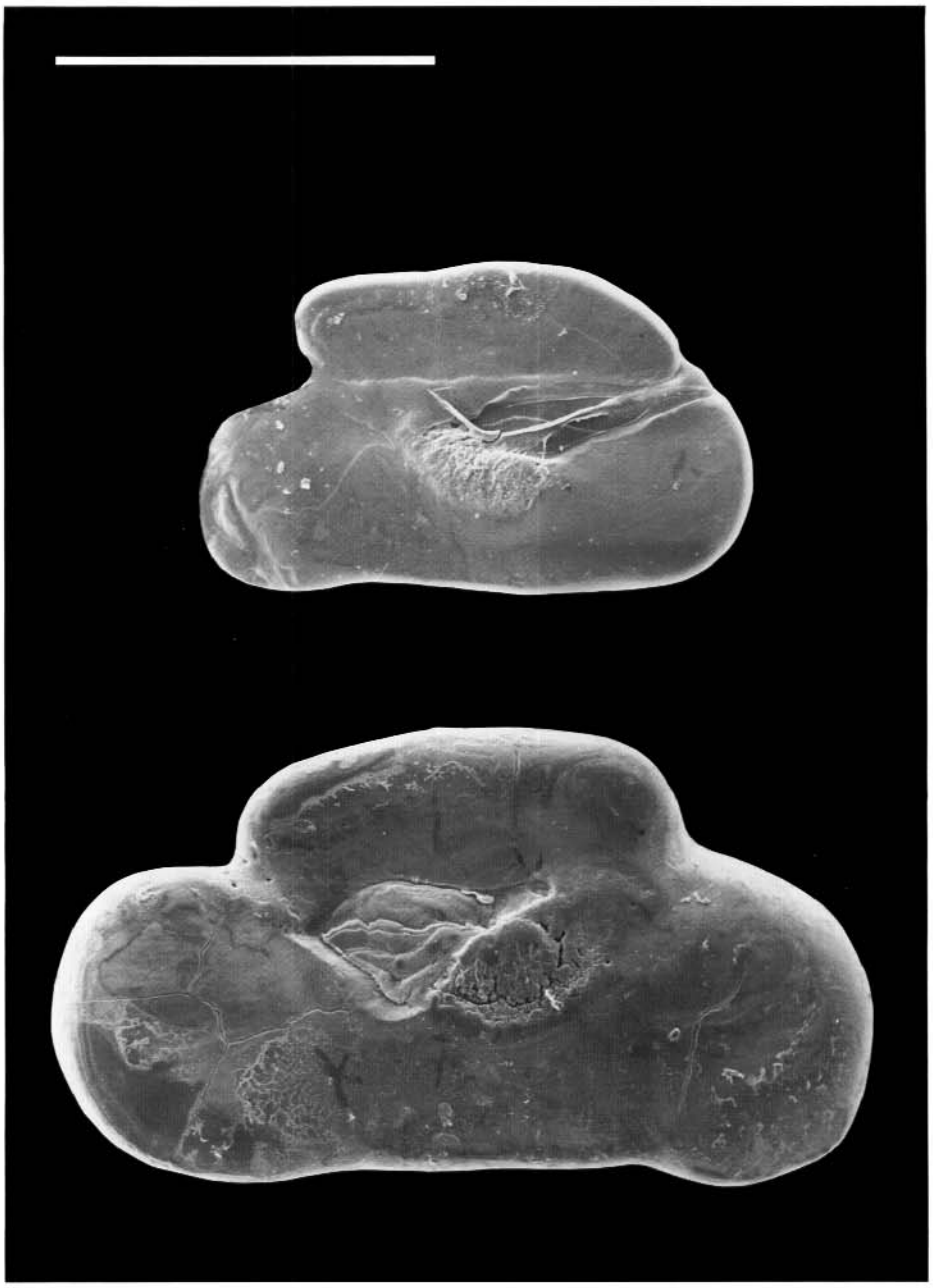

Figure 21. Otoliths of *Notolepis coatsi* from fish of standard length 128 mm (top) and 284 mm.

Notolepis coatsi Dollo

Remarks

A characteristic paralepidid otolith with small dorsal part and large ventral part. Differs from *M. prionosa* in having weakly-developed ventral lobes and colliculi.

Conversion factors

SL	Mass	Otolith mean length	Otolith mean width	Otolith mean length/width
284	23.08	2.650	1.350	1.963
128	2.250	1.750	1.000	1.750

Distribution

Within AAT
Oceanic waters from the Antarctic Convergence south to the Antarctic Continent, but not on the continental shelf. ANARE records show its distribution between 54°S and 67°S in waters off AAT.

Elsewhere
Circumglobal from the Antarctic Convergence south to the Antarctic Continent, but not on the continental shelf (Fischer and Hureau 1985).

Habitat

One of the commonest pelagic fish, encountered from the surface to very deep waters. ANARE records indicate a depth distribution between 20 m and 1029 m, with small juveniles being commonest at the shallower depths. Adults are sometimes associated with krill swarms, on which they predate (Williams 1985).

Known predators

This species constitutes a significant percentage of the diet of emperor penguins from the Mawson area (G. Robertson, pers. comm.) and the Weddell Sea (Klages 1989).

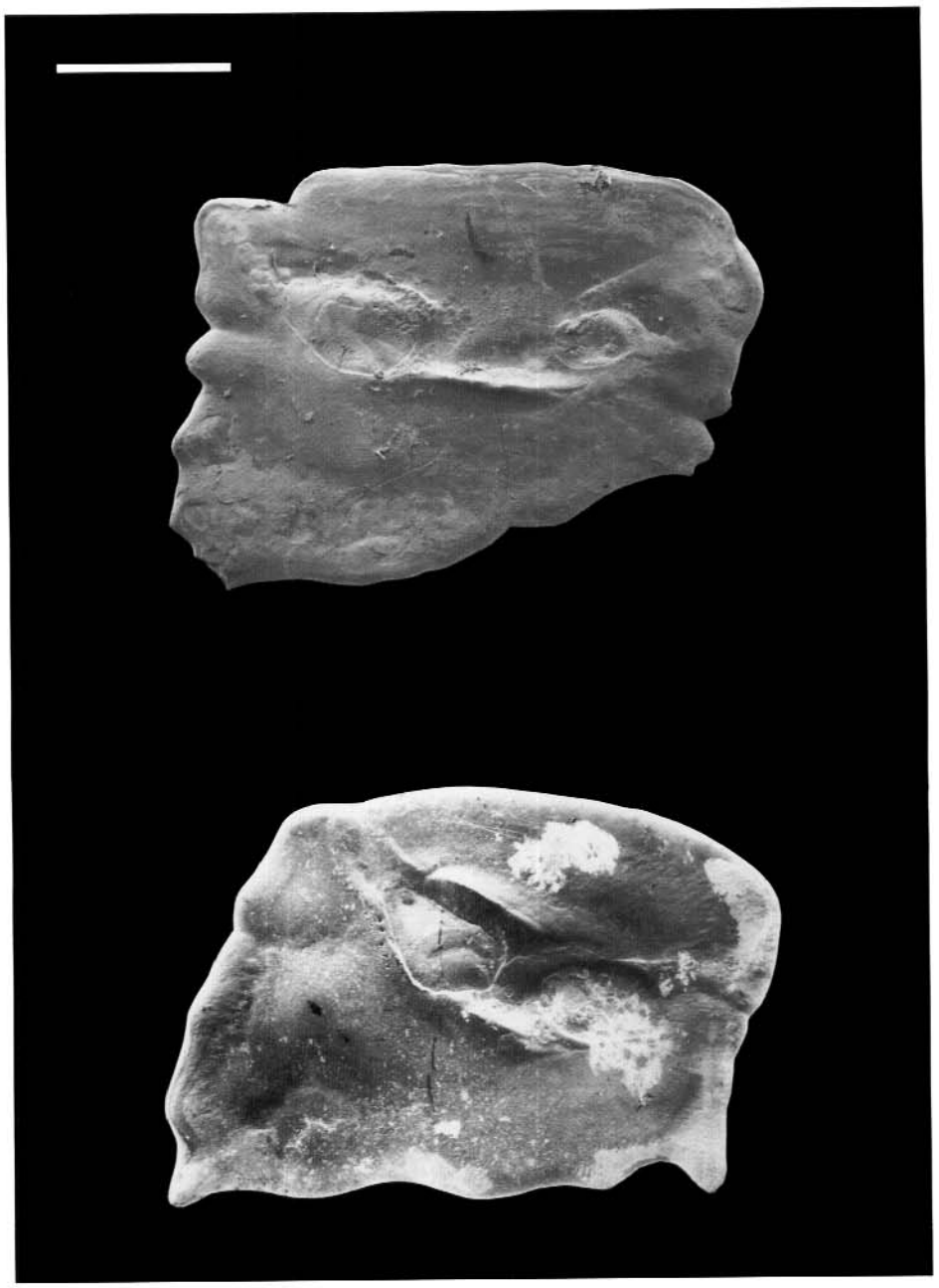

Figure 22. Otoliths of *Scopelarchoides kreefti*, standard length 117 mm (top), and *Benthalbella macropinna*, standard length 171 mm.

FAMILY SCOPELARCHIDAE

Benthalbella macropinna Bussing & Bussing

Remarks

The near rectangular shape and dorsally directed cauda make this otolith easily recognisable.

Conversion factors

SL	Mass	Otolith mean length	Otolith mean width	Otolith mean length/width
182	33.34	5.90	4.00	1.475

Distribution

Within AAT
Subantarctic and Antarctic waters in the Antarctic circumpolar current probably throughout the area (Johnson 1974). ANARE records confirm this, with three captures between 49°51'S, 131°20'E and 61°50'S, 78°01'E.

Elsewhere
Circumpolar in a similar latitudinal band (Johnson 1974).

Habitat

A bathypelagic fish, not usually encountered in water less than 500 m deep (Johnson 1974). ANARE records indicate a depth distribution between 845 m and 1500 m.

Known predators

None observed.

Scopelarchoides kreefti Johnson

Remarks

Similar to the other scopelarchid, *Benthalbella macropinna*, but less rectangular in shape and cauda more antero-posterior in alignment.

Conversion factors

SL	Mass	Otolith mean length	Otolith mean width	Otolith mean length/width
117	11.12	3.70	2.625	1.410

Distribution

Within AAT
Only positive record is from 46°50'S, 131°38'E.

Elsewhere
Western and central South Atlantic between 34° and 41°S (Johnson 1974).

Habitat

A rare bathypelagic fish not encountered in depths less than 500 m.

Known predators

None observed.

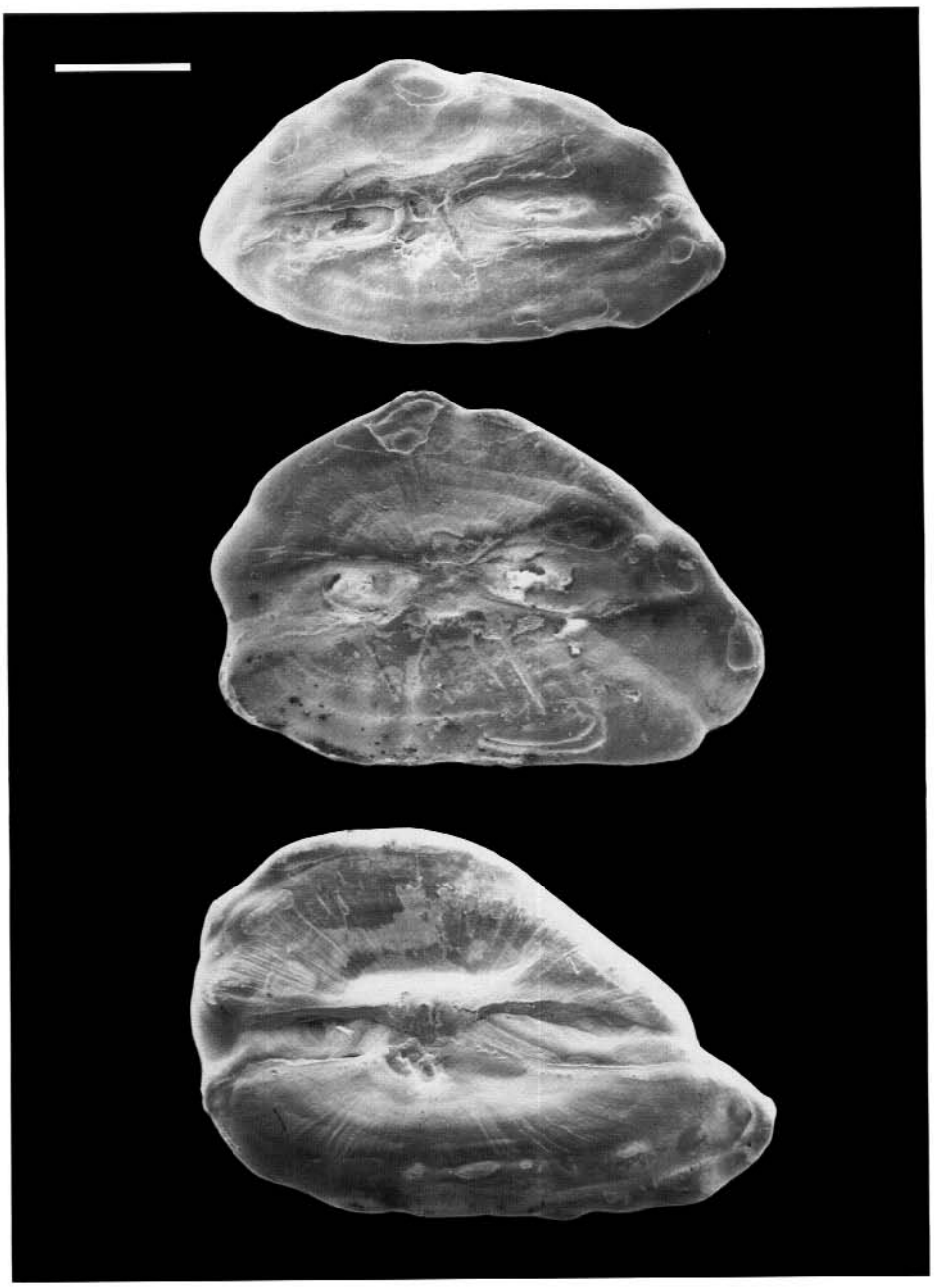

Figure 23. Otoliths of *Muraenolepis marmoratus* from fish of standard length 210 mm (top), 292 mm and 364 mm.

FAMILY MURAENOLEPIDIDAE

Muraenolepis marmoratus Gunther

Remarks

An elongate roughly triangular shaped otolith with few diagnostic features. The well-developed sulcus acusticus with approximately equal ostium and cauda, constricted collum and obvious cristae help to identify this otolith. *M. marmoratus* is one of four species of *Muraenolepis* found in the subantarctic areas, which probably all have similar otoliths (see Hecht 1987). As the status of *Muraenolepis* at Macquarie Island is uncertain (Williams 1988a), as is probably also the case at Heard Island, specific identifications within this genus should be made with extreme care.

Conversion factors

SL = 45.75904 OL + 53.34070	R = 0.563	n = 28
SL = 108.3560 OW - 68.3156	R = 0.759	n = 28
Mass = 9.065×10^{-5} $SL^{2.589}$	R = 0.950	n = 28
mean OL/OW = 1.514	SD = 0.115	Range = 1.293 - 1.817

Longest otolith size recorded (mm): OL 5.45 OW 3.46

Size range of fish in otolith sample 210 - 364 mm SL

Distribution

Within AAT
Shelves of Heard and Macquarie Islands only.

Elsewhere
Shelves of Kerguelen and Crozet Islands (Fischer and Hureau 1985).

Habitat

A benthic fish, moderately common from the sublittoral to the continental slope, with a depth range of 10 - 1600 m (Fischer and Hureau 1985, Williams 1988a).

Known predators

A species of *Muraenolepis* occurs occasionally in the diet of cormorants at Heard and Macquarie Islands (Green et al. 1990), and in gentoo penguins at Heard Island (Klages et al. 1989). As the most common inshore *Muraenolepis* at these localities is *M. marmoratus*, this is the species most likely taken. The closely related *M. microps* has been reported from wandering albatross (*Diomedea exulans*) from South Georgia (Croxall et al. 1988).

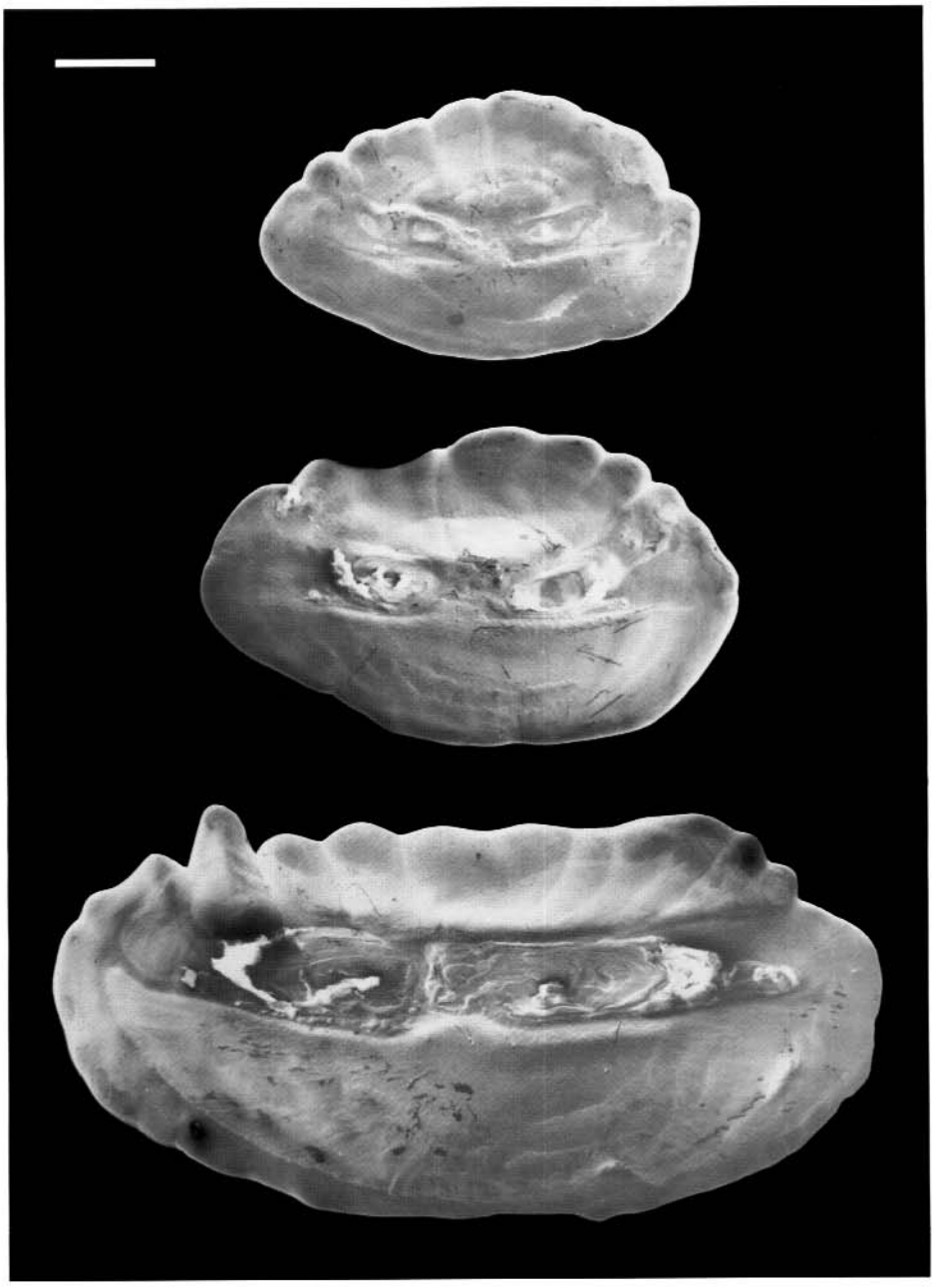

Figure 24. Otoliths of *Macrourus holotrachys* from fish of total length 163 mm (top), 210 mm and 459 mm.

FAMILY MACROURIDAE

Macrourus holotrachys Gunther

Remarks

The elongate shape with a wide sulcus acusticus opening both anteriorly and posteriorly are characteristic. Could be confused with otoliths of *Dissostichus eleginoides* (Figure 32), which occurs in the same areas, but the latter is diagnosed by the prominent cristae, presence of a rostrum (although not always obvious), and much more prominent sculpturing on both dorsal and ventral edges.

Conversion factors

TL = 40.23886 OL - 21.1335	R = 0.951	n = 15
TL = 105.0123 OW - 154.326	R = 0.905	n = 15
Mass = 3.43×10^{-7} $TL^{3.463}$	R = 0.995	n = 14
mean OL/OW = 1.884	SD = 0.272	Range = 1.527-2.357

Largest otolith size recorded (mm): OL 14.83 OW 6.300

Size range of fish in otolith sample 163 - 541 mm SL

Distribution

Within AAT

Continental slopes of Antarctica throughout the area, Heard and Macquarie Islands (Fischer and Hureau 1985).

Elsewhere

Circum-antarctic and all subantarctic islands, Patagonia and New Zealand (Fischer and Hureau 1985).

Habitat

A benthic species on the continental slope, and hence normally in deep water. Can, however be found in waters as shallow as 240 m (Fischer and Hureau 1985) especially on the Heard Island shelf (ANARE records).

Known predators

None observed.

Figure 25. Otoliths of *Zanclorhynchus spinifer* from fish of standard length 106 mm (top), 162 mm and 213 mm.

FAMILY CONGIOPODIDAE

Zanclorhynchus spinifer (Gunther)

Remarks

An otolith superficially very similar to many nototheniids in having a prominent rostrum and well-developed sulcus acusticus with raised collum. Can be separated from these by the long slender rostrum, very deeply incised ostium, and excisura ostii with very acute angle. The otolith size varies enormously with fish size in this species making the relationships of OL and OW to SL useless.

Conversion factors

SL = 4.088044 OL + 170.3344	R = 0.101	n = 65
SL = 10.71815 OW + 163.0687	R = 0.126	n = 65
Mass = 1.63×10^{-5} $SL^{3.047}$	R = 0.993	n = 152
mean OL/OW = 1.655	SD = 0.180	Range = 1.096-2.090

Largest otolith size recorded (mm): OL 3.799 OW 2.201

Size range of fish in otolith sample 150 - 214 mm SL

Distribution

Within AAT
Shelves of Macquarie and Heard Islands only.

Elsewhere
Shelves of Kerguelen, Crozet and Marion Islands only (Fischer and Hureau 1985).

Habitat

A benthic species abundant in inshore waters from 5 m to 100 m depth (Williams 1988a). Often found on bare sandy bottoms, it relies on its large spines for protection from predators.

Known predators

Because of its medium size and large spines, it is not an important dietary item, but has occasionally been found at Macquarie Island in gentoo penguin stomachs (Hindell 1989), rockhopper penguins (Hindell 1988c) and New Zealand fur seals (Green et al. 1990); and in the Heard Island cormorant (Green et al. 1990).

Figure 26. Otoliths of *Dolloidraco longedorsalis* from fish of standard length 68 mm (top), 80 mm and 93 mm.

FAMILY ARTEDIDRACONIDAE

Dolloidraco longedorsalis Roule

Remarks

The well-marked rounded ostium and cauda separated by a prominent collum are characteristic. Separated from similar members of this family by the rounded shape (*Histiodraco velifer* is triangular) and in older specimens by a prominent rostrum and excisura ostii with an angle of close to 90° (other species have no rostrum or excisura ostii greater than 90°).

Conversion factors

SL = 10.28439 OL + 50.70341	R = 0.674	n = 33
SL = 14.15432 OW + 55.13149	R = 0.571	n = 33
Mass = 3.86×10^{-5} $SL^{2.840}$	R = 0.914	n = 47
mean OL/OW = 1.592	SD = 0.129	Range = 1.244-1.810

Largest otolith size recorded (mm): OL 3.819 OW 2.631

Size range of fish in otolith sample 74 - 93 mm SL

Distribution

Within AAT

Continental shelf and upper slope, probably throughout the region, but the only positive records are off Casey, Shackleton Ice Shelf region and off Mawson (DeWitt 1971), and Prydz Bay.

Elsewhere

Probably circum-antarctic on the continental shelf. Positive records for the Ross Sea and western Antarctic Peninsula (DeWitt 1971).

Habitat

A benthic species in the mid depth to deeper waters of the continental shelf, most occurrences in depths 230-860 m (DeWitt 1971 and ANARE data). In Prydz Bay it occurs in and around the inner shelf depression in depths between 465 and 760 m.

Known predators

An occasional component of the spring diet of Weddell seals in the Weddell Sea (Plotz and Ekau in press).

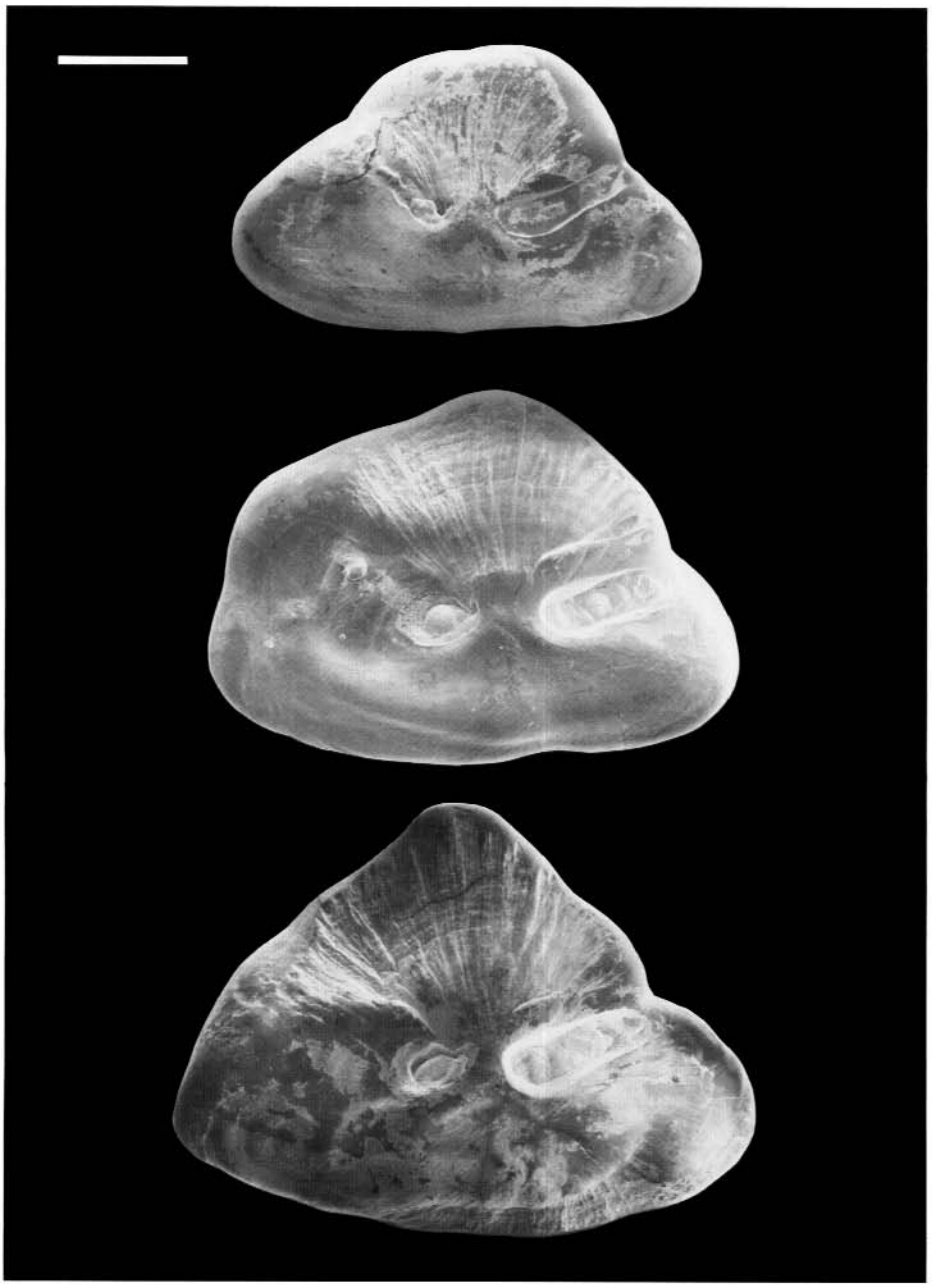

Figure 27. Otoliths of *Histiodraco velifer* from fish of standard length 107 mm (top), 131 mm and 141 mm.

Histiodraco velifer Regan

Remarks

Similar to many other Artedidraconidae with its rounded pit-like ostium and cauda with prominent collum. The triangular shape with poorly developed rostrum and an obvious crista superior over the ostium are diagnostic.

Conversion factors

SL	Mass	Otolith mean length	Otolith mean width	Otolith mean length/width
107	27.76	4.065	2.185	1.860
133	57.62	4.281	3.017	1.419

Distribution

Within AAT
Antarctic continental shelf probably throughout the area. Positive records from off Mawson (DeWitt 1971) and Prydz Bay (ANARE records).

Elsewhere
Continental shelf of East Antarctica. Positive records from the Ross Sea and Riiser-Larsen Sea (DeWitt 1971) and Weddell Sea (Schwarzbach 1988).

Habitat

A fairly rare benthic fish in the depth range 210-430 m (DeWitt 1971). It occurs in the NE part of Prydz Bay in depths between 343 and 525 m.

Known predators

An occasional component of the spring diet of Weddell seals in the Weddell Sea (Plotz and Ekau in press).

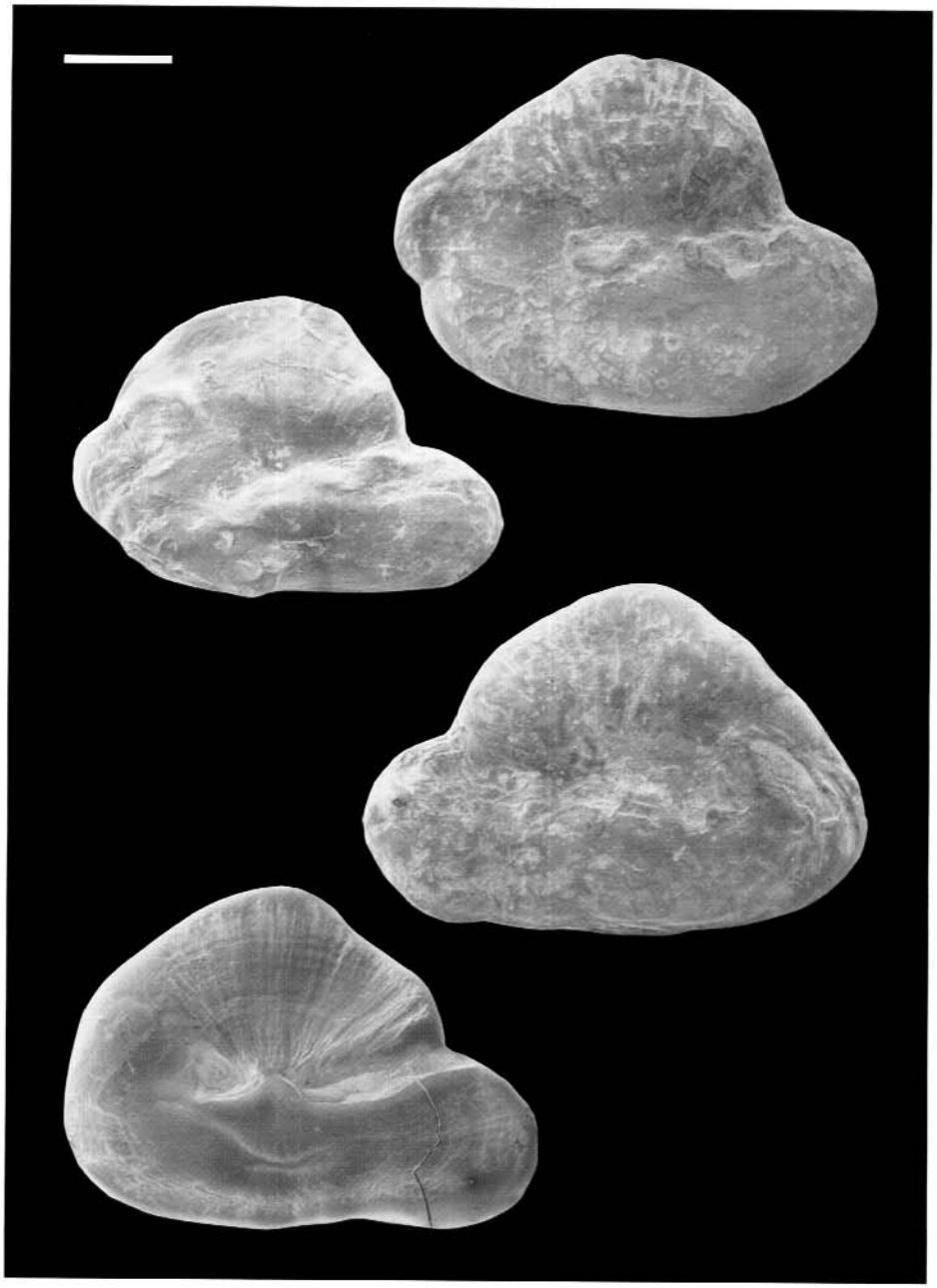

Figure 28. Otoliths of (from top) *Pogonophryne permitini*, SL 177 mm; *P. marmorata*, SL 171 mm; *P. barsukovi*, SL 189 mm; *P. ventrimaculata*, SL 175 mm.

Pogonophryne barsukovi Andriashev

Remarks

The otoliths of *Pogonophryne* spp. differ from other species in the Artedidraconidae by having shallow, generally elongate ostium and cauda and a more or less prominent rostrum. In this they resemble some nototheniid otoliths (e.g. *Aethotaxis mitopteryx*, some *Pagothenia* and *Trematomus* species) but can be differentiated by the much more triangular dorsal section. There appears to be little variation within the genus, and diagnoses are not reliable given the small number of specimens available (except for *P. phyllopogon*). *P. barsukovi* appears to have the least prominent rostrum and sulcus acusticus and has a somewhat more rounded shape than most other species of *Pogonophryne*.

Conversion factors

SL	Mass	Otolith mean length	Otolith mean width	Otolith mean length/width
160	96.56	5.115	3.333	1.535
189	154.69	5.115	3.621	1.413

Distribution

Within AAT
Antarctic continental shelf. Two positive records from Knox Coast (65°35'S, 109°12'E) (Eakin 1977) and Prydz Bay.

Elsewhere
Ross Sea, South Shetland and South Orkney Islands only (Eakin and Kock 1984).

Habitat

A rare benthic fish, only known from a few specimens from the continental shelf in depths of 220 to 112 m (Eakin 1977, Eakin and Kock 1984). In Prydz Bay, two specimens have been recorded from near the shelf break in 430 to 732 m depth.

Known predators

None observed.

Pogonophryne marmorata Norman

Remarks

See general notes under *P. barsukovi*. *P. marmorata* appears to be most similar to *P. phyllopogon* in having a prominent rostrum and a crista superior above the cauda, but has a more rounded shape, more slender rostrum and less bold relief. There is also a prominent posterior lobe.

Conversion factors

SL	Mass	Otolith mean length	Otolith mean width	Otolith mean length/width
101	23.31	2.759	1.897	1.454
171	140.54	4.477	3.263	1.372
176	158.63	5.323	3.847	1.384

Distribution

Within AAT
Antarctic continental shelf. Two positive records from Davis Sea and Prydz Bay.

Elsewhere
Ross Sea, South Shetland and South Orkney Islands only (Eakin 1977).

Habitat

A rare benthic fish, only known from a few specimens, from the continental shelf in depths of 160 to 1405 m (Eakin 1977). In Prydz Bay, two specimens have been recorded from near the shelf break in 383 m and NE of Davis in 606 m.

Known predators

None observed.

Pogonophryne permitini Andriashev

Remarks

See general notes under *P. barsukovi*. *P. permitini* appears to be very similar to *P. marmorata*, but has a shorter, broader rostrum and a smaller posterior lobe.

Conversion factors

SL	Mass	Otolith mean length	Otolith mean width	Otolith mean length/width
177	146.01	5.058	3.793	1.334

Distribution

Within AAT
Antarctic continental shelf. Two positive records from Davis Sea (Eakin 1977) and Prydz Bay.

Elsewhere
Ross Sea, South Shetland and South Orkney Islands only (Eakin 1977).

Habitat

A benthic fish, only known from a few specimens from the continental shelf in depths of 430 to 1120 m (Eakin 1977, Eakin and Kock 1984). One specimen has been recorded from near the centre of Prydz Bay in 461 m depth.

Known predators

None observed.

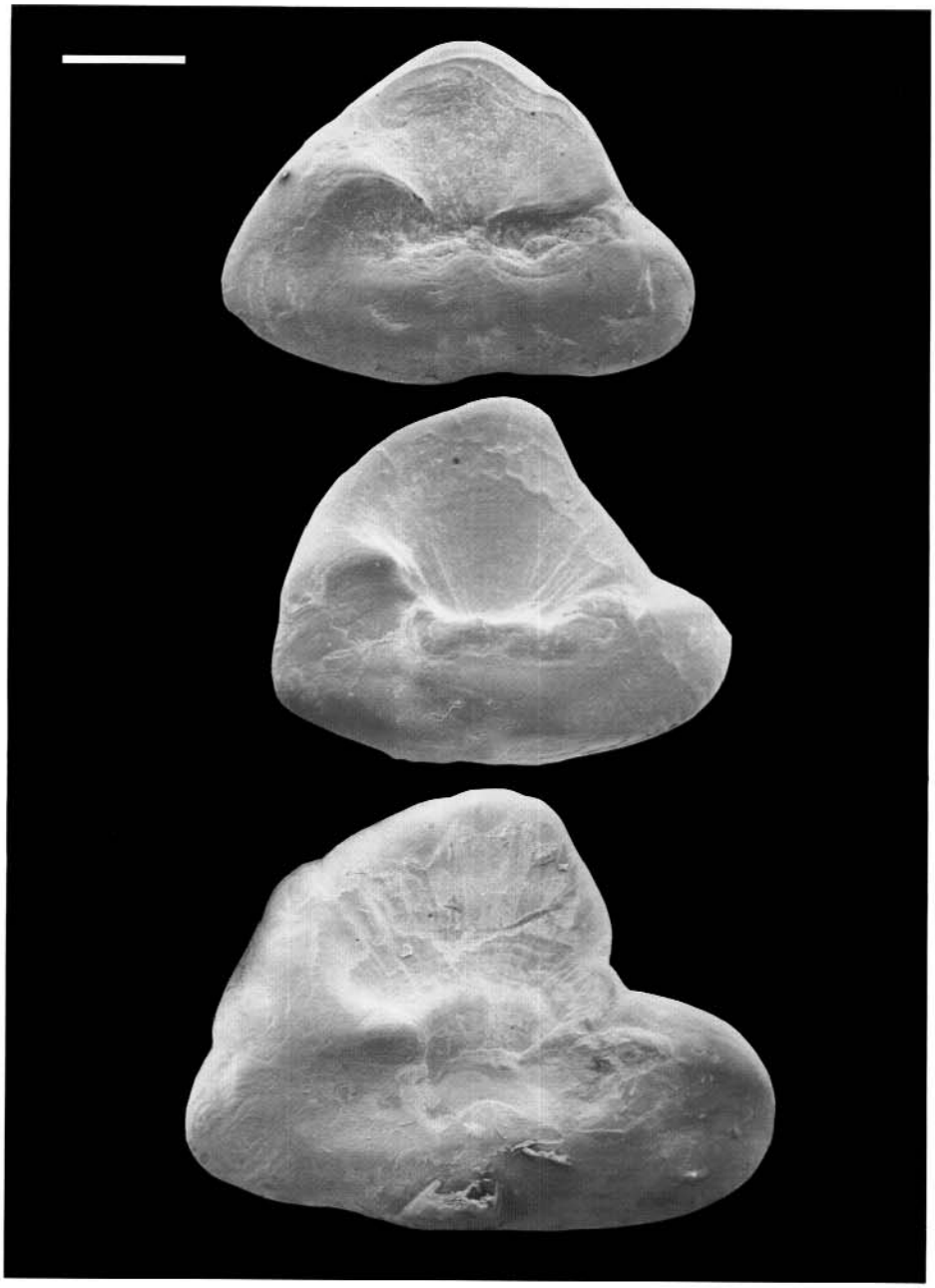

Figure 29. Otoliths of *Pogonophryne phyllopogon* from fish of standard length 131 mm (top), 146 mm and 167 mm.

Pogonophryne phyllopogon Andriashev

Remarks

See general notes under *P. barsukovi*. *P. phyllopogon* has the most distinctive otolith in this group, with a prominent rostrum in larger animals, a triangular shape with high dorsal part and a prominent crista superior over the cauda.

Conversion factors

SL = 30.64437 OL + 42.28450	R = 0.550	n = 16
SL = 39.05815 OW + 47.90287	R = 0.537	n = 16
Mass = 4.78×10^{-6} $SL^{3.343}$	R = 0.986	n = 18
mean OL/OW = 1.330	SD = 0.121	Range = 1.148-1.618
Largest otolith size recorded (mm):	OL 5.85	OW 4.45
Size range of fish in otolith sample 131 - 226 mm SL		

Distribution

Within AAT
The only records are for the continental shelf of Prydz Bay in the depth range 350 to 515 m.

Elsewhere
Possibly circum-antarctic on the continental shelf. Positive records for the Ross Sea, Antarctic Peninsula, Weddell Sea and S Shetland Islands (Eakin and Kock 1984).

Habitat

A benthic species in the mid-depth to deeper waters of the continental shelf, most occurrences in depths of 200-400 m (Eakin and Kock 1984). In Prydz Bay it occurs in the shallower parts of the shelf near the continental slope in depths between 350 and 515 m.

Known predators

None observed.

Pogonophryne ventrimaculata Eakin

Remarks

See general notes under *P. barsukovi*. *P. ventrimaculata* appears to have the best developed sulcus acusticus with the ostium obviously reaching the anterior margin and forming an excisura ostii, and with a well-developed cauda without crista superior.

Conversion factors

SL	Mass	Otolith mean length	Otolith mean width	Otolith mean length/width
175	151.84	4.550	3.400	1.338

Distribution

Within AAT
Antarctic continental shelf. The only positive record is from Prydz Bay.

Elsewhere
Weddell Sea only (Eakin 1987).

Habitat

A rare benthic fish. A single specimen has been recorded from near the centre of Prydz Bay in 460 m depth.

Known predators

None observed.

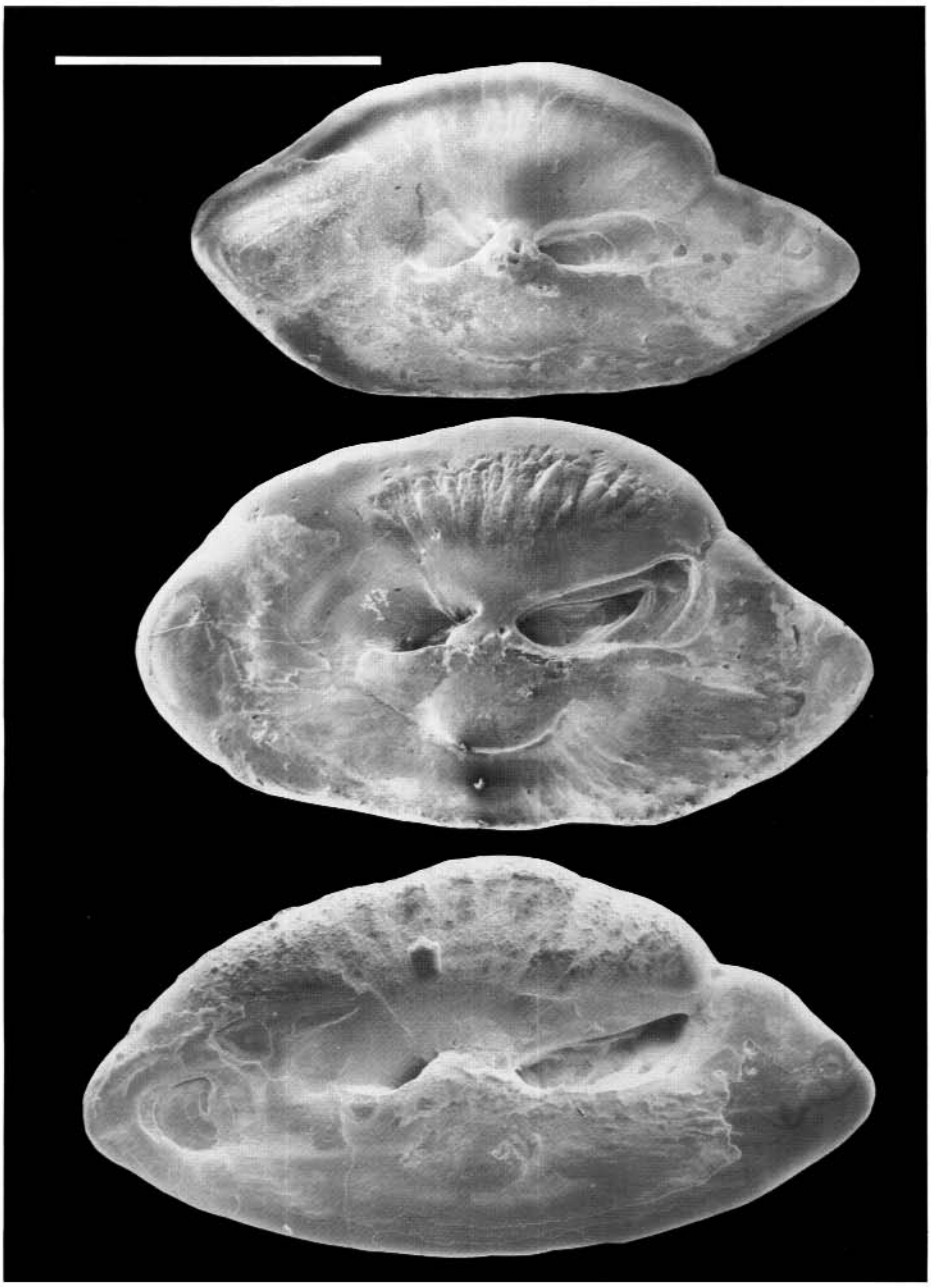

Figure 30. Otoliths of *Harpagifer georgianus georgianus* from fish of standard length 42 mm (top), 53 mm and 60 mm.

FAMILY HARPAGIFERIDAE

Harpagifer georgianus georgianus Nybelin

Remarks

Somewhat similar to many Artedidraconid otoliths in having a small, deeply incised ostium and cauda with a prominent collum, but the narrow oval shape and small size should differentiate it from these. Could be confused with a small *Nototheniops mizops* or *Notothenia acuta*, but the wider, shallower ostium and cauda and greater degree of sculpturing on the margins of the latter should distinguish them.

Conversion factors

SL	Mass	Otolith mean length	Otolith mean width	Otolith mean length/width
42	2.20	2.25	1.10	2.045
42	2.38	2.15	1.00	2.150
53	3.33	2.20	1.35	1.630

Distribution

Within AAT
Shelves of Macquarie and Heard Islands only (Williams 1988a, ANARE records).

Elsewhere
The genus *Harpagifer* has a circum-antarctic distribution on all the subantarctic islands and the Antarctic Peninsula, but is represented by a closely related series of species and subspecies, each with its own restricted range within this area, and some have a discontinuous distribution. *H. g. georgianus* is one such example, and is found outside the AAT at Marion and S Georgia Islands (Hureau et al. 1979).

Habitat

One of the commonest benthic fish, encountered from the sublittoral to about 100 m depth. This small species usually lives under stones or kelp (Williams 1988a).

Known predators

An important item in the diet of Macquarie Island cormorants (Brothers 1985, Green et al. 1990), and a minor component in the diets of gentoo and rockhopper penguins (Hindell 1988c, 1989) and royal penguins (Horne 1985). Also important in the diet of Heard Island cormorants (Green et al. 1990) and gentoo penguins at Heard Island (Klages et al. 1989).

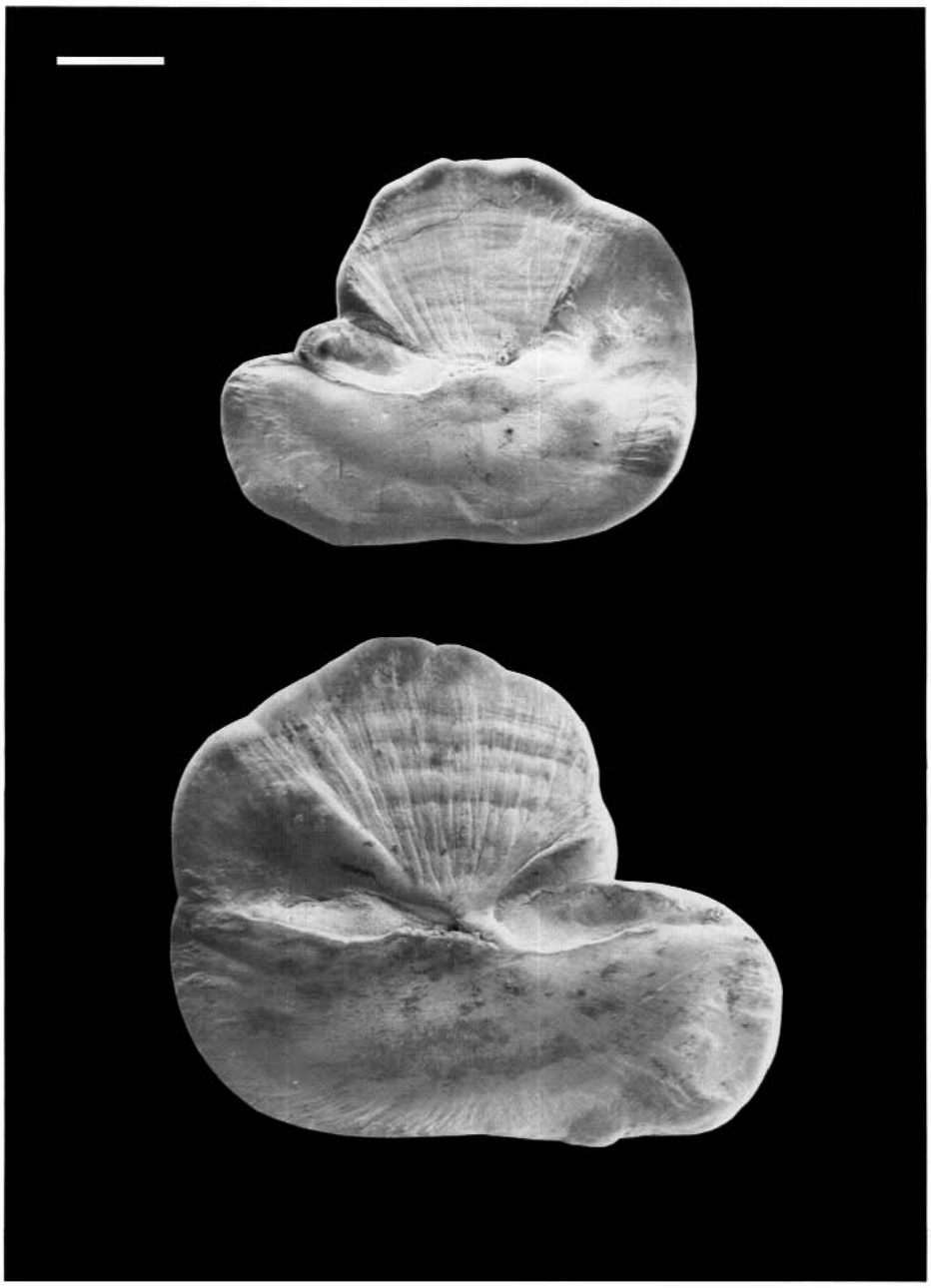

Figure 31. Otoliths of *Aethotaxis mitopteryx* from fish of standard length 255 mm (top) and 364 mm.

FAMILY NOTOTHENIIDAE

Aethotaxis mitopteryx DeWitt

Remarks

A typical notothenid otolith with a well-developed dorsal part, prominent wide rostrum and obvious ostium and cauda with well-marked collum overlain by the crista inferior. Similar to many *Pagothenia* and *Trematomus* species, but can be distinguished by the relatively short, wide and rounded rostrum and shallow sulcus acusticus. See also under *Pogonophryne barsukovi*.

Conversion factors

SL	Mass	Otolith mean length	Otolith mean width	Otolith mean length/width
255	179.28	5.057	4.007	1.262
364	631.58	5.553	5.125	1.084

Distribution

Within AAT
Antarctic continental shelf and slope, probably throughout the area, but positive records only for Prydz Bay (Fischer and Hureau 1985).

Elsewhere
Circumpolar on the shelf and slope, including the Scotia Arc, but not S Georgia (Fischer and Hureau 1985).

Habitat

An uncommon pelagic notothenid, usually in deep waters over the shelf and slope, but occasionally near the surface (Fischer and Hureau 1985). In Prydz Bay it has been found in 700 to 785 m depth over the continental slope.

Known predators

None observed.

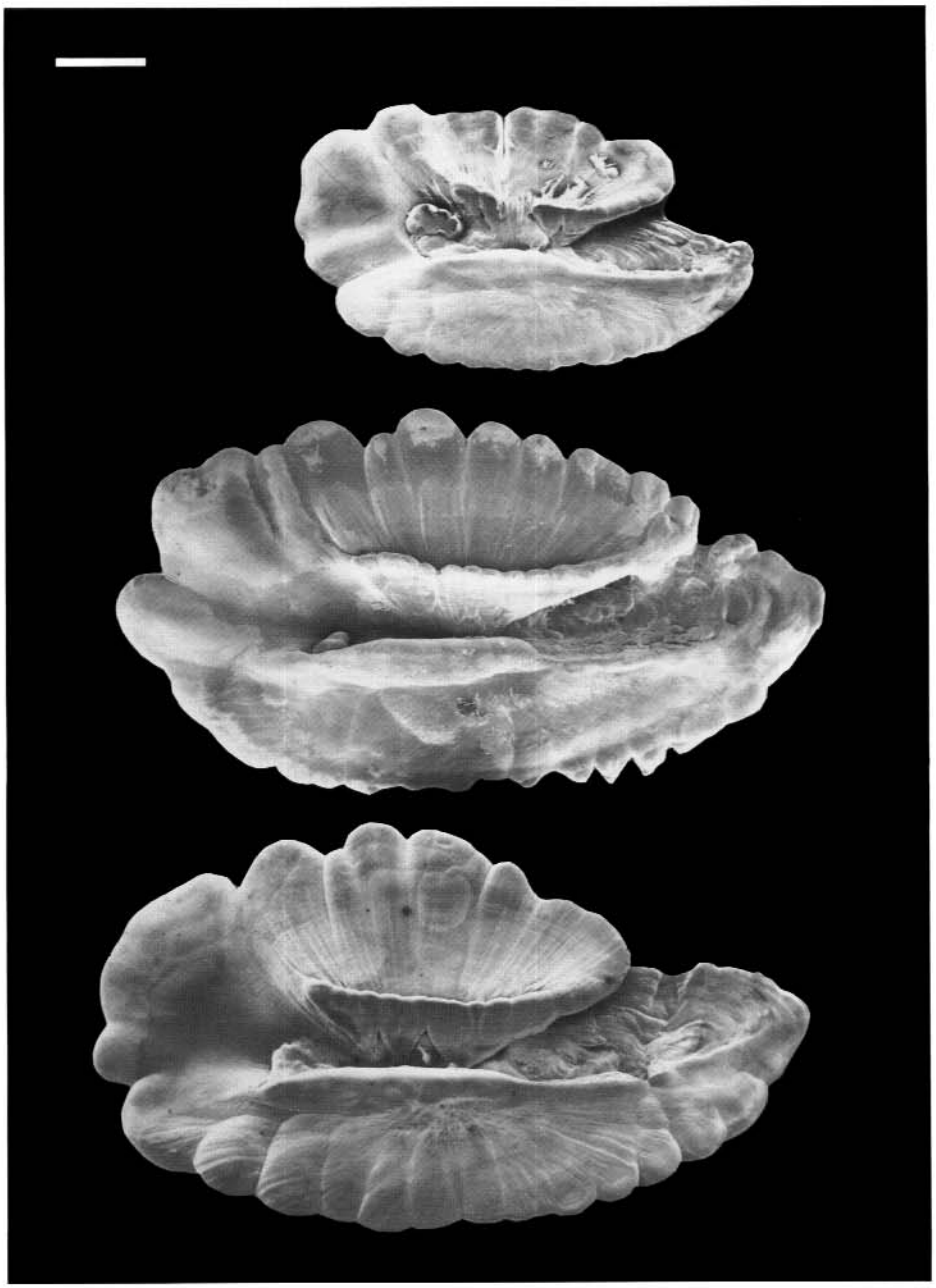

Figure 32. Otoliths of *Dissostichus eleginoides* from fish of standard length 314 mm (top), 467 mm and 570 mm.

Dissostichus eleginoides Smitt

Remarks

A distinctive otolith, but could be confused with *Macrourus holotrachys* (Figure 24) which is found in the same areas. Can be distinguished by the prominent cristae, presence of a rostrum and much more prominent sculpturing on both dorsal and ventral margins.

Conversion factors

SL = 73.86329 OL - 191.414	R = 0.916	n = 160
SL = 141.9414 OW - 264.490	R = 0.922	n = 160
Mass = 4.59×10^{-6} $SL^{3.187}$	R = 0.985	n = 159
mean OL/OW = 1.748	SD = 0.124	Range = 1.228-2.120

Largest otolith size recorded (mm): OL 14.636 OW 7.874

Size range of fish in otolith sample 218 - 966 mm SL

Distribution

Within AAT
Shelves of Heard and Macquarie Islands only.

Elsewhere
Shelves of Kerguelen, Crozet, Marion and Prince Edward, Bouvet and S Georgia Islands, Scotia Arc, Ob' and Lena Banks, tip of Antarctic Peninsula and Patagonia (Fischer and Hureau 1985).

Habitat

A bentho-pelagic species, common on the shelf and upper slope within its range from 70 to 1500 m depths (Fischer and Hureau 1985). Younger fish (up to about 500 mm SL) tend to be found in the shallower part of the depth range, with the older, mature fish in deeper waters.

Known predators

Most individuals would be too large for most predators (except toothed whales and dolphins), but some small specimens have been recovered from antarctic fur seals at Heard Island (Green et al. 1989). Otoliths from a small juvenile were found in the stomach of a Macquarie Island cormorant (Green et al. 1990).

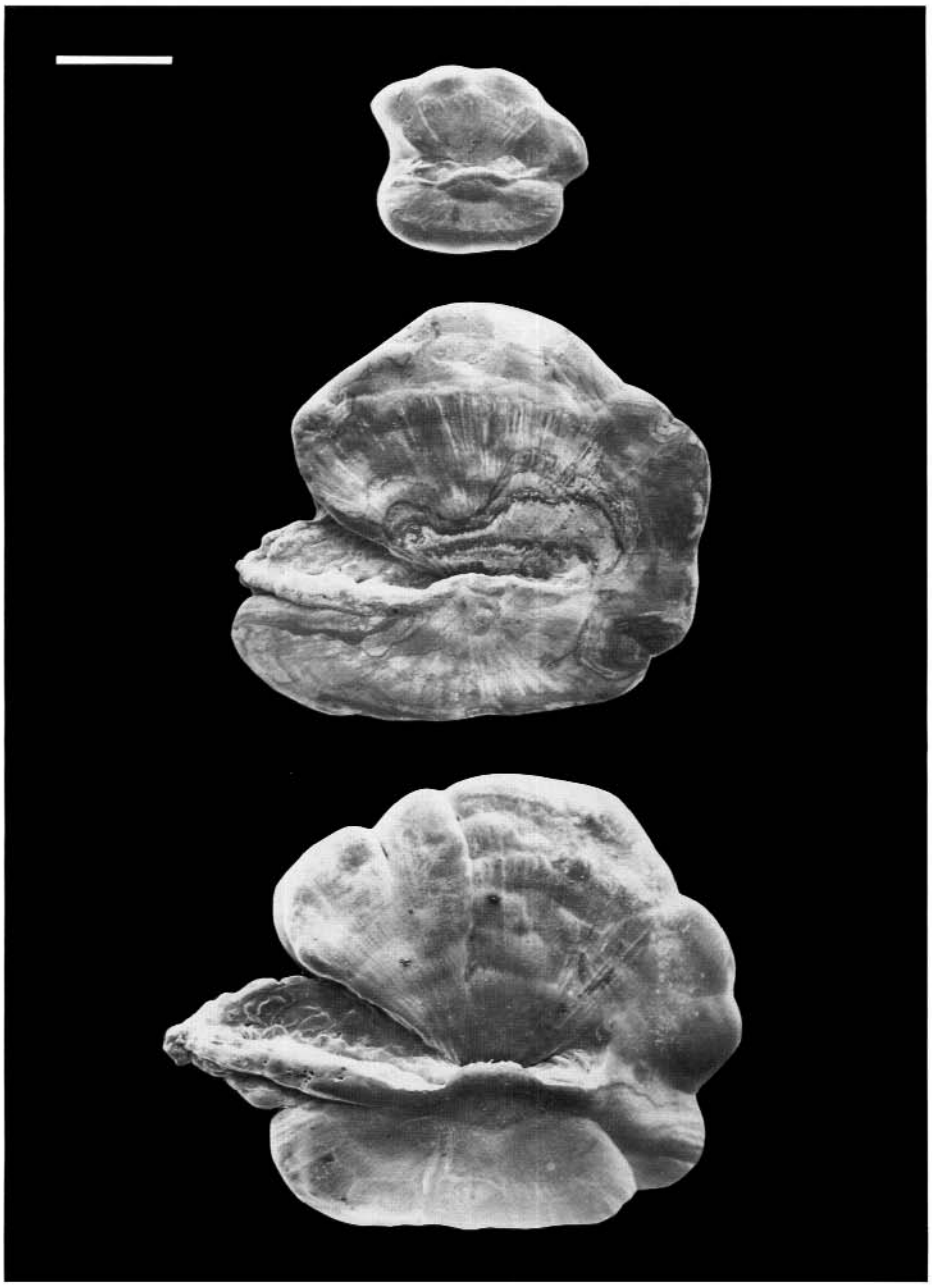

Figure 33. Otoliths of *Dissostichus mawsoni* from fish of standard length 145 mm (top), 286 mm and 453 mm.

Dissostichus mawsoni Norman

Remarks

Otoliths from larger specimens are very distinctive with the large ostium, small cauda and prominent rostrum. In small specimens the ostium and cauda are more equal in size and the rostrum is not developed, making it hard to distinguish from small otoliths of many nototheniids.

Conversion factors

SL = 90.83046 OL - 94.9810	R = 0.904	n = 64
SL = 97.36677 OW - 58.5629	R = 0.784	n = 64
Mass = 2.17×10^{-6} $SL^{3.317}$	R = 0.994	n = 72
mean OL/OW = 1.191	SD = 0.115	Range = 1.011-1.886

Largest otolith size recorded (mm): OL 6.282 OW 5.042

Size range of fish in otolith sample 145 - 650 mm SL

Distribution

Within AAT

Antarctic continental shelf and slope throughout the area (Fischer and Hureau 1985).

Elsewhere

Circumpolar on the antarctic continental shelf and slope, including the Antarctic Peninsula, S Shetland and S Orkney Islands (Fischer and Hureau 1985).

Habitat

A bentho-pelagic species, common on the shelf and upper slope within its range from 100 to 1600 m depths (Fischer and Hureau 1985). Younger fish (up to about 250 mm SL) can be found near shore, especially at Casey in the depth range 20 to 85 m (ANARE records), with the older, mature fish in deeper waters.

Known predators

Weddell seals have been observed to bring large specimens of *D. mawsoni* to the surface in McMurdo Sound (Testa et al. 1985).

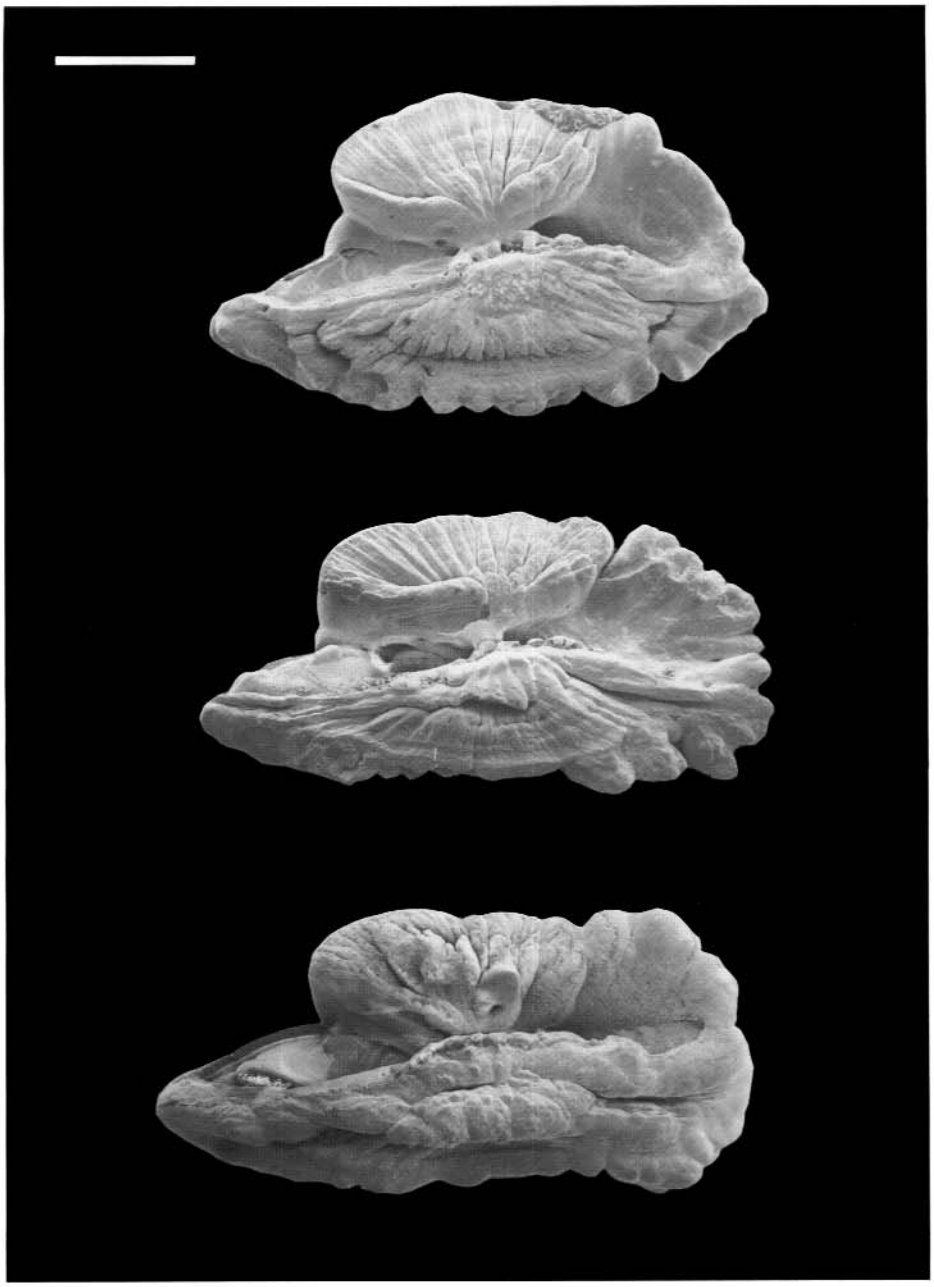

Figure 34. Otoliths of *Notothenia (N.) coriiceps* from fish of standard length 337 mm (top), 364 mm and 431 mm.

Notothenia (Notothenia) coriiceps Richardson

Remarks

Otoliths from the subgenus *Notothenia* (*N. coriiceps, N. neglecta* and *N. rossii*) together with *Paranotothenia magellanica* are very similar but show considerable variability within each species, making them extremely hard to separate with confidence. Otoliths of *Zanclorhynchus spinifer* can also be confused with this group (see under that species for distinguishing features). The group shares the features of small size, elongated rectangular form with a prominent slender rostrum and usually obvious sculpturing. *N. coriiceps ca*n be identified from the other members of the group by the greater degree of crenation of the margins and cristae and the high OL:OW ratio.

Conversion factors

SL = 86.59886 OL - 27.91347	R = 0.935	n = 13
SL = 105.9125 OW + 110.2998	R = 0.700	n = 13
Mass = 2.78×10^{-5} $SL^{2.943}$	R = 0.988	n = 20
mean OL/OW = 1.971	SD = 0.236	Range = 1.441-2.364

Largest otolith size recorded (mm): OL 5.836 OW 2.950

Size range of fish in otolith sample 235 - 512 mm SL

Distribution

Within AAT
Heard Island shelf only.

Elsewhere
Shelves of Kerguelen, Crozet, Marion and Prince Edward Islands (Fischer and Hureau 1985).

Habitat

A benthic species, common inshore to depths of 80 m.

Known predators

An occasional component of the diet of antarctic fur seals (Green et al. 1989), and gentoo penguins (Klages et al. in press) at Heard Island and gentoo penguins at Marion Island (LaCock et al. 1984). As the otoliths of *N. coriiceps, N. neglecta* and *N. rossii* are very difficult to distinguish, the presence of all these species should be suspected when they are quoted as present in a predator's diet in locations where their distributions overlap.

Figure 35. Otoliths of *Notothenia (N.) neglecta* from fish of standard length 161 mm (top), 259 mm and 352 mm.

Notothenia (Notothenia) neglecta Nybelin

Remarks

Another of the small, rectangular group of notothenid otoliths (see under *N. coriiceps* for details). *N. neglecta can* be identified from the other members of the group by the relatively short rostrum and small OL:OW ratio, both of which give the otolith a more 'square' look, and a rather rounded ventral margin. In larger specimens, the crista superior is very prominent.

Conversion factors

SL = 71.41905 OL + 13.67271	R = 0.744	n = 218
SL = 112.1938 OW + 23.14088	R = 0.684	n = 218
Mass = 5.71×10^{-6} $SL^{3.259}$	R = 0.974	n = 264
mean OL/OW = 1.640	SD = 0.142	Range = 1.066-2.046
Largest otolith size recorded (mm):	OL 4.417	OW 3.424
Size range of fish in otolith sample	161 - 352 mm SL	

Distribution

Within AAT

The only positive record is from the Casey vicinity. Unlikely to occur further west as intensive sampling at Davis, Mawson and in Prydz Bay have failed to record this species.

Elsewhere

Antarctic continental shelf east of Casey as far as the Antarctic Peninsula, islands of Scotia Arc, South Georgia, Bouvet and Peter I Islands. Apparently not present in the Weddell Sea (Ekau 1988, Schwarzbach 1988) or eastwards as far as Casey.

Habitat

A benthic species, very common inshore to depths of 50 m, and occasionally to 100 m (Hureau 1970, Fischer and Hureau 1985, ANARE records).

Known predators

Adults of this species are probably too large for most predators except for Weddell, leopard or fur seals, although the juveniles may be eaten by predators such as gentoo penguins. See note under *N. coriiceps*.

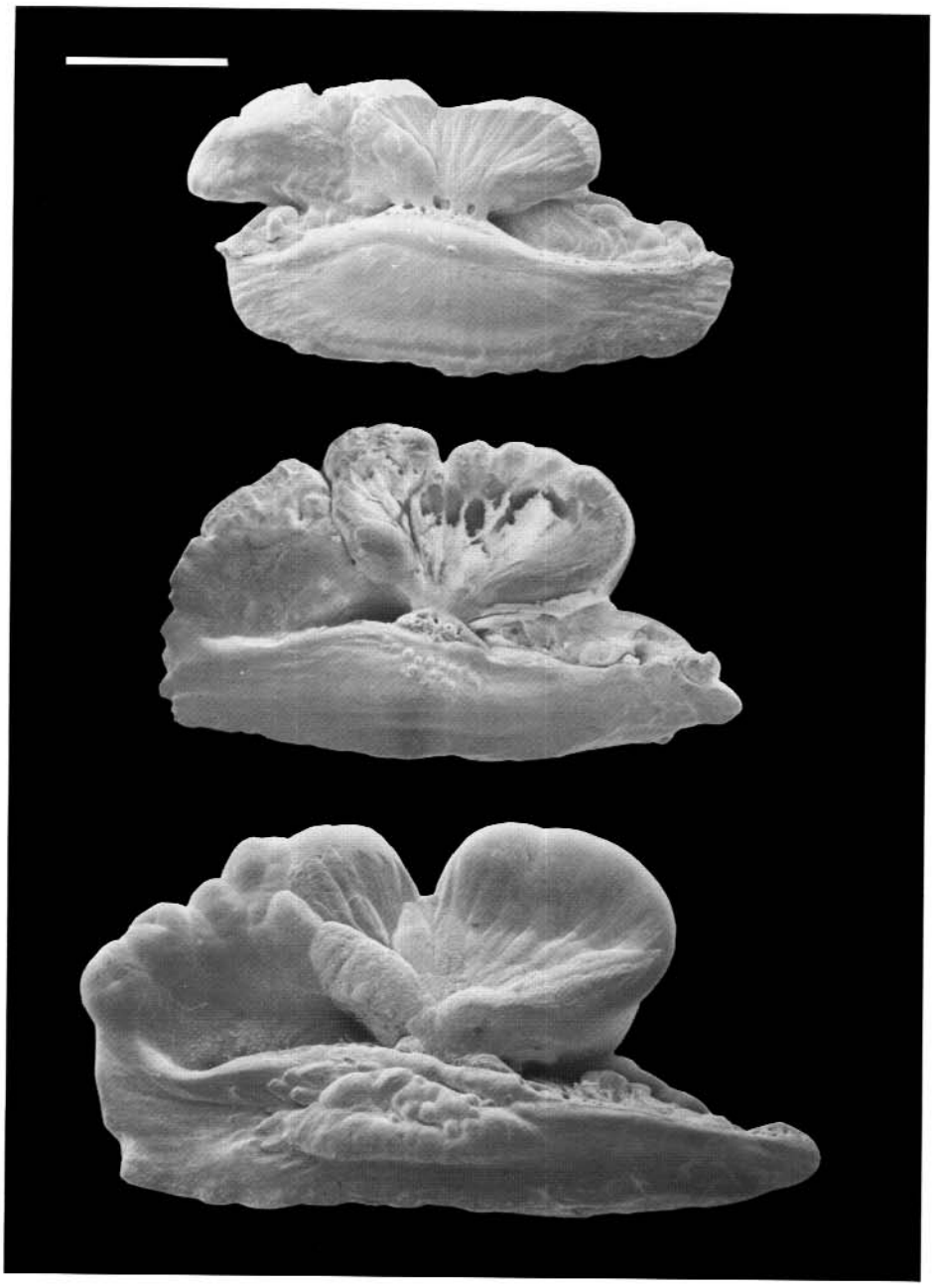

Figure 36. Otoliths of *Notothenia (N.) rossii rossii* from fish of standard length 301 mm (top), 426 mm and 550 mm.

Notothenia (Notothenia) rossii rossii Richardson

Remarks

Another of the small, rectangular group of nototheniid otoliths (see under *N. coriiceps* for details). *N. r. rossii* can be identified from the other members of the group by the relatively straight and unsculptured ventral and posterior margins, one or more notches in the dorsal margin and the slender pointed rostrum.

Conversion factors

SL = 82.58219 OL + 43.68991	R = 0.884	n = 19
SL = 140.0371 OW + 50.05416	R = 0.811	n = 19
Mass = 3.366×10^{-6} $SL^{3.306}$	R = 0.994	n = 19
mean OL/OW = 1.730	SD = 0.195	Range = 1.385-2.128

Largest otolith size recorded (mm): OL 5.416 OW 3.217

Size range of fish in otolith sample 220 - 550 mm SL

Distribution

Within AAT

Shelves of Heard and Macquarie Islands only.

Elsewhere

N. r. rossii is found on the shelves of Kerguelen, Crozet and Marion and Prince Edward Islands, and the Ob' and Lena seamounts. The very similar *N. r. marmorata* is found at S Georgia, the Scotia Arc and the tip of the Antarctic Peninsula (Fischer and Hureau 1985).

Habitat

A benthic species, very common from inshore to depths of 500 m (Fischer and Hureau 1985). In most areas of its range, its abundance has been drastically reduced by fishing. Juveniles (to approx. 50 mm SL) are pelagic, sub-adults (to approx. 450 mm SL) live close inshore in bays and fjords, and adults live more offshore in deeper water where they feed and spawn.

Known predators

Small individuals are sometimes taken by cormorants (Brothers 1985, Green et al. 1990) and gentoo penguins (Hindell 1989) at Macquarie Island. Larger sub-adults are a minor constituent of the diet of antarctic fur seals at Heard Island (Green et al. 1989) and S Georgia (North et al. 1983) and gentoo penguins at S Georgia (Croxall and Prince 1980). See note under *N. coriiceps*.

Figure 37. Otoliths of *Notothenia (L.) kempi* from fish of standard length 107 mm (top), 195 mm and 350 mm.

Notothenia (Lepidonotothen) kempi Norman

Remarks

The two members of the subgenus *Lepidonotothen* have similar and distinctive otoliths with very prominent broad, rounded rostra and a massive crista superior, especially over the ostium. *N. kempi* should be distinguishable from *N. squamifrons* on the basis of location in most cases, as their distribution only overlaps in S Georgia and the Scotia Arc. Otherwise the relatively shorter rostrum, smaller, shallower cauda and lower OL/OW ratio of *N. kempi* may help to distinguish it.

Conversion factors

SL = 58.01994 OL - 90.11051	R = 0.961	n = 17
SL = 108.6725 OW - 122.6568	R = 0.971	n = 17
Mass = 5.00×10^{-6} $SL^{3.217}$	R = 0.999	n = 23
mean OL/OW = 1.650	SD = 0.089	Range = 1.479-1.831
Largest otolith size recorded (mm):	OL 7.428	OW 4.057
Size range of fish in otolith sample	107 - 350 mm SL	

Distribution

Within AAT
The only positive record is from Prydz Bay. May occur on the antarctic continental shelf throughout the AAT, as the paucity of sampling in most areas may not yet have established the presence of this uncommon species.

Elsewhere
South Georgia, Scotia Arc, tip of Antarctic Peninsula and Scott Island only (Fischer and Hureau 1985).

Habitat

A benthic species in a wide depth range of 160 to 900 m (Fischer and Hureau 1985), but nowhere common. In Prydz Bay it has only been encountered on the extreme northern edge of the shelf and on the upper slope in 430 to 700 m depth.

Known predators

Has been observed in the stomach of a leopard seal off the Eastern Sector (Vagin and Shust 1989).

Figure 38. Otoliths of *Notothenia (L.) squamifrons* from fish of standard length 31 mm (top), 188 mm and 388 mm.

Notothenia (Lepidonotothen) squamifrons Gunther

Remarks

Another of the *Lepidonotothen* group of otoliths. See under *N. kempi* for details. Features which can help distinguish this species from *N. kempi* include the relatively longer rostrum, wider, deeper cauda and higher OL/OW ratio.

Conversion factors

SL = 56.02584 OL - 86.2886	R = 0.952	n = 155
SL = 95.73879 OW - 69.2128	R = 0.952	n = 155
Mass = 1.10×10^{-5} $SL^{3.097}$	R = 0.992	n = 839
mean OL/OW = 1.855	SD = 0.175	Range = 1.171-2.758

Largest otolith size recorded (mm): OL 8.325 OW 4.440

Size range of fish in otolith sample 31 - 413 mm SL

Distribution

Within AAT
Shelves of Heard and Macquarie Islands only.

Elsewhere
Shelves of Kerguelen, Crozet, Marion and Prince Edward and S Georgia Islands, the Scotia Arc and the Ob' and Lena seamounts (Fischer and Hureau 1985).

Habitat

A bentho-pelagic species, very common from inshore to depths of 550 m (Fischer and Hureau 1985, Williams 1988a). In most areas of its range, its abundance has been drastically reduced by fishing.

Known predators

Larger sub-adults are a common constituent of the diet of antarctic fur seals at Heard Island (Green et al. 1989), and small individuals are a minor constituent of the diet of Heard Island cormorants (Green et al. 1990). This species is the main food in winter of gentoo penguins at Marion Island (Croxall and Lishman 1987).

Figure 39. Otoliths of *Notothenia (G.) acuta* from fish of standard length 174 mm (top), 199 mm and 232 mm.

Notothenia (Gobionotothen) acuta Gunther

Remarks

Otoliths of this species have a characteristic extended triangular shape due to the conical posterior lobe and fairly short rostrum. Among nototheniids it can be confused with small *Lepidonotothen* spp. and *Nototheniops mizops*. It can be differentiated from the former by the much higher OL:OW ratio, weaker crista superior and more sculptured dorsal margin, and from the latter by the shorter rostrum, shorter collum and narrower sulcus acusticus.

Conversion factors

SL = 37.65546 OL - 23.2003	R = 0.953	n = 40
SL = 85.83036 OW - 24.0200	R = 0.940	n = 40
Mass = 4.08×10^{-7} $SL^{3.634}$	R = 0.990	n = 40
mean OL/OW = 2.272	SD = 0.142	Range = 1.982-2.637

Largest otolith size recorded (mm): OL 7.347 OW 3.228

Size range of fish in otolith sample 110 - 261 mm SL

Distribution

Within AAT
Shelves of Heard Island only.

Elsewhere
Shelves of Kerguelen, Crozet, Marion and Prince Edward Islands (Fischer and Hureau 1985).

Habitat

A benthic species, common nearshore at Heard Island from 30 to 200 m depths (ANARE records), and in similar habitats elsewhere in its range (Fischer and Hureau 1985).

Known predators

Larger sub-adults are a minor constituent of the diet of antarctic fur seals at Heard Island (Green et al. 1989) and small individuals are a minor constituent of the diet of Heard Island cormorants (Green et al. 1990). They are also common in the diet of gentoo penguins at Heard Island (Klages et al. 1989).

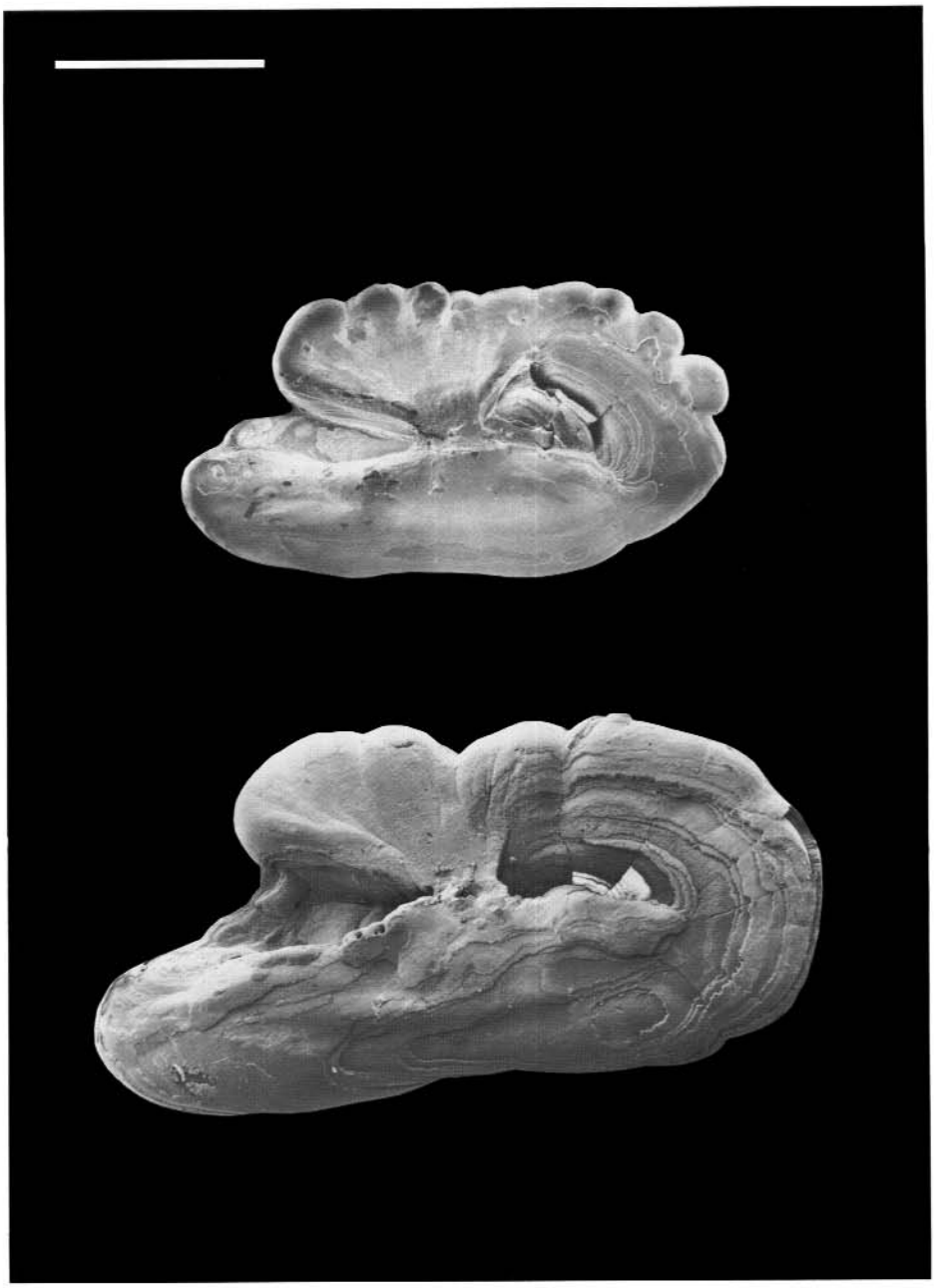

Figure 40. Otoliths of *Notothenia (G.) cyanobrancha* from fish of standard length 136 mm (top) and 205 mm.

Notothenia (Gobionotothen) cyanobrancha Richardson

Remarks

A fairly distinctive nototheniid otolith. Sometimes difficult to distinguish from *Paranotothenia magellanica*, especially when slightly eroded, but the short rounded rostrum, smoothly rounded posterior margin and crenate dorsal margin are diagnostic. The otoliths illustrated in Figure 40 are from specimens which have been preserved in formalin for a short period, and hence are somewhat eroded.

Conversion factors

SL	Mass	Otolith mean length	Otolith mean width	Otolith mean length/width
136	36.20	3.003	1.613	1.862
205	160.80	3.936	1.950	2.018

Distribution

Within AAT
Shelf of Heard Island only.

Elsewhere
Shelf of Kerguelen Island only (Fischer and Hureau 1985).

Habitat

Benthic fish from the sublittoral to depths of 20 m in inshore bays and fjords (Fischer and Hureau 1985).

Known predators

A major constituent of the diet of Heard Island cormorants (Green et al. 1990), and a minor component of the rockhopper penguin diet at Heard Island (Klages et al. 1989).

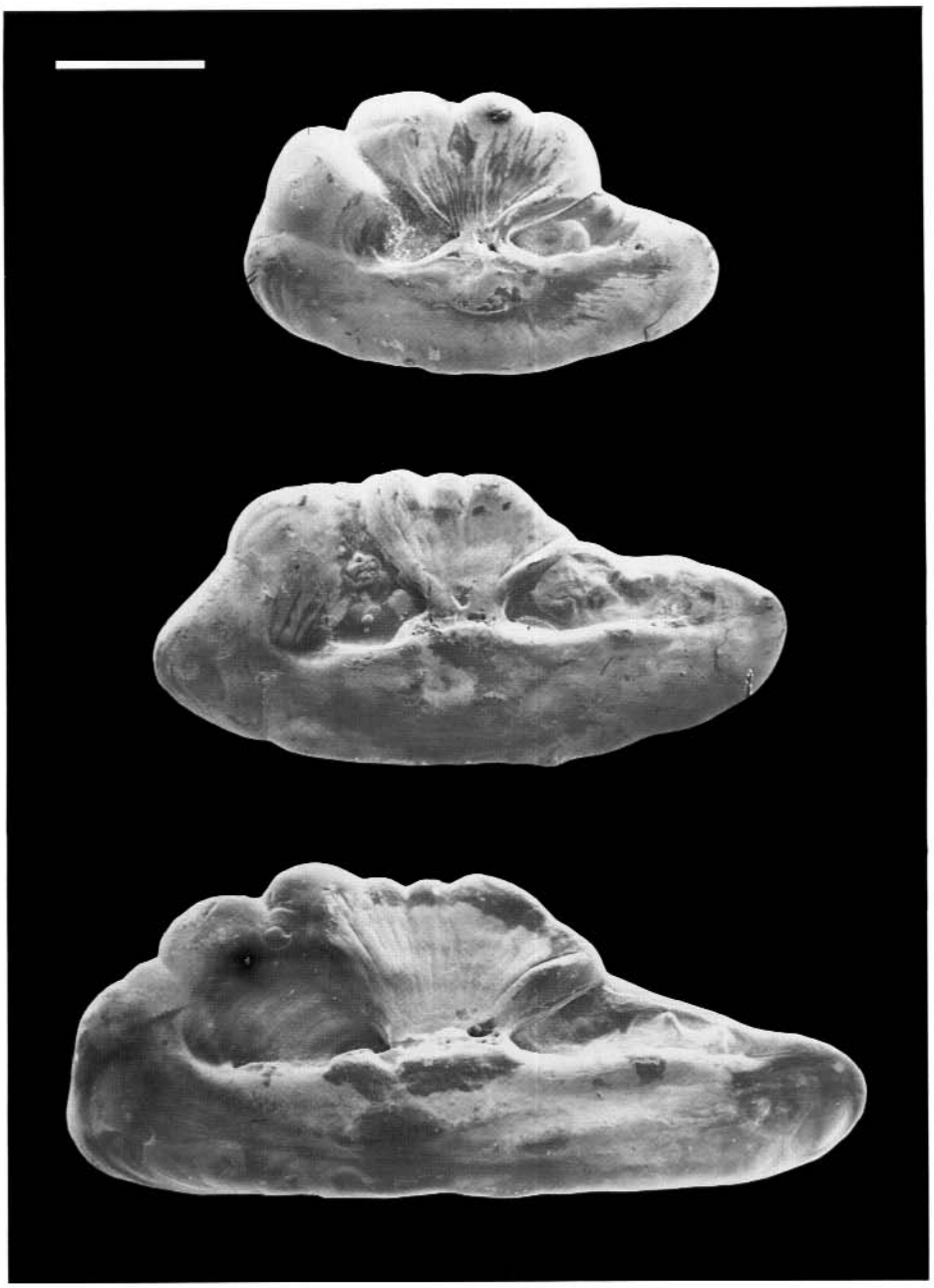

Figure 41. Otoliths of *Nototheniops mizops* from fish of standard length 105 mm (top), 141 mm and 178 mm.

Nototheniops mizops (Gunther)

Remarks

Similar to *N. acuta* in general form. See under that species for general notes. Can be differentiated from *N. acuta* by the shorter, more broadly-based posterior lobe, longer collum and wider sulcus acusticus. Larger specimens often have a characteristic bilobed dorsal margin.

Conversion factors

SL = 27.03747 OL + 11.14213	R = 0.903	n = 43
SL = 61.11118 OW + 6.299111	R = 0.777	n = 43
Mass = 1.253×10^{-6} $SL^{3.463}$	R = 0.952	n = 43
mean OL/OW = 2.186	SD = 0.144	Range = 1.690-2.456
Largest otolith size recorded (mm):	OL 6.200	OW 2.913
Size range of fish in otolith sample	105 - 177 mm SL	

Distribution

Within AAT
Shelf of Heard Island only.

Elsewhere
Shelf of Kerguelen Islands only (Fischer and Hureau 1985).

Habitat

A benthic species, common on the Heard Island shelf from 200 to 415 m depths (ANARE records), and in similar habitats elsewhere in its range (Fischer and Hureau 1985).

Known predators

A minor constituent of the diet of antarctic fur seals at Heard Island (Green et al. 1989) and common in the diet of Heard Island cormorants (Green et al. 1990).

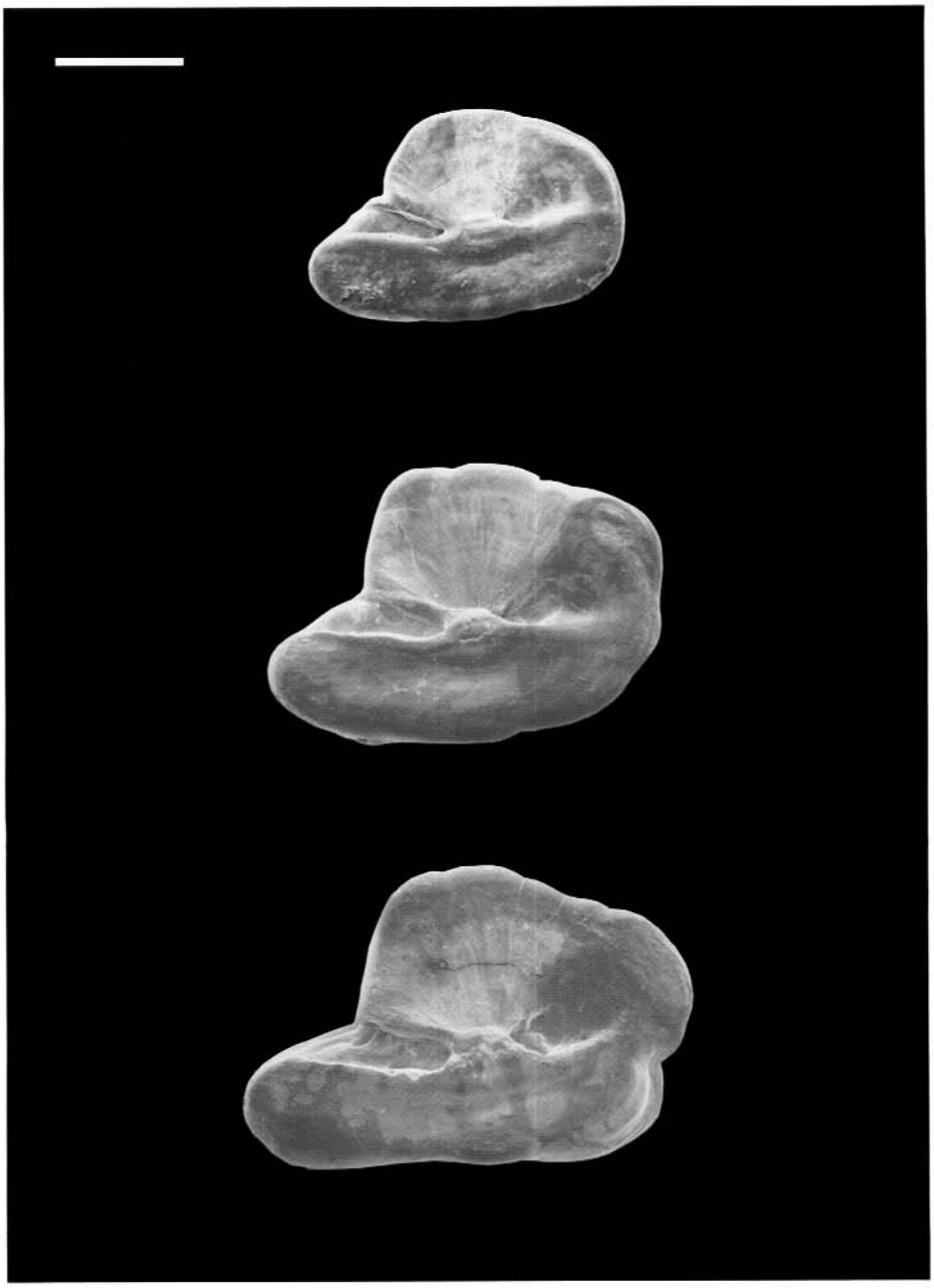

Figure 42a. Otoliths of *Pagothenia bernacchii* from fish of standard length 91 mm (top), 126 mm and 141 mm.

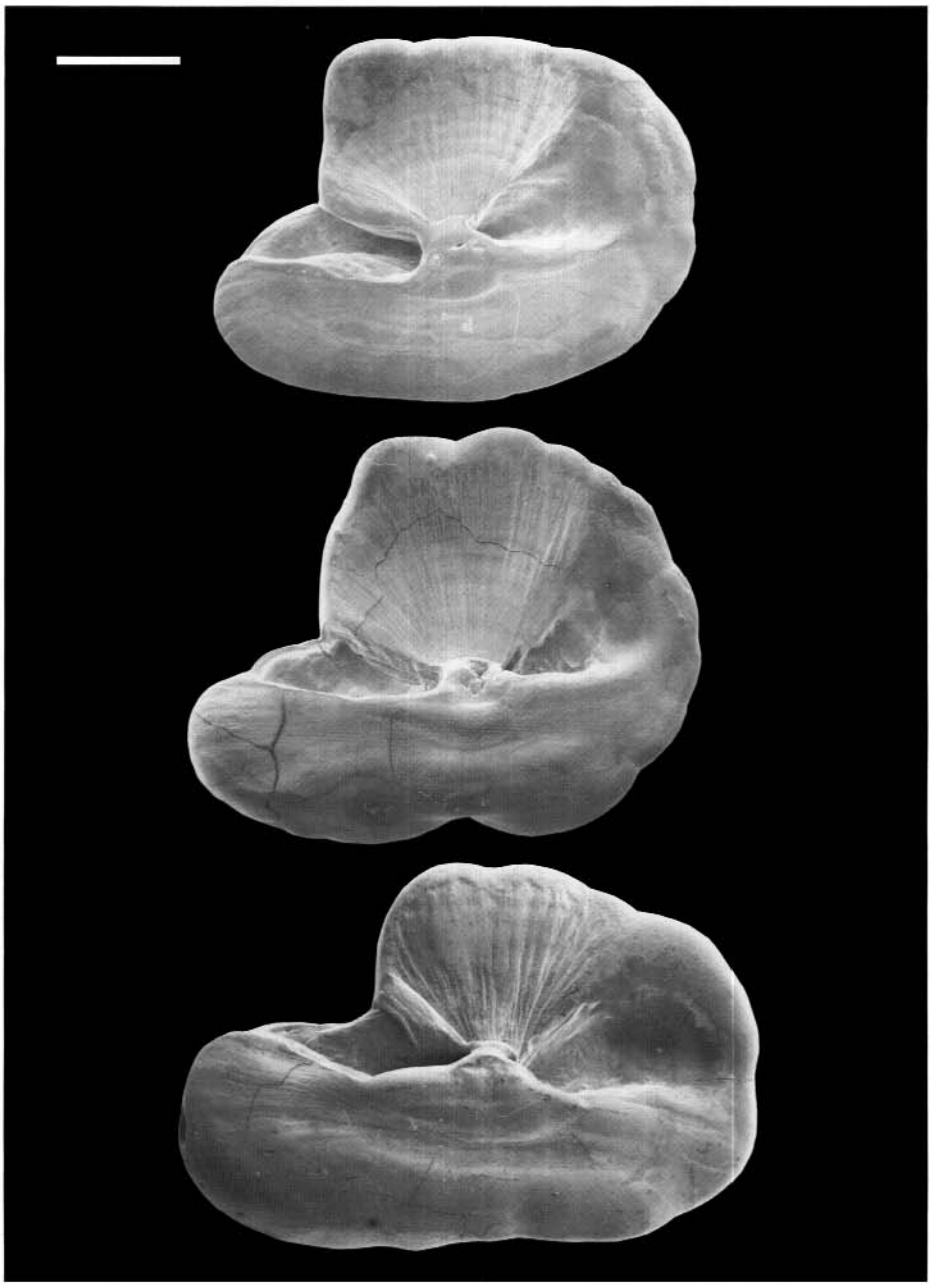

Figure 42b. Otoliths of *Pagothenia bernacchii* from fish of standard length 186 mm (top), 210 mm and 286 mm.

Pagothenia bernacchii (Boulenger)

Remarks

Otoliths of most species of *Aethotaxis, Pagothenia* and *Trematomus* are very alike in having a well-developed short broad rostrum, well-developed ostium and cauda separated by a fairly wide collum overlain by an isthmus formed by the cristae, and a generally quadrate shape with little ornamentation. Within this group, *P. bernacchii* can be identified by the long broad rostrum, more or less rectangular dorsal part and excisura ostii angle of about 90°. The crista inferior is particularly well developed. The size of the otoliths in this species is variable in relation to fish size, as evinced by the rather low value of R given the large number of specimens measured.

Conversion factors

SL = 45.24226 OL - 17.0435	R = 0.756	n = 278
SL = 59.55118 OW - 5.83741	R = 0.786	n = 278
Mass = 7.71×10^{-6} $SL^{3.119}$	R = 0.978	n = 1283
mean OL/OW = 1.412	SD = 0.124	Range = 1.166-3.825

Largest otolith size recorded (mm): OL 5.243 OW 3.825

Size range of fish in otolith sample 91 - 286 mm SL

Distribution

Within AAT

On the antarctic continental shelf throughout the region (Fischer and Hureau 1985).

Elsewhere

Circumpolar on the antarctic continental shelf, including the Antarctic Peninsula, Peter I Island and Scotia Arc (Fischer and Hureau 1985).

Habitat

The commonest inshore species, from the sublittoral to about 60 m (Williams 1988b) but commonly reaches depths of 400 m (Fischer and Hureau 1985). Lives among boulders and algae in virtually every coastal location, including fjords and bays within its range.

Known predators

Occasionally taken by emperor penguins in the Mawson area (G. Robertson, pers. comm.), Weddell seals at Davis (Green and Burton 1987), and probably at other coastal sites.

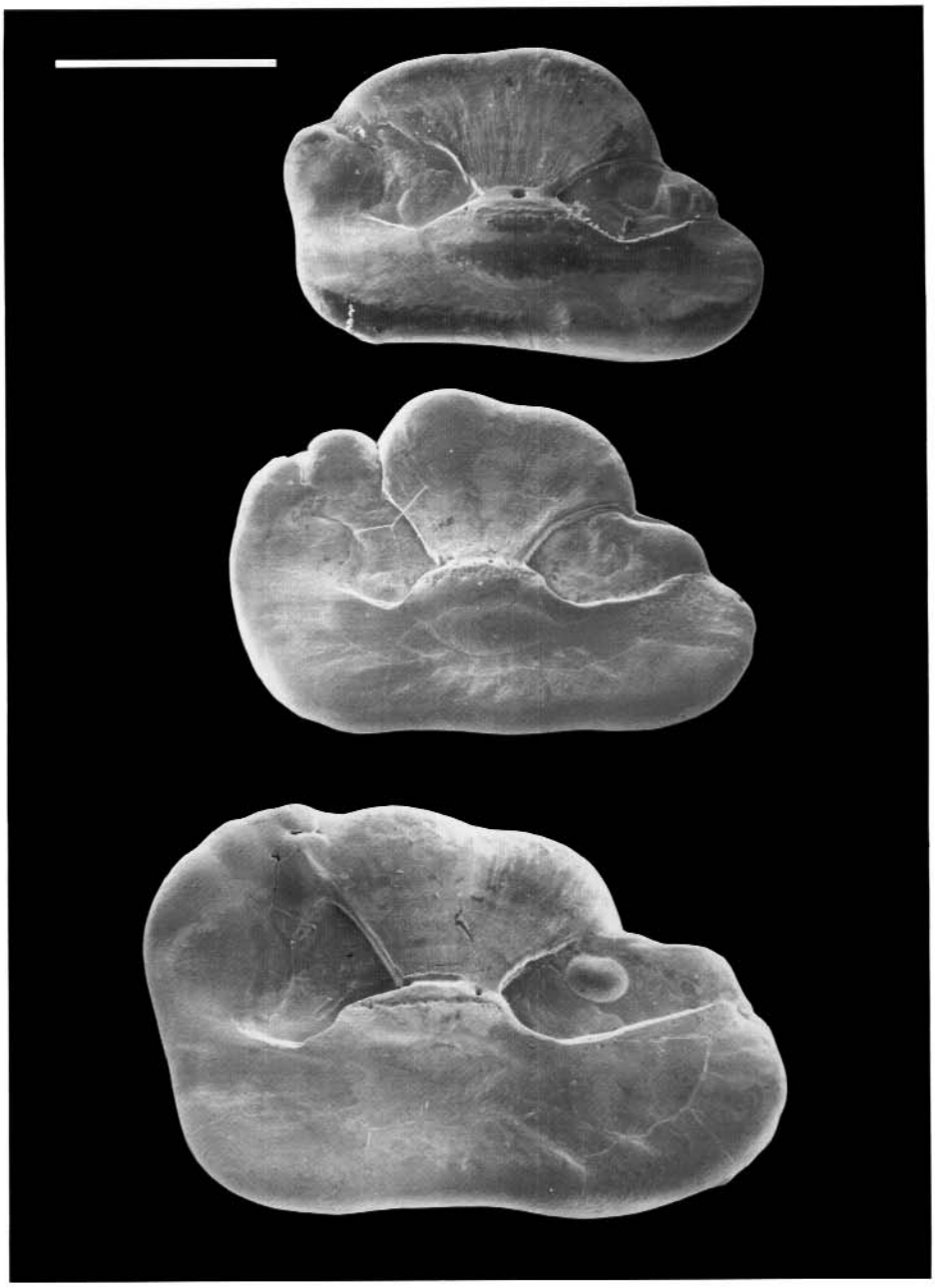

Figure 43. Otoliths of *Pagothenia borchgrevinki* from fish of standard length 151 mm (top), 164 mm and 208 mm.

Pagothenia borchgrevinki (Boulenger)

Remarks

P. borchgrevinki and *P. hansoni* are somewhat atypical of the *Pagothenia/Trematomus* group in having a poorly-developed rostrum and shallow, rather circular ostium and cauda, and with a tendency for the cristae to unite anterior to the ostium. *P. borchgrevinki* can be separated from *P. hansoni* by the wider ostium and cauda, longer collum, more prominent rostrum and higher OL:OW ratio.

Conversion factors

SL = 96.50210 OL - 84.2582	R = 0.932	n = 26
SL = 166.5863 OW - 115.064	R = 0.931	n = 26
Mass = 5.62×10^{-6} $SL^{3.212}$	R = 0.990	n = 159
mean OL/OW = 1.506	SD = 0.081	Range = 1.329-1.647
Largest otolith size recorded (mm):	OL 3.012	OW 1.829
Size range of fish in otolith sample 86 - 211 mm SL		

Distribution

Within AAT
On the antarctic continental shelf throughout the region (Fischer and Hureau 1985).

Elsewhere
Circumpolar on the antarctic continental shelf, including the Antarctic Peninsula and Scotia Arc (Fischer and Hureau 1985).

Habitat

A cryopelagic species usually associated with the under surface of the sea ice and adjacent water column, especially when young, but some individuals live near the bottom in shallow water (Williams 1988b). Not usually found deeper than 50 m. Penetrates almost to the shoreline and into fjords and semi-enclosed bays.

Known predators

Occasionally taken by emperor penguins at Amanda Bay and Mawson area (ANARE records) and Adélie Land (Offredo and Ridoux 1986).

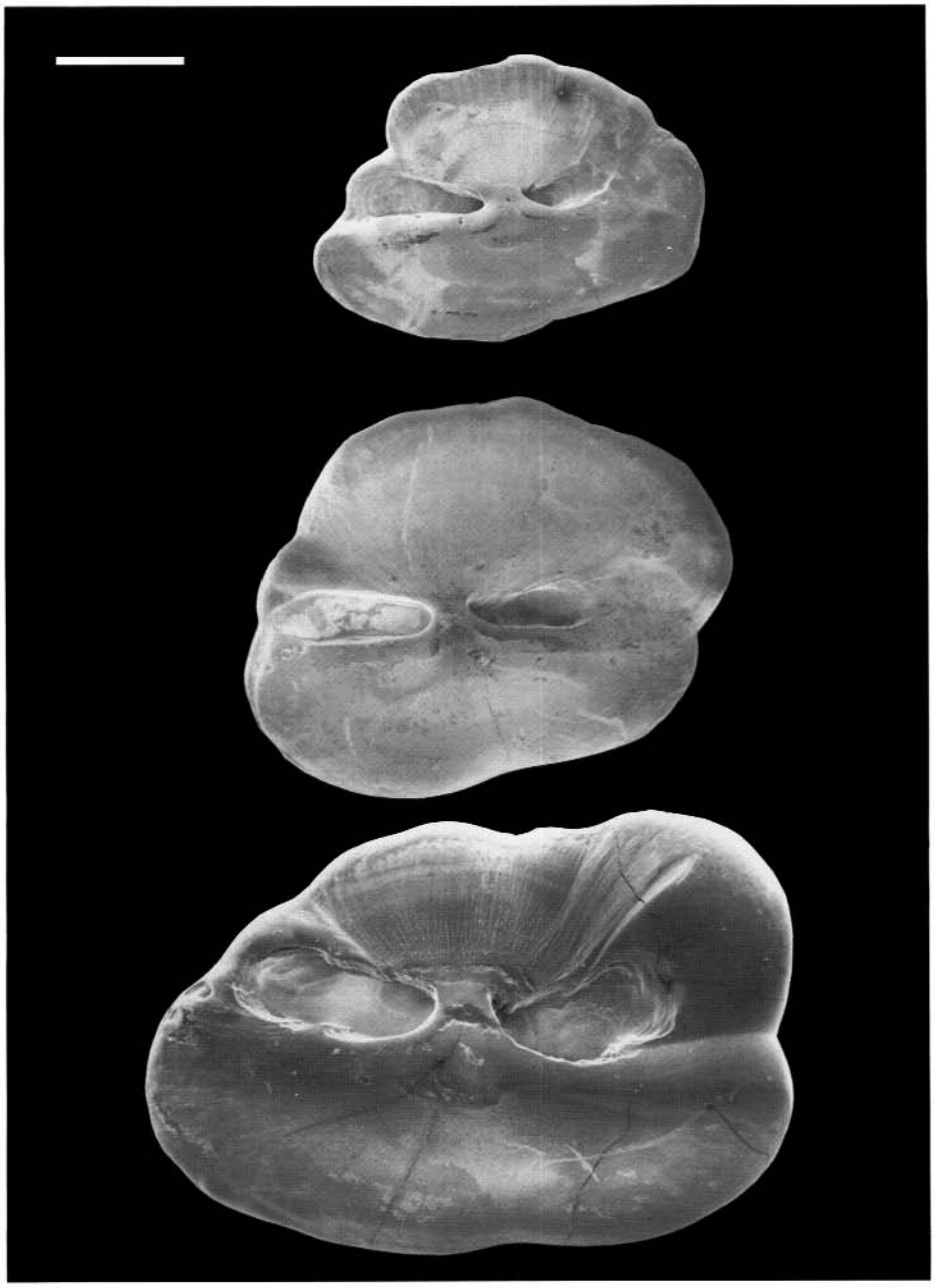

Figure 44. Otoliths of *Pagothenia hansoni* from fish of standard length 136 mm (top), 241 mm and 340 mm.

Pagothenia hansoni (Boulenger)

Remarks

P. hansoni and *P. borchgrevinki* are somewhat atypical of the *Pagothenia/Trematomus* group in having a poorly-developed rostrum and shallow, rather circular ostium and cauda, and with a tendency for the cristae to unite anterior to the ostium. *P. hansoni* can be separated from *P. borchgrevinki* by the narrower ostium and cauda, shorter collum, less prominent rostrum and lower OL:OW ratio.

Conversion factors

SL = 52.82707 OL - 19.7430	R = 0.740	n = 105
SL = 85.57609 OW - 62.2665	R = 0.788	n = 105
Mass = 4.86×10^{-6} $SL^{3.250}$	R = 0.969	n = 331
mean OL/OW = 1.372	SD = 0.111	Range = 1.084-1.678

Largest otolith size recorded (mm): OL 5.604 OW 4.428

Size range of fish in otolith sample 136 - 340 mm SL

Distribution

Within AAT

On the antarctic continental shelf throughout the region (Fischer and Hureau 1985).

Elsewhere

Circumpolar on the antarctic continental shelf, including the Antarctic Peninsula, Scotia Arc and South Georgia (Fischer and Hureau 1985).

Habitat

A benthic species common in nearshore waters, especially those between 20 and 100 m (Williams 1988b). Elsewhere in Prydz Bay it is occasionally found in depths to 475 m in the shallower areas to the NE and NW of the bay. A similar distribution has been observed in other parts of its range (Fischer and Hureau 1985, DeWitt 1971).

Known predators

Occasionally taken by emperor penguins in the Mawson area (G. Robertson, pers. comm.), Weddell seals in the Davis area (Green and Burton 1987), and antarctic fur seals at S Georgia (North et al. 1983).

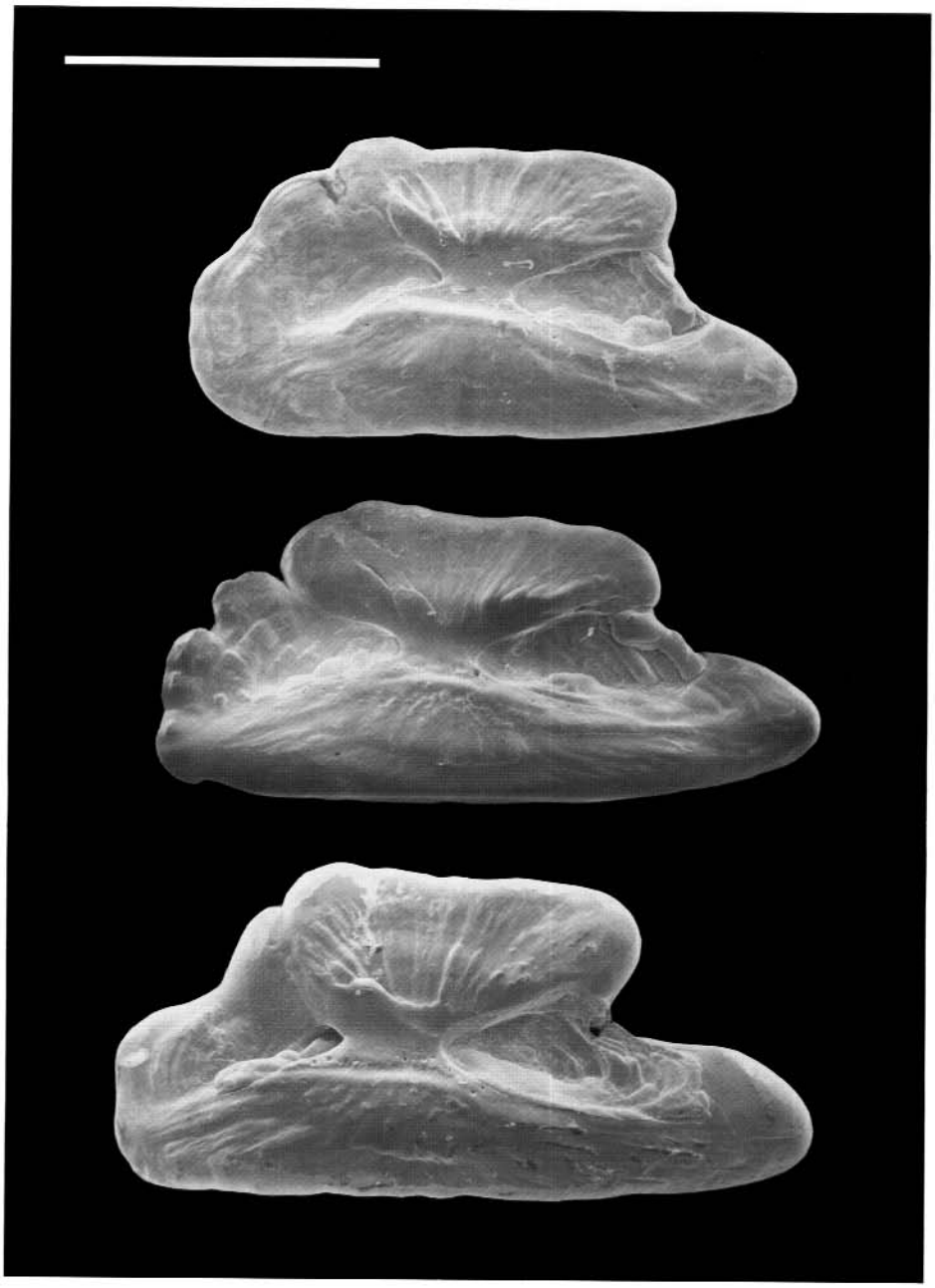

Figure 45. Otoliths of *Paranotothenia magellanica* from fish of standard length 120 mm (top), 131 mm and 147 mm.

Paranotothenia magellanica (Forster)

Remarks

Another of the small, rectangular group of nototheniid otoliths (see under *N. coriiceps* for details). *P. magellanica can* be identified from the other members of the group by the lack of sculpturing on most margins, the relatively shallow and wide sulcus acusticus, the posterior lobe and high OL:OW ratio.

Conversion factors

SL	Mass	Otolith mean length	Otolith mean widthh	Otolith mean length/width
86		1.30	0.70	1.857
120	46.6	2.412	1.125	2.144
121	44.92	2.281	1.153	1.978
123		2.50	1.225	2.041
167	123.56	2.614	1.231	2.123
180		2.25	1.10	2.045

Distribution

Within AAT
Vicinity of Heard and Macquarie Islands only.

Elsewhere
Circumglobal on shelves around all subantarctic islands, as well as New Zealand (South Island) and Patagonia (Fischer and Hureau 1985).

Habitat

One of the commonest inshore fish, especially at Macquarie Island, from the sublittoral to 255 m depth (Fischer and Hureau 1985, Williams 1988a). Juvenile stages are pelagic, which may explain its wide distribution, and adults are bentho-pelagic.

Known predators

Small specimens are the major component of the diet of Macquarie Island cormorants (Brothers 1985, Green et al. 1990), but a minor component in the Heard Island cormorant (Green et al. 1990). It occurs rarely in the diet of New Zealand fur seals (*Arctocephalus forsteri*) (Green et al. 1990), rockhopper, royal and gentoo penguins (Williams 1989) at Macquarie Island and gentoo penguins at Marion Island (LaCock et al. 1984).

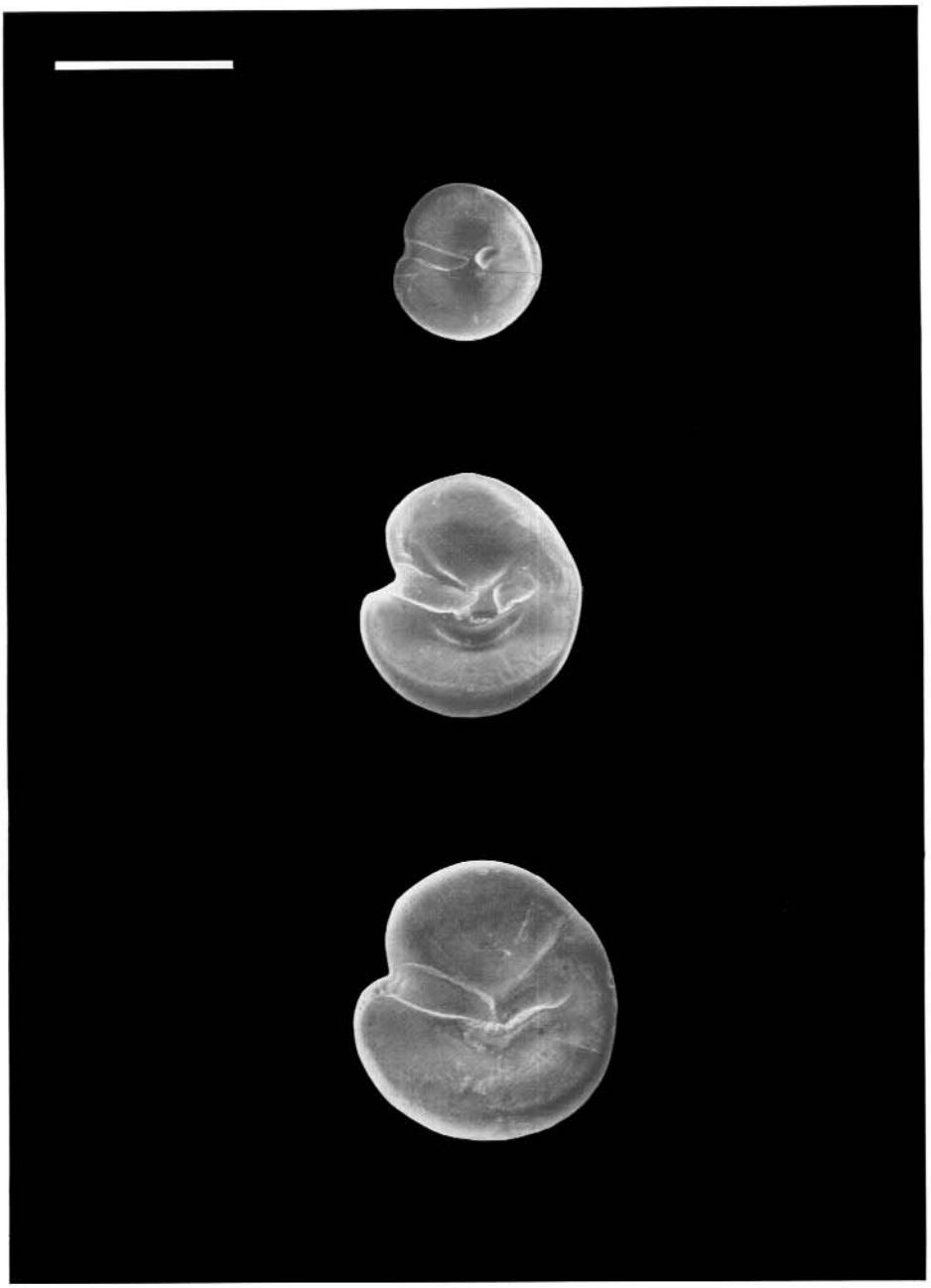

Figure 46a. Otoliths of *Pleuragramma antarcticum* from fish of standard length 80 mm (top), 110 mm and 150 mm.

Paranotothenia magellanica (Forster)

Remarks

Another of the small, rectangular group of notothenid otoliths (see under *N. coriiceps* for details). *P. magellanica can* be identified from the other members of the group by the lack of sculpturing on most margins, the relatively shallow and wide sulcus acusticus, the posterior lobe and high OL:OW ratio.

Conversion factors

SL	Mass	Otolith mean length	Otolith mean widthh	Otolith mean length/width
86		1.30	0.70	1.857
120	46.6	2.412	1.125	2.144
121	44.92	2.281	1.153	1.978
123		2.50	1.225	2.041
167	123.56	2.614	1.231	2.123
180		2.25	1.10	2.045

Distribution

Within AAT
Vicinity of Heard and Macquarie Islands only.

Elsewhere
Circumglobal on shelves around all subantarctic islands, as well as New Zealand (South Island) and Patagonia (Fischer and Hureau 1985).

Habitat

One of the commonest inshore fish, especially at Macquarie Island, from the sublittoral to 255 m depth (Fischer and Hureau 1985, Williams 1988a). Juvenile stages are pelagic, which may explain its wide distribution, and adults are bentho-pelagic.

Known predators

Small specimens are the major component of the diet of Macquarie Island cormorants (Brothers 1985, Green et al. 1990), but a minor component in the Heard Island cormorant (Green et al. 1990). It occurs rarely in the diet of New Zealand fur seals (*Arctocephalus forsteri*) (Green et al. 1990), rockhopper, royal and gentoo penguins (Williams 1989) at Macquarie Island and gentoo penguins at Marion Island (LaCock et al. 1984).

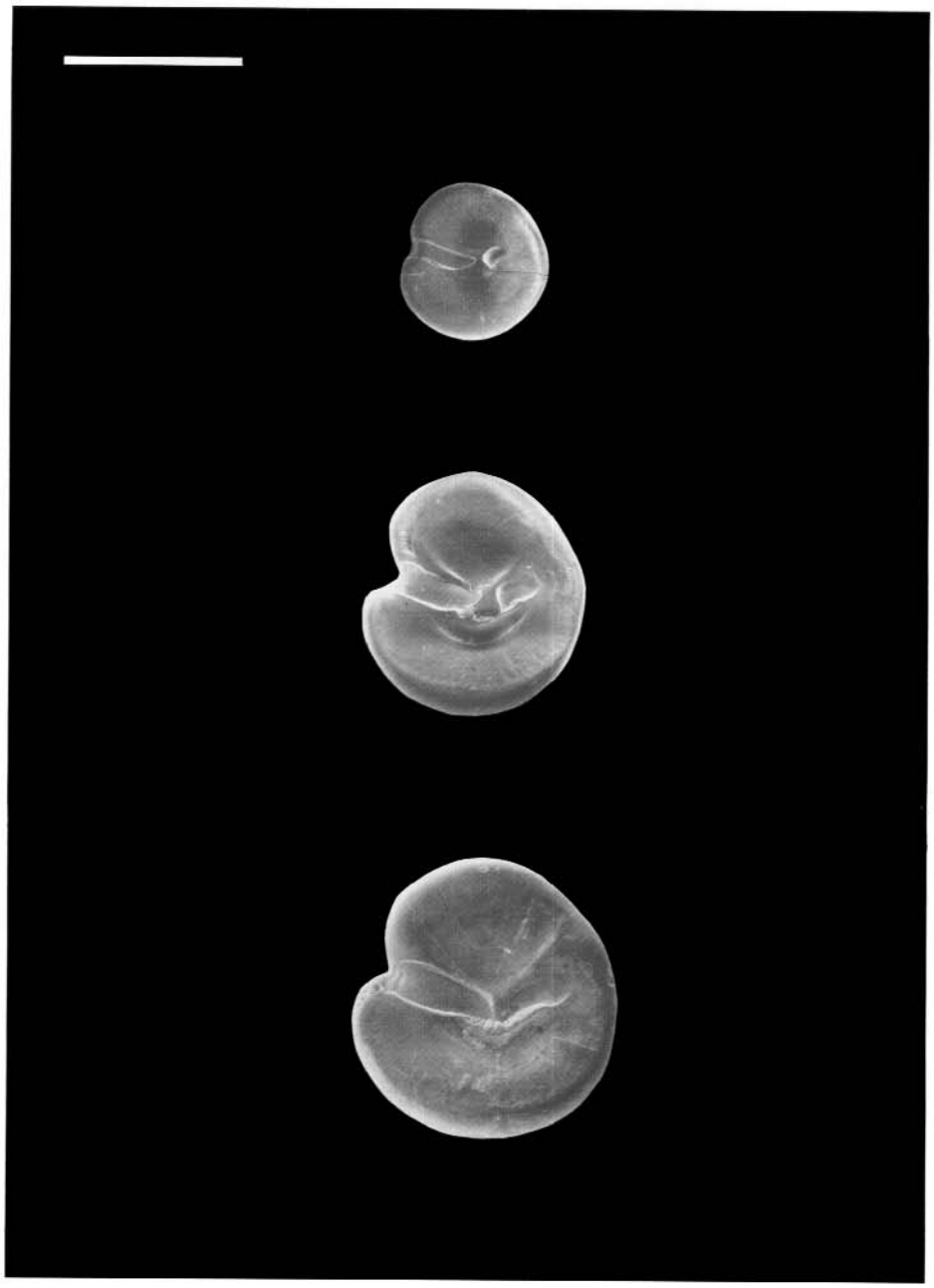

Figure 46a. Otoliths of *Pleuragramma antarcticum* from fish of standard length 80 mm (top), 110 mm and 150 mm.

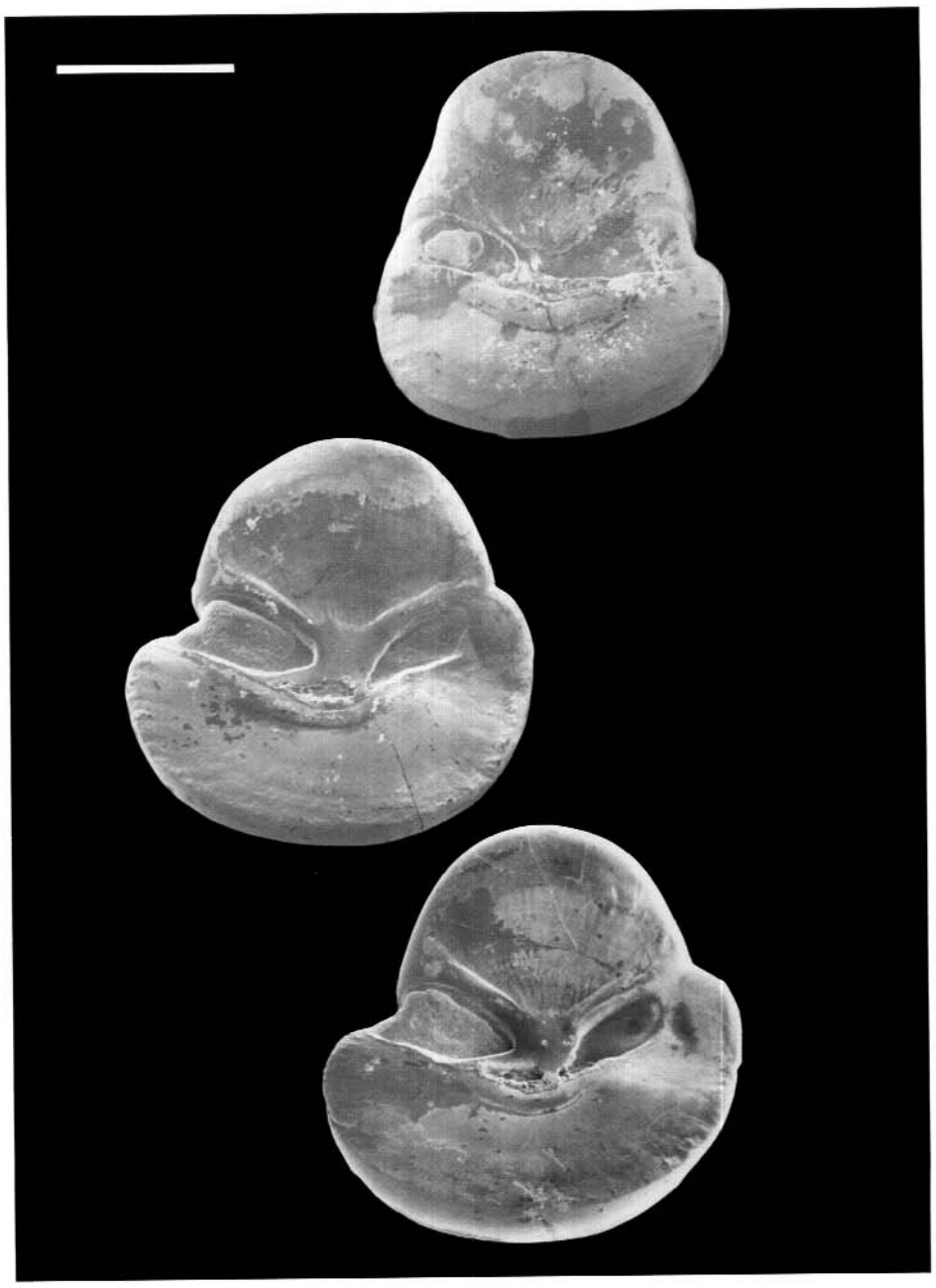

Figure 46b. Otoliths of *Pleuragramma antarcticum* from fish of standard length 204 mm (top), 231 mm and 260 mm.

Pleuragramma antarcticum Boulenger

Remarks

A very characteristic otolith, unlikely to be confused with anything else. The inverted 'map of Africa' shape is characteristic, although aberrant shapes are found. In some specimens the posterior lobe is almost the same size as the rostrum, and the width of the ventral part can vary considerably. Viewed side-on, the otolith is distinctly concavo-convex and the crista inferior is very prominent.

Conversion factors

SL = 76.67621 OL +.17.05014	R = 0.868	n = 766
SL = 69.21882 OW + 15.81990	R = 0.906	n = 759
Mass = 2.71×10^{-6} $SL^{3.200}$	R = 0.992	n = 1297
mean OL/OW = 0.896	SD = 0.064	Range = 0.617-1.313

Largest otolith size recorded (mm): OL 2.469 OW 2.431

Size range of fish in otolith sample 79 - 260 mm SL

Distribution

Within AAT

On the antarctic continental shelf throughout the region (Fischer and Hureau 1985).

Elsewhere

Circumpolar on and near to the antarctic continental shelf, including the Antarctic Peninsula, S Orkney and S Shetland Islands (Fischer and Hureau 1985).

Habitat

The only entirely pelagic nototheniid, it is usually abundant over the continental shelf, especially in the higher latitudes where it is sometimes virtually the only fish caught. Larvae and juveniles tend to occur in the top 100 m of water over the shelf and in oceanic waters, whereas the adults tend to occur near the bottom over the shelf (Hubold and Ekau 1987, ANARE records). In Prydz Bay this species is ubiquitous over the shelf area in depths from the surface to 800 m. Some larvae and juveniles are found in oceanic waters beyond the shelf.

Known predators

A major constituent of the diet of virtually every large predator feeding over the continental shelf of East Antarctica, including emperor penguins from Prydz Bay (Gales et al. 1990), Mawson area (G. Robertson, pers. comm.), Adélie Land (Offredo and Ridoux 1986) and Weddell Sea (Klages 1989); Adélie penguins, antarctic fulmars, antarctic petrels and cape petrels in Prydz Bay (Williams 1989) and Casey vicinity (J. van Franeker, pers. comm.); Weddell seals in Prydz Bay (Green and Burton 1987) and Weddell Sea (Plotz 1986); and leopard and crabeater seals from Prydz Bay (Green and Williams 1986), and from off the Eastern Sector (Vagin and Shust 1989).

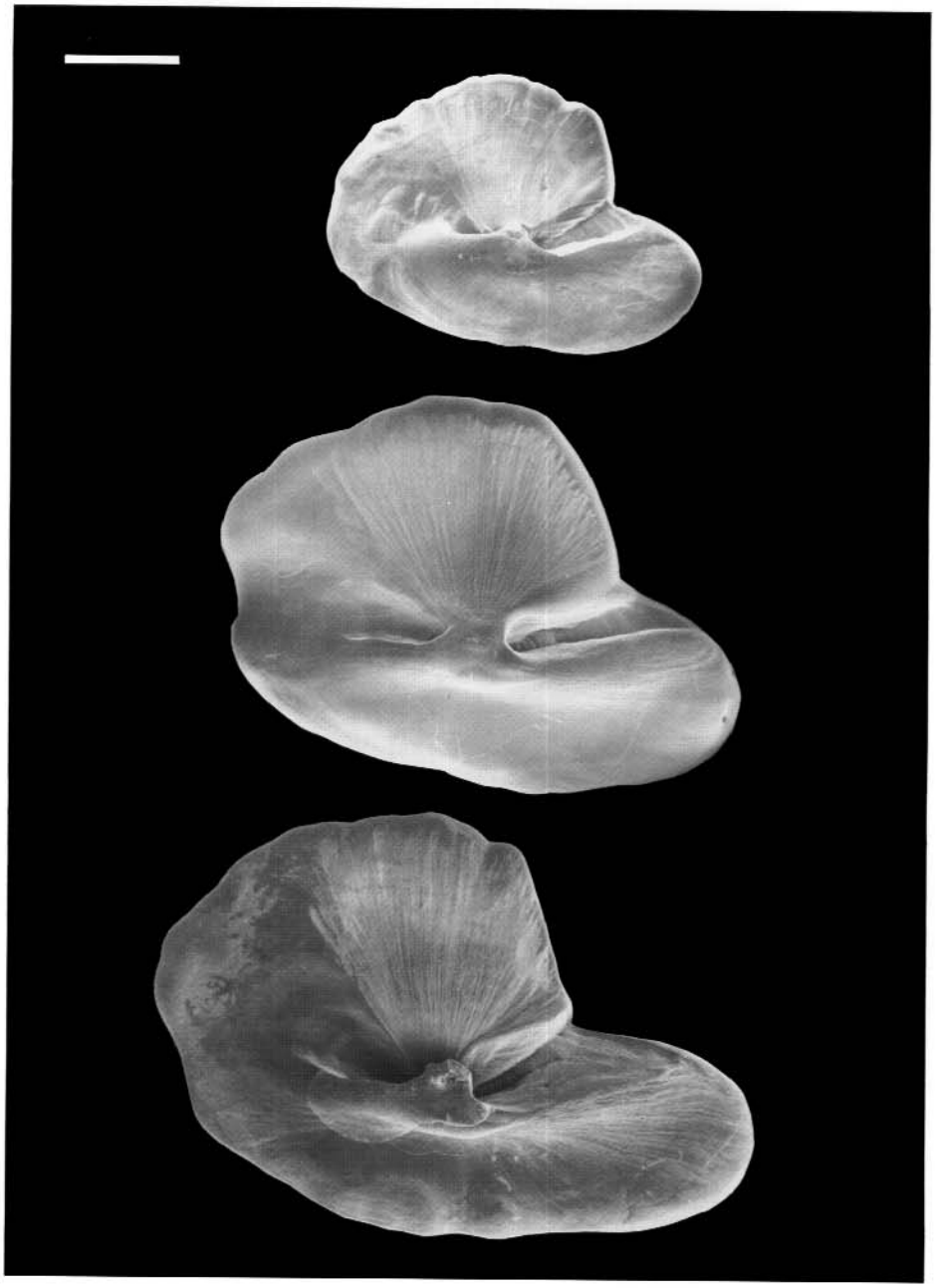

Figure 47. Otoliths of *Trematomus centronotus* from fish of standard length 126 mm (top), 193 mm and 238 mm.

Trematomus centronotus Regan

Remarks

One of the classic *Pagothenia/Trematomus* group of otoliths. See under *P. bernacchii* for details. *T. centronotus* can be identified by the combination of long, narrow rostrum, narrow sulcus acusticus with a short collum, slightly obtuse excisura ostii and wide, squarish dorsal part.

Conversion factors

SL = 41.11492 OL - 28.9586	R = 0.880	n = 23
SL = 43.54976 OW + 24.25075	R = 0.854	n = 23
Mass = 6.34×10^{-6} $SL^{3.220}$	R = 0.985	n = 24
mean OL/OW = 1.470	SD = 250	Range = 1.302-2.567
Largest otolith size recorded (mm):	OL 6.205	OW 4.357

Size range of fish in otolith sample 105 - 238 mm SL

Distribution

Within AAT
On the antarctic continental shelf throughout the region (DeWitt 1971).

Elsewhere
Continental shelf of East Antarctica, including the Ross Sea (DeWitt 1971).

Habitat

A widespread but not common benthic species, from inshore to depths of 680 m. In Prydz Bay it occurs inshore near Davis in depths to 90 m, and on the relatively shallow banks in the NE and NW of the bay in depths of 117 to 312 m.

Known predators

Occasionally taken by Weddell seals in the Davis area (Green and Burton 1987).

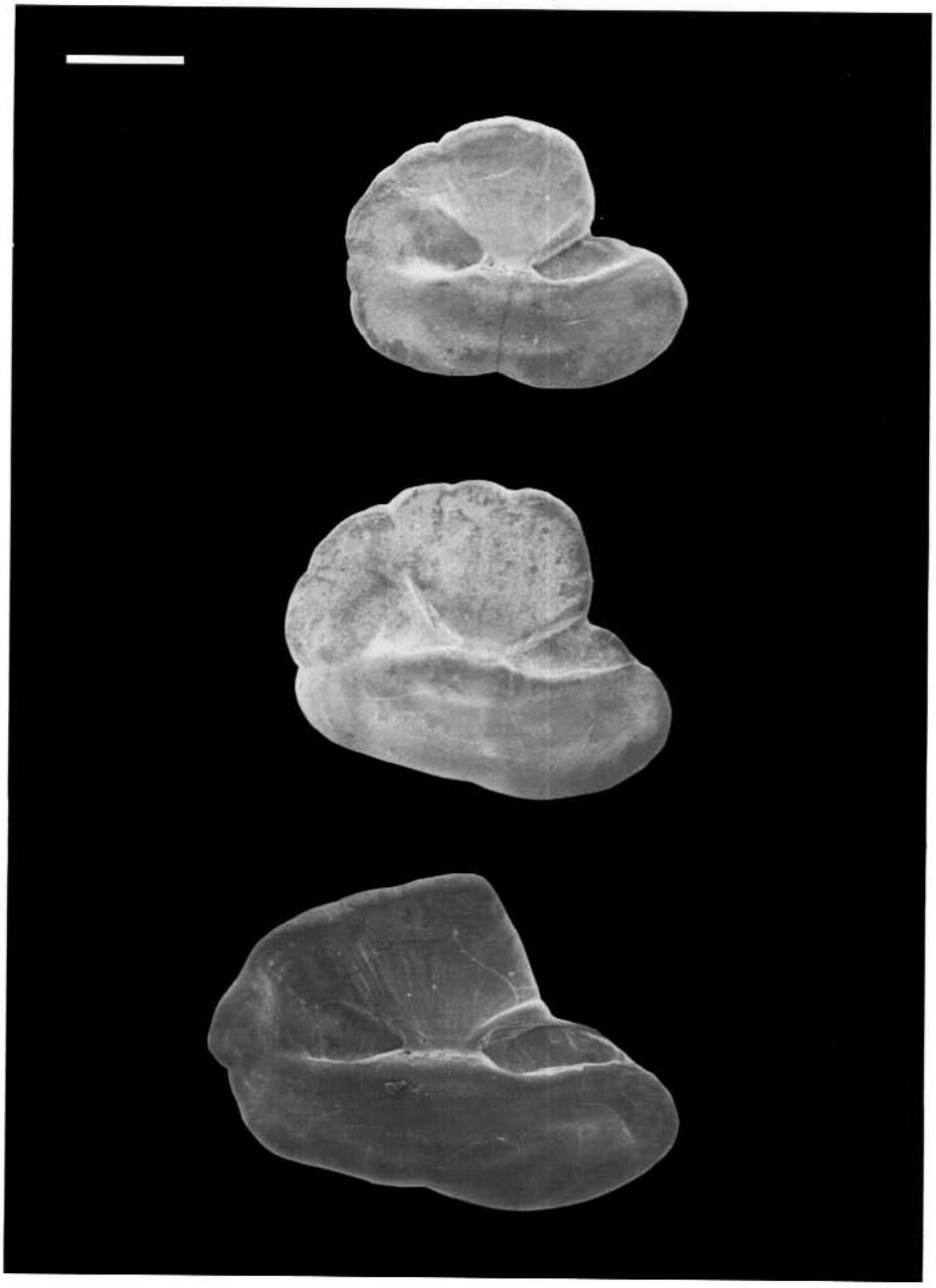

Figure 48a. Otoliths of *Trematomus eulepidotus* from fish of standard length 154 mm (top), 178 mm and 215 mm.

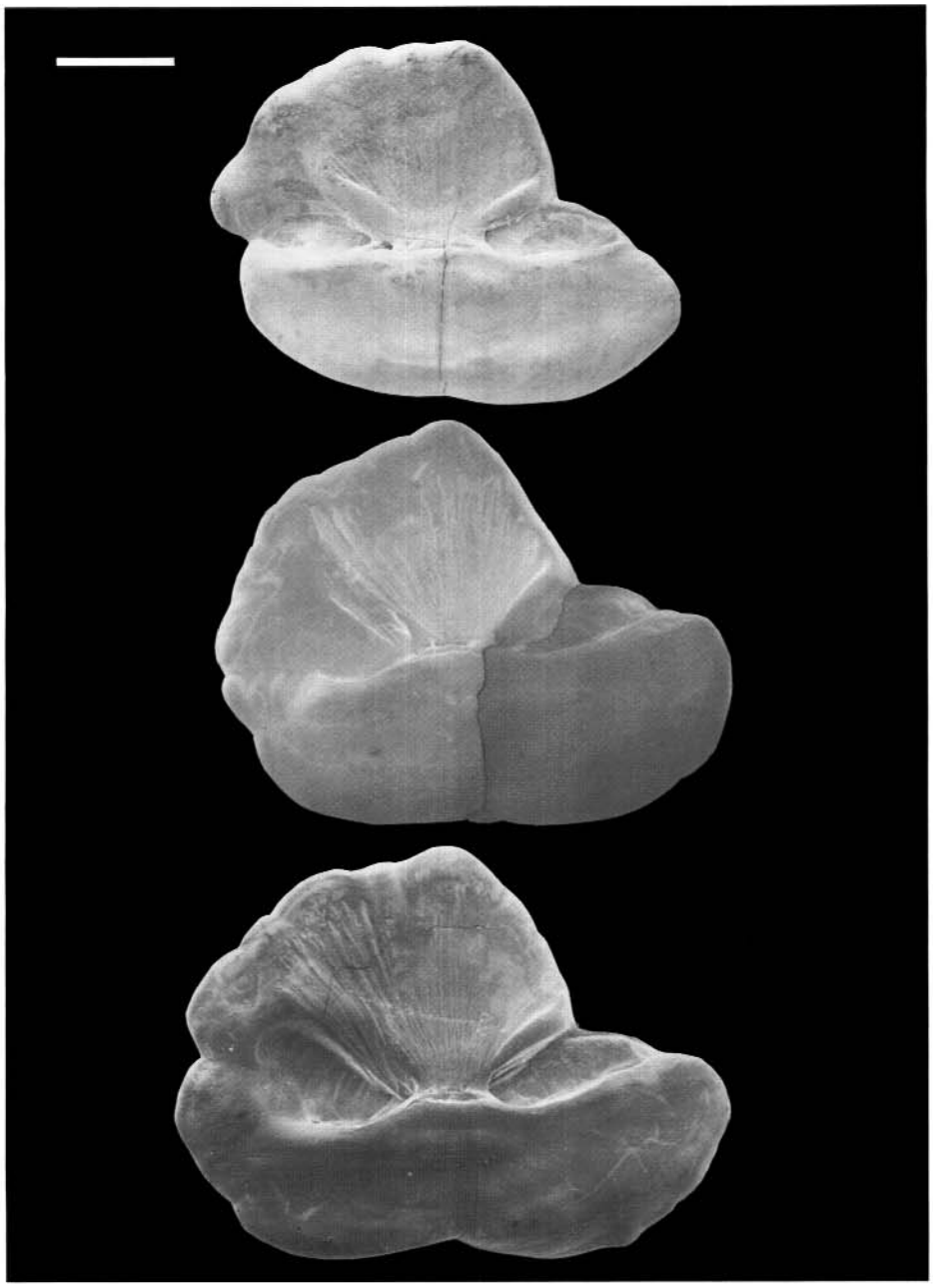

Figure 48b. Otoliths of *Trematomus eulepidotus* from fish of standard length 238 mm (top), 266 mm and 272 mm.

Trematomus eulepidotus Regan

Remarks

One of the classic *Pagothenia/Trematomus* group of otoliths. See under *P. bernacchii* for details. *T. eulepidotus* can be identified by the combination of short, wide angular rostrum, large triangular cauda and long collum, prominent crista superior (especially over the ostium), rounded triangular dorsal part and oblique excisura ostii.

Conversion factors

SL = 41.94812 OL + 36.65645	R = 0.753	n = 182
SL = 71.48074 OW - 14.8643	R = 0.751	n = 182
Mass = 9.03×10^{-7} $SL^{3.583}$	R = 0.970	n = 200
mean OL/OW = 1.286	SD = 0.150	Range = 0.793-2.421

Largest otolith size recorded (mm): OL 5.856 OW 3.924

Size range of fish in otolith sample 105 - 351 mm SL

Distribution

Within AAT

On the antarctic continental shelf throughout the region (DeWitt 1971).

Elsewhere

Circumpolar on the antarctic continental shelf, including S Shetland and S Orkney Islands (DeWitt 1971).

Habitat

A widespread and common benthic species, from nearshore to depths of 700 m, but more common in shallower areas between 100 and 500 m depth. In Prydz Bay it occurs most commonly in the shallowest areas in the NE and NW of the bay and west of Cape Darnley, in depths of 120 to 470 m. This species feeds heavily on krill, and thus must spend considerable time in the top 200 m of the water column (Schwarzbach 1988, ANARE records).

Known predators

An important part of the diet of emperor penguins in the Mawson area, less so at Amanda Rookery in Prydz Bay (ANARE records). Also recorded commonly from Weddell seals in the Weddell Sea (Plotz and Ekau in press).

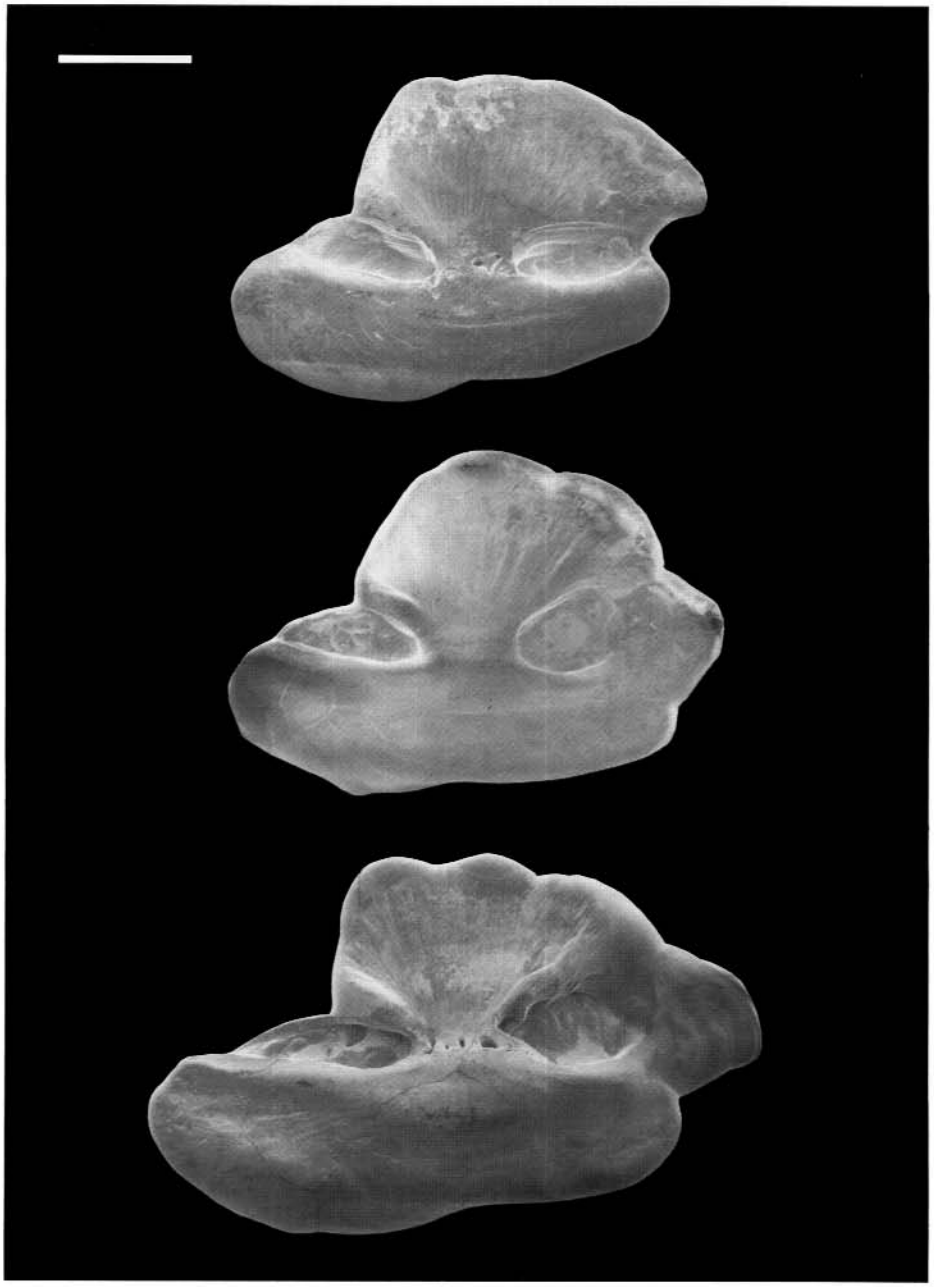

Figure 49. Otoliths of *Trematomus lepidorhinus* from fish of standard length 127 mm (top), 172 mm and 225 mm.

Trematomus lepidorhinus Pappenheim

Remarks

One of the classic *Pagothenia/Trematomus* group of otoliths. See under *P. bernacchii* for details. *T. lepidorhinus* can be identified by the combination of prominent lobe on the postero-dorsal margin, very long collum and short, rounded rostrum.

Conversion factors

SL = 46.34517 OL + 0.913925	R = 0.880	n = 36
SL = 82.41719 OW - 36.5589	R = 0.854	n = 36
Mass = 9.48×10^{-7} $SL^{3.551}$	R = 0.976	n = 42
mean OL/OW = 1.460	SD = 0.111	Range = 1.261-1.752

Largest otolith size recorded (mm): OL 4.887 OW 3.098

Size range of fish in otolith sample 106 - 225 mm SL

Distribution

Within AAT
On the antarctic continental shelf throughout the region (DeWitt 1971).

Elsewhere
Continental shelf of East Antarctica, including the Ross Sea (DeWitt 1971), and Weddell Sea (Ekau 1988).

Habitat

A widespread but not very common benthic species, from nearshore to depths of 800 m (DeWitt 1971). In Prydz Bay it is widespread, except in the inner shelf depression. Its depth range is from 117 m to 785 m from the shallow banks to the continental slope.

Known predators

A minor constituent of the diet of emperor penguins from the Mawson area (G. Robertson, pers. comm.) and Weddell Sea (Klages 1989), from Weddell seals in the Weddell Sea (Plotz and Ekau in press), and an elephant seal from off the Eastern Sector (Vagin and Shust 1989).

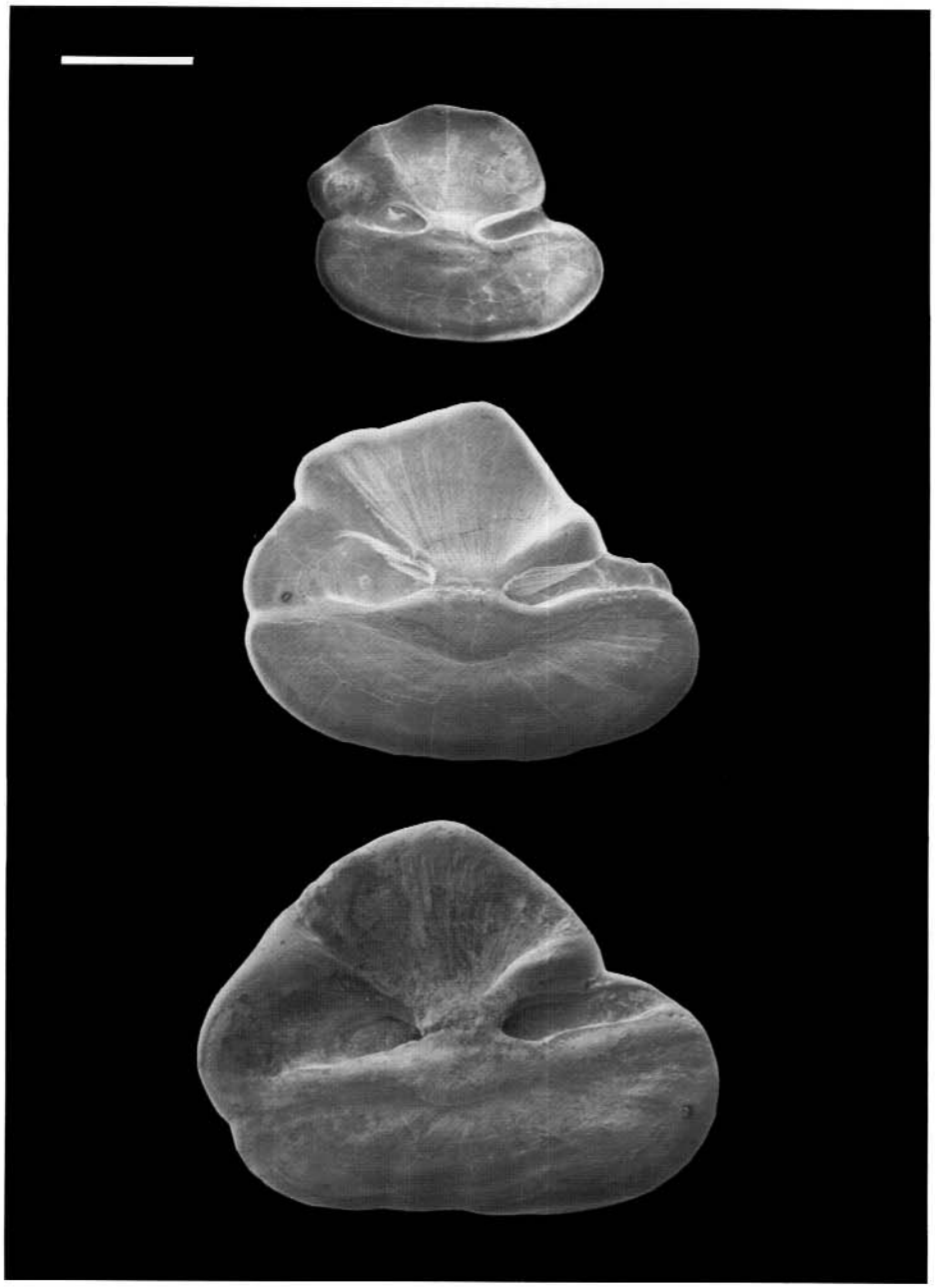

Figure 50. Otoliths of *Trematomus loennbergi* from fish of standard length 119 mm (top), 193 mm and 251 mm.

Trematomus loennbergi Regan

Remarks

One of the classic *Pagothenia/Trematomus* group of otoliths. See under *P. bernacchii* for details. *T. loennbergi* can be identified by the combination of very short, rounded rostrum, triangular dorsal part with small postero-dorsal lobe and very oblique excisura ostii.

Conversion factors

SL = 48.87498 OL + 4.405789	R = 0.935	n = 24
SL = 81.76850 OW - 40.3490	R = 0.890	n = 24
Mass = 1.42210^{-6} $SL^{3.476}$	R = 0.983	n = 34
mean OL/OW = 1.303	SD = 0.121	Range = 1.123-1.608

Largest otolith size recorded (mm): OL 4.388 OW 3.200

Size range of fish in otolith sample 119 - 226 mm SL

Distribution

Within AAT

On the antarctic continental shelf throughout the region (Fischer and Hureau 1985).

Elsewhere

Circumpolar on the antarctic continental shelf, including the Antarctic Peninsula and Balleny Islands (Fischer and Hureau 1985).

Habitat

A widespread and moderately common bentho-pelagic species in the mid-depths to deeper waters, 65 to 832 m deep. In Prydz Bay it is widespread in the middle and southern parts of the bay, including the inner shelf depression, and on the continental slope in depths of 310 to 785 m. It is rare in the shallowest waters near the shelf break and the banks to the NE and NW of the bay.

Known predators

Occasionally taken by emperor penguins in the Mawson area (G. Robertson, pers. comm.).

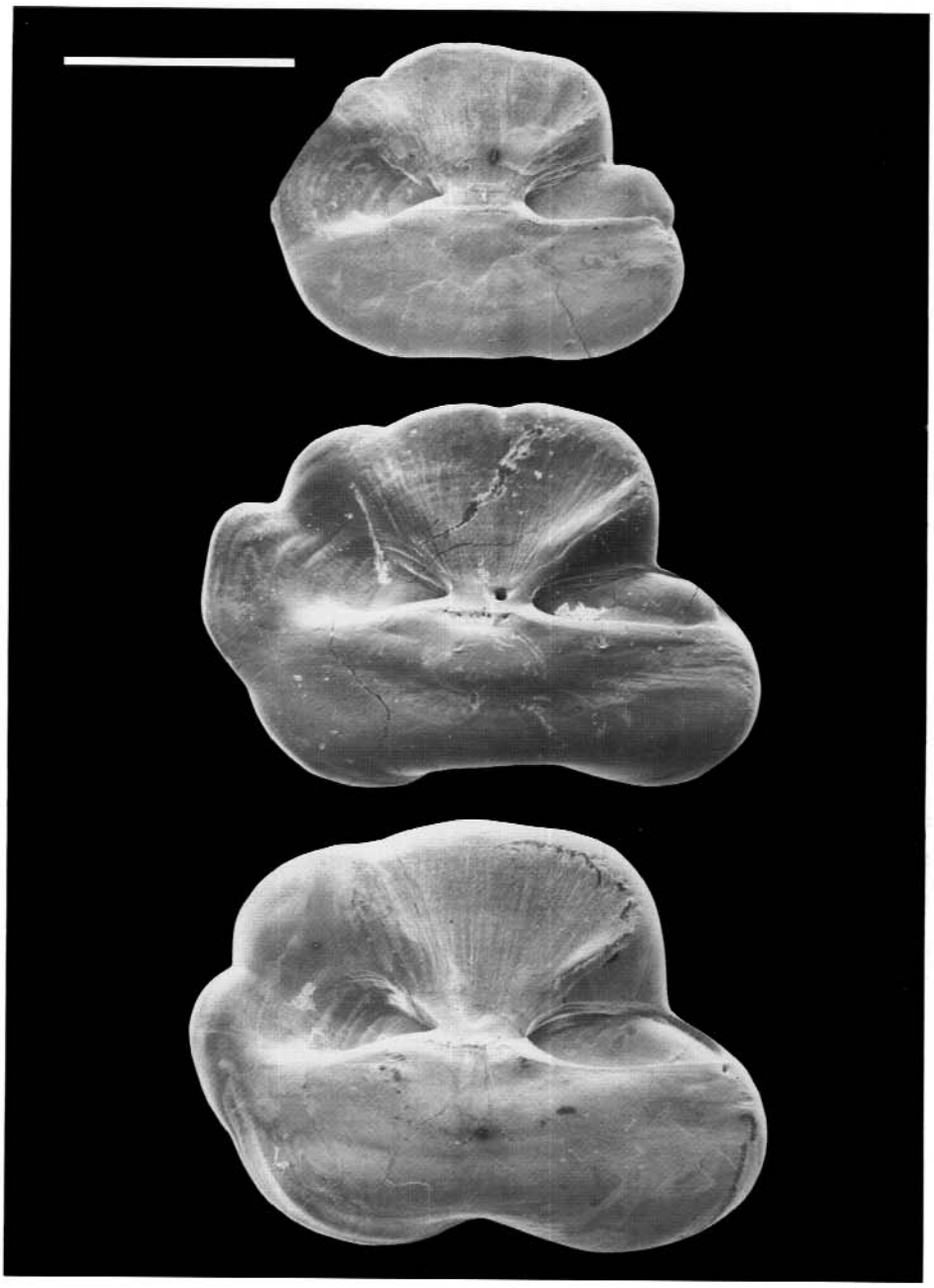

Figure 51. Otoliths of *Trematomus newnesi* from fish of standard length 127 mm (top), 165 mm and 205 mm.

Trematomus newnesi Boulenger

Remarks

One of the classic *Pagothenia/Trematomus* group of otoliths. See under *P. bernacchii* for details. *T. newnesi* can be identified by the combination of very short, blunt rostrum, long collum, lobes on the posterior, postero-ventral and antero-ventral margins, squarish dorsal part and oblique excisura ostii.

Conversion factors

SL = 58.14674 OL + 37.74691	R = 0.719	n = 45
SL = 107.9159 OW - 27.0953	R = 0.875	n = 45
Mass = 8.43×10^{-6} $SL^{3.127}$	R = 0.967	n = 239
mean OL/OW = 1.414	SD = 0.106	Range = 1.183-2.068
Largest otolith size recorded (mm):	OL 2.957	OW 2.068

Size range of fish in otolith sample 115 - 205 mm SL

Distribution

Within AAT
On the antarctic continental shelf throughout the region (Fischer and Hureau 1985).

Elsewhere
Probably circumpolar on the antarctic continental shelf, including S Shetland and S Orkney Islands (Fischer and Hureau 1985).

Habitat

A benthic species, locally very common inshore to depths of 75 m. Common at Casey and Dumont d'Urville, but much less common further west in the AAT (Hureau 1970 and ANARE records).

Known predators

The only positive observation is from Adélie penguins from Adélie Land (Ridoux and Offredo 1989), but being a small inshore species, it is a prime candidate for the diet of larger predators such as Weddell seals and emperor penguins, and many unidentified nototheniids reported in the diets of predators may well belong to this species.

Figure 52. Otoliths of *Trematomus nicolai* from fish of standard length 122 mm (top), 218 mm and 306 mm.

Trematomus nicolai Boulenger

Remarks

One of the classic *Pagothenia/Trematomus* group of otoliths. See under *P. bernacchii* for details. *T. nicolai* can be identified by the combination of short, blunt rostrum, short collum and narrow sulcus acusticus, very wide squarish dorsal part, margins without prominent lobes and oblique excisura ostii.

Conversion factors

SL = 54.99567 OL - 33.3770	R = 0.852	n = 60
SL = 73.19373 OW - 62.8714	R = 0.933	n = 60
Mass = 1.35×10^{-5} $SL^{3.071}$	R = 0.992	n = 75
mean OL/OW = 1.182	SD = 0.065	Range = 0.995-1.294
Largest otolith size recorded (mm):	OL 5.803	OW 4.601

Size range of fish in otolith sample 122 - 282 mm SL

Distribution

Within AAT
On the antarctic continental shelf, probably throughout the AAT, although much commoner in the eastern part. Common at Casey (ANARE records), otherwise the only positive record is a single specimen from Prydz Bay.

Elsewhere
Probably circum-antarctic on the continental shelf. Positive records for the Ross Sea (DeWitt 1971), Weddell Sea (Ekau 1988) and Dumont d'Urville (Hureau 1970).

Habitat

A benthic species, locally very common inshore to depths of 100 m (ANARE records). The occurrence in Prydz Bay, however, was from near the shelf break in depth of 508 m.

Known predators

A Weddell seal off the Eastern Sector has been observed with 19 kg of fish, probably *T. nicolai* up to 190 mm long in its stomach (Vagin and Shust 1989). Also observed occasionally in Weddell seals in the Weddell Sea (Plotz and Ekau in press).

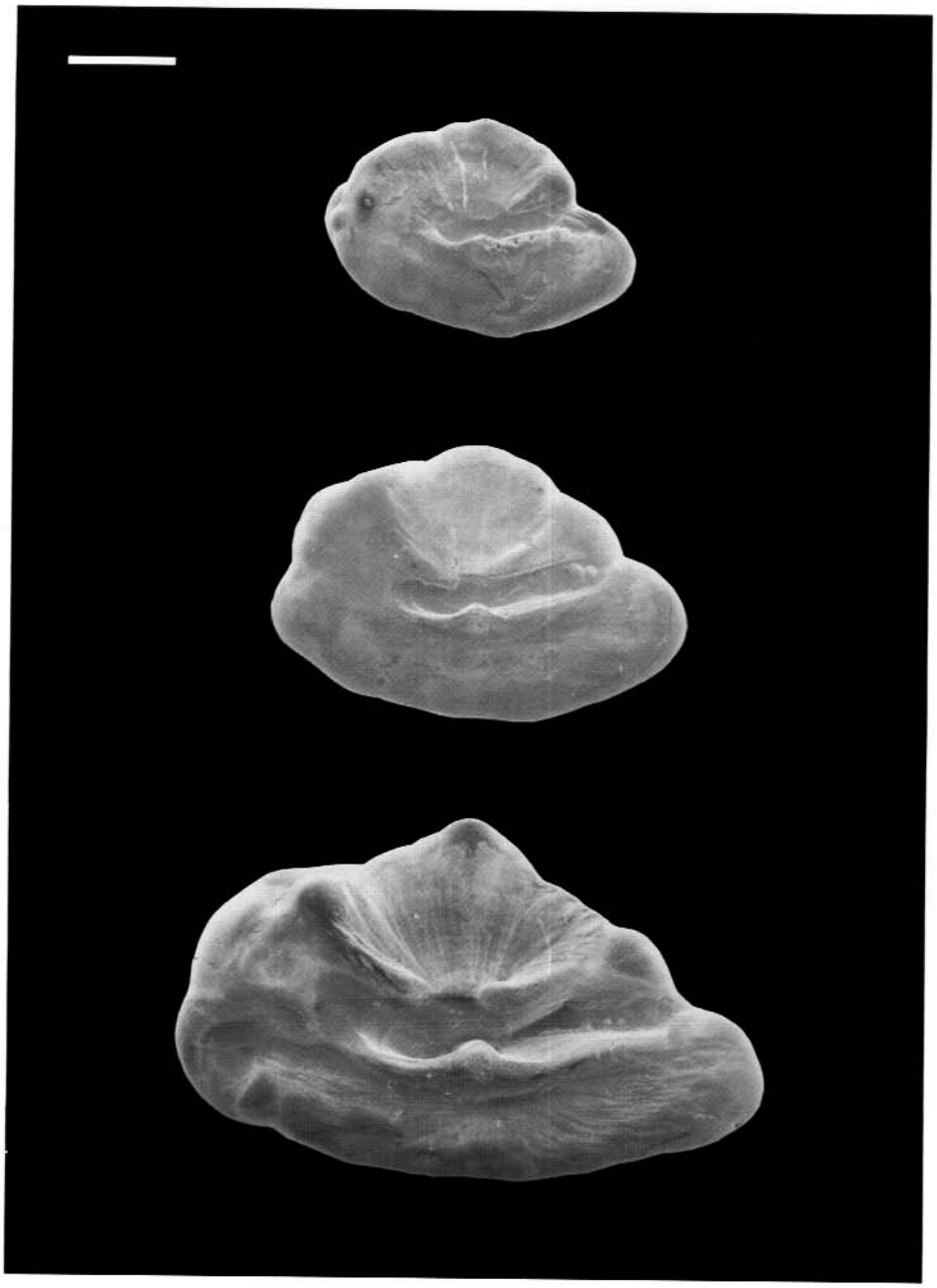

Figure 53. Otoliths of *Trematomus scotti* from fish of standard length 74 mm (top), 109 mm and 145 mm.

Trematomus scotti Boulenger

Remarks

One of the classic *Pagothenia/Trematomus* group of otoliths. See under *P. bernacchii* for details. *T. scotti* can be identified by the combination of very short rostrum, long narrow sulcus acusticus not or only partially divided by a small collum, rounded triangular dorsal part and a lobe on the postero-ventral margin.

Conversion factors

SL = 21.54601 OL + 12.52645	R = 0.910	n = 56
SL = 37.54624 OW + 0.724937	R = 0.907	n = 56
Mass = 1.04×10^{-6} $SL^{3.583}$	R = 0.990	n = 67
mean OL/OW = 1.548	SD = 0.083	Range = 1.313-1.741

Largest otolith size recorded (mm): OL 6.171 OW 3.765

Size range of fish in otolith sample 74 - 145 mm SL

Distribution

Within AAT

On the antarctic continental shelf throughout the region (Fischer and Hureau 1985).

Elsewhere

Circumpolar on the antarctic continental shelf, including S Shetland Islands (Fischer and Hureau 1985).

Habitat

A widespread and common benthic species, from inshore to depths of 680 m. In Prydz Bay it occurs most commonly in the northern half of the shelf, away from the inner shelf depression, in depths of 200 to 682 m.

Known predators

None observed, despite being a small and accessible species. Its absence in dietary studies so far is probably genuine, as the distinctive otoliths should be easily recognisable.

Figure 54. Otoliths of *Akarotaxis nudiceps* from fish of standard length 69 mm (top), 97 mm and 122 mm.

FAMILY BATHYDRACONIDAE

Akarotaxis nudiceps (Waite)

Remarks

Most bathydraconid otoliths are oval to sub triangular with the rostrum small or absent and a short narrow sulcus acusticus with a wide collum, and ostium much longer than the cauda. Within this group, otoliths of *A. nudiceps* can be recognised by the combination of virtual absence of a rostrum and lack of notches or lobes on the margin, and the prominent cristae.

Conversion factors

SL = 18.63593 OL + 52.6617	R = 0.822	n = 20
SL = 45.29275 OW + 17.48898	R = 0.833	n = 20
Mass = 8.2×10^{7} $SL^{3.476}$	R = 0.977	n = 25
mean OL/OW = 1.488	SD = 0.144	Range = 1.042-1.689

Largest otolith size recorded (mm): OL 3.675 OW 2.276

Size range of fish in otolith sample 69 - 177 mm SL

Distribution

Within AAT

Confined to the antarctic continental shelf. Positive records only for the Shackleton Ice Shelf region and Prydz Bay.

Elsewhere

Continental shelf of East Antarctica, including the Ross Sea (DeWitt and Hureau 1979).

Habitat

Deeper waters of continental shelf. In Prydz Bay it is generally confined to the inner shelf basin >600 m deep.

Known predators

None observed.

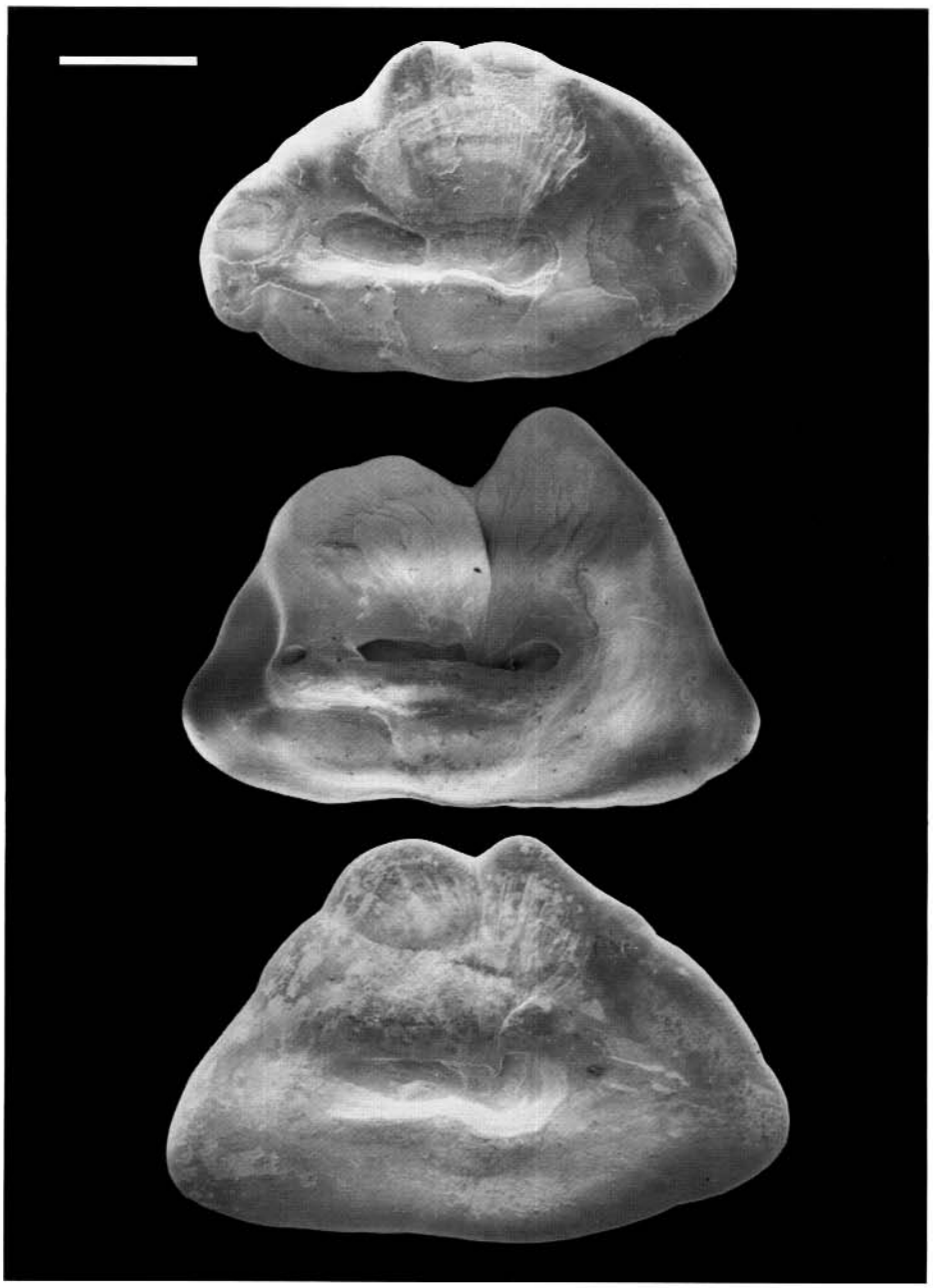

Figure 55. Otoliths of *Bathydraco marri* from fish of standard length 170 mm (top), 198 mm and 211 mm.

Bathydraco marri Norman

Remarks

Another of the classic bathydraconid type otoliths (see *Akarotaxis nudiceps* for details). Within the group, this species can be recognised by the combination of triangular shape with prominent notch in dorsal margin, short sulcus acusticus and absence of an excisura ostii.

Conversion factors

SL = 28.07392 OL + 60.19519	R = 0.793	n = 11
SL = 42.79164 OW + 58.67819	R = 0.711	n = 11
Mass = 5.57×10^{6} $SL^{3.109}$	R = 0.926	n = 11
mean OL/OW = 1.508	SD = 0.067	Range = 1.378-1.607
Largest otolith size recorded (mm):	OL 5.352	OW 3.403
Size range of fish in otolith sample 170 - 211 mm SL		

Distribution

Within AAT
Continental shelf and upper slope, probably throughout the region, but the only positive records are for Prydz Bay.

Elsewhere
Confined to the antarctic continental shelf. Positive records for the Ross Sea, Antarctic Peninsula, South Shetland Islands and Riiser-Larsen Sea (DeWitt 1985).

Habitat

Deeper waters of the continental shelf and upper slope, depth range 300 to 1300 m (DeWitt 1985). In Prydz Bay, it has only been encountered so far from the upper shelf slope in the depth range 702 to 785 m.

Known predators

None observed.

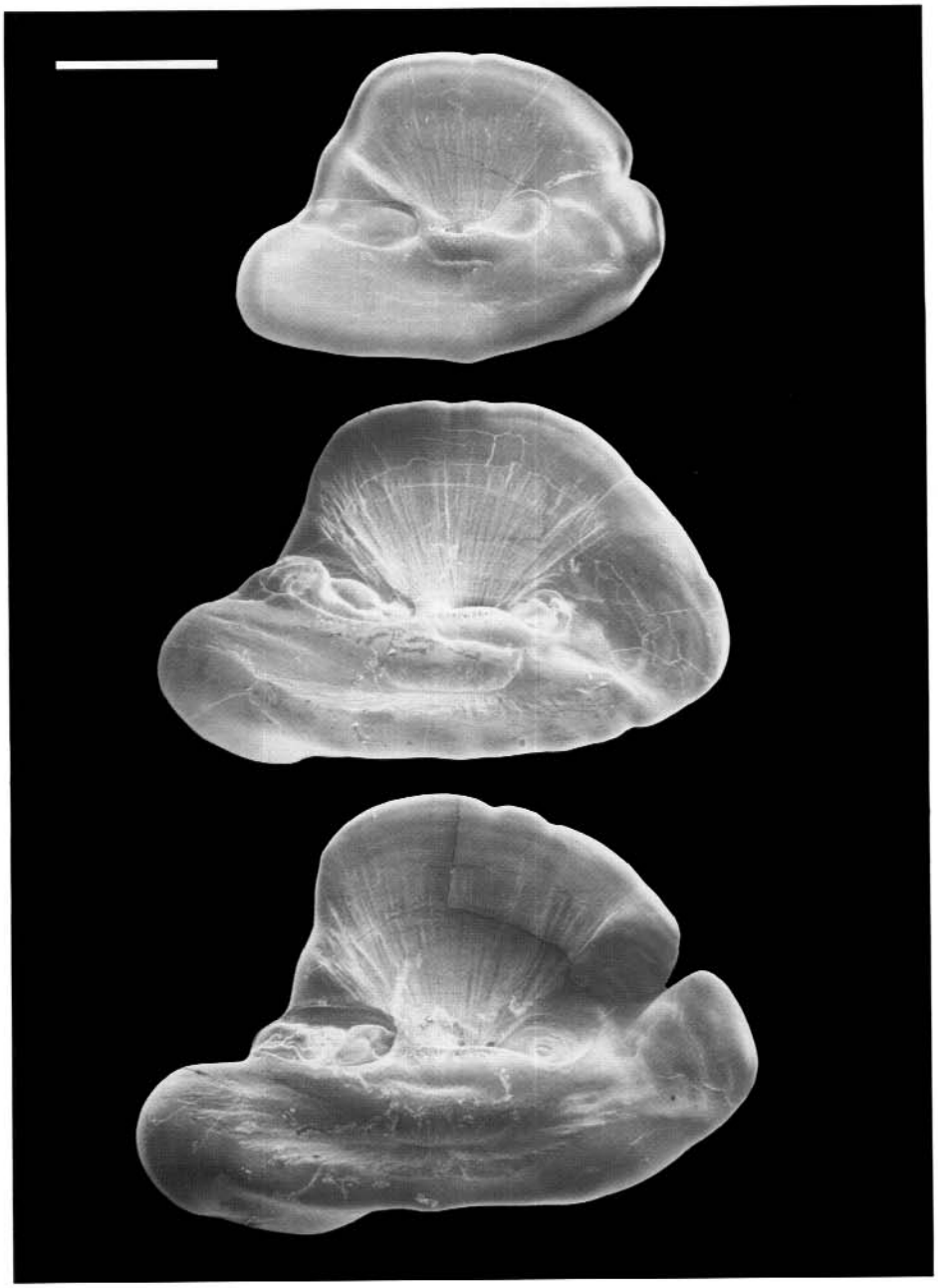

Figure 56. Otoliths of *Cygnodraco mawsoni* from fish of standard length 225 mm (top), 303 mm and 390 mm.

Cygnodraco mawsoni Waite

Remarks

A rather atypical bathydraconid otolith, superficially more similar to many nototheniid otoliths with the prominent rostrum and isthmus of the crista inferior separating the rather rounded ostium and cauda. Can be differentiated from them by the small and shallow ostium and cauda. Within the Bathydraconidae, it is similar to *Gymnodraco acuticeps*, but can be separated from it by the more prominent rostrum, more obvious groove in the central part of the crista inferior and more rounded triangular dorsal half.

Conversion factors

SL = 89.25862 OL + 4.117655	R = 0.980	n = 14
SL = 130.9788 OW - 12.8564	R = 0.978	n = 14
Mass = 6.60×10^{7} $SL^{3.298}$	R = 0.981	n = 18
mean OL/OW = 1.357	SD = 0.115	Range = 1.056-1.535

Largest otolith size recorded (mm): OL 5.352 OW 3.403

Size range of fish in otolith sample 121 - 441 mm SL

Distribution

Within AAT

Continental shelf, probably throughout the region; positive records for the Davis Sea, off Mawson (DeWitt 1971) and Prydz Bay.

Elsewhere

Confined to the east antarctic continental shelf. Positive records from the Riiser-Larsen Sea (DeWitt 1971).

Habitat

A benthic species in the shallower waters of the continental shelf, most occurrences in depths <250 m (DeWitt 1971 and ANARE data). In Prydz Bay it occurs on the shallower banks to the NW and NE of the bay in the depth range 36 to 430 m.

Known predators

Very occasionally observed in emperor penguin stomachs in the Mawson area (G. Robertson, pers. comm.).

Figure 57. Otoliths of *Gymnodraco acuticeps* from fish of standard length 156 mm (top), 245 mm and 335 mm.

Gymnodraco acuticeps Boulenger

Remarks

Another rather atypical bathydraconid otolith (see under *Cygnodraco mawsoni* for details). Can be distinguished from *C. mawsoni* by the shorter rostrum, squarer dorsal half and virtual lack of a groove in the central crista inferior.

Conversion factors

SL = 28.73122 OL + 173.7627	R = 0.477	n = 61
SL = 44.27358 OW + 149.0950	R = 0.668	n = 61
Mass = 1.010×10^{-5} $SL^{2.993}$	R = 0.990	n = 76
mean OL/OW = 1.238	SD = 0.126	Range = 1.003-1.515
Largest otolith size recorded (mm):	OL 4.513	OW 3.672
Size range of fish in otolith sample 200 - 335 mm SL		

Distribution

Within AAT
Antarctic continental shelf throughout the region (DeWitt 1971).

Elsewhere
Continental shelf of East Antarctica, including the Ross Sea (DeWitt 1971) and Weddell Sea (Schwarzbach 1988).

Habitat

A benthic species generally confined to near shore areas less than 100 m deep, although Ekau (1988) reports occasional catches in depths up to 467 m. In Prydz Bay it is also occasionally found offshore in near surface waters.

Known predators

A minor constituent of the diet of emperor penguins in Prydz Bay and the Mawson area (ANARE records) and Adélie Land (Offredo and Ridoux 1986); and Weddell seals in the Weddell Sea (Plotz and Ekau in press).

Figure 58. Otoliths of *Prionodraco evansii* from fish of standard length 51 mm (top), 112 mm and 132 mm.

Prionodraco evansii Regan

Remarks

Another of the classic bathydraconid type otoliths (see *Akarotaxis nudiceps* for details). Within the group, this species can be recognised by the combination of ostium being much longer than cauda, a short, broad rostrum and wide excisura ostii and well-developed crista superior above the ostium.

Conversion factors

SL = 28.04149 OL + 17.17142	R = 0.935	n = 46
SL = 47.67497 OW + 11.58396	R = 0.924	n = 46
Mass = 2.94×10^{-6} $SL^{3.176}$	R = 0.988	n = 55
mean OL/OW = 1.605	SD = 0.111	Range = 1.238-1.808

Largest otolith size recorded (mm): OL 4.180 OW 2.553

Size range of fish in otolith sample 51 - 132 mm SL

Distribution

Within AAT

Continental shelf throughout the region; positive records for the Eastern Sector, Davis Sea, off Mawson and off Enderby Land (DeWitt 1971) and Prydz Bay.

Elsewhere

Circum-antarctic on the continental shelf, including the South Orkney and South Shetland Islands and Antarctic Peninsula (DeWitt 1971).

Habitat

A benthic species in the shallow to mid-depth range, from the coast to 700 m deep. Most occurrences in depths <450 m (DeWitt 1971 and ANARE data). In Prydz Bay it occurs on the shallower banks to the NW and NE of the bay and west of Cape Darnley in the depth range 30 to 700 m.

Known predators

Small specimens are very occasionally observed in Adélie and emperor penguin stomachs (ANARE records).

Figure 59. Otoliths of *Racovitzia glacialis* from fish of standard length 216 mm (top), 231 mm and 265 mm.

Racovitzia glacialis Dollo

Remarks

Another of the classic bathydraconid type otoliths (see *Akarotaxis nudiceps* for details). Within the group, this species can be recognised by the combination of a triangular shape, often with a prominent notch in the dorsal margin, very short rostrum, highly-oblique excisura ostii and well-developed crista superior.

Conversion factors

SL = 14.57153 OL + 160.0175	R = 0.384	n = 17
SL = 43.65942 OW + 90.67653	R = 0.668	n = 14
Mass = 7.87×10^{6} $SL^{2.974}$	R = 0.961	n = 19
mean OL/OW = 1.581	SD = 0.084	Range = 1.369-1.749

Largest otolith size recorded (mm): OL 6.016 OW 3.853

Size range of fish in otolith sample 216 - 265 mm SL

Distribution

Within AAT

Continental shelf and upper slope, probably throughout the region, but the only positive records are for the Shackleton Ice Shelf region and off Mawson (DeWitt 1971), and Prydz Bay.

Elsewhere

Probably circum-antarctic on the continental shelf and upper slope. Positive records for the Ross Sea, western Antarctic Peninsula and Riiser-Larsen Sea (DeWitt 1971).

Habitat

A benthic species in the shallow to mid-depth waters of the continental shelf, with most occurrences in depths of 200-600 m (DeWitt 1971 and ANARE data). In Prydz Bay it occurs mostly in the central region of the bay in depths between 400 and 600 m.

Known predators

Occasionally found in the spring diet of Weddell seals in the Weddell Sea (Plotz and Ekau in press).

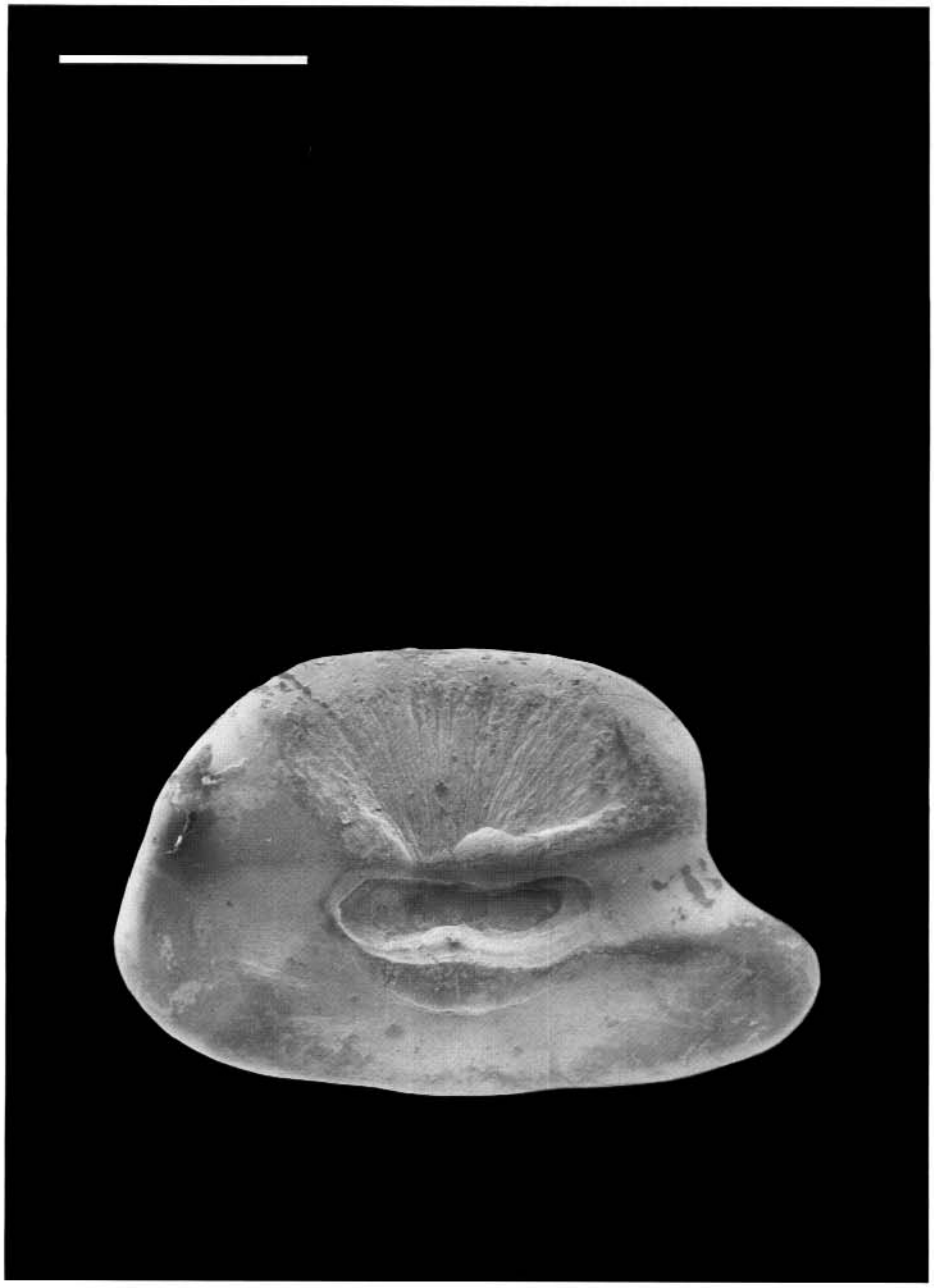

Figure 60. Otoliths of *Vomeridens infuscipinnis* from a fish of standard length 114 mm.

Vomeridens infuscipinnis (DeWitt)

Remarks

Another of the classic bathydraconid type otoliths (see *Akarotaxis nudiceps* for details). Within the group, this species can be recognised by the combination of quadrate shape with prominent rostrum, smooth margins and short sulcus acusticus.

Conversion factors

SL	Mass	Otolith mean length	Otolith mean width	Otolith mean length/width
132	11.24	2.887	1.886	1.531

Distribution

Within AAT
Probably throughout the area on the continental shelf. Positive records for Prydz Bay only (ANARE records).

Elsewhere
Probably circum-antarctic on the continental shelf, but positive records for the Weddell Sea, Antarctic Peninsula and S Orkney Islands only (DeWitt and Hureau 1979).

Habitat

A rare fish inhabiting the deeper waters of the continental shelf in the depth range 419 to 796 m (DeWitt and Hureau 1979, Ekau 1990). There is one record from the central part of Prydz Bay in 525 m depth.

Known predators

None observed.

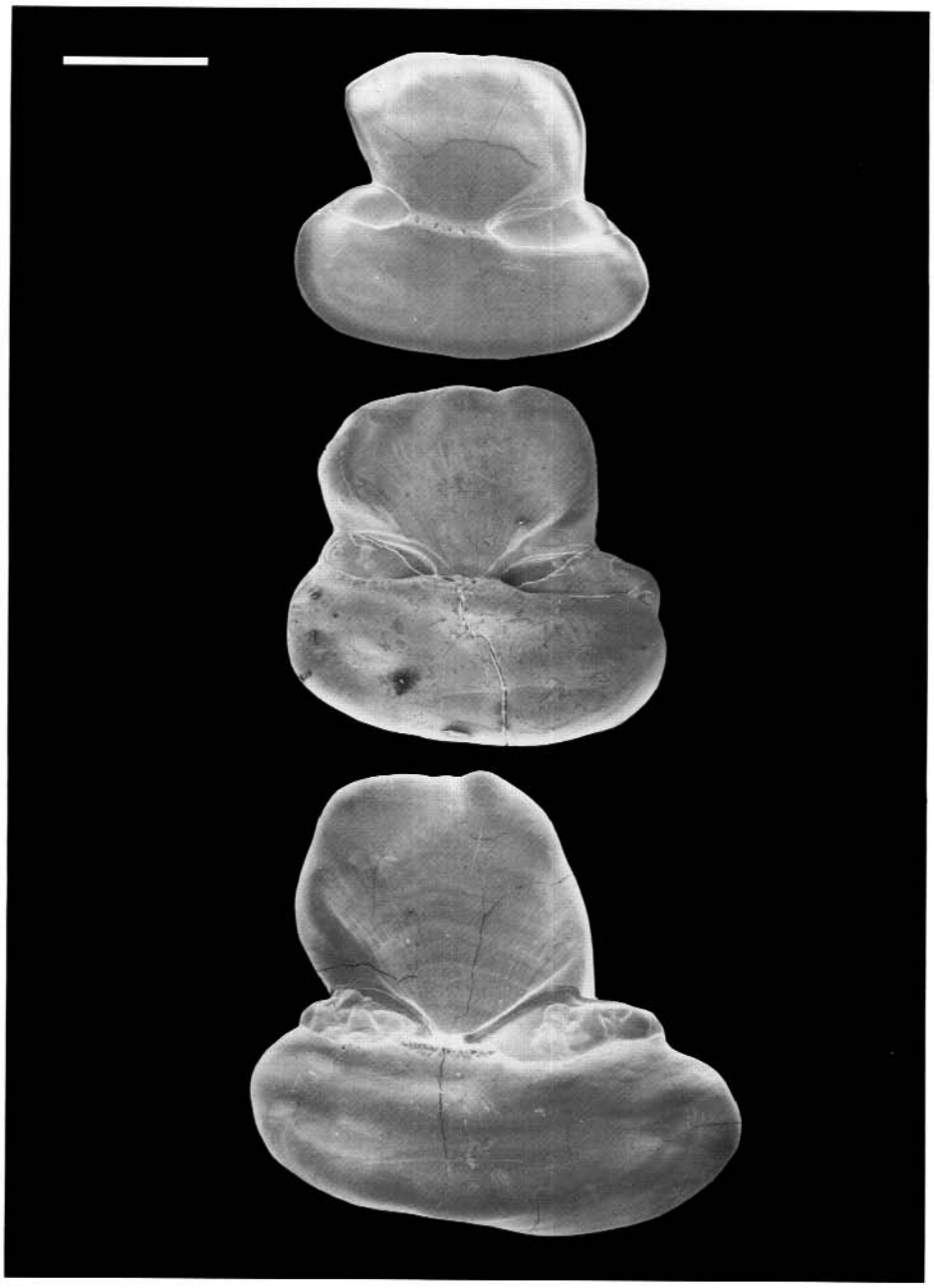

Figure 61. Otoliths of *Chaenodraco wilsoni* from fish of standard length 200 mm (top), 251 mm and 306 mm.

FAMILY CHANNICHTHYIDAE

Chaenodraco wilsoni Regan

Remarks

Most channichthyid otoliths are very easily recognised by their dorso-ventral elongation, prominent rounded rostrum and pseudo rostrum (on the postero-ventral corner) and prominent collicula (especially the anterior one) separated by a narrow collum usually overhung by the crista inferior. Within the family, most species are very hard to separate. In particular *Chaenodraco, Chionodraco* and *Neopagetopsis* form one very similar group with a short, wide dorsal half (OL/OW generally less than 1) and generally smooth margins, while *Champsocephalus, Channichthys* and *Cryodraco* form another group with a longer, narrower dorsal half (OL/OW generally greater than 1) and more sculptured margins. Within its sub group, *C. wilsoni* may be indicated by the relatively well developed pseudo rostrum and pseudo excisura ostii and the asymmetrical triangular or rectangular ostium and cauda.

Conversion factors

SL = 63.92876 OL + 57.43653	R = 0.837	n = 31
SL = 58.41415 OW + 85.92148	R = 0.842	n = 31
Mass = 1.51 x 10^{-6} $SL^{3.350}$	R = 0.995	n = 42
mean OL/OW = 1.089	SD = 0.103	Range = 0.978-1.521
Largest otolith size recorded (mm):	OL 3.756	OW 3.489
Size range of fish in otolith sample 184 - 306 mm SL		

Distribution

Within AAT
Antarctic continental shelf throughout the region (Fischer and Hureau 1985).

Elsewhere
Probably circum-antarctic on the continental shelf, also S Orkney and S Shetland Islands (Fischer and Hureau 1985).

Habitat

A bentho-pelagic species occurring over a wide range of depths on the continental shelf, but rarely in waters deeper than 650 m. Also occurs in the water column where it feeds on krill. Most occurrences are from depths of 300-450 m. Juvenile stages (up to about 70 mm SL) are pelagic.

Known predators

In Prydz Bay, a common but minor constituent of the diet of Adélie and emperor penguins (Williams 1989). Adélie penguins also sometimes take juvenile *C. wilsoni*. Also known from emperor penguins from the Mawson area (G. Robertson, pers. comm.), and from an elephant seal off the Eastern Sector (Vagin and Shust 1989).

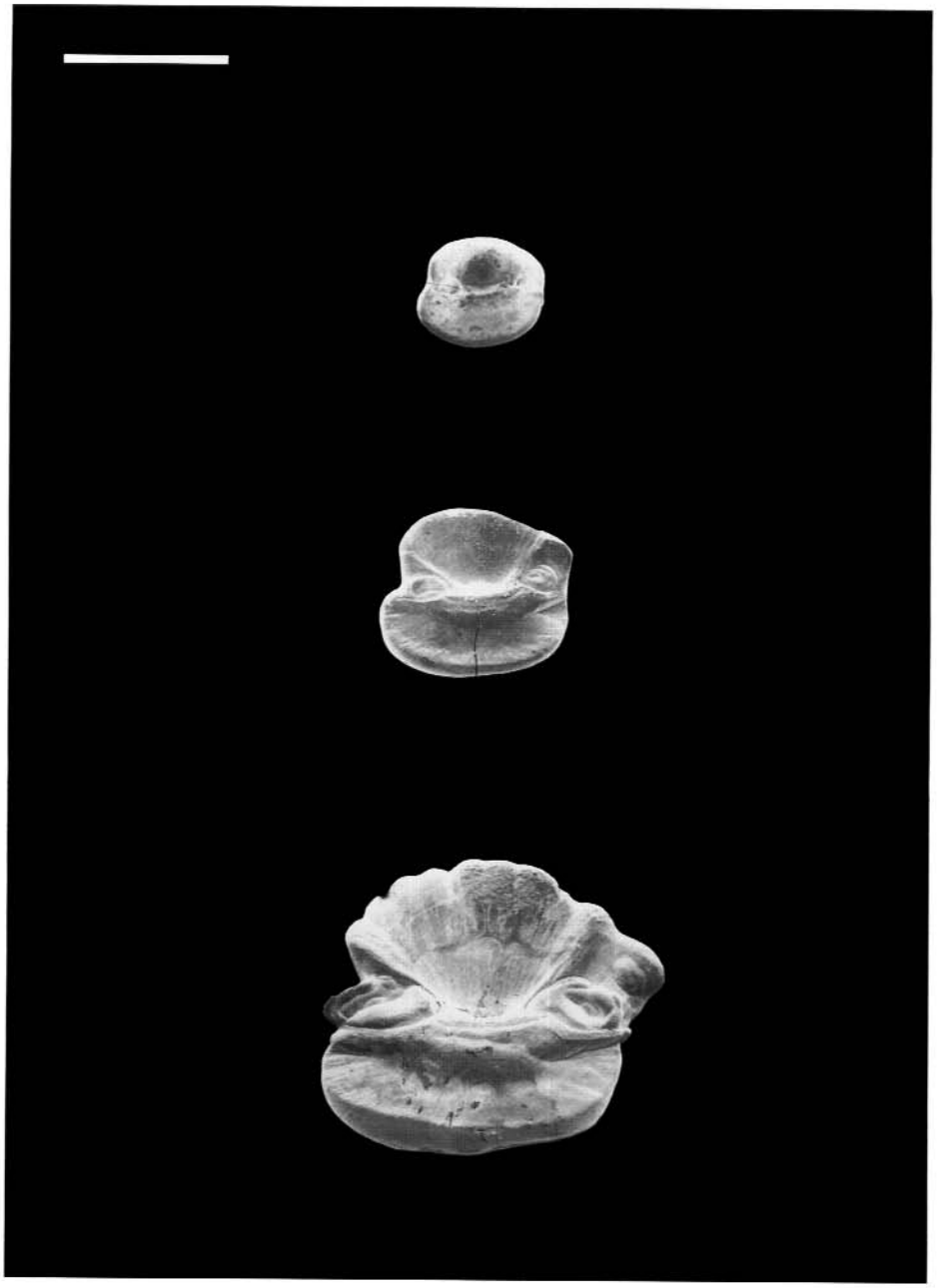

Figure 62a. Otoliths of *Champsocephalus gunnari* from fish of standard length 59 mm (top), 110 mm and 194 mm.

Figure 62b. Otoliths of *Champsocephalus gunnari* from fish of standard length 143 mm (top), 236 mm and 350 mm.

Champsocephalus gunnari Lonnberg

Remarks

See under *Chaenodraco wilsoni* for general notes on channichthyid otoliths. Within its sub-group, *C. gunnari* may be indicated by the longer than wide dorsal part, often with a posterior lobe, the large prominent elliptical posterior colliculum and an anterior colliculum which reaches almost to the end of the rostrum. Otoliths of *C. gunnari* and *C. rhinoceratus* are very alike in having by far the highest OL:OW ratio among channichthyids, the general shape, and the ontogenetic development of the rostrum. Except for the smallest otoliths, *C. gunnari* can be differentiated from *C. rhinoceratus* by the more prominent collicula (especially the anterior), and the straighter posterior margin.

Conversion factors

SL = 96.67480 OL - 20.02165	R = 0.979	n = 350
SL = 116.4060 OW - 33.2610	R = 0.990	n = 350
Mass = 1.48×10^{-6} $SL^{3.283}$	R = 0.999	n = 350
mean OL/OW = 1.138	SD = 0.064	Range = 1.001-1.328

Largest otolith size recorded (mm): OL 3.915 OW3.374

Size range of fish in otolith sample 49 - 354 mm SL

Distribution

Within AAT

Absent from continental antarctic waters. Common around Heard Island (Fischer and Hureau 1985; ANARE records).

Elsewhere

Tip of the Antarctic Peninsula, S Shetland, S Orkney, S Georgia, S Sandwich, Bouvet and Kerguelen Islands (Fischer and Hureau 1985).

Habitat

A bentho-pelagic species, often occurring in large concentrations on or near the shelves of islands where they occur in depths from 100-700 m, but most commonly in depths less than 500 m (Fischer and Hureau 1985). Aggregations can be found near the bottom, but younger fish especially are found in mid-water.

Known predators

Sub-adults of this species form a major part of the diet of antarctic fur seals at Heard Island (Green et al. 1989), and to a much lesser extent at S Georgia (North et al. 1983). They also occur in the diet of gentoo and macaroni penguins at Heard Island (Klages et al. 1989) and at South Georgia (Croxall and Lishman 1987); and in wandering albatross (*Diomedea exulans*) from S Georgia (Croxall et al. 1988).

Figure 63a. Otoliths of *Channichthys rhinoceratus* from fish of standard length 120 mm (top), 232 mm and 303 mm.

Figure 63b. Otoliths of *Channichthys rhinoceratus* from fish of standard length 394 mm (top), 427 mm and 558 mm.

Channichthys rhinoceratus Richardson

Remarks

See under *Chaenodraco wilsoni* for general notes on channichthyid otoliths. *C. rhinoceratus* belongs to the *C. gunnari* sub-group, and within this group it may be indicated by the long rostrum and relatively weakly developed collicula. Generally very similar to *C. gunnari* (see that species for detailed notes), but can be separated from it by the relatively rounded posterior margin and weak collicula. It is the only channichthyid otolith that could be confused with a nototheniid one, but the well-formed collicula and low OL:OW ratio should identify it.

Conversion factors

SL = 72.13656 OL + 108.9112	R = 0.659	n = 23
SL = 111.2226 OW + 24.09414	R = 0.841	n = 23
Mass = 3.29×10^{-6} $SL^{3.130}$	R = 0.981	n = 23
mean OL/OW = 1.182	SD = 0.129	Range = 0.961-1.424

Largest otolith size recorded (mm): OL 5.462 OW 4.346

Size range of fish in otolith sample 175 - 510 mm SL

Distribution

Within AAT

Absent from continental antarctic waters. Common around Heard Island (Fischer and Hureau 1985, ANARE records).

Elsewhere

Kerguelen Islands only (Fischer and Hureau 1985).

Habitat

A benthic species, common inshore and occurring on the islands' shelves to 700 m depth (Fischer and Hureau 1985, ANARE records).

Known predators

This species forms a minor part of the diet of antarctic fur seals at Heard Island (Green et al 1989), and has been found in the Heard Island cormorant (Green et al. 1990).

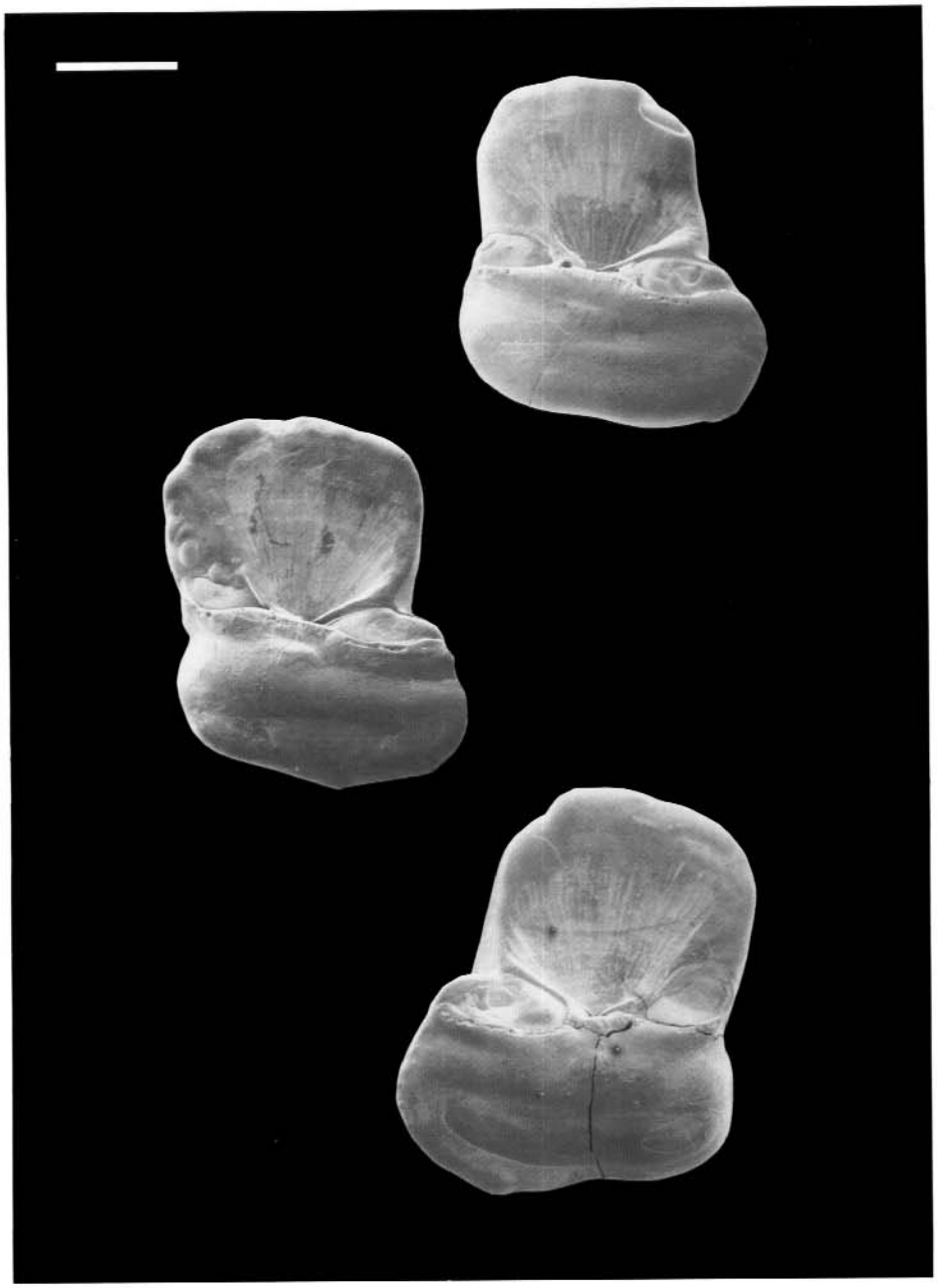

Figure 64a. Otoliths of *Chionodraco hamatus* from fish of standard length 296 mm (top), 331 mm and 360 mm.

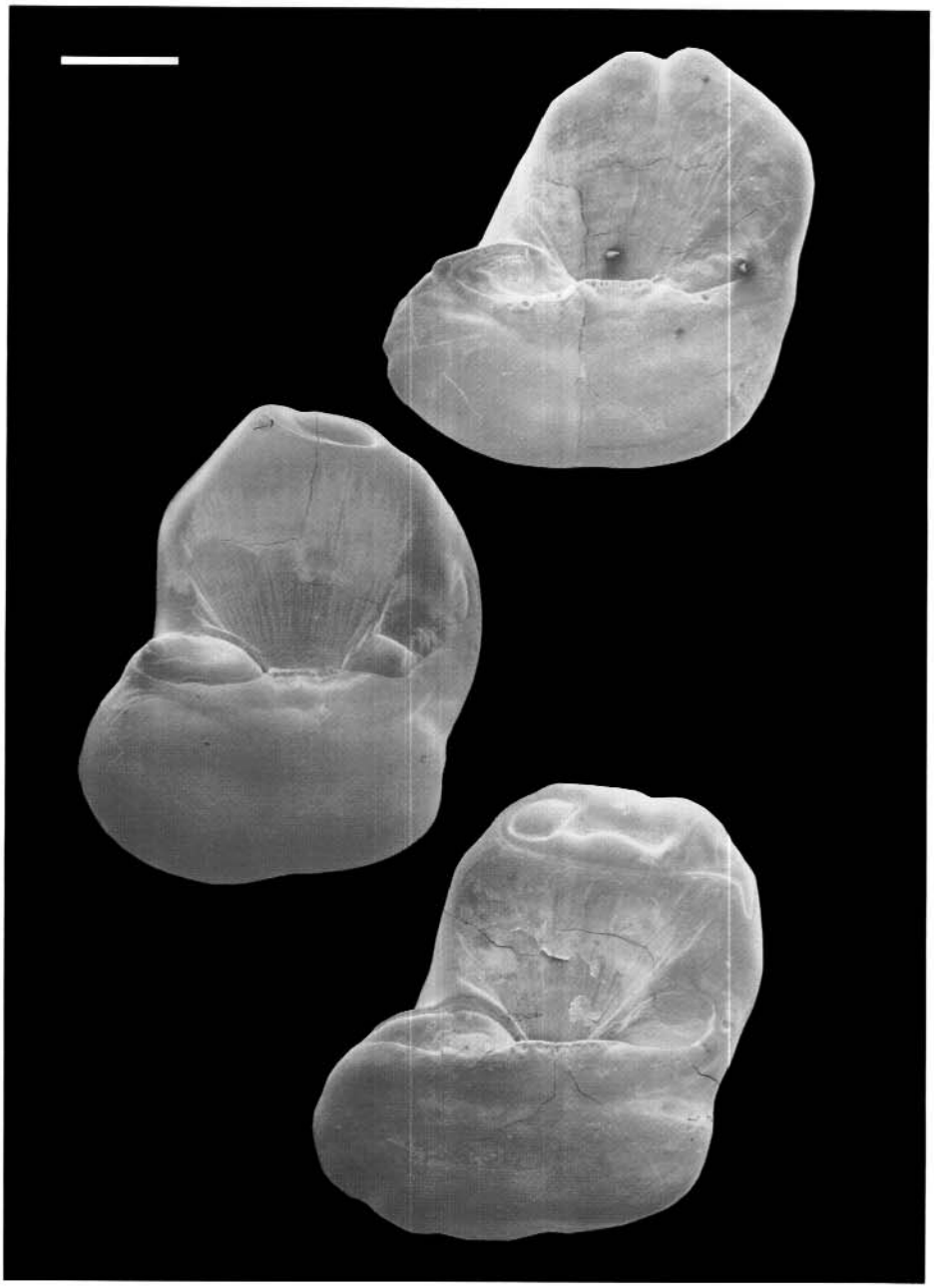

Figure 64b. Otoliths of *Chionodraco hamatus* from fish of standard length 396 mm (top), 426 mm and 451 mm.

Chionodraco hamatus (Lonnberg)

Remarks

See under *Chaenodraco wilsoni* for general notes on channichthyid otoliths. *C. hamatus* belongs to the *C. wilsoni* sub-group, and within this group it may be indicated by the very square dorsal part (although the dorsal margin may be somewhat rounded), the generally elliptical or teardrop-shaped ostium and cauda and the virtual absence of the pseudo rostrum and pseudo excisura ostii.

Conversion factors

SL = 74.31349 OL + 129.2359	R = 0.549	n = 141
SL = 76.99888 OW + 71.86458	R = 0.710	n = 141
Mass = 1.256×10^{-6} $SL^{3.361}$	R = 0.948	n = 167
mean OL/OW = 0.846	SD = 0.073	Range = 0.605-1.024

Largest otolith size recorded (mm): OL 4.100 OW 5.025

Size range of fish in otolith sample 235 - 466 mm SL

Distribution

Within AAT

Antarctic continental shelf throughout the region (DeWitt and Hureau 1979).

Elsewhere

Probably circum-antarctic on the continental shelf, including the Ross and Weddell Seas, but replaced in the Antarctic Peninsula, South Orkney and South Shetland Islands by the closely related *C. rastrospinosus* (Fischer and Hureau 1985).

Habitat

A benthic species occurring over a wide range of depths on the continental shelf, but rarely in waters deeper than 500 m. Unusually for a member of this family, it is also common in inshore waters. Near Davis it is one of the commonest fish in the depth zone 20-100 m (Williams 1988b). Elsewhere in Prydz Bay it is common in the northern, shallower parts of the shelf in depths of 300-460 m. Juvenile stages (up to about 70 mm SL) are pelagic and widespread over the shelf and adjacent seaward areas.

Known predators

In Prydz Bay, Adélie penguins occasionally feed on juvenile channichthyids, which may include this species. *Chionodraco* spp. constitute a minor part of the diet of emperor penguins in Prydz Bay (Gales et al. 1990), Weddell Sea (Klages 1989) and Mawson area (G. Robertson, pers. comm.).

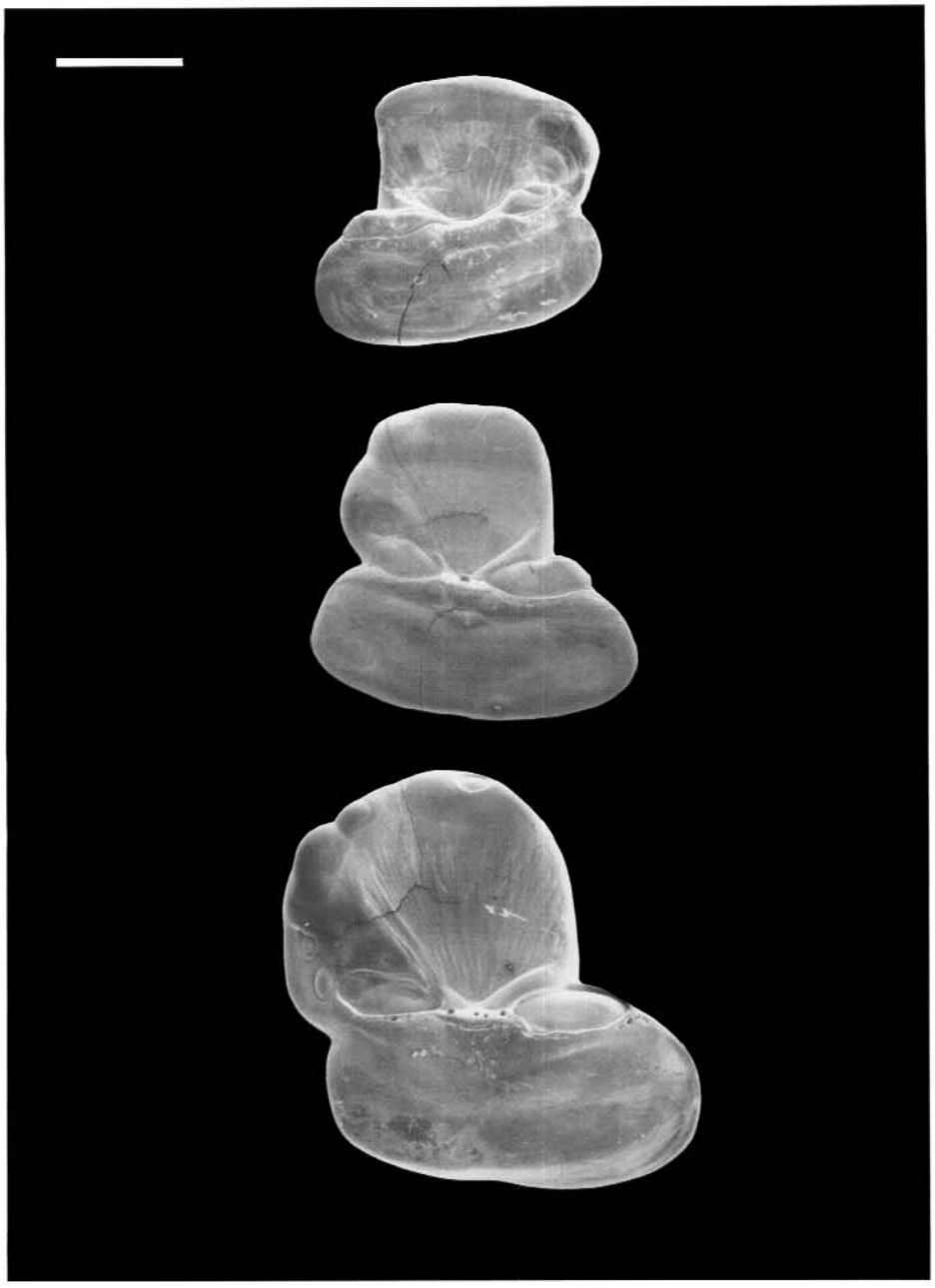

Figure 65a. Otoliths of *Chionodraco myersi* from fish of standard length 213 mm (top), 250 mm and 280 mm.

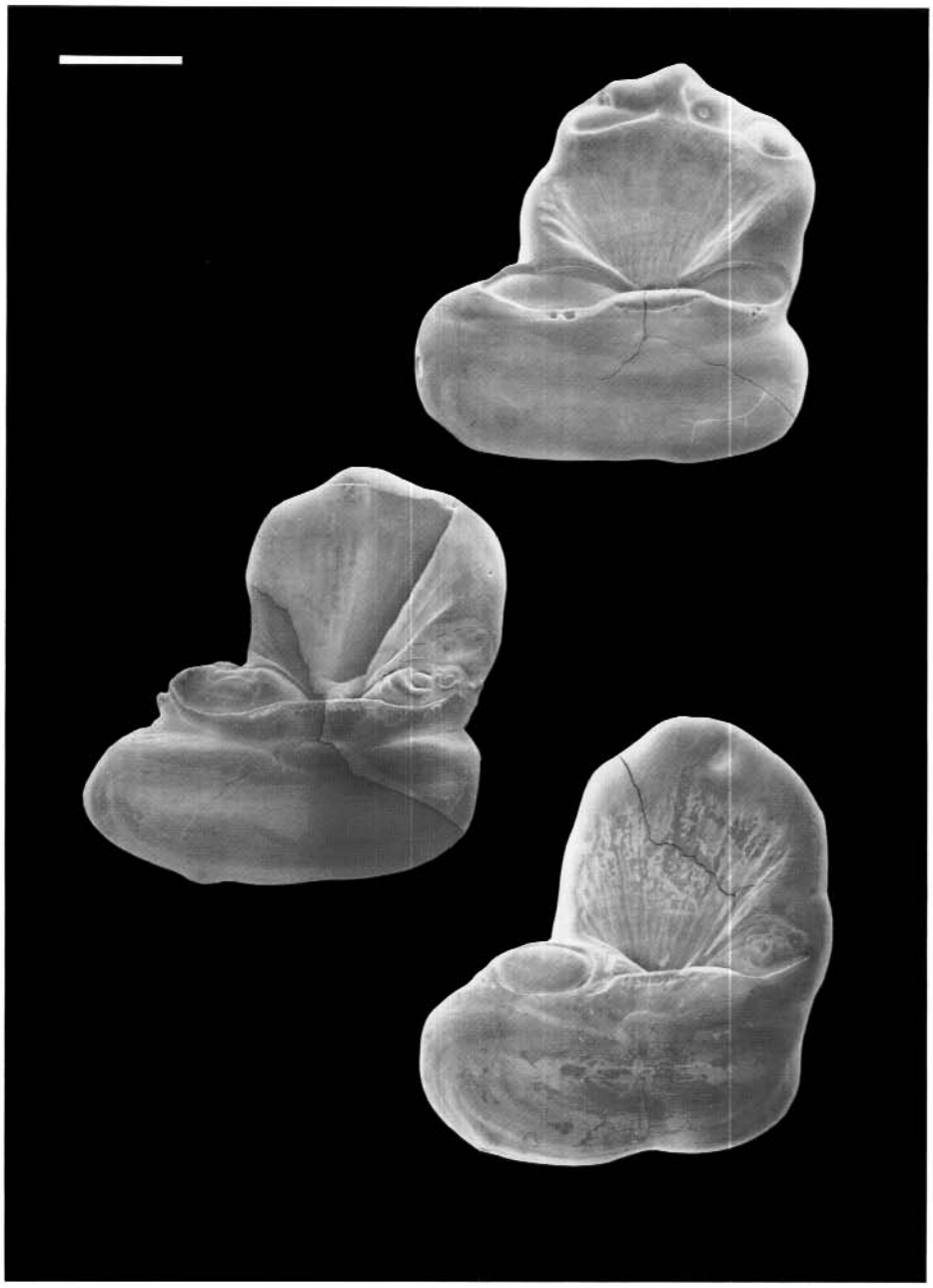

Figure 65b. Otoliths of *Chionodraco myersi* from fish of standard length 307 mm (top), 341 mm and 368 mm.

Chionodraco myersi DeWitt and Tyler

Remarks

See under *Chaenodraco wilsoni* for general notes on channichthyid otoliths. *C. myersi* belongs to the *C. wilsoni* sub-group, and within this group it may be indicated by the usually narrow, rounded dorsal margin, the prominent roughly elliptical anterior colliculum and the small pseudo rostrum and pseudo excisura ostii.

Conversion factors

SL = 88.72847 OL + 9.995439	R = 0.914	n = 59
SL = 84.17192 OW + 9.310984	R = 0.933	n = 59
Mass = 4.64×10^{-7} $SL^{3.530}$	R = 0.995	n = 78
mean OL/OW = 0.949	SD = 0.050	Range = 0.816-1.123

Largest otolith size recorded (mm): OL 4.036 OW 4.157

Size range of fish in otolith sample 102 - 355 mm SL

Distribution

Within AAT

Antarctic continental shelf probably throughout the region, but the only positive records are from Prydz Bay (ANARE records).

Elsewhere

Probably circum-antarctic on the continental shelf, including the Ross and Weddell Seas (DeWitt and Hureau 1979, Schwarzbach 1988).

Habitat

A benthic species occurring over a wide range of depths on the continental shelf. In Prydz Bay it is widespread except in the inner shelf depression in the depth range 130-700 m. Juvenile stages (up to about 70 mm SL) are pelagic and widespread over the shelf and adjacent seaward areas.

Known predators

In Prydz Bay, Adélie penguins occasionally feed on juvenile channichthyids, which may include this species. *Chionodraco* spp. constitute a minor part of the diet of emperor penguins in Prydz Bay (Gales et al. 1990), Weddell Sea (Klages 1989) and Mawson area (G. Robertson, pers. comm.). It is the dominant element in the spring diet of Weddell seals in the Weddell Sea (Plotz and Ekau in press).

Figure 66. Otoliths of *Cryodraco antarcticus* from fish of standard length 275 mm (top), 381 mm and 502 mm.

Cryodraco antarcticus Dollo

Remarks

See under *Chaenodraco wilsoni* for general notes on channichthyid otoliths. *C. antarcticus* belongs to the *C. gunnari* sub-group, and within this group it may be indicated by the very broad, fan-shaped posteriorly-directed dorsal part, very prominent anterior colliculum which does not encroach much on the rostrum and the lower OL:OW ratio.

Conversion factors

SL = 94.41020 OL + 33.27655	R = 0.967	n = 15
SL = 107.2410 OW + 10.50894	R = 0.954	n = 15
Mass = 3.50×10^{-7} $SL^{3.499}$	R = 0.995	n = 22
mean OL/OW = 1.056	SD = 0.092	Range = 0.929-1.120
Largest otolith size recorded (mm):	OL 4.819	OW 4.017

Size range of fish in otolith sample 153 - 502 mm SL

Distribution

Within AAT
Antarctic continental shelf throughout the region (DeWitt 1971).

Elsewhere
Circum-antarctic on the continental shelf, including South Orkney and South Shetland Islands (DeWitt 1971)

Habitat

A benthic species occurring over a wide range of depths on the continental shelf, from 110 to 750 m (DeWitt 1971). May also occur in the water column as it feeds at least partly on krill. Widespread but not common in Prydz Bay in depths of 180-630 m. Juvenile stages (up to about 70 mm SL) are pelagic.

Known predators

In Prydz Bay, adults and juveniles are a minor constituent of the diet of emperor penguins. It also forms a minor part of the spring diet of Weddell seals in the Weddell Sea (Plotz and Ekau in press).

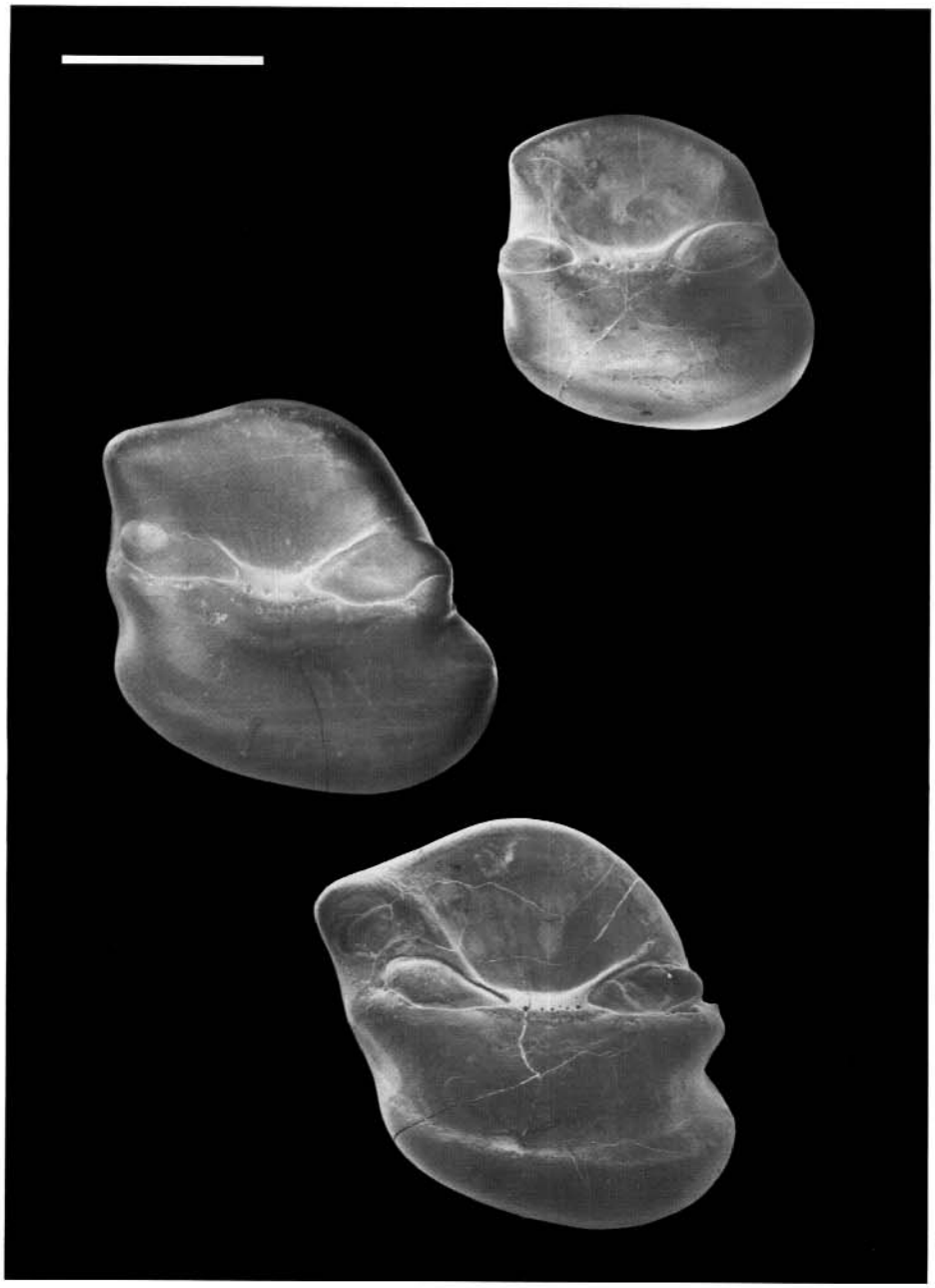

Figure 67. Otoliths of *Dacodraco hunteri* from fish of standard length 166 mm (top), 199 mm and 223 mm.

Dacodraco hunteri Waite

Remarks

The most distinctive channichthyid otolith, not fitting either of the sub-groups. Can be recognised by its near quadrate shape, virtually lacking any rostrum or other lobes, and the prominent collicula separated by a long collum.

Conversion factors

SL	Mass	Otolith mean length	Otolith mean width	Otolith mean length/width
166	45.38	1.695	1.701	0.996
172	45.32	1.717	1.780	0.965
174	49.90	1.780	1.915	0.929
199	81.16	2.032	2.057	0.988
204	72.31	2.086	2.144	0.973
206	76.24	2.020	2.263	0.893
207	83.15	2.070	2.303	0.899

Distribution

Within AAT
Antarctic continental shelf, probably throughout the region. Positive records for the Shackleton Ice Shelf and Davis Sea (DeWitt 1971) and Prydz Bay.

Elsewhere
Circumpolar high antarctic on the continental shelf. Positive records from the Weddell Sea (Scwarzbach 1988, Ekau 1990) and South Shetland Islands (Tiedtke and Kock 1989).

Habitat

An uncommon species over the continental shelf. A bentho-pelagic species in the depth range 350 to 850 m (DeWitt 1971, Hubold and Ekau 1987, Ekau 1990). In Prydz Bay, it has been encountered in midwater and bottom trawls in the depth range 50 to 778 m in the southern half of the bay in or near the inner shelf depression.

Known predators

A minor constituent of the diet of emperor penguins in Prydz Bay (ANARE records).

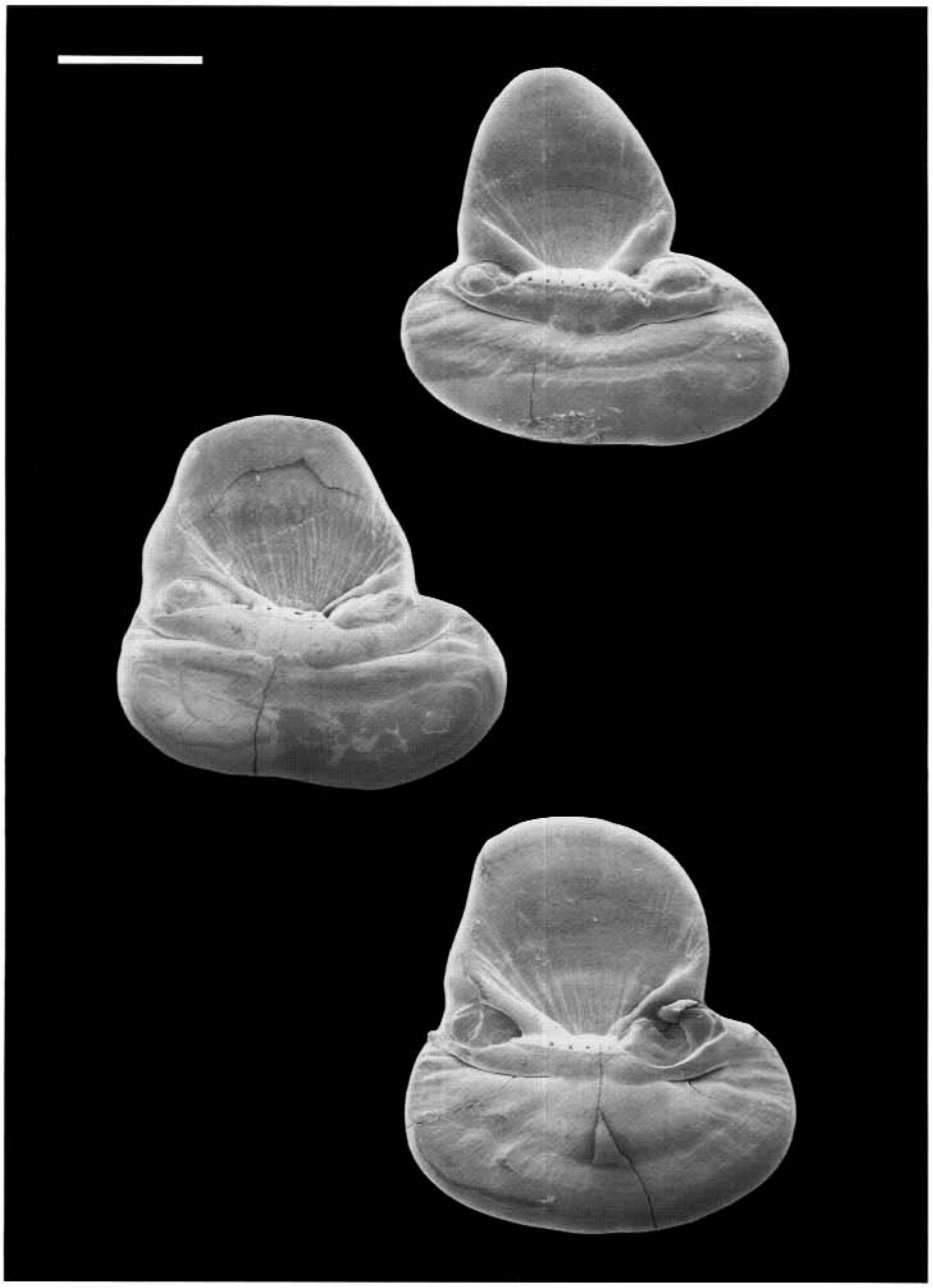

Figure 68. Otoliths of *Neopagetopsis ionah* from fish of standard length 395 mm (top), 425 mm and 482 mm.

Neopagetopsis ionah Nybelin

Remarks

See under *Chaenodraco wilsoni* for general notes on channichthyid otoliths. *N. ionah* belongs to the *C. wilsoni* sub-group, and within this group it is very similar to *Chionodraco* spp in having a very weak pseudo rostrum and lobes and a short wide rounded dorsal part. It can be separated from *Chionodraco* by the short smoothly rounded rostrum and by the small, irregularly circular collicula separated by a long isthmus formed by the crista inferior overhanging the collum.

Conversion factors

SL	Mass	Otolith mean length	Otolith mean width	Otolith mean length/width
395	755.5	3.103	2.769	1.088
396	698.9	2.679	2.506	1.069
396	740.5	2.933	2.892	1.014
414	786.3	2.909	2.842	1.024
425	713.2	2.994	2.848	1.051
428	891.0	2.780	2.812	0.989
451	1032.3	3.019	2.939	1.027
482	1435.6	3.180	2.902	1.096

Distribution

Within AAT
Waters on and nearby the antarctic continental shelf throughout the area (Abe and Suzuki 1981).

Elsewhere
Circumpolar on the shelves of the Antarctic Continent and islands of the Scotia Arc, but not South Georgia (DeWitt 1971).

Habitat

Probably the most pelagic of the channichthyids, it is encountered both near the bottom and in midwater over the shelf in depths to 900 m (DeWitt 1971). In locations between Enderby Land and off Casey, it has been caught in association with krill swarms off the continental shelf (Abe and Suzuki 1978). In Prydz Bay, it is widespread but uncommon in depths of 334 to 778 m.

Known predators

The type specimen was taken from the stomach of an unidentified baleen whale, which presumably ingested it along with krill (Nybelin 1947). Otherwise none observed, but may occur in the diet of emperor penguins in Prydz Bay, although the identification is uncertain.

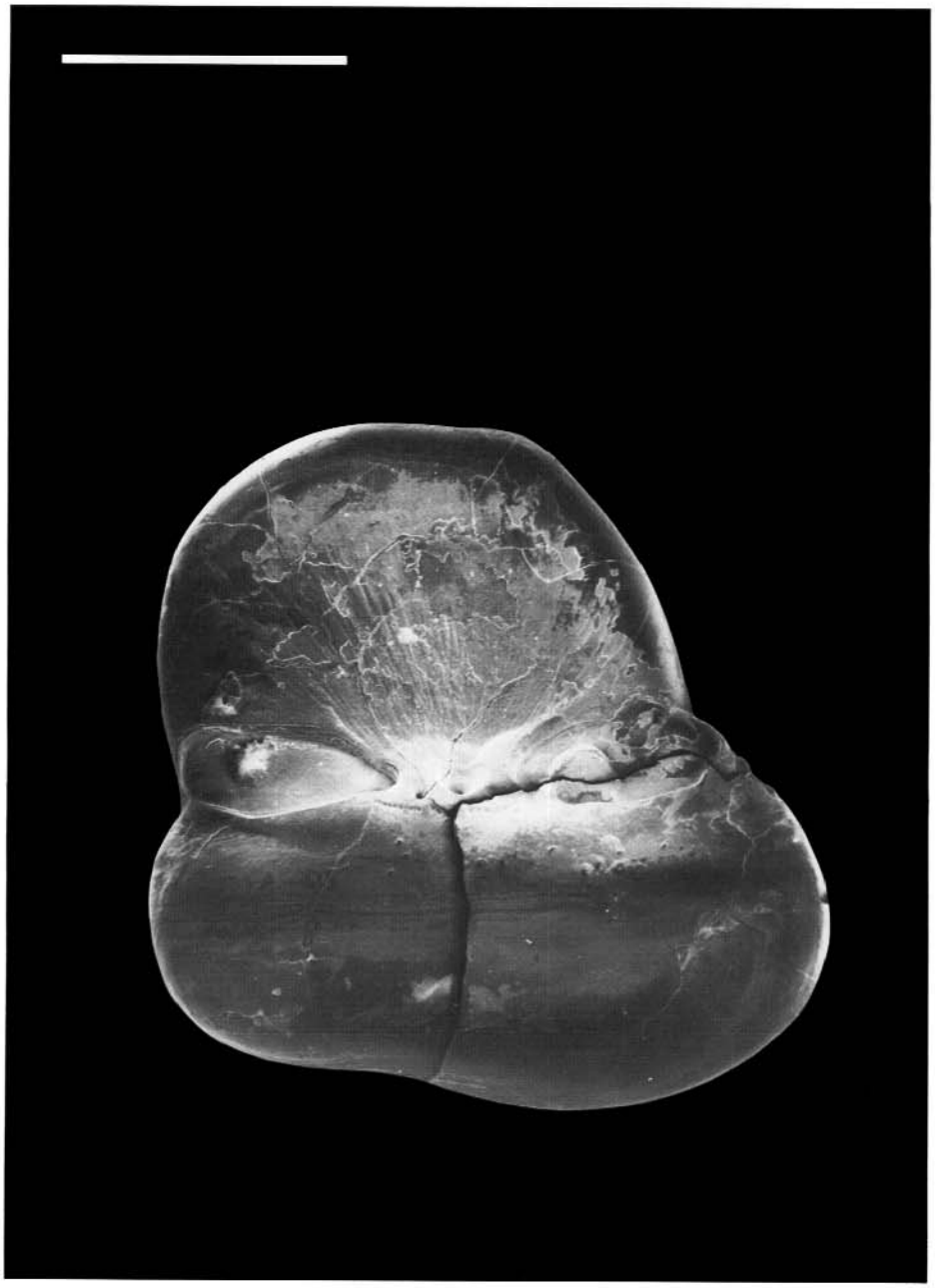

Figure 69. Otolith of *Pagetopsis macropterus* from a fish of standard length 293 mm.

Pagetopsis macropterus (Boulenger)

Remarks

See under *Chaenodraco wilsoni* for general notes on channichthyid otoliths. *P. macropterus* belongs to the *C. wilsoni* sub-group, and within this group it may be indicated by the very rounded shape with smooth margins and poorly-developed collicula, cristae and any other relief.

Conversion factors

SL	Mass	Otolith mean length	Otolith mean width	Otolith mean length/width
293	289.65	2.464	2.512	0.981

Distribution

Within AAT
Antarctic continental shelf throughout the region (DeWitt 1971).

Elsewhere
Circumpolar on the antarctic continental shelf (DeWitt 1971), and the South Shetland Islands (Tiedtke and Kock 1989).

Habitat

A bentho-pelagic species, it is found on the bottom in 20 to 655 m depths (DeWitt 1971). Juveniles and sub adults are pelagic. In Prydz Bay they have been found in waters to 180 m deep in all parts of the bay, and the adults have been found occasionally in the northern part of the Bay in depths from 182 to 343 m.

Known predators

Pagetopsis spp. occur occasionally in the diets of emperor penguins in Prydz Bay and the Mawson area (G. Robertson, pers. comm.), the Weddell Sea (Klages 1989); and Weddell seals in the Weddell Sea (Plotz and Ekau in press).

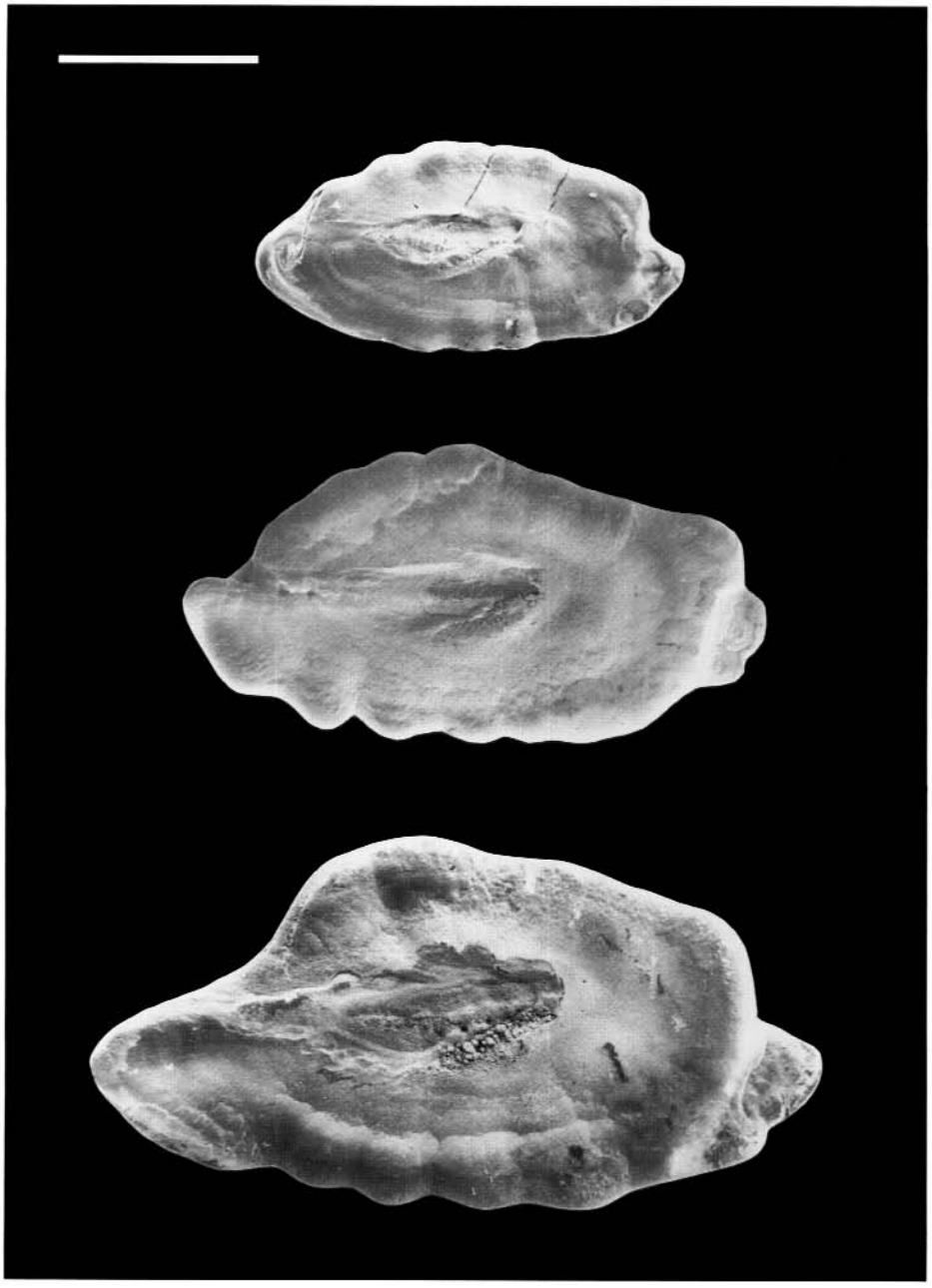

Figure 70. Otoliths of *Paradiplospinus gracilis* from fish of standard length 199 mm (top), 316 mm and 451 mm.

FAMILY GEMPYLIDAE

Paradiplospinus gracilis (Brauer)

Remarks

Recognisable by the lozenge shape caused by the small rostrum and prominent posterior lobe, the weakly-developed sulcus acusticus not differentiated into ostium and cauda, and the lack of any other relief, except a weak crista superior. Similar shaped otoliths, e.g. *Muraenolepis* spp., *Macrourus holotrachys* and *Dissostichus eleginoides* can be separated by their sulcus acusticus separated into ostium and cauda.

Conversion factors

SL = 123.8801 OL - 79.3186	R = 0.942	n = 110
SL = 231.1797 OW - 41.9938	R = 0.974	n = 110
Mass = 2.412×10^{-8} $SL^{3.666}$	R = 0.989	n = 110
mean OL/OW = 2.099	SD = 0.144	Range = 1.770-2.497

Longest otolith size recorded (mm): OL 4.128 OW 2.081

Size range of fish in otolith sample 196 - 451 mm SL

Distribution

Within AAT

Positive records from the vicinity of Heard Island (adults), and Macquarie Island (juveniles) (ANARE records) and off Mawson (Hecht 1987). Probably distributed over a wide latitudinal band throughout the area.

Elsewhere

Probably circumpolar in a wide latitudinal band. Adults are usually found south of the Antarctic Convergence (Mikhaylin 1976), but they spawn north of the convergence, and larvae have so far been found as far north as 34°40'S off Chile, near the Antarctic Peninsula, and off Argentina (Parin and Bekker 1972).

Habitat

A pelagic fish, in the upper waters, but not commonly encountered.

Known predators

Occurs rarely in Heard Island and Macquarie Island cormorants (Green et al. 1990), and quite frequently in gentoo penguins at Heard Island (Klages et al. 1990).

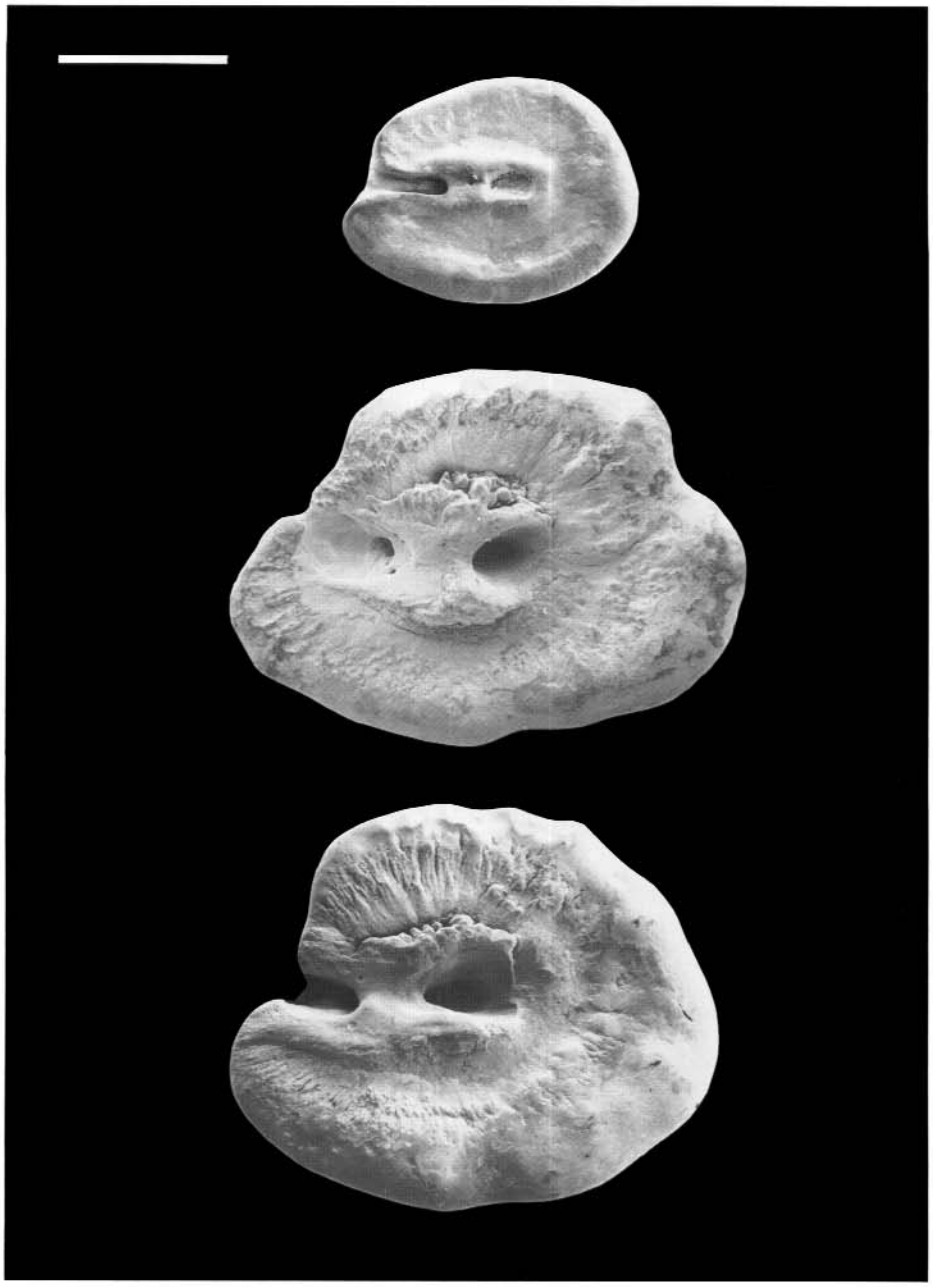

Figure 71. Otoliths of *Mancopsetta maculata* from fish of standard length 124 mm (top) 191 mm and 270 mm.

FAMILY BOTHIDAE

Mancopsetta maculata (Gunther)

Remarks

M. maculata has discoid otoliths with a prominent rostrum and postero-ventral lobe. Otherwise the form of the otoliths seems to be quite variable within a fairly small size range, as Hecht's (1987) figures also show.

Conversion factors

SL	Mass	Otolith mean length	Otolith mean width	Otolith mean length/width
124	28.3	1.800	1.450	1.241
143	42.9	1.936	1.598	1.212
191	111.9	3.425	2.399	1.428
210	158.7	3.361	2.366	1.421
235	191.3	3.155	2.666	1.183
246	191.8	2.981	2.872	1.038
254	230.1	2.500	2.100	1.190
270	299.2	3.150	2.500	1.260

Distribution

Within AAT
Shelf of Heard Island only (Fischer and Hureau 1985).

Elsewhere
Shelves of Kerguelen, Crozet, Marion and Prince Edward and S Georgia Islands, Ob', Lena and Kara Dag Banks (Fischer and Hureau 1985).

Habitat
Benthic fish on sand or mud bottoms in 20 to 600 m depth (Fischer and Hureau 1985).

Known predators

None observed.

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