

A Guide to the Otoliths of Southern Ocean Fishes

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This study is a contribution to the ichthyology and in particular to the study of predator / prey interrelationships in the Southern Ocean. The otoliths of 120 species, known to occur in the region, are described and illustrated. Synoptic notes on the diagnostic features, intraspecific morphological variation and ontogenetic development are provided. Wherever possible, the relationships between otolith length and fish length as well as between fish length and mass are also presented. A key to the otoliths, based primarily on geometric shape, has been developed to facilitate the identification of otoliths found in predator stomachs.

Hierdie studie is 'n bydrae tot die viskunde en in besonder tot die studie van die predator – prooiwisselwerking in die Suidelike Oseaan. Die otoliete van 120 spesies wat in die gebied voorkom, word beskryf en geïllustreer. Sinoptiese aantekeninge oor hul diagnostiese kenmerke, intraspesifieke morfologiese variasie en ontogenetiese ontwikkeling word verskaf. Waar moontlik word die verhouding tussen otolietlengte en vislengte en die verhouding tussen vislengte en massa gegee. 'n Sleutel vir die identifisering van dié otoliete word ook verskaf.

Introduction

In September 1981 the BIOMASS Working Party on Bird Ecology passed a recommendation to the Group of Specialists on Southern Ocean Ecosystems and their Living Resources "that the BIOMASS Working Party on Fish Ecology be asked to arrange for the production of a handbook for the identification of remains of Antarctic and sub-Antarctic fish" ---. It was stressed that such a handbook should, in particular, include a guide to the identification of otoliths. The rationale behind this request was "to improve the understanding of the role of Antarctic and sub-Antarctic seabirds, marine mammals and fish as predators on fish in these regions" ---(Anon. 1981). At the meeting of the BIOMASS Working Party on Fish Ecology in Hamburg during the IV Congress of European Ichthyologists, in September 1982, it was decided to initiate this project.

An understanding of the predator / prey interrelationships upon which the foodweb of the region can be modelled could provide valuable information towards the ultimate rational management of the ecosystem. Recent investigations have indicated that the foodweb of the Southern Ocean, in fact, appears to be more complex than originally surmised (S.Z. El-Sayed pers. comm.). The identification of the prey of piscivorous predators should, however, be viewed only as a first step in the quantitative assessment of the role played by predators in the ecosystem. As a second and ultimately more important step the transfer of energy between trophic

levels needs to be quantified. For this purpose the calorific content of prey species is of paramount importance (Hecht & Cooper 1986), and greater emphasis will have to be given to such investigations in future.

For the purpose of this investigation the Southern Ocean is defined as the sea area south of a line joining the following meridians: 50 S; 50 S, 30 E; 45 S, 30 E; 45 S, 80 E; 55 S, 80 E; 55 S, 150 E; 60 S, 150 E; 60 S, 50 W; 50 S, 50 W; 50 S (Fig. 1). However, as several Southern Ocean marine predators often frequent the coasts of Tierra del Fuego, Tasmania, the southern Island of New Zealand and some of the islands lying north of the convergence (e.g. Gough Island), the otoliths of some species obtained from these regions have also been included into this guide.

Otoliths show a high level of species specificity and hence have for a long time been used to achieve varied objectives (Hecht 1977a, 1978). Others like Koken (1884), Weiler (1942, 1958), Fitch (1966, 1967), Nolf (1969, 1970), Gaemers (1971, 1981, 1984), Schwarzhans (1976, 1980), Nolf & Steurbaut (1983), (to mention but a few of their studies) have used fossil otoliths to reconstruct the fish faunas of several regions from the early to the late Cenozoic Era. Moreover, as otoliths are conservative structures which show distinct plesiomorphic and apomorphic characters, Fitch & Craig (1964), Weiler (1968), Greenwood (1970), Karrer (1971), Fitch & Barker (1972), Schwarzhans (1972, 1978, 1981), Gaemers (1976), Nolf (1978, 1979), Nolf & Tavern (1978), Hecht & Hecht (1978), Hecht (1982), Heemstra & Hecht (1986), and others, have been able to comment on the evolutionary history and the systematic position of several groups. Otoliths have also been used to distinguish between closely related species (Schmidt 1969, Post & Hecht 1977, Post & Quero 1981), and to separate stocks of commercially important species (Botha 1971, Messieh 1972, Price 1978, Payne 1985).

The chemical composition and crystalline structure of otoliths, discussed by Irie (1955) and Degens *et al* (1969), makes them remarkably more resistant to attrition by digestive fluids than fish bone and hence are often the only remains of fishes found in the stomachs or faecal pellets of their predators (Esiuzo 1963, Martini 1964, Fitch & Brownell 1968, Pinkas *et al* 1971, Cooper *et al* 1984, La Cock *et al* 1984, Smale & Bruton 1985). Moreover, the size of a prey species can also be calculated from the size of their otoliths. This has obvious advantages for detailed feeding studies, particularly as regards more detailed investigations on energy transfer between trophic levels.

This guide to the otoliths of the Southern Ocean fishes is the first study which describes exclusively the otoliths of the fish from a specific zoogeographic region. It is regarded as a contribution to the ichthyology, and in particular, to the study of predator-prey interrelationships of the region.

Material and methods

All the material described and illustrated in this guide was collected and made available by colleagues at the following institutions: the British Antarctic Survey (BAS), the Alfred Wegener Institut für Marine und Polarforschung, Bremerhaven (AWI), the South African Museum, Cape Town (SAM), the Port Elizabeth Museum (PEM), the JLB Smith Institute of Ichthyology, Grahamstown (RUSI), the Rijksmuseum van Geologie en Mineralogie, Gent (RMGM), the Bundesforschungsanstalt für Fischerei, Hamburg (BAF), the Zoologisches Institut und Museum, Universität Hamburg (ZIMH), the Morski Instytut Rybacki, Poland (MIRP), the Institut Royal des Sciences Naturelles de Belgique, Brussels (IRSNB), the Muséum National d'Histoire Naturelle Paris (MNHN), the College of Marine Studies of the University of Delaware (CMSUD), the Department of Ecology & Behavioural Biology of the University of Minnesota (DEBBUM), the Instituto Antartica Argentino (IAA), the National Institute of Polar Research, Tokyo (NIPRT), the Department of Science and Technology, Antarctic Division, Tasmania (DSTADT), and the Department of Physiology and Biophysics of the University of Illinois (DPBUI).

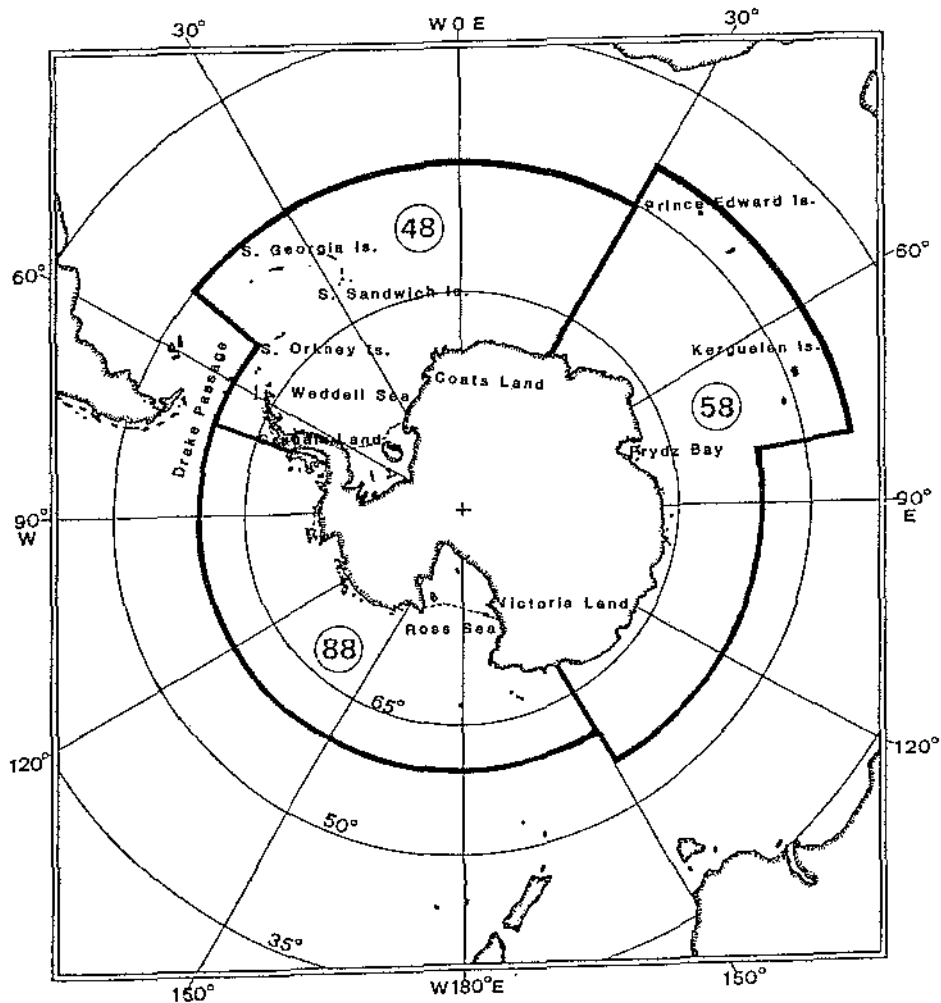
A representative sample of otoliths of each species is housed in the otolith collection of the Department of Ichthyology and Fisheries Science, Rhodes University, Gra-

hamstown (DIFS). The otoliths are curated in a dry state in numbered gelatin capsules and all the material is catalogued on a computer database. In the descriptive section of this guide the DIFS otolith catalogue numbers for each species are presented.

Most of the otoliths that were examined for the preparation of this guide showed poor relief on their medial sides. In order to emphasize the fine structure on the medial side, thereby facilitating description and illustration, they were coated with a layer of ammonium chloride (Hecht 1977b). As otoliths which are removed from the stomachs of their predators have been subjected to a greater or lesser degree of attrition, it is strongly recommended that they be treated in a similar fashion prior to any attempt at identification. Moreover, stomach contents of predators should preferably be examined in a fresh state. Fixation of the material in formalin, particularly unbuffered formalin, results in further corrosion (McMahon & Tash 1979) which effectively negates any possibility of their being identified.

All the otoliths were measured for length to the nearest 0.01 mm using vernier callipers. These data together with fish length were subjected to regression analyses. The equation of best fit is presented for each species for which an adequate size range was available. When an adequate size range was not available the mean Otolith Length:Fish Length ratio was calculated and presented, together with the standard deviation of the mean and the range. Otolith length

Figure 1 Map of the Southern Ocean.



is the greatest distance between the anterior-most tip of the rostrum and the posterior-most edge of the posterior margin (cf. Fig. 2).

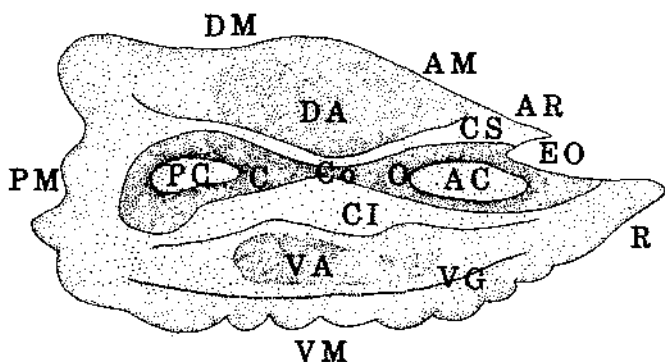


Figure 2 Schematic diagram of the medial side of a left sagittal otolith showing the main diagnostic features used in the descriptions and in the key. The sulcus acusticus comprising the ostium (O) and the cauda (C), the anterior colliculum (AC), the posterior colliculum (PC), the collum (Co), the crista superior (CS), the crista inferior (CI), the rostrum (R), the antirostrum (AR), the excisura ostii (EO), the dorsal area (DA), the ventral area (VA), the ventral groove (VG), the dorsal margin (DM), the posterior margin (PM), the ventral margin (VM) and the anterior margin (AM).

Wherever possible a size range of otoliths from each species is illustrated to show intraspecific variation as well as their ontogeny. All illustrations were made using a stereo microscope and camera lucida.

A recent checklist of the ichthyofauna of the Southern Ocean by Gon (1985) showed that there are some 195 osteichthyan fishes in the region. In this guide the otoliths of 120 species (94 from Gon's checklist and 26 which might possibly occur in the area or be taken by Southern Ocean predators) are described and illustrated. A list of these species is presented in the species index.

In order to facilitate the identification of the otoliths a key has been developed. This together with instructions for its use is presented at the end of the guide. While the key may be useful for the identification of some species to the genus or species level, it will in most cases only be useful to the level of the family. Even if otoliths can be keyed out it is nevertheless recommended that the otolith be cross checked with the illustrations and the descriptions.

Otolith morphology and terminology

A fairly standardized terminology already exists to describe otoliths (Schwarzhan 1978, Hecht 1978 and Gaemers 1984). No new terms have been introduced into this text, although some are used in a slightly different connotation than originally conceived. For this reason and in order for the user to be able to make full use of the guide and the key, all the terms have been redefined and illustrated. The anatomy of the inner ear of fishes and the position of the three otoliths (the sagitta, asteriscus and the lapillus) situated in their labyrinthine chambers (the sacculus, lagena and utriculus respectively) of the semicircular canals, on either side of the neurocranium, have been adequately described in ichthyological textbooks such as Lagler *et al* (1977) and Bond (1979). All

the material described in this guide are sagittal otoliths as these are the most specific of the three.

The medial or inner surface of the sagittal otoliths is well sculptured in relation to the lateral side. The latter is generally devoid of any relief and hence of diagnostic features. In general, the variation in the definition of the sculptures on the medial side are of particular diagnostic value for the lower taxa at the genus and species level, while the geometric shape of the otolith is of greater importance for the delimitation of higher taxa at the family and order level. Exceptions to this general rule do, however, occur but these are pointed out as and where necessary.

The following series of schematic diagrams have been included to illustrate the various terms used in the descriptive section of this guide and in the key. Figure 2 illustrates the main diagnostic features of otoliths. Three features were not included. These are the pseudo-rostrum, the pseudo-antirostrum and the pseudo-excisura ostii. These structures, if present, are essentially the same as the rostrum, antirostrum and excisura ostii except that they are found on the posterior end of the otolith. Figure 3 illustrates the types of otolith shape. Figure 4 illustrates the types of sulcus acusticus openings. Figure 5 illustrates the various sulcus acusticus and colliculi types, and Figure 6 illustrates the different types of marginal sculpture. It is not uncommon that parts of the margin are sculptured in different ways, which necessitates the division of the margin into several distinctly circumscribed regions, viz.

- (i) the dorsal margin – between the proximal end of the antirostrum and the postero-dorsal corner,
- (ii) the posterior margin – between the postero-dorsal corner and the postero-ventral corner of the otolith,
- (iii) the ventral margin – between the postero-ventral corner and the proximal end of the rostrum,
- (iv) the anterior margin – comprising the margin of the rostrum, the antirostrum and the excisura ostii (should the margins of the latter three structures differ in sculpture then they are described separately). *In order to make full use of the guide and the key it is essential to become fully familiarized with all the terms and the context in which they are used.*

Throughout the descriptive section of this guide the otoliths of the various species have been described in a particular sequence for reasons of standardization and ease of reference, viz. **geometric shape**, sculpture and shape of the **margins**, the opening of the **sulcus acusticus**, the definition of the **ostium** and the **cauda** (which determines the sulcal type), the definition of the **collum**, the development and definition of the **colliculi**, the development, sculpture and definition of the **cristae superior** and **inferior**, the development and shape of the **dorsal** and **ventral areas**, the size, shape and definition of the **rostrum**, **antirostrum** and the **excisura ostii**.

Otolith descriptions

In this guide the orders and families are arranged according to Nelson's (1984) phylogenetic sequence. The species within the various families are arranged in alphabetical order. The scale bars below the illustrations are 1 mm in length. In the legends to the plates the length of the fish from which the otoliths were removed is given. These are either given as Total Length (TL), Standard Length (SL) or

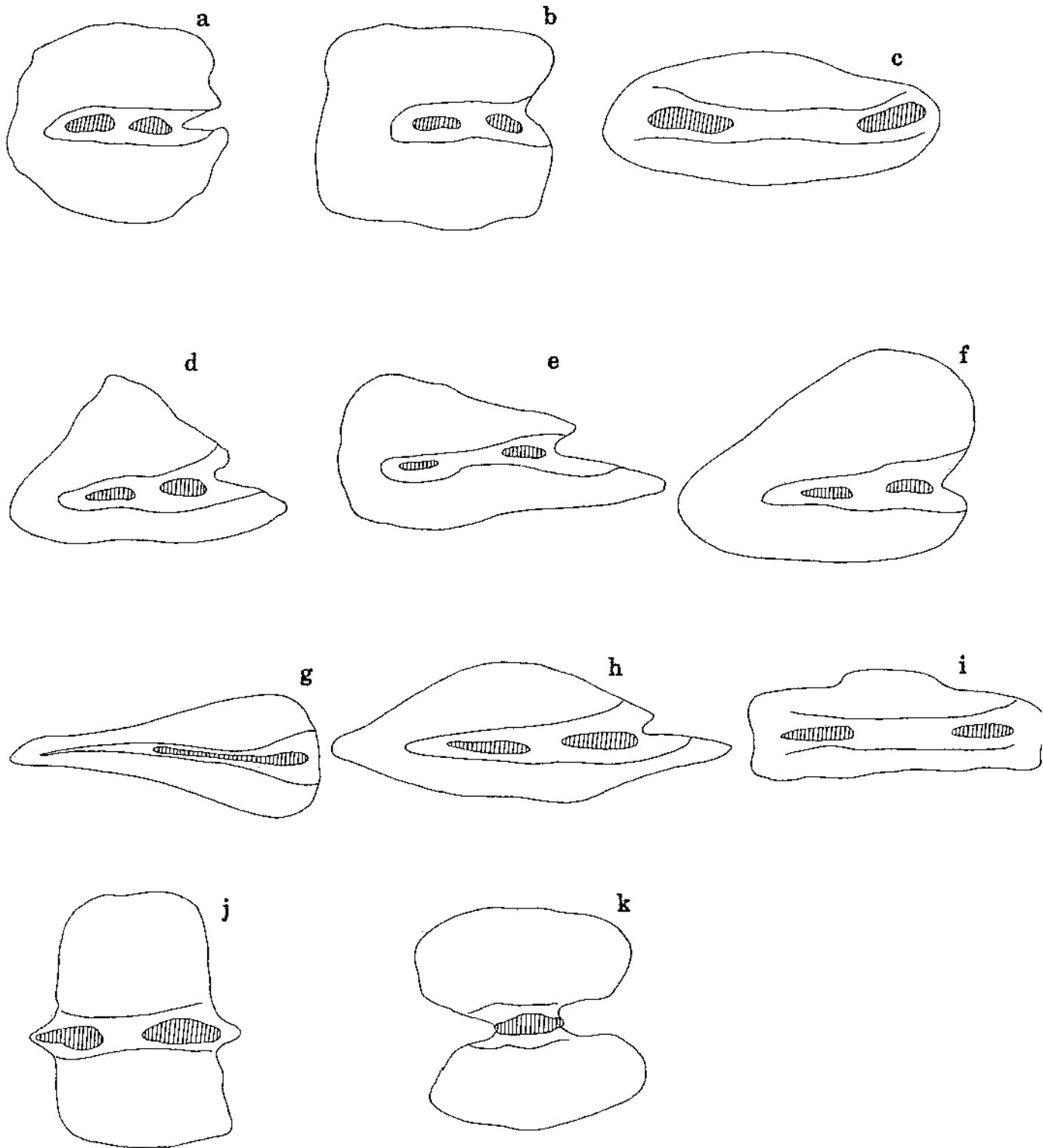


Figure 3 Schematic diagrams of the various types of otolith shape: a - discoid, b - square, c - oval, d - triangular, e - ovate, f - obovate, g - pyriform, h - fusiform, i - rectangular, j - greater in height than in length, k - hour-glass shape. The sulcus acusticus and the colliculi are hatched for orientation purposes.

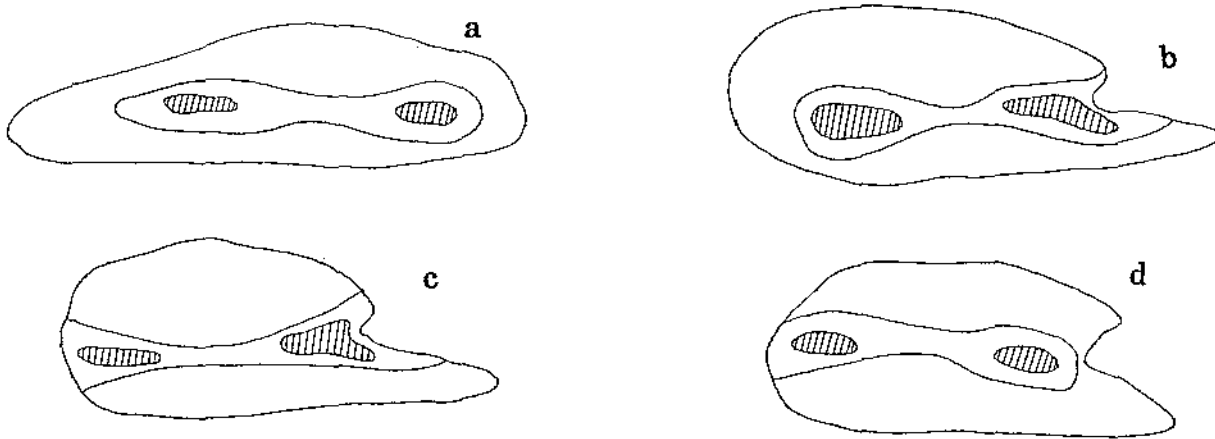


Figure 4 Schematic diagrams of the different types of sulcus acusticus openings: a - medial (sulcus acusticus does not open onto anterior and posterior margin), b - ostial (sulcus acusticus opens only onto anterior margin), c - ostio-caudal (sulcus acusticus opens onto anterior and posterior margins), d - caudal (sulcus acusticus opens only onto posterior margin). The sulcus acusticus and the colliculi are hatched for orientation purposes.

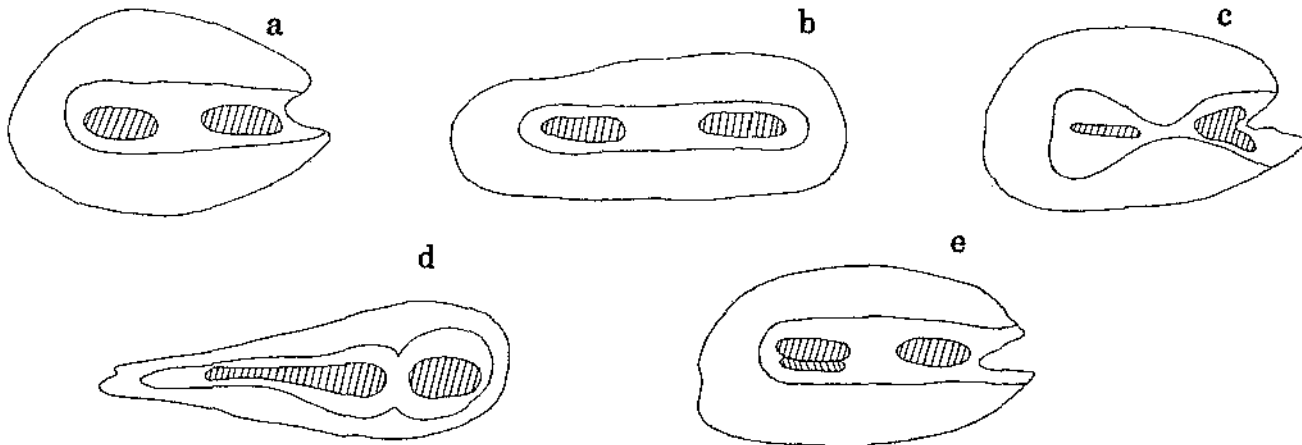


Figure 5 Schematic diagrams of the different sulcus acusticus and colliculi (hatched) types: a & b - homosulcoid sulcus acusticus (not differentiated into ostium and cauda) and homomorph colliculi (equal in size and shape), c & d - heterosulcoid sulcus acusticus (distinctly recognizable ostium and cauda) and heteromorph colliculi (different in size and shape), e - homosulcoid sulcus acusticus, homomorph colliculi with pseudo-colliculum.

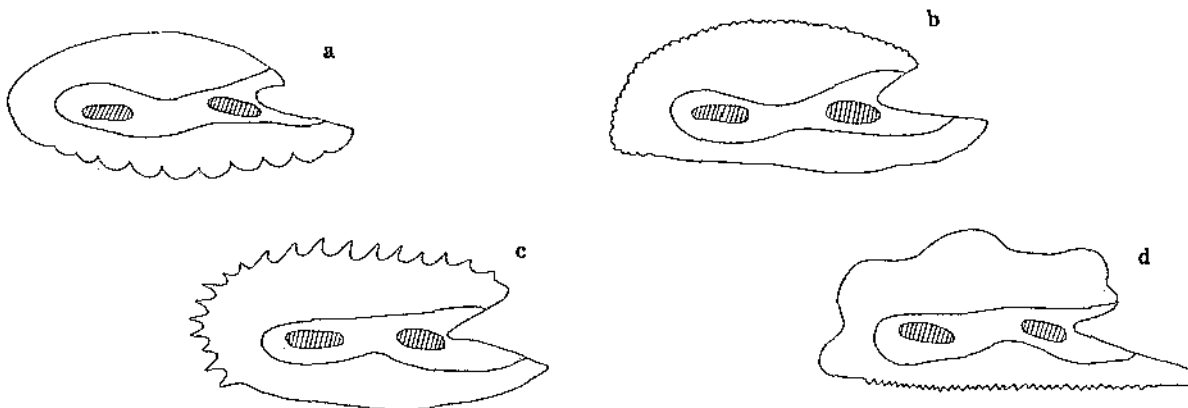


Figure 6 Schematic diagrams of otoliths showing the different types of marginal sculpture: a - dorsal and posterior margins *entire* and ventral margin *sinuate*, b - dorsal and posterior margins *crenate* and ventral margin *entire*, c - dorsal and posterior margins *dentate* and ventral margin *entire*, d - dorsal and posterior margins *lobed* and ventral margin *serrate*. The sulcus acusticus and the colliculi (hatched) are included for orientation.

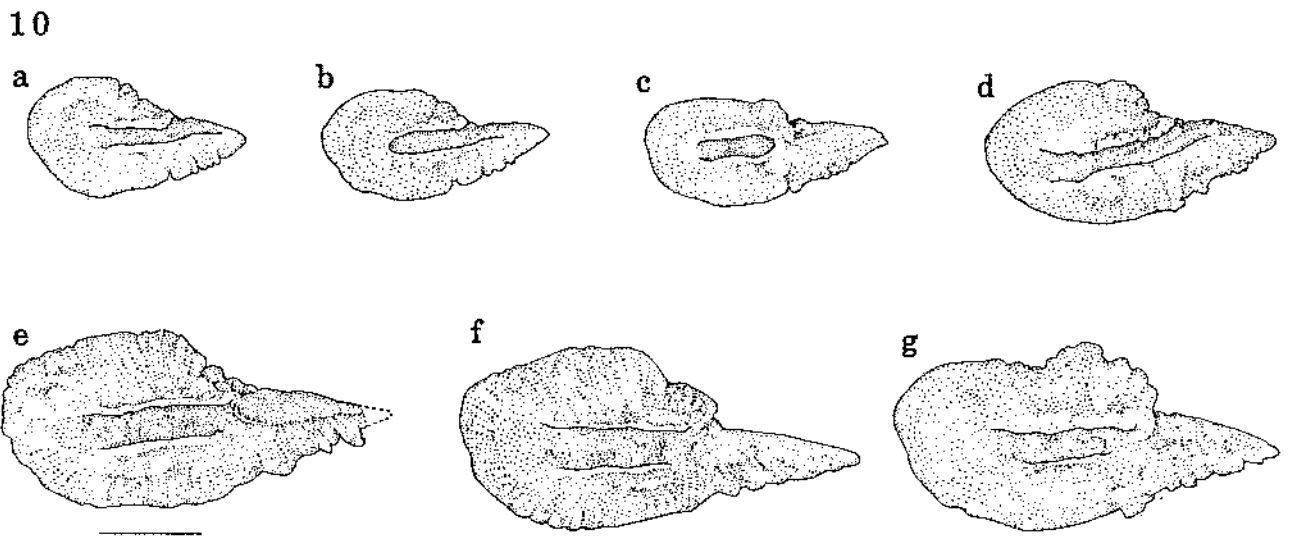
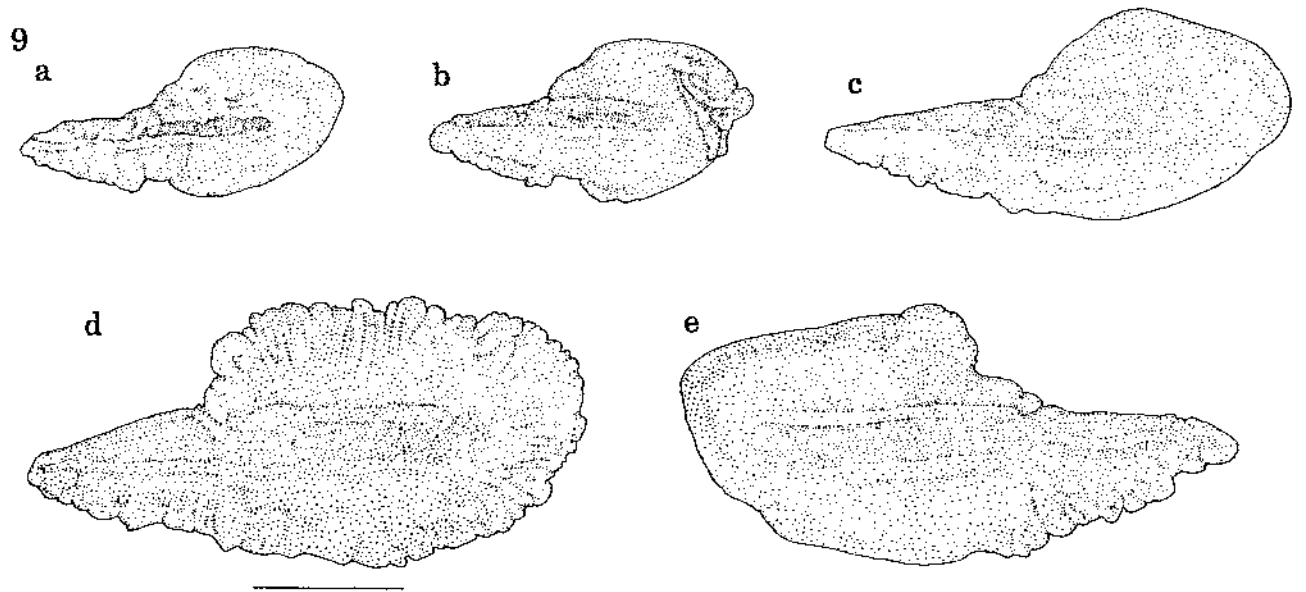


PLATE 2

Figure 9 *Bathylagus glacialis* a - 71 mm, b - 71 mm, c - 105 mm, d - 147 mm, e - 156 mm SL; Figure 10 *Bathylagus* sp. a - 75 mm, b - 83 mm, c - 95 mm, d - 115 mm, e - 170 mm, f - 170 mm, g - 180 mm SL; Figure 11 *Nansenia* sp. 103 mm SL.

together with the extremely elongate and distally acutely pointed rostrum. There is a significant difference in the size of the rostra of the various species, which can be used in order to distinguish between them. The values presented below are mean percentage rostrum length in total otolith length, the standard deviation of the mean and the range –

<i>Bathylagus antarcticus</i>	33,57 ± 6,3 %	(Range 25,0 – 42,9 %)
<i>Bathylagus euryops</i>	40,6 %	
<i>Bathylagus glacialis</i>	41,5 %	(Range 33,3 – 48,4 %)
<i>Bathylagus</i> sp	46,3 ± 6,1 %	(Range 33,3 – 52,4 %)

Nansenia sp.

(Plate 2, Figure 11)

MATERIAL Description based on a photograph provided by R. Coggan of the BAS. Specimen reference no. BAS 850690, identified by O. Gon. Catch locality: South Georgia. The specimen from which the otoliths were removed measured 103 mm SL.

DESCRIPTION

Otolith elongate ovate and sagitate in shape. **Posterior margin, dorsal and ventral margin** entire to slightly irregular. Dorsal and ventral margin of rostrum dentate. **Sulcus acusticus** heterosulcoid and ostial. **Cauda** long and narrow. **Ostium** of approximately equal length to cauda but broader. **Collum** distinctly constricted. **Crista superior** broad and bold. **Crista inferior** also broad and bold below entire sulcus acusticus. Distinct **ventral groove** present. **Rostrum** not as pointed as in *Bathylagus* species, comprising c. 40 % of total otolith length, proximally broad and distally slender but rounded. **Antirostrum** absent. **Excisura ostii** present with wide angle.

DIAGNOSTIC FEATURES

The elongate and sagitate shape, the elongate sulcus acusticus with a distinctly constricted collum in association with the large proximally broad and distally slender but rounded rostrum.

Note: The geometric shape of the otolith and the shape of the rostrum of *Nansenia* is markedly different from those of the *Bathylagus* species.

MORPHOMETRY

OL : SL Ratio

1 : 24,4

ORDER AULOPIFORMES
SUBORDER AULOPOIDEI

FAMILY Scopelarchidae

SPECIES *Benthalbella elongata* (Norman, 1937)
(Plate 3, Figure 12)

MATERIAL Description based on the otoliths of one specimen of 186 mm TL. DIFS otolith catalogue number : 1742. Catch locality : off Mawson, Antarctica. Collected by O. Gon of the RUSI.

DESCRIPTION

Otolith generally oval except for lunate anterior margin. Medio-laterally extremely thin. Medially flat with poor relief, laterally slightly convex. **Margin** lobed, except for **anterior margin** which is entire. **Sulcus acusticus** ostial, homosulcoid and reniform. **Cauda** directed dorsally and larger than **ostium**. Except for slight constriction of collum, difficult to distinguish between ostium and cauda. **Crista superior** V-shaped with wide angle. **Crista inferior** broader than crista superior. **Dorsal and ventral areas** absent. Anteriorly the otolith is distinctly lunate. **Rostrum** and **antirostrum** of near equal size. Rostrum more rounded than antirostrum distally. **Excisura ostii** lunate.

DIAGNOSTIC FEATURES

Lunate anterior margin with reniform sulcus acusticus and dorsally directed cauda.

MORPHOMETRY

OL : TL Ratio

1 : 66,67

SPECIES *Benthalbella macropinna* Bussing & Bussing, 1966
(Plate 3, Figure 13)

MATERIAL Description based on the otoliths of one specimen of unknown length and the illustration by Schwarzhans (1978).

DESCRIPTION

Otolith generally rectangular except for deep excisura ostii. Medio-laterally extremely thin. Medially flat with poor relief, laterally flat to slightly convex. **Margin** entire to slightly lobed. **Sulcus acusticus** ostial and near homosulcoid. **Ostium** and **cauda** can only be distinguished from each other by median notch in crista inferior. Entire sulcus acusticus directed dorsally. **Crista superior** relatively broad but not high. **Crista inferior** more ridge-like with distinct notch in mid-medial region. **Rostrum** and **antirostrum** of near equal size, except that rostrum is near pointed distally and antirostrum is more rounded distally. **Excisura ostii** extremely deep with acute angle.

DIAGNOSTIC FEATURES

Near rectangular shape except for deep excisura ostii and the dorsally directed sulcus acusticus.

SUBORDER ALEPISAUROIDEI

FAMILY Paralepididae

SPECIES *Lestidiops similis* (Ege, 1933)
(Plate 3, Figure 14)

MATERIAL Description based on the formalin corroded otoliths of two specimens of unknown length. The material was made available to the author by Ch. Karrer of the ZIMU. Catch locality unknown.

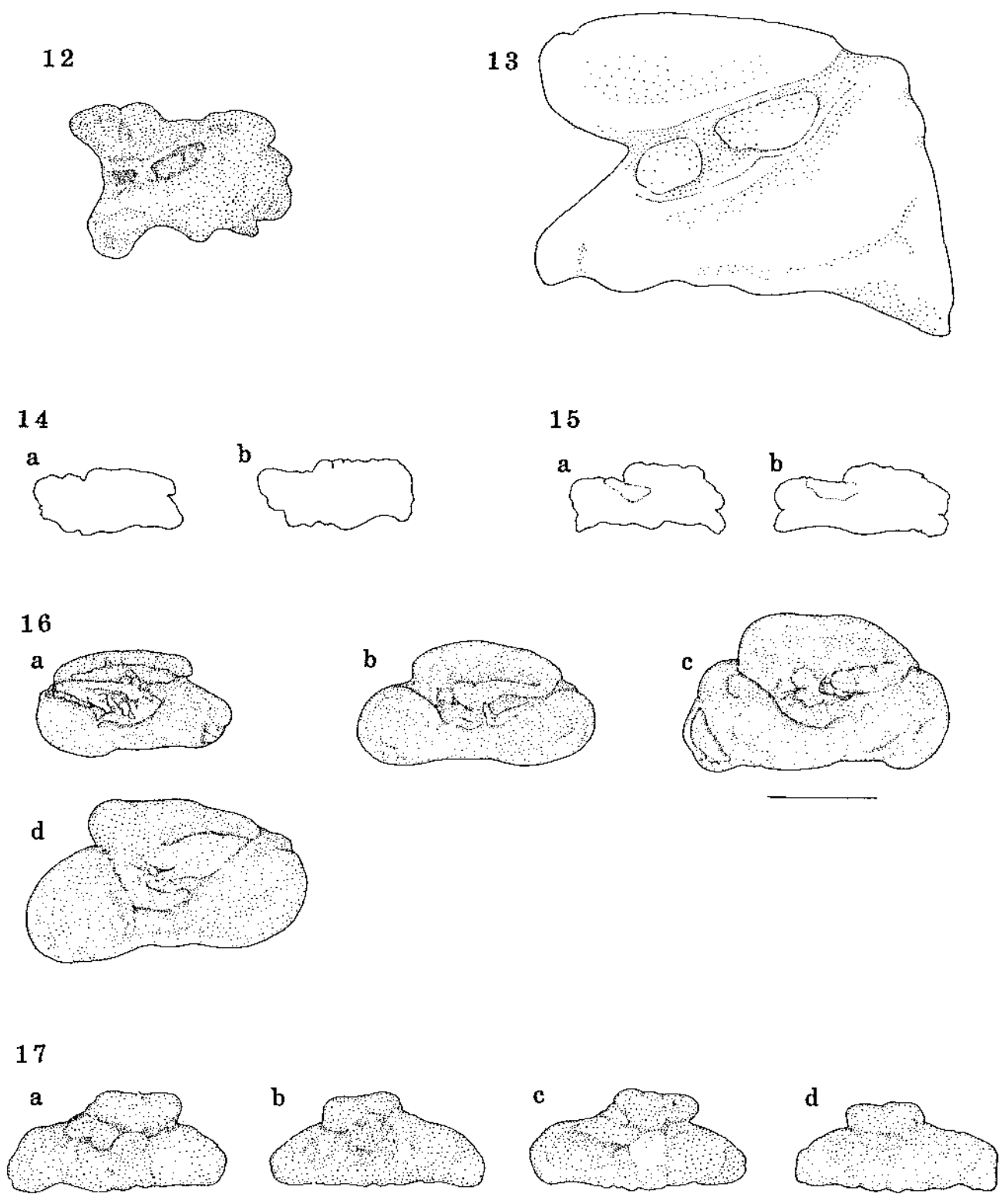


PLATE 3

Figure 12 *Benthalbella elongata* 186 mm TL; Figure 13 *Benthalbella macropinna* – length unknown; Figure 14 *Lestidiops similis* – length unknown; Figure 15 *Macroparulepis macrogeneion* – length unknown; Figure 16 *Notolepis coatsi* a – 161 mm, b – 195 mm, c – 258 mm, d – 287 mm TL; Figure 17 *Notolepis risoi* length unknown.

DESCRIPTION

Geometric shape of otolith extremely similar to *Macroparalepis macrogeneion*. **Ventral margin** entire. **Dorsal margin** sinuate to crenate. **Posterior margin** either bifid or blunt. Anterior portion of **rostrum** curved dorsally and not bifid like in *M. macrogeneion*. In all other respects identical to those of *M. macrogeneion*.

INTRASPECIFIC VARIATION

Negligible.

DIAGNOSTIC FEATURES

The elongate shape, the bifid posterior margin and the dorsally curved rostrum.

SPECIES *Macroparalepis macrogeneion* Post, 1973
(Plate 3, Figure 15)

MATERIAL Description based on the otoliths of two specimens of unknown length. Material made available to the author by Ch. Karrer of the ZIMH. Catch locality unknown.

DESCRIPTION

Otolith elongate and generally squared off anteriorly and posteriorly. **Ventral margin** generally entire to lightly irregular. **Dorsal margin** sinuate to crenate. **Sulcus acusticus** and associated structures cannot be distinguished due to poor preservation of the specimens. **Rostrum** with anterior constriction and bifid, comprising c. 45 % of total otolith length. **Posterior margin** also bifid. Ventral lobes of the bifid anterior and posterior margins are directed ventrally. **Antirostrum** small and rounded distally. **Excisura ostii** with 90 degree angle.

INTRASPECIFIC VARIATION

Negligible for the two available sets of otoliths.

DIAGNOSTIC FEATURES

The elongate shape and the bifid anterior and posterior margins.

SPECIES *Notolepis coatsi* Dollo, 1908
(Plate 3, Figure 16)

MATERIAL Description based on the otoliths of 11 specimens ranging from 140 – 287 mm TL. DIFS otolith catalogue numbers: 1209, 1298, 1313, 1361, 1377, 1395, 1440, 1441, 1744 – 1746. Catch locality: off Mawson, Antarctica and South Georgia. Collected by O. Gon of the RUSI and the BAS.

DESCRIPTION

Otolith oval to rectangular, except for raised **dorsal margin**. Medially flat with poor relief, laterally slightly convex to flat. Otolith thin and fragile. Antero- and postero-ventral corners turned down. **Margin** generally entire to faintly lobed. **Sulcus acusticus** poorly defined, ostial and heterosulcoid. **Ostium** absent, **cauda** prominent with well developed **colliculum**. **Cristae** generally fused in region anterior to cauda. **Crista inferior** knob-like. Distinct **dorsal groove** pres-

ent over caudal section. **Rostrum** prominent, rounded distally and turned down. **Antirostrum** small and rounded distally. **Excisura ostii** with variable angle.

INTRASPECIFIC VARIATION

Negligible.

DIAGNOSTIC FEATURES

The oval to rectangular shape, the fused cristae anterior to the cauda, the raised dorsal margin, the down turned antero- and postero-ventral corners, the absence of the ostium and the prominent cauda and posterior colliculum.

ONTOGENY

Negligible.

MORPHOMETRY**OL / TL Relationship**

$$TL = 55.85 OL^{1.79} \text{ mm}$$

n = 9; Std Err Est = 0,157; Coeff Det = 0,93; Corr Coeff = 0,96

Mass / TL Relationship

$$\text{Mass} = 2.87 \times 10^{-7} TL^{3.27} \text{ g}$$

n = 8; Std Err Est = 0,257; Coeff Det = 0,99; Corr Coeff = 0,99

OL / Fish Mass Relationship

$$\text{Mass} = 0.153 OL^{6.29} \text{ g}$$

n = 6; Std Err Est = 0,211; Coeff Det = 0,99; Corr Coeff = 1,0

SPECIES *Notolepis rissoi* (Bonaparte, 1840)
(Plate 3, Figure 17)

MATERIAL Description based on the otoliths of 45 specimens of unknown but near equal length. Specimens were on brief loan to the author from the ZIMH. Catch locality of the material unknown.

DESCRIPTION

Otolith elongate with distinctly elevated mid-dorsal section. Anterior and posterior ends rounded to squared-off (sometimes slightly turned down). **Dorsal margin** entire except for squared off mid-dorsal section. **Ventral margin** entire to gently crenate. **Sulcus acusticus** poorly defined, ostio-caudal and heterosulcoid. **Colliculi** heteromorph. **Anterior colliculum** prominent and large, although not very high. **Posterior colliculum** minute. **Crista superior** absent. **Crista inferior** poorly defined to absent. **Rostrum** large and rounded to squared-off distally. **Antirostrum** and **excisura ostii** absent.

INTRASPECIFIC VARIATION

Negligible.

DIAGNOSTIC FEATURES

The elongate shape, and the raised, squared-off mid-dorsal section of the dorsal margin.

Fork Length (FL). Otolith length (OL) is the distance between the anterior tip of the rostrum and the posterior margin.

ORDER SALMONIFORMES
SUBORDER ARGENTINOIDEI

FAMILY Bathylagidae

SPECIES *Bathylagus antarcticus* Günther, 1878
(Plate 1, Figure 7)

MATERIAL Description based on the otoliths of six specimens ranging from 63 – 140 mm SL. Catch locality: off Mawson, Antarctica. DIFS otolith catalogue numbers: 2021 – 2026. Collected by O. Gon of the RUSI.

DESCRIPTION

Otolith ovate, rounded posteriorly and extremely pointed anteriorly and medio-laterally thin. Medially flat with poor relief, laterally slightly convex. **Ventral** margin of rostrum serrate, remainder of ventral margin entire. **Antero-dorsal margin** sinuate to lobed (sometimes dentate). **Sulcus acusticus** ostial to ostio-pseudocaudal and homosulcoid. **Colliculi** poorly defined and heteromorph. **Ostium** only present on dorsal face of rostrum. **Crista superior** distinct and ridge-like. **Crista inferior** also ridge-like but poorly developed. **Rostrum** distinctly elongate, prominent and pointed distally. Rostrum measures $33,57 \pm 6,31$ % (Range 25 – 42,86) in total otolith length. **Antirostrum** usually absent, if present then minute and rounded distally. **Excisura ostii** usually absent, if present with wide angle.

INTRASPECIFIC VARIATION

The antirostrum is either present or absent and the sculpture of the antero-dorsal margin varies from sinuate, dentate to lobed.

MORPHOMETRY

OL : SL Ratio

1 : 44,95

n = 6; Std Dev = 5,29; Range 37,50 – 49,09

SPECIES *Bathylagus euryops* Goode & Bean, 1895
(Plate 1, Figure 8)

MATERIAL Description based on the otoliths of one specimen of unknown length, made available to the author on loan from the IRSNB otolith collection of D. Nolf. Catch locality unknown.

DESCRIPTION

The otoliths of this species are identical, in all respects, to those of *Bathylagus antarcticus*, except for the size of the rostrum which in this species measures 40,6 % in total otolith length.

SPECIES *Bathylagus glacialis* Regan, 1913
(Plate 2, Figure 9)

MATERIAL Description based on the otoliths of 10 specimens ranging from 71 – 156 mm SL. Catch locality: South Georgia. DIFS otolith catalogue numbers: 2004 – 2013. Collected by A.W. North of the BAS.

DESCRIPTION

The otoliths of this species are also similar to those of *B. antarcticus*, except for the significant difference in rostrum size.

INTRASPECIFIC VARIATION

The antirostrum is either present or absent and the sculpture of the antero-dorsal margin varies from sinuate to dentate to lobed.

ONTOGENY

In fish < 95 mm SL the sulcus acusticus is ostial, whereafter it becomes ostio-pseudocaudal.

MORPHOMETRY

OL / SL Relationship

SL = 29,45 OL^{1,334} mm

n = 9; Std Err Est = 7,95x10⁻²; Coeff Det = 0,94; Corr Coeff = 0,97

Mass / SL Relationship

Mass = 2,19x10⁻⁷ SL^{3,80} g

n = 10; Std Err Est = 0,123; Coeff Det = 0,99; Corr Coeff = 0,99

SPECIES *Bathylagus* sp.
(Plate 2, Figure 10)

MATERIAL Description based on the otoliths of 30 specimens ranging from 75 – 170 mm SL. Catch locality: South Georgia. DIFS otolith catalogue numbers: 1218 – 1222, 1258 – 1260, 1314 – 1317, 1320 – 1324, 1326 – 1332, 1732 – 1737. Collected by the BAS.

DESCRIPTION

The otoliths of this species are identical, in all respects, to those of *Bathylagus antarcticus* and *B. glacialis* except for the size of the rostrum, which in this case is larger. Mean rostrum length in total otolith length = $46,26 \pm 6,09$ % (Range 33,33 – 52,38).

MORPHOMETRY

OL / SL Relationship

SL = 26,85 OL^{1,407} mm

n = 26; Std Err Est = 0,111; Coeff Det = 0,90; Corr Coeff = 0,95

GENERAL DIAGNOSTIC FEATURES AND ROSTRUM SIZE OF BATHYLAGUS SPECIES

No diagnostic features have been presented for the individual *Bathylagus* species as they are all extremely similar in shape and are difficult to differentiate on the structure of the features on the medial face alone. The general diagnostic features can, however, be summarized as follows: The distinctly ovate shape with the clearly rounded posterior margin

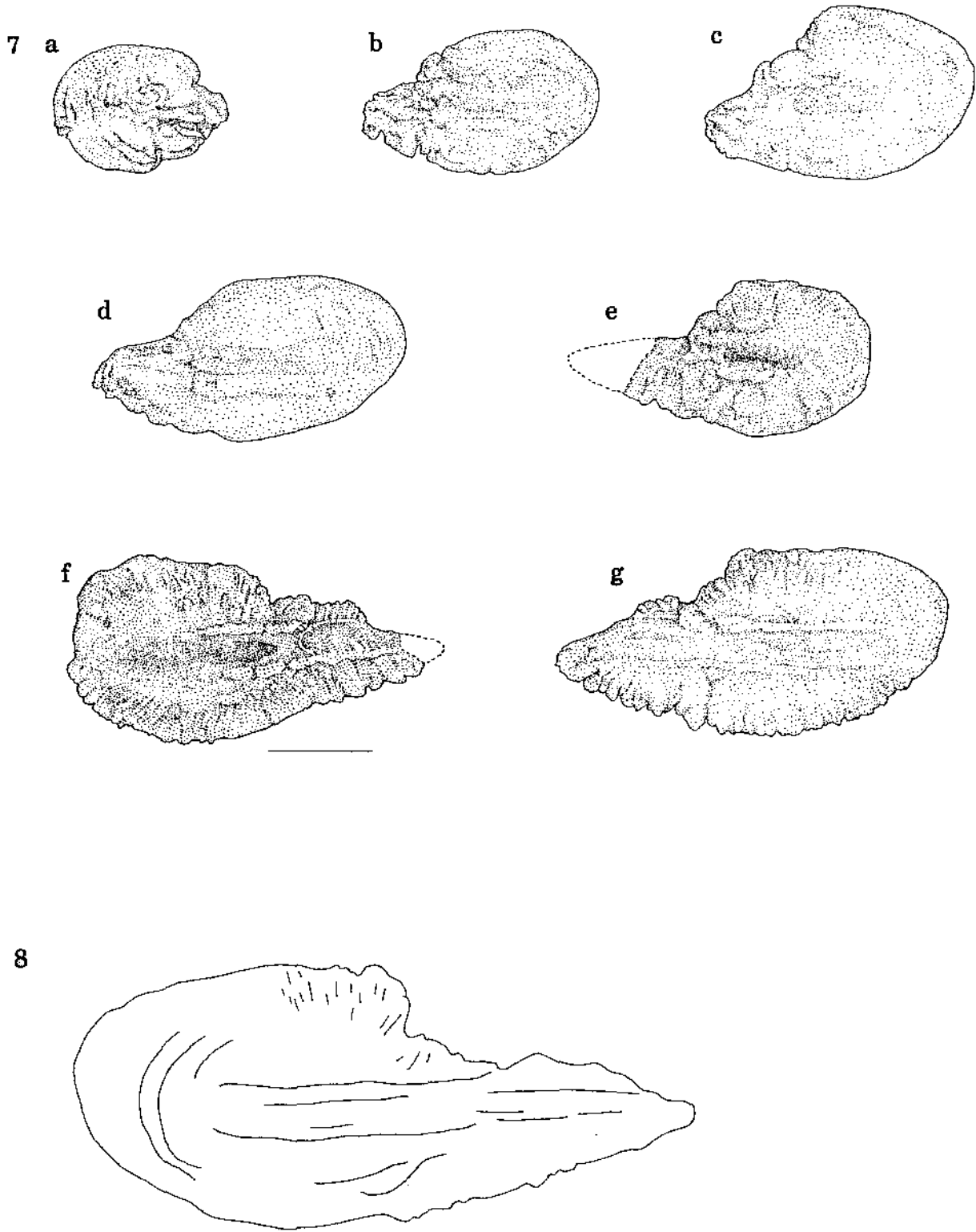


PLATE 1
Figure 7 *Bathylagus antarcticus* a - 63 mm, b - 85 mm, c - 97 mm, d - 108 mm, e - 128 mm, f - 156 mm, g - 140 mm SL; **Figure 8** *Bathylagus euryops* - length unknown.

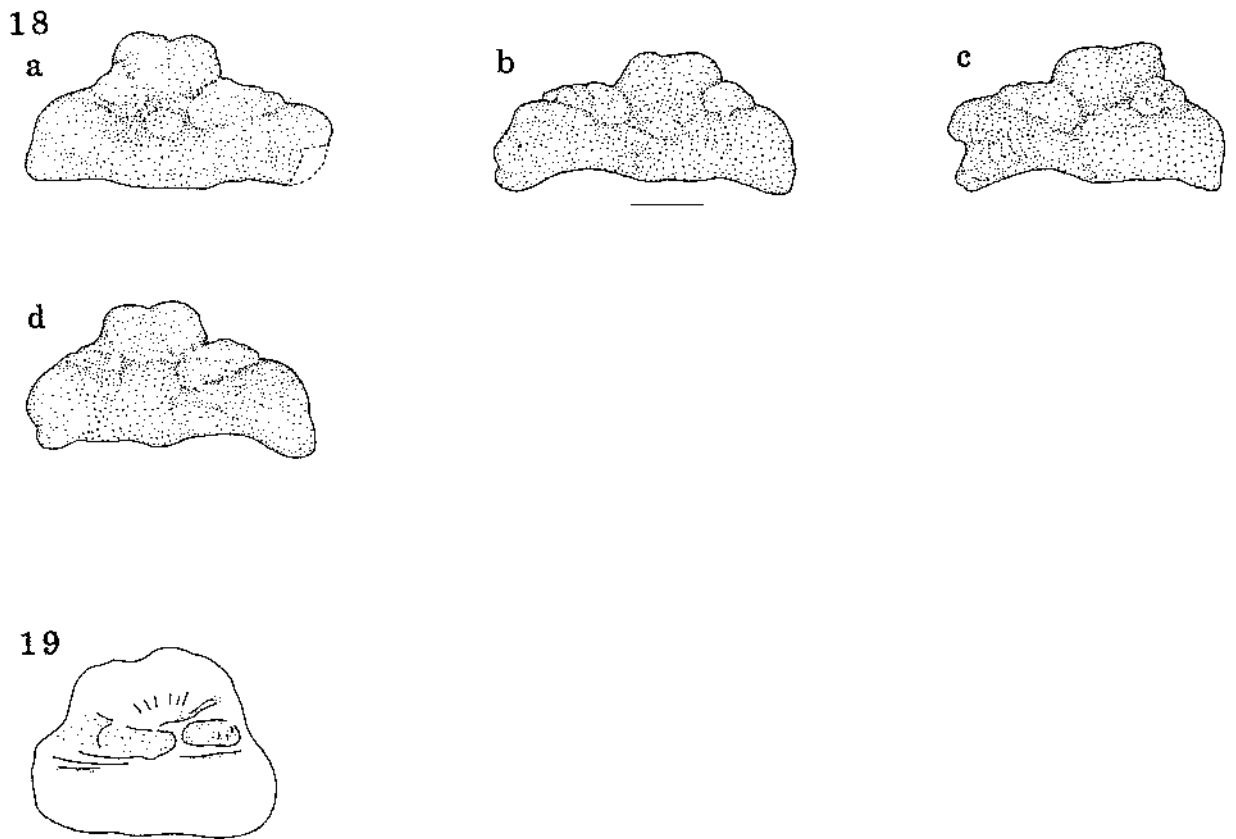


PLATE 4

Figure 18 *Paralepis coregonoides* length unknown; Figure 19 *Anotopterus pharao* length unknown.

SPECIES *Paralepis coregonoides* Risso, 1820
(Plate 4, Figure 18)

MATERIAL Description based on the otoliths of 38 specimens of unknown but near equal length. Material was on brief loan to the author from the ZIMH. Catch locality of the material unknown.

DESCRIPTION

Otolith elongate with distinctly raised, squared-off mid-dorsal section. Dorsally the raised mid-section is faintly V-shaped. Anterior and posterior ends rounded and distinctly turned down. Medial face with poor relief. **Dorsal margin** entire, except for squared-off raised portion. **Ventral margin** entire. **Sulcus acusticus** poorly defined, ostio-caudal and heterosulcoid. **Colliculi** heteromorph. **Anterior colliculum** large and prominently raised. **Posterior colliculum** smaller than anterior colliculum, but well defined. (This is the best feature with which to distinguish between the otoliths of *Notolepis rissoi* and *P. coregonoides*). **Crista superior** absent. **Crista inferior** poorly defined to absent. **Rostrum** large, rounded and curved ventrally. **Antirostrum** and **excisura ostii** absent.

INTRASPECIFIC VARIATION

Negligible.

DIAGNOSTIC FEATURES

The elongate shape, the raised, squared-off, slightly V-

shaped mid-dorsal section of the dorsal margin, the well defined posterior colliculum and the turned down antero- and postero-ventral corners.

FAMILY Anotopteridae

SPECIES *Anotopterus pharao* Zugmayer, 1911
(Plate 4, Figure 19)

MATERIAL Description based on the otoliths of one specimen of unknown length made available to the author from the IRSNB otolith collection of D. Nolf. Catch locality unknown.

DESCRIPTION

Otolith square to near discoid. **Margin** entire. Medially flat with poor relief, laterally weakly convex. **Sulcus acusticus** ostio-caudal and homosulcoid. **Collum** indistinguishable. Both **anterior** and **posterior colliculum** well developed and prominent. **Crista superior** poorly developed. **Dorsal area** present. **Crista inferior** better developed than crista superior. **Ventral area** absent. **Rostrum** short, broad and rounded distally. **Antirostrum** and **excisura ostii** absent.

DIAGNOSTIC FEATURES

The square to near discoid shape, the entire margin and the homomorph and prominent colliculi.

ORDER MYCTOPHIFORMES

FAMILY Myctophidae

SPECIES *Ceratoscopelus townsendi* (Eigenmann & Eigenmann, 1889)
(Plate 5, Figure 20)

MATERIAL Description based on the otoliths of three specimens of unknown length and the illustration presented by Schwarzhans (1978).

DESCRIPTION

Otolith generally ovate. Medially flat with poor relief, laterally slightly convex. **Margin** generally entire, except for notch in **posterior margin** and two or three lobes on **dorsal margin**. **Sulcus acusticus** ostial and heterosulcoid. **Collum** ventrally distinctly constricted. **Ostium** and **cauda** well differentiated. **Colliculi** near homomorph, although **anterior colliculum** slightly larger than **posterior colliculum**. Distinct **pseudo-colliculum** present below posterior colliculum. **Crista superior** poorly developed, anterior portion slightly better developed than posterior section. **Crista inferior** broad. Distinct **ventral groove** present. **Dorsal area** slightly V-shaped but shallow. **Rostrum** prominent and large, proximally broad, tapering to rounded distal end, comprising c. 33 % of total otolith length. **Antirostrum** small and rounded distally. **Excisura ostii** with acute angle.

INTRASPECIFIC VARIATION

Negligible.

DIAGNOSTIC FEATURES

The ovate shape, the notch in the posterior margin and the lobes of the mid-dorsal margin, the homomorph colliculi and the presence of the pseudo-colliculum in association with the large rostrum.

SPECIES *Ceratoscopelus warmingii* (Lütken, 1892)
(Plate 5, Figure 21)

MATERIAL Description based on the study by Hecht & Hecht (1978). Catch locality : South African east coast. Collected by G.J.B. Ross of the PEM.

DESCRIPTION

Otolith ovate. **Margin** generally entire to slightly crenate. **Sulcus acusticus** ostial and homosulcoid. **Collum** not constricted. **Anterior** and **posterior colliculi** well developed and typically myctophiform. Both **cristae** poorly developed to absent. **Rostrum** short, proximally broad and distally rounded. **Antirostrum** absent. **Excisura ostii** with wide angle.

DIAGNOSTIC FEATURES

The ovate shape, the ostial and homosulcoid sulcus acusticus and the typically myctophiform colliculi.

MORPHOMETRY**OL : SL Ratio**

1 : 20,0

SPECIES *Electrona antarctica* (Günther, 1878)
(Plate 5, Figure 22)

MATERIAL Description based on the otoliths of 26 specimens ranging from 58 – 100 mm SL. Catch locality : South Georgia and off Mawson, Antarctica. DIFS otolith catalogue numbers: 821, 822, 1193 – 1203, 1215, 1226 – 1237. Collected by the BAS, O. Gon of the RUSI and P.A. Hulley of the SAM.

DESCRIPTION

Otolith dorso-ventrally reniform. **Anterior margin** slightly concave. Ventral half of otolith slightly bulbous. Medially flat, laterally convex. **Margin** entire. **Sulcus acusticus** homosulcoid and ostial. **Anterior** and **posterior colliculi** generally homomorph. **Pseudo-colliculum** generally present below posterior colliculum. Both **cristae** poorly developed. **Rostrum** and **antirostrum** poorly developed and rounded distally. **Excisura ostii** present with wide angle.

INTRASPECIFIC VARIATION

Negligible.

DIAGNOSTIC FEATURES

The dorso-ventral reniform-like geometric shape, the homomorph colliculi in association with the pseudo-colliculum below the posterior colliculum and the homosulcoid sulcus acusticus.

MORPHOMETRY**OL / SL Relationship**

$$SL = 31,42 OL^{1,106} \text{ mm}$$

n = 19; Std Err Est = $7,76 \times 10^{-2}$; Coeff Det = 0,92; Corr Coeff = 0,96

Mass / SL Relationship

$$\text{Mass} = 1,08 \times 10^{-5} SL^{3,05} \text{ g}$$

n = 19; Std Err Est = 0,237; Coeff Det = 0,94; Corr Coeff = 0,97

OL / Fish Mass Relationship

$$\text{Mass} = 0,358 OL^{5,97} \text{ g}$$

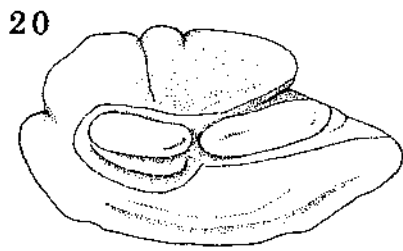
n = 26; Std Err Est = 0,172; Coeff Det = 0,97; Corr Coeff = 0,98

SPECIES *Electrona carlsbergi* (Taning, 1932)
(Plate 5, Figure 23)

MATERIAL Description based on the otoliths of 24 specimens ranging from 69 – 105 mm TL. DIFS otolith catalogue numbers: 823, 1250, 1253 – 1360, 1362, 1363, 1378 – 1382, 1386 – 1391. Catch locality: South Georgia. Collected by the BAS.

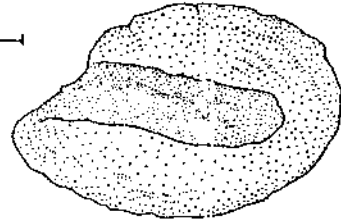
DESCRIPTION

Otolith discoid in shape although the ventral margin tends to be triangular. **Dorsal margin** entire to gently lobed. **Ventral margin** generally entire. Medially flat with poor relief, laterally slightly convex. **Sulcus acusticus** homosulcoid and ostial. **Collum** not constricted. **Colliculi** heteromorph. **Ante-**



21

1 mm

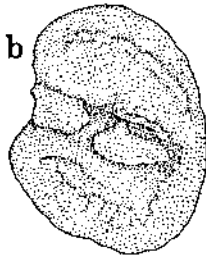


22

a



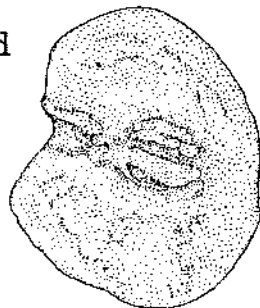
b



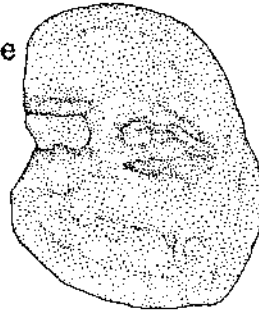
c



d

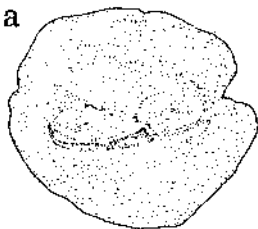


e

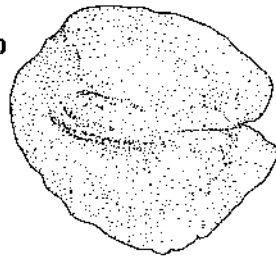


23

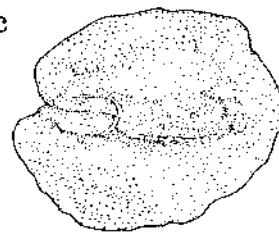
a



b



c



d

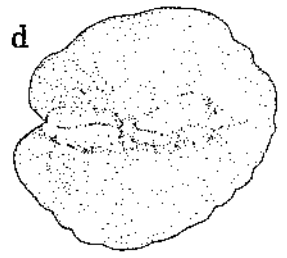


PLATE 5

Figure 20 *Ceratoscopelus townsendi* - length unknown; Figure 21 *Ceratoscopelus warmingii* 34 mm SL; Figure 22 *Electrona antarctica* a - 58 mm, b - 65 mm, c - 72 mm, d - 87 mm, e - 100 mm SL; Figure 23 *Electrona carlsbergi* a - 90 mm, b - 88 mm, c - 99 mm, d - 105 mm TL.

rior **colliculum** double, **posterior colliculum** single. Delicate crenate ridge situated ventrally in **cauda** below posterior colliculum. Both **cristae superior** and **inferior** present but poorly developed. **Dorsal area** present. **Rostrum** and **antirostrum** of equal size and rounded distally. **Excisura ostii** present with acute angle.

INTRASPECIFIC VARIATION

Negligible

DIAGNOSTIC FEATURES

The generally discoid shape, the slightly triangular ventral margin, the near equally sized rostrum and antirostrum, the double anterior colliculum, the single posterior colliculum and the crenate caudal ridge below the posterior colliculum.

MORPHOMETRY

OL : TL Ratio

1 : 29,13

n = 24; Std Dev = 1,01; Range 27,00 – 30,75

SPECIES *Electrona subaspera* (Günther, 1864)
(Plate 6, Figure 24)

MATERIAL Description based on the illustration by Schwarzhans (1980). Fish length unknown. Catch locality: Southern Ocean.

DESCRIPTION

Otolith generally discoid. Medially flat, laterally slightly convex. **Margin** entire to lobed postero-dorsally. **Sulcus acusticus** near homosulcoid and ostial. **Collum** slightly constricted ventrally. **Ostium** approximately twice the size of **cauda**. **Colliculi** homo- to heteromorph (similar shape, but different in size). **Anterior colliculum** approximately twice the size of **posterior colliculum**. **Pseudo-colliculum** present below posterior colliculum. **Crista superior** poorly developed but nevertheless slightly ridge-like. **Crista inferior** broad but not well developed. **Rostrum** proximally broad, short and pointed distally, comprising c. 19 % of total otolith length. **Antirostrum** short, broad and rounded distally. **Excisura ostii** deep with acute angle.

DIAGNOSTIC FEATURES

The discoid shape, the near homosulcoid sulcus acusticus, the typically myctophiform colliculi, the large anterior colliculum in comparison to the posterior colliculum, the pointed rostrum and the rounded antirostrum.

SPECIES *Gymnoscopelus braueri* (Lönnerberg, 1905)
(Plate 6, Figure 25)

MATERIAL Description based on the otoliths of 26 specimens ranging from 40,5 – 120 mm SL. DIFS otolith catalogue numbers: 818, 819, 1210 – 1214, 1292 – 1297, 1300 – 1311, 1334. Catch locality: South Georgia. Collected by the BAS.

DESCRIPTION

Otolith generally discoid, except for rostral projections. Medially flat with poor relief, laterally strongly convex. **Margin**

generally entire. **Sulcus acusticus** ostial and homosulcoid. **Ostium** and **cauda** nearly indistinguishable. **Collum** not constricted. **Colliculi** near homomorph and well developed. **Crista superior** ridge-like and well developed over ostial section of sulcus acusticus. **Crista inferior** broad and bold particularly below collum. **Rostrum** short, broad proximally and pointed distally. **Antirostrum** small and rounded distally to absent. **Excisura ostii** with wide angle.

INTRASPECIFIC VARIATION

Negligible.

DIAGNOSTIC FEATURES

The discoid shape, the ostial and homosulcoid sulcus acusticus, the entire margin and the near homomorph and typically myctophiform colliculi.

ONTOGENY

With an increase in fish size the general geometric shape of the otoliths changes from generally more dorso-ventrally oval to discoid.

MORPHOMETRY

OL / SL Relationship

SL = 44,84 OL^{0,85} mm

n = 10; Std Err Est = 9,31x10⁻²; Coeff Det = 0,94; Corr Coeff = 0,97

Mass / SL Relationship

Mass = 4,59x10⁻⁸ SL^{2,68} g

n = 9; Std Err Est = 0,281; Coeff Det = 0,93; Corr Coeff = 0,96

SPECIES *Gymnoscopelus fraseri* (Fraser-Brunner, 1931)
(Plate 6, Figure 26)

MATERIAL Description based on the otoliths of four specimens ranging from 57 – 77 mm SL. Catch locality unknown. Material made available to the author from the SAM collection of P.A. Hulley.

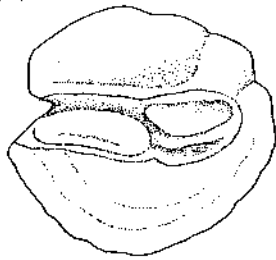
DESCRIPTION

Otolith ovate to oval. **Posterior margin** blunt. **Dorsal margin** straight. **Ventral margin** slightly bulbous. Medially flat, laterally slightly concave. **Margin** entire except for some (usually three) slight lobes on the posterior margin. **Sulcus acusticus** ostial and homosulcoid. **Ostium** and **cauda** distinguishable from each other by slightly constricted **collum**. **Ostium** approximately twice the size of **cauda**. Both **anterior** and **posterior colliculi** present but heteromorph, anterior colliculum approximately twice the size of the posterior colliculum. Both **cristae superior** and **inferior** present, but poorly defined. **Rostrum** prominent, proximally broad but pointed distally, comprising c. 17 % of total otolith length. **Antirostrum** also prominent although only half the size of rostrum and rounded distally. **Excisura ostii** small with angle of c. 90 degrees.

INTRASPECIFIC VARIATION

Negligible.

24



25

a



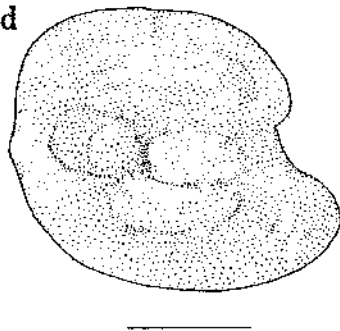
b



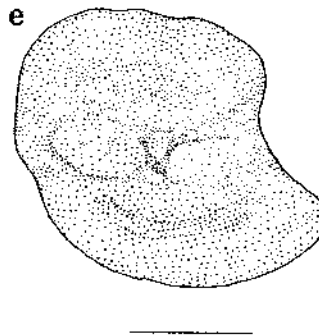
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d

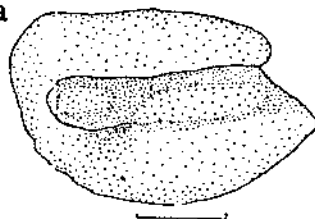


e



26

a



b

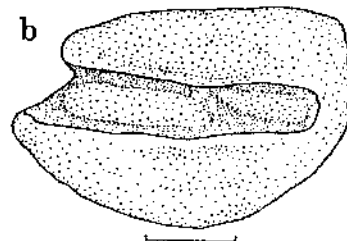


PLATE 6

Figure 24 *Electrona subaspera* – length unknown; Figure 25 *Gymnoscopelus braueri* a – 40,5 mm SL, b – 72 mm TL, c – 74 mm SL, d – 118 mm SL, e – 139 mm SL; Figure 26 *Gymnoscopelus fraseri* a – 57 mm, b – 77 mm SL.

DIAGNOSTIC FEATURES

The ovate to oval shape, the straight dorsal margin, the associated bulbous ventral margin, the ostial and homosulcoid sulcus acusticus and the large heteromorph colliculi.

MORPHOMETRY**OL : SL Ratio**

1 : 20,98

n = 4; Range 20,31 – 21,50

SPECIES *Gymnoscopeus nicholsi* (Gilbert, 1911)
(Plate 7, Figure 27)

MATERIAL Description based on the otoliths of 30 specimens ranging from 127 – 184 mm TL. Catch locality: South Shetland, South Georgia and Elephant Islands. DIFS otolith catalogue numbers: 120 – 138, 816, 817, 1318, 1333, 1366, 1437 – 1439, 1747 – 1749. Collected by the BAS and by Y. Naito of the NIPRT.

DESCRIPTION

Otolith ovate, rounded posteriorly, pointed anteriorly. Medially flat with poor relief, laterally slightly concave. **Dorsal margin** nearly straight and entire. **Ventral margin** bulbous and coarsely dentate. **Posterior margin** with some (usually three) slight lobes (similar to *G. fraseri*). **Sulcus acusticus** slightly heterosulcoid and ostial. **Ostium** and **cauda** poorly distinguishable from each other. **Colliculi** heteromorph, anterior colliculum approximately twice the size of posterior colliculum. **Crista superior** ridge-like and only clearly defined over anterior portion of ostium. **Crista inferior** only clearly defined below anterior portion of cauda. **Rostrum** prominent, proximally broad and pointed distally, comprising c. 25 % of total otolith length. **Antirostrum** approximately half the size of rostrum and rounded to pointed distally. **Excisura ostii** deep with acute angle.

INTRASPECIFIC VARIATION

Negligible.

DIAGNOSTIC FEATURES

The virtually straight and entire dorsal margin, the dentate and bulbous ventral margin. The otoliths of *G. fraseri* and *G. nicholsi* are extremely similar in their general geometric shape. They are, however, easily distinguishable from each other by the sculpture of the margins, particularly as regards the ventral margin.

MORPHOMETRY**OL / TL Relationship**

TL = 21,57 OL^{1,09} mm

n = 28; Std Err Est = 7,07x10⁻²; Coeff Det = 0,65; Corr Coeff = 0,81

Mass / TL Relationship

Mass = 1,23x10⁻⁵ TL^{2,87} g

n = 26; Std Err Est = 7,93x10⁻²; Coeff Det = 0,90; Corr Coeff = 0,95

SPECIES *Gymnoscopeus opisthopterus*

Fraser-Brunner, 1949

(Plate 7, Figure 28)

MATERIAL Description based on the otoliths of eight specimens ranging from 80 – 158 mm SL. Catch locality: 73° 26' S, 22° 04' W. DIFS otolith catalogue numbers: 1980 – 1987. Collected by the AWI.

DESCRIPTION

Note: The otoliths were removed from formalin fixed material and some were severely corroded.

Otolith dorso-ventrally longer than antero-posteriorly. Medially flat with poor relief, laterally slightly convex. **Margin** entire. **Sulcus acusticus** ostial and homosulcoid. **Ostium** and **cauda** distinguishable from each other by slightly constricted **collum**. **Colliculi** well developed and near homomorph with pseudo-colliculum below posterior colliculum. **Crista superior** present but poorly developed over entire sulcus acusticus. **Crista inferior** slightly more prominent than crista superior. Distinct **ventral groove** present. **Rostrum** and **antirostrum** usually absent, if present, then rounded distally. **Excisura ostii**, if present, with wide angle.

DIAGNOSTIC FEATURES

The generally dorso-ventrally oval to rectangular shape, the typical myctophiform sulcus acusticus with prominent anterior and posterior colliculi.

MORPHOMETRY**OL : SL Ratio**

1 : 65,32

n = 8; Std Dev = 9,73; Range 49,10 – 75,61

Mass / SL Relationship

Mass = 1,05x10⁻⁵ SL^{3,0} g

n = 8; Std Err Est = 9,98x10⁻²; Coeff Det = 0,98; Corr Coeff = 0,99

SPECIES *Gymnoscopeus piabilis* (Whitley, 1931)

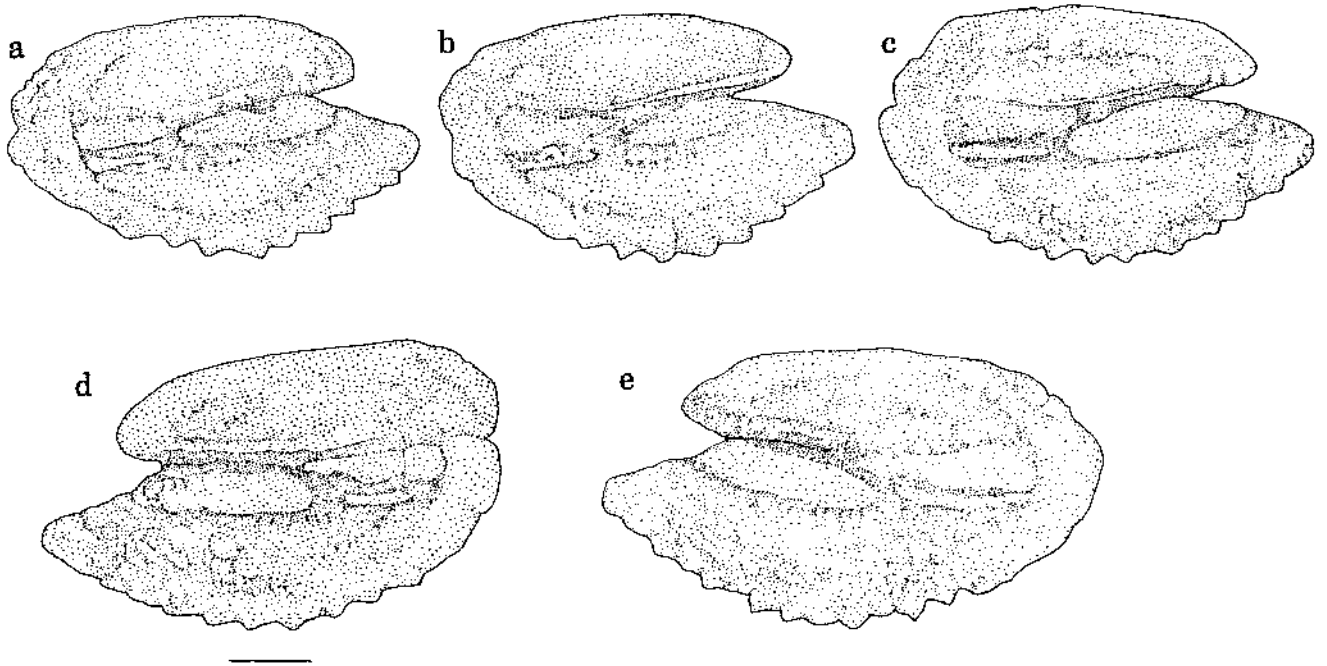
(Plate 7, Figure 29)

MATERIAL Description based on the illustration presented by Schwarzhan (1980). Catch locality: South West Atlantic. Fish length unknown.

DESCRIPTION

Otolith oval. **Dorsal margin** entire, **ventral margin** slightly serrate. **Posterior margin** with distinct notch. **Sulcus acusticus** homosulcoid and ostial. **Ostium** approximately three times length of **cauda**. **Collum** slightly constricted ventrally. **Colliculi** heteromorph. **Anterior colliculum** approximately three times length of **posterior colliculum**. **Pseudo-colliculum** distinctly present below posterior colliculum. **Crista superior** poorly developed. **Crista inferior** broad but also poorly developed. **Dorsal area** allantoid in shape but rather obscure. **Rostrum** short, broad and rounded distally, comprising c. 16 % of total otolith length. **Antirostrum** approximately quarter size of rostrum and pointed distally. **Excisura ostii** well developed with acute angle.

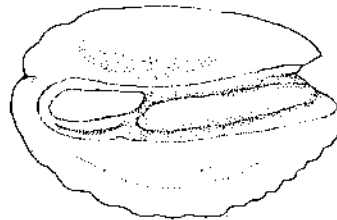
27



28



29



30

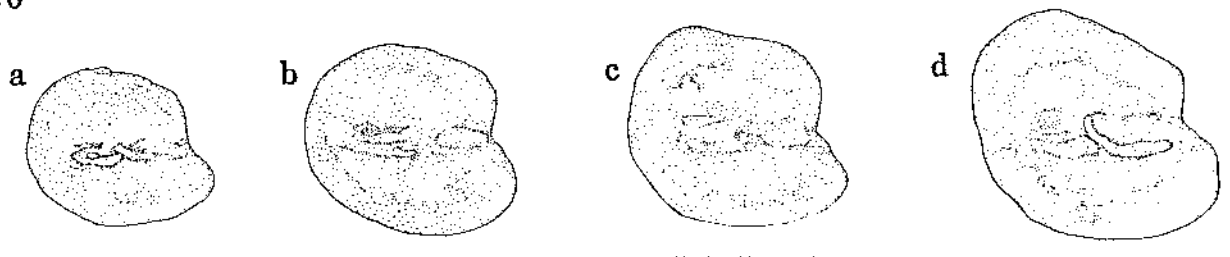


PLATE 7

Figure 27 *Gymnoscopelus nichalsi* a - 149 mm, b - 127 mm, c - 156 mm, d - 184 mm, e - 180 mm TL; Figure 28 *Gymnoscopelus opisthopterus* - length unknown; Figure 29 *Gymnoscopelus piabilis* - length unknown; Figure 30 *Krefflichthys anderssoni* a - 52 mm, b - 71 mm, c - 71 mm, d - 82 mm TL.

DIAGNOSTIC FEATURES

The oval shape with the small but distinct notch in the posterior margin, the smooth dorsal margin and the dentate ventral margin, the homosulcoid sulcus acusticus, the large anterior and small posterior colliculum and the distally pointed antirostrum.

SPECIES *Krefflichthys anderssoni* (Lönnerberg, 1905)
(Plate 7, Figure 30)

MATERIAL Description based on the otoliths of 21 specimens ranging from 33 – 66 mm TL. Catch locality: South Georgia. DIFS otolith catalogue numbers: 806, 807, 1205 – 1208, 1243 – 1247, 1255, 1256, 1262, 1284 – 1287, 1342, 1348 – 1352. Collected by the BAS and P.A. Hulley of the SAM.

DESCRIPTION

Otolith discoid to sub-quadrangle. Medially flat, laterally slightly convex. **Margin** entire. **Sulcus acusticus** ostial and heterosulcoid. **Ostium** and **cauda** continuous but collum high and constricted. **Cauda** generally larger than ostium. **Colliculi** heteromorph. Distinct **pseudo-colliculum** present in cauda below posterior colliculum. **Cristae superior** and **inferior** poorly developed. **Ventral area** sometimes present. **Rostrum** and **antirostrum** rounded anteriorly. **Excisura ostii** present with wide angle c. 160 degrees.

INTRASPECIFIC VARIATION

Negligible.

DIAGNOSTIC FEATURES

The discoid to sub-quadrangle shape, the ostial and heterosulcoid sulcus acusticus, the distinctive myctophiform colliculi plus the presence of a pseudo-colliculum in the cauda.

MORPHOMETRY**OL : TL Ratio**

1 : 42,55

n = 22; Std Dev = 3,94; Range 30,48 – 47,80

SPECIES *Lampanychthys achirus* Andriyashev, 1962.
(Plate 8, Figure 31)

MATERIAL Description based on the otoliths of two specimens of 147 and 160 mm TL. Catch locality: South Georgia. DIFS otolith catalogue numbers: 1319, 1383. Collected by the BAS.

DESCRIPTION

Otolith dorso-ventrally rectangular. Medially flat with poor relief, laterally strongly convex. **Margin** entire. **Sulcus acusticus** situated mid-medially, homosulcoid and ostial. **Colliculi** hetero- to homomorph. **Crista superior** absent. **Crista inferior** present but poorly defined. **Rostrum**, **antirostrum** and **excisura ostii** absent. Prominent **ventral area** present.

DIAGNOSTIC FEATURES

Dorso-ventral rectangular shape with the mid-medially situated ostial and homosulcoid sulcus acusticus.

MORPHOMETRY**OL : TL Ratio**

1 : 82,88

n = 2; Range 82,47 – 83,29

SPECIES *Lobianchia gemellari* (Cocco, 1838)
(Plate 8, Figure 32)

MATERIAL Description based on the otoliths of two specimens of 26 and 58 mm SL made available to the author on loan from the ZIMH, and the illustration by Schwarzzhans (1978).

DESCRIPTION

Otolith ovate. Medially flat with poor relief, laterally slightly convex. **Dorsal** and **posterior margins** entire. **Ventral margin** slightly serrate. **Sulcus acusticus** ostial and near homosulcoid. **Collum** with slight ventral notch. **Ostium** c. twice the size of **cauda**. **Colliculi** heteromorph, but well developed. **Anterior colliculum** c. twice the size of **posterior colliculum**. **Pseudo-colliculum** present below posterior colliculum. **Crista superior** somewhat ridge-like but poorly developed. **Crista inferior** broad and wide below cauda and half of ostium. **Dorsal area** large but shallow. **Rostrum** short, broad proximally and near pointed distally. **Antirostrum** small and pointed distally. **Excisura ostii** small with extremely acute angle.

DIAGNOSTIC FEATURES

The ovate shape, the entire dorsal and posterior margins, the serrate ventral margin, the presence of a pseudo-colliculum and the short but distally pointed rostrum and antirostrum.

SPECIES *Notoscopelus resplendens* (Richardson, 1845)
(Plate 8, Figure 33)

MATERIAL Description based on the otoliths of five specimens ranging from 20 – 67mm SL made available to the author from the ZIMH, and the illustration by Schwarzzhans (1980). Catch locality unknown.

DESCRIPTION

Otolith oval. Medially flat with poor relief, laterally slightly convex. **Dorsal margin** entire. **Posterior margin** sinuate. **Ventral margin** slightly serrate. **Sulcus acusticus** ostial and homosulcoid. **Ostium** approximately four times length of **cauda**. **Collum** with slight ventral constriction. **Colliculi** heteromorph. **Anterior colliculum** c. four times size of **posterior colliculum**. **Crista superior** ridge-like but poorly developed. Distinct **pseudo-colliculum** present below posterior colliculum. **Crista inferior** broad but also poorly developed. **Dorsal area** present but shallow and elongate. **Rostrum** short and blunt distally, comprising c. 10 % of total otolith length. **Antirostrum** minute and pointed distally. **Excisura ostii** shallow with near rectangular angle.

DIAGNOSTIC FEATURES

The oval shape, the ostial and homosulcoid sulcus acusticus, the entire dorsal margin, the slightly serrate ventral margin, the sinuate posterior margin, the extremely short and dis-

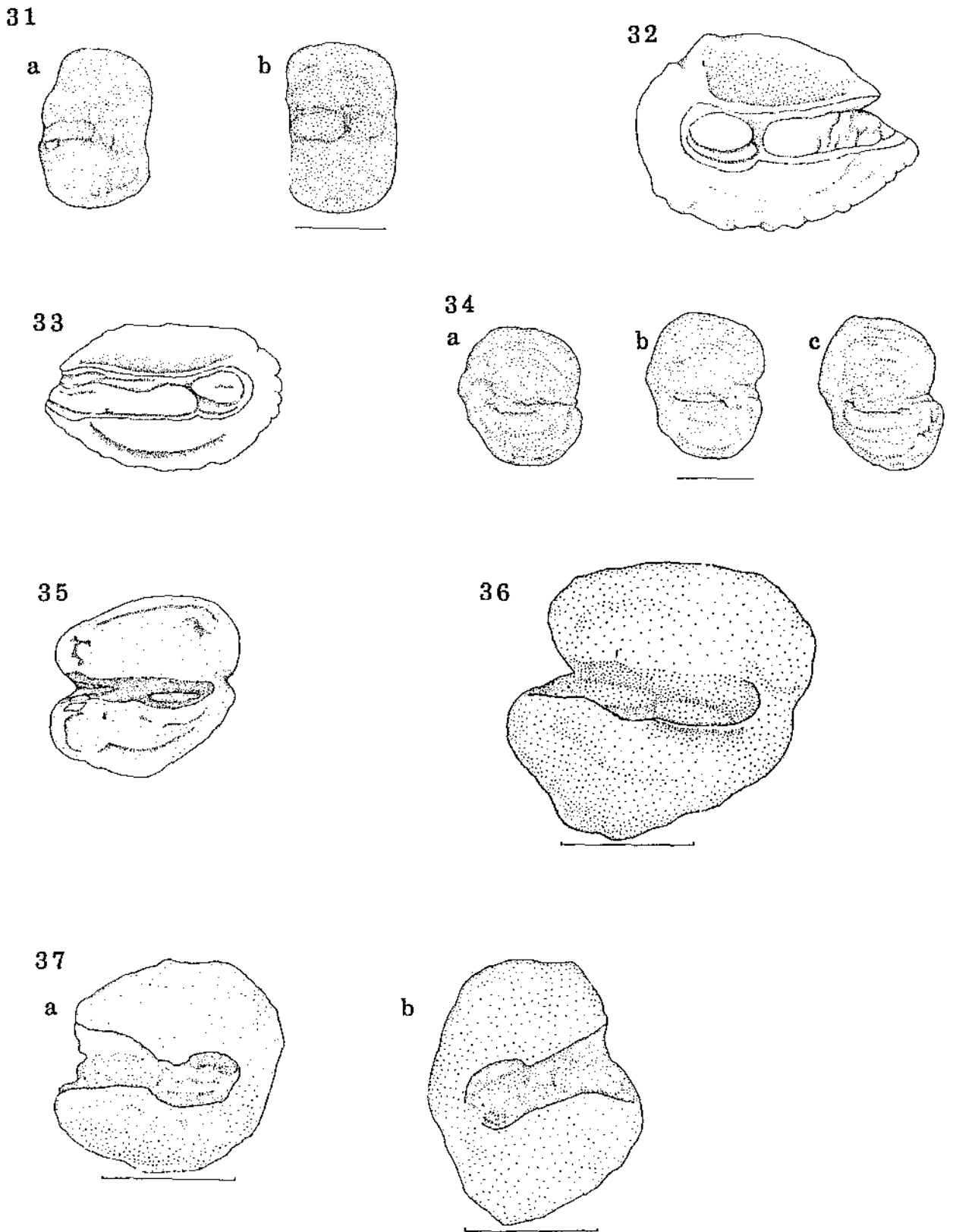


PLATE 8

Figure 31 *Lampanychthus achirus* a - 147 mm, b - 160 mm TL; Figure 32 *Lobianchia gemellari* - length unknown; Figure 33 *Notoscopeus resplendens* - length unknown; Figure 34 *Protomyctophum bolini* a - 40 mm, b - 43 mm, c - 45 mm TL; Figure 35 *Protomyctophum choriodon* 76 mm SL; Figure 36 *Protomyctophum normani* 70 mm SL; Figure 37 *Protomyctophum tenisoni* a - 43 mm, b - 55 mm TL.

tally blunt rostrum and the distinct colliculi of which the anterior colliculum is approximately four times the size of the posterior colliculum.

SPECIES *Protomyctophum bolini* (Fraser-Brunner, 1949)
(Plate 8, Figure 34)

MATERIAL Description based on the otoliths of 25 specimens ranging from 46 – 70 mm TL. Catch locality: South Georgia. DIFS otolith catalogue numbers: 820, 1204, 1248, 1249, 1251, 1257, 1299, 1335, 1337 – 1341, 1343 – 1347, 1353, 1364, 1365, 1369 – 1372. Collected by the BAS.

DESCRIPTION

Otolith dorso-ventrally oval. Medially flat with poor relief, laterally convex. **Margin** entire, usually with characteristic indentation in **posterior margin**. **Sulcus acusticus** ostial and homosulcoid. **Ostium** and **cauda** only distinguishable by position of colliculi. **Colliculi** poorly defined and heteromorph. **Pseudo-colliculum** present below **posterior colliculum**. **Crista superior** absent. **Crista inferior** poorly developed. **Dorsal** and **ventral areas** absent. **Rostrum** short and blunt distally. **Antirostrum** usually absent. **Excisura ostii** shallow with wide angle.

INTRASPECIFIC VARIATION

Negligible.

DIAGNOSTIC FEATURES

The dorso-ventral oval shape, the entire margin, the absence of the crista superior, the heteromorph colliculi and the presence of a pseudo-colliculum in association with the notch in the posterior margin.

MORPHOMETRY

OL / TL Relationship

$$TL = 24,76 OL^{1,17} \text{ mm}$$

$n = 24$; Std Err Est = $7,05 \times 10^{-2}$; Coeff Det = 0,72; Corr Coeff = 0,85

SPECIES *Protomyctophum choriodon* Hulley, 1981
(Plate 8, Figure 35)

MATERIAL Description based on the otoliths of two specimens of 60 and 76 mm SL made available to the author by T. Linkowski of the MIRP. Catch locality unknown.

DESCRIPTION

Otolith near discoid in shape, although the **ventral margin** is somewhat triangular. Medially and laterally relatively flat. **Margin** generally entire, except for the **ventral margin** which can be slightly irregular. **Posterior margin** with distinct notch. **Sulcus acusticus** generally homosulcoid and ostial. **Ostium** and **cauda** not clearly distinguishable from each other. **Collum** not constricted. **Colliculi** near homomorph and slender. **Pseudo-colliculum** not well developed. **Crista superior** poorly developed. **Crista inferior** relatively broad, but not prominently developed. **Dorsal area** absent. **Ventral groove** present. **Rostrum** and **antirostrum** broad, near equal in size, well developed and rounded distally, comprising c.

15 % of total otolith length. **Excisura ostii** deep with acute angle. **Pseudo-rostrum**, **pseudo-antirostrum** and **pseudo-excisura ostii** prominent.

INTRASPECIFIC VARIATION

Negligible.

DIAGNOSTIC FEATURES

The near discoid shape with the slightly triangular ventral margin, the near equally sized rostrum and antirostrum, the homosulcoid sulcus acusticus and the presence of a pseudo-rostrum, pseudo-antirostrum and pseudo-excisura ostii.

MORPHOMETRY

OL : SL Ratio

1 : 31,67

$n = 2$; Range 30,3 – 33,04

SPECIES *Protomyctophum normani* (Taning, 1932)
(Plate 8, Figure 36)

MATERIAL Description based on the otoliths of one specimen of 70 mm SL made available on loan to the author by P.A. Hulley of the SAM. Catch locality : South West Atlantic.

DESCRIPTION

Otolith generally discoid. Medially flat, laterally slightly convex. **Margin** generally entire to gently lobed. **Posterior margin** slightly V-shaped. **Sulcus acusticus** ostial and homosulcoid. **Collum** not constricted although slightly raised. **Ostium** and **cauda** of approximately equal size. **Colliculi** homomorph. Poorly developed **pseudo-colliculum** present below **posterior colliculum**. **Crista superior** poorly developed to absent. **Crista inferior** more prominent than crista superior, but also not well developed. **Rostrum** and **antirostrum** of approximately equal size, proximately and distally broad and distally rounded. **Excisura ostii** with acute angle.

DIAGNOSTIC FEATURES

The generally discoid shape and the V-shaped ventral margin, in association with the typically myctophiform sulcus acusticus and colliculi.

MORPHOMETRY

OL : SL Ratio

1 : 31,8

SPECIES *Protomyctophum tenisoni* (Norman, 1930)
(Plate 8, Figure 37)

MATERIAL Description based on the otoliths of 11 specimens ranging from 37 – 55 mm TL, made available on loan to the author by P.A. Hulley of the SAM. Catch locality : South West Atlantic Ocean.

DESCRIPTION

Otolith of small fish discoid and becoming dorso-ventrally oval/rectangular in larger fish. Medially flat, laterally slightly

convex. **Margin** generally entire. **Sulcus acusticus** ostial and heterosulcoid. **Collum** slightly constricted, particularly dorsally. **Ostium** and **cauda** of approximately equal size. **Colliculi** homomorph, although **anterior colliculum** slightly larger than **posterior colliculum**. Small **pseudo-colliculum** present below posterior colliculum. Both **cristae** poorly developed. **Rostrum**, **antirostrum** and **excisura ostii** becoming less well developed with increase in fish size. Both rostra rounded distally.

DIAGNOSTIC FEATURES

The typically myctophiform sulcus acusticus with homomorph colliculi and in particular the dorsally constricted collum.

INTRASPECIFIC VARIATION

Negligible.

ONTOGENY

The otoliths of fishes <40 mm SL are discoid whereafter they become dorso-ventrally oval to rectangular.

MORPHOMETRY

OL : SL Ratio

1 : 32,7

n = 11; Std Dev of the mean = 3,9

ORDER GADIFORMES SUBORDER MURAENOLEPIDOIDEI

FAMILY Muraenolepididae

SPECIES *Muraenolepis marmorata* Günther, 1880 (Plate 9, Figure 38)

MATERIAL Description based on the otoliths of five specimens ranging from 200 – 331 mm TL. Catch locality: Kerguelen and Crozet Islands. DIFS otolith catalogue numbers: 331 – 335. Collected by J.-C. Hureau of the MNHN.

DESCRIPTION

Otolith oval to triangular in shape. Medial face with poor relief and flat, laterally slightly convex. **Margin** entire to gently lobed in some specimens. **Sulcus acusticus** generally heterosulcoid and pseudo-ostio-caudal. **Collum** acutely constricted, clearly separating **ostium** from **cauda**. Ostium and cauda of equal size. **Anterior** and **posterior colliculi** present, well defined and homomorph. **Crista superior** broad and bold over entire sulcus acusticus. **Crista inferior** less well defined, although usually prominent below collum. Small fusiform **dorsal area** present. **Rostrum** prominent and rounded distally, comprising c. 14 % of total otolith length. **Antirostrum** approximately half size of rostrum. **Excisura ostii** shallow to deep with variable angle. **Pseudo-rostrum**, **-antirostrum** and **pseudo-excisura ostii** sometimes present.

INTRASPECIFIC VARIATION

Geometric shape is variable, from oval to slightly triangular, otherwise negligible.

DIAGNOSTIC FEATURES

The otoliths of this species and *M. microps* are both typified by their characteristic heteromorph gadiform colliculi and the equally sized ostium and cauda. The otoliths of *M. marmorata* can be distinguished from those of *M. microps* by the presence of a clearly defined rostrum, antirostrum and excisura ostii.

MORPHOMETRY

OL : TL Ratio

1 : 62,54

n = 5; Std Dev = 7,97; Range 50,59 – 71,79

SPECIES *Muraenolepis microps* Lönnberg, 1905 (Plate 9, Figure 39)

MATERIAL Description based on the otoliths of 52 specimens ranging from 157 – 390 mm TL. Catch locality: South Georgia Island, 60° 28' S, 45° 28' W; 61° 12' S, 56° 10' W and 70° 26' S, 8° 39' W. DIFS otolith catalogue numbers: 270, 713 – 732, 808, 809, 1159, 1165 – 1167, 1500 – 1502, 1569 – 1576, 1688 – 1701. Collected by K.-H. Kock of the BAF, by the MIRP and the BAS.

DESCRIPTION

Otolith oval to triangular. Medially flat with poor relief, laterally slightly convex. **Margin** entire to gently lobed. **Sulcus acusticus** ostio-caudal and heterosulcoid. **Collum** acutely constricted, clearly separating **ostium** from **cauda**. Ostium and cauda of equal size. **Colliculi** homomorph and of near equal size. **Crista superior** variable in definition, sometimes continuous over entire sulcus acusticus and sometimes split over ostium and cauda. **Crista inferior** more robust than crista superior, particularly immediately below the collum. **Dorsal area** sometimes present and oval in shape. **Rostrum** only present in larger specimens and then small and rounded distally. **Antirostrum** also only present in larger specimens and then of equal size as rostrum. **Excisura ostii** if present with acute angle. **Pseudo-rostrum**, **-antirostrum** and **-excisura ostii** present in larger specimens.

INTRASPECIFIC VARIATION

Geometric shape variable, oval to triangular, otherwise negligible except for ontogenetic changes.

DIAGNOSTIC FEATURES

The oval to triangular shape, the typical gadoid sulcus acusticus and colliculi and the broad ridge-like structure below the crista inferior.

ONTOGENY

The geometric shape changes from oval to generally triangular in fish > 350 mm TL. Also in fish 350 mm TL the rostral and pseudo-rostral structures start to develop.

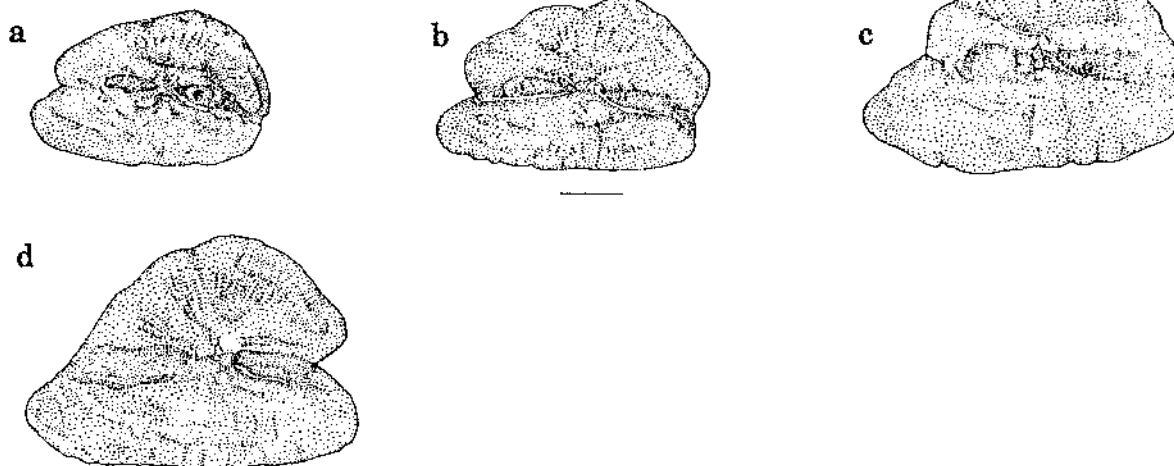
MORPHOMETRY

OL / TL Relationship

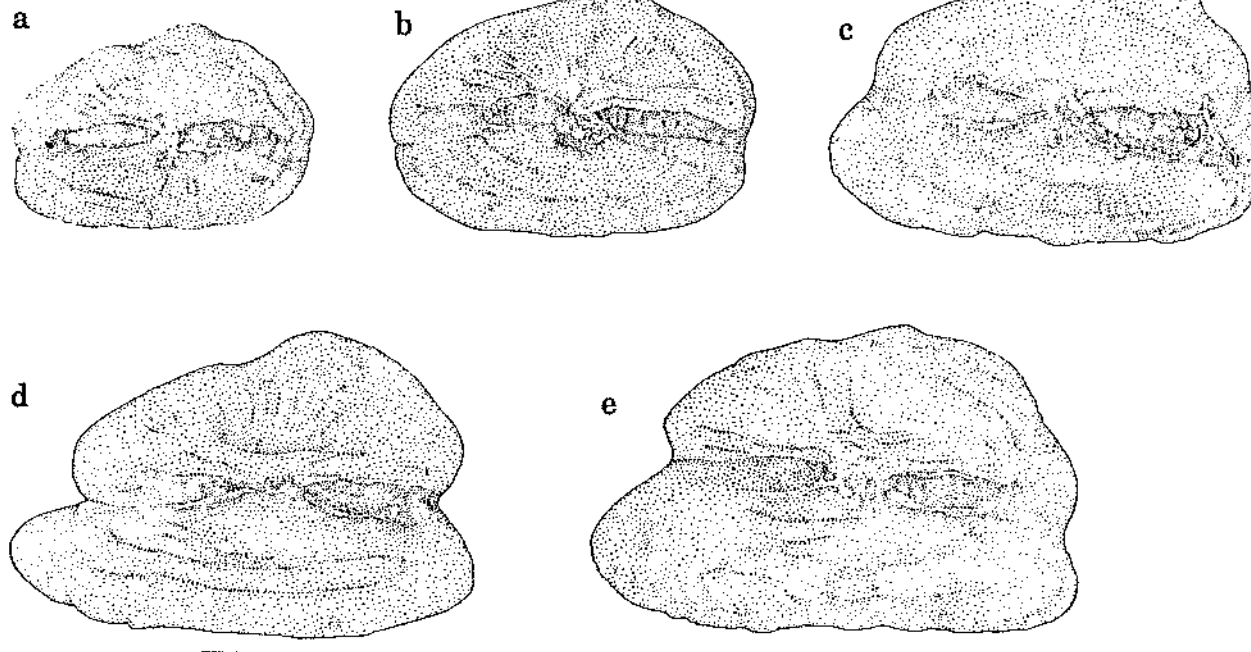
TL = 28,21 OL^{1,60} mm

n = 47; Std Err Est = 0,125; Coeff Det = 0,81; Corr Coeff = 0,90

38



39



40



PLATE 9

Figure 38 *Muraenolepis marmorata* a - 200 mm, b - 280 mm, c - 325 mm, d - 331 mm TL; Figure 39 *Muraenolepis microps* a - 188 mm, b - 218 mm, c - 320 mm, d - 336 mm, e - 360 mm TL; Figure 40 *Antimora rostrata* - length unknown.

Mass / TL Relationship

$$\text{Mass} = 8,98 \times 10^{-7} \text{ TL}^{3,49} \text{ g}$$

$n = 37$; Std Err Est = 0,111; Coeff Det = 0,98; Corr Coeff = 0,99

SUBORDER GADOIDEI**FAMILY Moridae**

SPECIES *Antimora rostrata* (Günther, 1878)
(Plate 9, Figure 40)

MATERIAL Description based on the otoliths of 15 specimens of unknown length made available to the author on loan by Ch. Karrer of the ZIMH. Catch locality unknown.

DESCRIPTION

Otolith pyriform. **Antero-dorsal margin** bulbous and lobed. Remainder of **margin** entire. **Sulcus acusticus** caudal and heterosulcoid. No constriction at **collum** yet **ostium** and **cauda** distinct. Ostium oval, cauda wider at posterior end. **Colliculi** heteromorph. **Anterior colliculum** raised and noduliferous. **Posterior colliculum** ridge-like in cauda. **Crista superior** poorly developed, starting mid-way over ostium and ending on postero-dorsal margin. **Crista inferior** also starting mid-way below ostium and ending on postero-ventral margin. **Dorsal area** oval and shallow, situated midway above ostium and cauda. Distinct **rostrum**, **antirostrum** and **excisura ostii** absent. Small **pseudo-rostrum**, **-antirostrum** and **-excisura ostii** present.

DIAGNOSTIC FEATURES

Near pyriform shape, the caudal and heterosulcoid sulcus acusticus and the ridge-like posterior colliculum.

MORPHOMETRY**OL : TL Ratio**

1 : 29,93

$n = 15$; Std Dev = 1,80; Range 26,59 – 32,12

FAMILY Melanonidae

SPECIES *Melanonus gracilis* Günther, 1878
(Plate 10, Figure 41)

MATERIAL Description based on the otoliths of one specimen of 148,5 mm SL made available to the author on loan from the RMGM otolith collection of P.A.M. Gaemers. Catch locality unknown.

DESCRIPTION

Otolith oval to sub-quadrate. Anterior margin of otolith oblique, remainder of otolith near oval. **Margin** entire except for distinct indentation in **posterior margin**. Medially flat to slightly convex with relatively poor relief, laterally weakly convex. **Sulcus acusticus** ostio-caudal and homosulcoid and allantoid in shape. **Collum** slightly constricted. **Colliculi** homomorph and well developed. **Rostrum** short and pointed distally. **Antirostrum** absent. **Excisura ostii** with wide angle (near 180 degrees). The projection on the

oblique anterior margin is an excisural projection, which is not as well developed as in *M. zugmayeri*.

DIAGNOSTIC FEATURES

The oval to subquadrate shape with the oblique anterior margin, the homomorph colliculum, the entire margin in association with the excisural projection.

MORPHOMETRY**OL : SL Ratio**

1 : 48,2

SPECIES *Melanonus zugmayeri* Norman, 1930
(Plate 10, Figure 42)

MATERIAL Description based on the otoliths of three specimens of 186, 219 and 226 mm SL, made available to the author from the RMGM otolith collection of P.A.M. Gaemers. Catch locality unknown.

DESCRIPTION

Otolith shape changes from dorso-ventrally oval to near triangular in specimens > 226 mm SL. **Margin** entire with slight notch in **posterior margin**. Medially flat to weakly concave with relatively poor relief, laterally weakly convex. **Sulcus acusticus** ostio-caudal and homosulcoid. **Ostium** and **cauda** separated by slightly constricted **collum**. **Colliculi** homomorph and well developed. **Rostrum** prominent and rounded distally. **Antirostrum** absent. **Excisura ostii** with extremely wide angle (160 – 180 degrees) with prominent **excisural projection**. The size of the projection increases with fish size.

INTRASPECIFIC VARIATION

Negligible except for the ontogenetic changes.

DIAGNOSTIC FEATURES

The dorso-ventrally oval to triangular shape, the homomorph colliculi, the entire margin and the distinct excisural projection.

ONTOGENY

Shape of otolith changes from dorso-ventrally oval to triangular in fish > 220 mm SL (ventral margin forms the base of the triangle). The excisural projection also increases with fish size.

MORPHOMETRY**OL : SL Ratio**

1 : 87,35

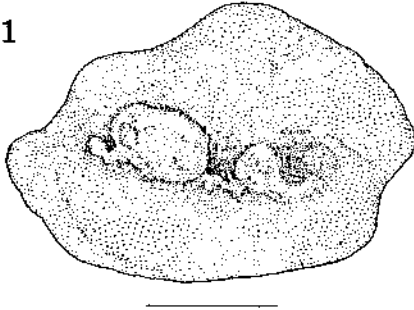
$n = 3$; Range 79,57 – 94,89

FAMILY Gadidae

SPECIES *Micromesistius australis* Norman, 1937
(Plate 10, Figure 43)

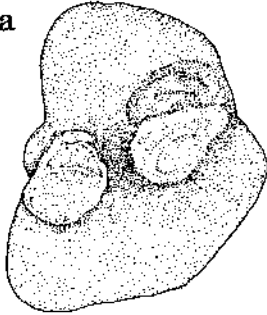
MATERIAL Description based on the otoliths of two specimens of 420 and 500 mm TL. Catch locality: 54° 53' S,

41

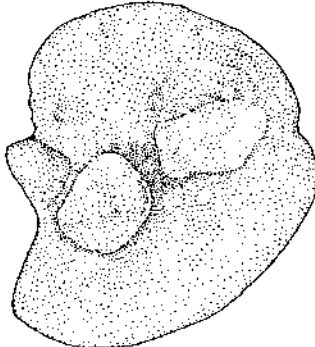


42

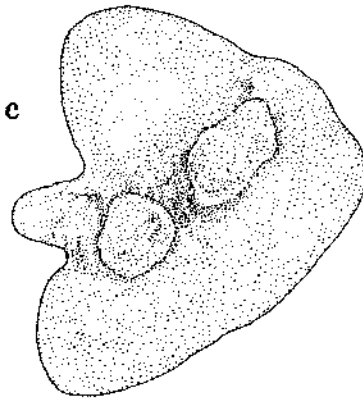
a



b



c



43

a



b

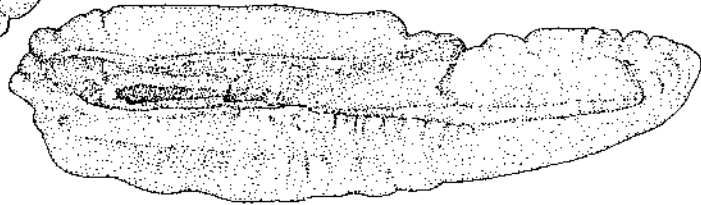


PLATE 10

Figure 41 *Melanonus gracilis* 148,5 mm SL; Figure 42 *Melanonus zugmayeri* 219 mm SL; Figure 43 *Micromesistius australis* a - 420 mm, b - 500 mm TL.

57° 39' W. DIFS otolith catalogue numbers: 254, 258. Collected by K.-H. Kock of the BAF.

DESCRIPTION

Otolith extremely elongate and oval. Medially slightly convex with relatively poor relief, laterally slightly concave. **Dorsal margin** entire. Dorsal margin of rostrum, **ventral margin** and **posterior margin** sinuate. **Sulcus acusticus** ostial and homosulcoid extending over entire length of otolith. **Collum** indistinct. **Colliculi** heteromorph, but poorly developed. **Anterior colliculum** c. twice size of **posterior colliculum**. **Crista superior** and **crista inferior** ridge-like above and below entire sulcus acusticus, but poorly developed. **Crista inferior** sinuate anterior of mid-region. Distinct horizontal ventral groove with prominent sinuate dorsal and ventral ridges. **Dorsal** and **ventral areas** absent. **Rostrum** large and rounded distally, comprising c. 38 % of total otolith length. **Antirostrum** absent. **Excisura ostii** present with wide angle.

INTRASPECIFIC VARIATION

Negligible

DIAGNOSTIC FEATURES

The elongate oval shape, the homosulcoid sulcus acusticus, the horizontal ventral groove, with distinctly sinuate dorsal and ventral ridges.

MORPHOMETRY

OL : TL Ratio

1 : 26,85

n = 2; Range 25,93 – 27,78

FAMILY Merlucciidae

SPECIES *Macroronus novaezelandiae* Waite, 1911
(Plate 11, Figure 44)

MATERIAL Description based on the otoliths of 20 specimens ranging from 650 – 963 mm SL. Catch locality: 41° 43' S, 144° 25' E. DIFS otolith catalogue numbers: 884 – 903. Collected by M.A. Wilson of the DSTADT.

DESCRIPTION

Otolith generally oval. Medially slightly convex, laterally slightly concave. **Dorsal**, **posterior** and **antero-ventral margins** sinuate. **Ventral margin** entire. Characteristic indentation in dorsal margin mid-way over ostium. **Sulcus acusticus** medial and heterosulcoid. **Ostium** and **cauda** of near equal size, separated by raised and constricted **collum**. **Colliculi** homomorph and well developed. **Crista superior** ridge-like over posterior portion of ostium, **collum** and anterior portion of cauda. **Crista inferior** broad but poorly developed to absent. **Rostrum**, **antirostrum** and **excisura ostii** absent.

INTRASPECIFIC VARIATION

Negligible.

DIAGNOSTIC FEATURES

The oval shape, the medial and homosulcoid sulcus acusticus with near equal sized ostium and cauda and the homomorph colliculi.

MORPHOMETRY

OL : SL Ratio

1 : 35,08

n = 20; Std Dev = 1,26; Range 32,81 – 38,99

SUBORDER MACROUROIDEI

FAMILY Macrouridae

SPECIES *Cynomaerurus piriei* Dollo, 1909
(Plate 11, Figure 45)

MATERIAL Description based on the otoliths of four specimens ranging from 78 – 386 mm SL. Catch locality: South Georgia. DIFS otolith catalogue numbers: 1216, 1312, 1325, 1367. Collected by the BAS.

DESCRIPTION

Otolith discoid and small in relation to fish size. Medially completely flat with poor relief, laterally strongly convex. **Margin** entire. **Sulcus acusticus** heterosulcoid and medial. **Cristae** and **colliculi** variable. **Rostrum**, **antirostrum** and **excisura ostii** absent.

INTRASPECIFIC VARIATION

Negligible except for the variability of the colliculi and the definition of the cristae.

DIAGNOSTIC FEATURES

The discoid geometric shape, the flat medial face, the strongly convex lateral face and the medial sulcus acusticus.

MORPHOMETRY

OL : SL Ratio

1 : 122,1

n = 4; Range 73,58 – 183,37

SPECIES *Lionurus filicauda* (Günther, 1878)
(Plate 11, Figure 46)

MATERIAL Description based on the otoliths of one specimen of unknown length made available to the author on loan from the IRSNB otolith collection of D. Nolf. Catch locality 46° 46' S, 13° E.

DESCRIPTION

Otolith generally oval. Posteriorly more blunt than anteriorly. **Margin** entire. **Sulcus acusticus** ostio-caudal and heteromorph. Ostial section of sulcus acusticus directed dorsally. **Ostium** and **cauda** continuous but distinguishable from each other by constricted **collum**. **Colliculi** large but heteromorph. **Crista superior** narrow. **Crista inferior** broad. **Rostrum**, **antirostrum** and **excisura ostii** absent.

DIAGNOSTIC FEATURES

The generally oval shape, the entire margin, the ostio-caudal and heterosulcoid sulcus acusticus and the large heteromorph colliculi.

SPECIES *Macrourus holotrachys* Günther, 1878
(Plate 11, Figure 47)

MATERIAL Description based on the otoliths of one specimen of unknown length made available to the author on loan from the IRSNB otolith collection of D. Nolf. Catch locality: 52° 31' S, 63° 25' W.

DESCRIPTION

Otolith elongate oval, slightly more slender than that of *Macrourus whitsoni*. **Ventral margin** with isolated lobes. Mid-section of **dorsal margin** finely sinuate. **Sulcus acusticus** ostio-caudal and homosulcoid. **Ostium** and **cauda** continuous but clearly distinguishable by ventral constriction of **collum**. **Colliculi** homomorph and elongate in comparison to *Macrourus whitsoni*. **Cristae** poorly developed. **Rostrum, antirostrum** and **excisura ostii** absent.

DIAGNOSTIC FEATURES

The elongate oval shape, the sinuate mid-section of the dorsal margin, the ostio-caudal and homosulcoid sulcus acusticus and the homomorph colliculi.

SPECIES *Macrourus whitsoni* (Regan, 1913)
(Plate 11, Figure 48)

MATERIAL Description based on the otoliths of three specimens of unknown length made available to the author on loan from the IRSNB otolith collection of D. Nolf. Catch locality unknown.

DESCRIPTION

Otolith generally oval. **ventral margin** entire, **dorsal margin** lobed (variable degree). **Sulcus acusticus** ostio-caudal and near homosulcoid. **Ostium** and **cauda** continuous although clearly distinguishable from each other by slight ventral constriction of **collum**. **Colliculi** relatively small in comparison to *Macrourus holotrachys* and homomorph. **Anterior and posterior colliculi** equally well developed. **Crista superior** relatively well developed. **Crista inferior** poorly developed. **Rostrum, antirostrum** and **excisura ostii** absent.

DIAGNOSTIC FEATURES

The oval shape, the ostio-caudal and homosulcoid sulcus acusticus and the homomorph colliculi.

SPECIES *Nematonurus armatus* Hector, 1875
(Plate 11, Figure 49)

MATERIAL Description based on the otoliths of one specimen of unknown length made available to the author on loan from the RMGM otolith collection of P.A.M. Gaemers. Catch locality unknown.

DESCRIPTION

Otolith distinctly oval and relatively thick. **Margin** entire. Medially and laterally weakly convex. Concentric grooves around sulcus acusticus. **Sulcus acusticus** medial and homosulcoid. **Ostium** and **cauda** separated by slightly constricted

collum. **Colliculi** homomorph and prominent. **Rostrum, antirostrum** and **excisura ostii** absent.

DIAGNOSTIC FEATURES

The oval shape with the entire margin, the medial sulcus acusticus and the homomorph colliculi.

ORDER BERYCIFORMES
SUBORDER BERYCOIDEI

FAMILY Anoplogasteridae

SPECIES *Anoplogaster cornuta* (Valenciennes, 1833)
(Plate 12, Figure 50)

MATERIAL Description based on the otoliths of one specimen of unknown length made available to the author on loan from the RMGM otolith collection of P.A.M. Gaemers and the illustration by Schwarzzhans (1980). Catch locality: New South Wales.

DESCRIPTION

Otolith broadly subquadrate. **Posterior** and **ventral margins** nearly right angular. **Dorsal** and **anterior margins** rounded. **Margin** entire to slightly irregular. Medially flat with relatively little relief, laterally weakly convex. Medio-laterally thin. **Sulcus acusticus** ostial to medial and heterosulcoid. **Ostium** broad, large and ventrally slightly bulbous. **Cauda** short. Both **cristae superior** and **inferior** poorly developed. **Rostrum** broad, bold and rounded distally. **Antirostrum** small and rounded distally. **Excisura ostii** with acute angle.

DIAGNOSTIC FEATURES

The broadly subquadrate shape and the "myrpristid-like" ostium (i.e. bulbous ventral margin of the ostium) (Hecht 1982).

SUBORDER STEPHANOBERYCOIDEI

FAMILY Melamphaidae

SPECIES *Sio nordenskjöldii* (Lönnerberg, 1905)
(Plate 12, Figure 51)

MATERIAL Description based on the otoliths of 11 specimens ranging from 88 – 134 mm TL. DIFS otolith catalogue numbers: 1223 – 1225, 1368, 1375, 1376, 1385, 1393, 1394, 1396. Catch locality: South Georgia. Collected by the BAS.

DESCRIPTION

Otolith generally ovate in shape. Medio-laterally thin. Medially flat with poor relief, laterally slightly convex. **Margin** irregularly lobed. **Sulcus acusticus** generally medial and homosulcoid. No distinction between **ostium** and **cauda**. **Colliculi** heteromorph. **Anterior colliculum** large and extremely prominent. **Posterior colliculum** absent. **Crista superior** absent. **Crista inferior** broad but not well developed. **Rostrum** and **antirostrum** small with acute **excisura ostii**.

INTRASPECIFIC VARIATION

Irregular sculpture of margin and the variable ovate shape.

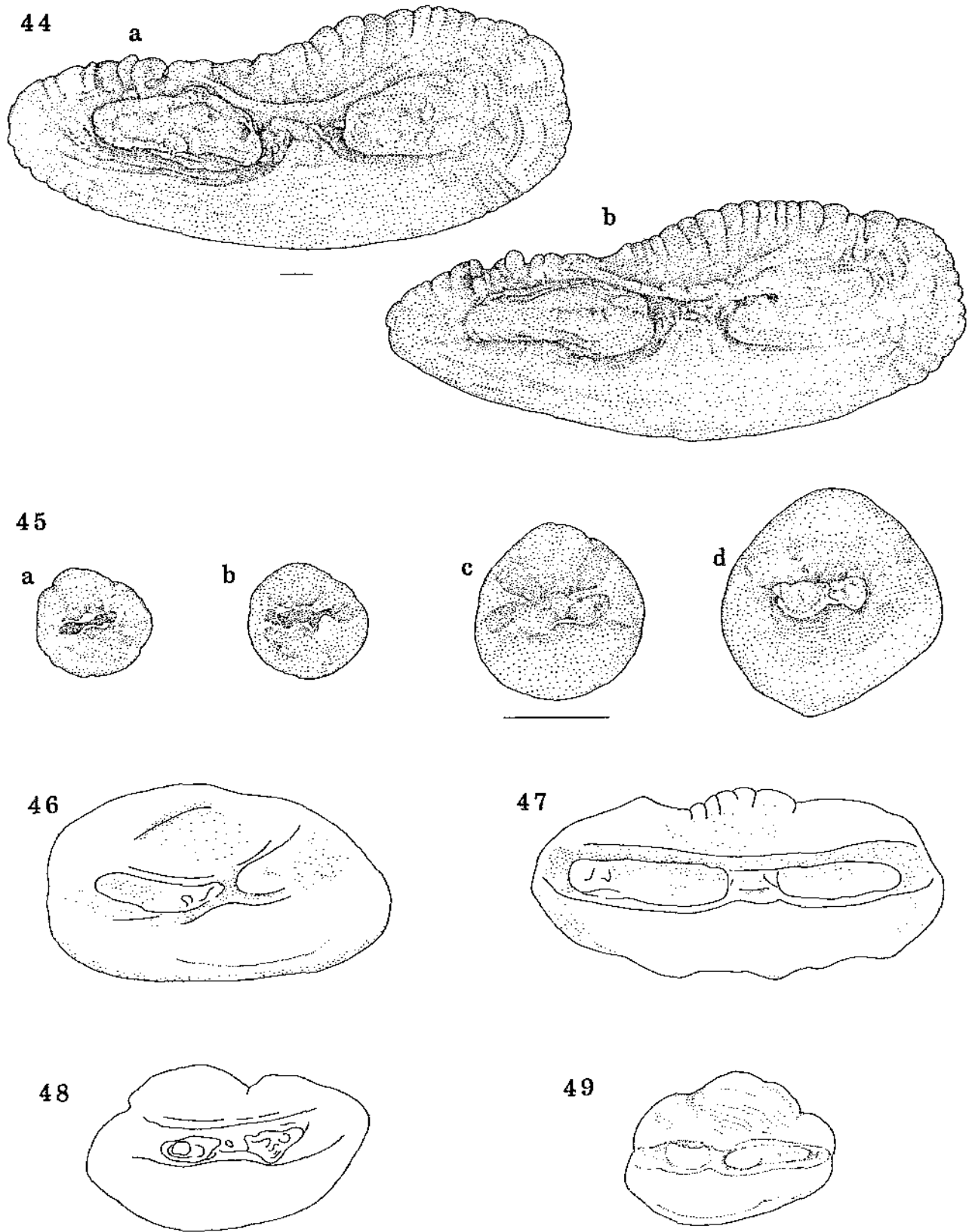


PLATE 11

Figure 44 *Macroronus novaeseelandiae* a - 654 mm, b - 657 mm SL; Figure 45 *Cynomacrurus piriei* a - 78 mm, b - 119 mm, c - 213 mm, d - 386 mm TL; Figure 46 *Lionurus filicauda* - length unknown; Figure 47 *Macrourus holotrachys* - length unknown; Figure 48 *Macrourus whitsoni* - length unknown; Figure 49 *Nematonurus armatus* - length unknown.

DIAGNOSTIC FEATURES

The generally ovate shape, the irregular sculpture of the margin in association with the large and prominent anterior colliculum.

ONTOGENY

Otoliths of fish < 80 mm SL are greater in height than in length, whereafter they become ovate.

MORPHOMETRY**OL : TL Ratio**

1 : 23,14

n = 11; Std Dev = 3,94; Range 19,85 – 31,76

ORDER ZEIFORMES**FAMILY Oreosomatidae**

SPECIES *Pseudocyttus maculatus* Gilchrist, 1906 and
Xenocyttus nemotoi Abe, 1957
(Plate 12, Figures 52 & 53)

MATERIAL The description of the otoliths of *P. maculatus* is based on two specimens of unknown length, collected off the coast of New Zealand by Ch. Karrer. DIFS otolith catalogue numbers: 1774, 1775. The description and illustration of the sagittal otolith of *Xenocyttus nemotoi* (149 mm SL) is based on the illustration presented by Abe and Suzuki (1981).

DESCRIPTION

Note: The otoliths of the two oreosomatid species are indistinguishable from each other and are, therefore, described together.

Otolith essentially dorso-ventrally oval, with deep mid-anterior and mid-posterior marginal constrictions (hour-glass shape). Medially and laterally convex. **Dorsal margin** entire to lobed. **Ventral margin** acutely dentate. **Sulcus acusticus** ostio-caudal and heterosulcoid. **Colliculi** homo- to heteromorph with both **anterior** and **posterior colliculi** well defined. **Crista superior** usually well defined above ostium, but sometimes present above entire sulcus acusticus. **Crista inferior** prominent and bold (sometimes knob-like) particularly below **collum**. **Rostrum** and **antirostrum** of equal size. **Rostrum** pointed distally while **antirostrum** is distally rounded. **Pseudo-rostrum** and **pseudo-antirostrum** of equal size, shape and definition as **rostrum** and **antirostrum** respectively. **Excisura ostii** and **pseudo-excisura ostii** also of equal size. **Dorsal area** sometimes present. **Ventral area** absent. Mid-ventral horizontal grooves and ridges sometimes present.

DIAGNOSTIC FEATURES

The dorso-ventrally oval shape and the deep constrictions in the mid-anterior and posterior margins.

ADDENDUM

The otoliths of a further two oreosomatid species, *Neocyttus rhomboidalis* (Gilchrist, 1906) (Plate 12, Fig. 54) and *Alloocyttus verrucosus* (Gilchrist, 1906) (Plate 12, Fig. 55), were made available to the author by M.A. Wilson of DSTADT. The geometric shape of these otoliths are identical to those

described above. DIFS otolith catalogue numbers: *N. rhomboidalis*: 1044 – 1063 and *A. verrucosus*: 984 – 1003. The material was collected off the coast of Tasmania at 42° 14' S, 144° 39' E.

**ORDER SCORPAENIFORMES
SUBORDER SCORPAENOIDEI****FAMILY Scorpaenidae**

SPECIES *Helicolenus mouchezi* (Sauvage, 1875)
(Plate 13, Figure 56)

MATERIAL Description based on the otoliths of two specimens of 340 and 350 mm TL. Catch locality: Gough Island. DIFS otolith catalogue number: 735, 737. Collected by W. Uys of the DIFS.

DESCRIPTION

Otolith generally fusiform. Medially convex, laterally concave. **Dorsal margin** serrate. **Ventral margin** dentate. **Sulcus acusticus** ostial, near homosulcoid and deep. **Ostium** nearly indistinguishable from cauda. **Collum** indistinct. **Cauda** with slight postero-ventral angle. **Colliculi** heteromorph and poorly developed. **Crista superior** prominent and ridge-like above sulcus acusticus, forming ventral border of oval **dorsal area**. **Crista inferior** well developed, particularly below posterior section of cauda. **Rostrum** variable in size but prominent, distally slender and rounded. **Antirostrum** and **excisura ostii** either present or absent.

INTRASPECIFIC VARIATION

Negligible, except for variable shape of rostrum.

DIAGNOSTIC FEATURES

The fusiform shape, the deep, ostial and homosulcoid sulcus acusticus with a slight postero-ventral angle, the well developed **crista superior** and the oval shaped **dorsal area**.

MORPHOMETRY**OL : TL Ratio**

1 : 30,37

n = 2; Range 28,33 – 32,41

SPECIES *Helicolenus papillosus* Richardson, 1845
(Plate 13, Figure 57)

MATERIAL Description based on the otoliths of 20 specimens ranging from 206 – 348 mm TL. Catch locality: 41° 43' S, 144° 25' E. DIFS otolith catalogue numbers: 964 – 983. Collected by M.A. Wilson of the DSTADT.

DESCRIPTION

Otolith ovate to near fusiform. Medially convex, laterally concave. **Dorsal margin** lobed to slightly irregular. **Ventral margin** sinuate. **Sulcus acusticus** ostial, near homosulcoid, straight and not as deep as in *H. mouchezi*. **Ostium** indistinguishable from cauda. **Collum** obscure. **Colliculi** heteromorph. **Anterior colliculum** present but poorly developed. **Posterior colliculum** variable. **Crista superior** prominent and

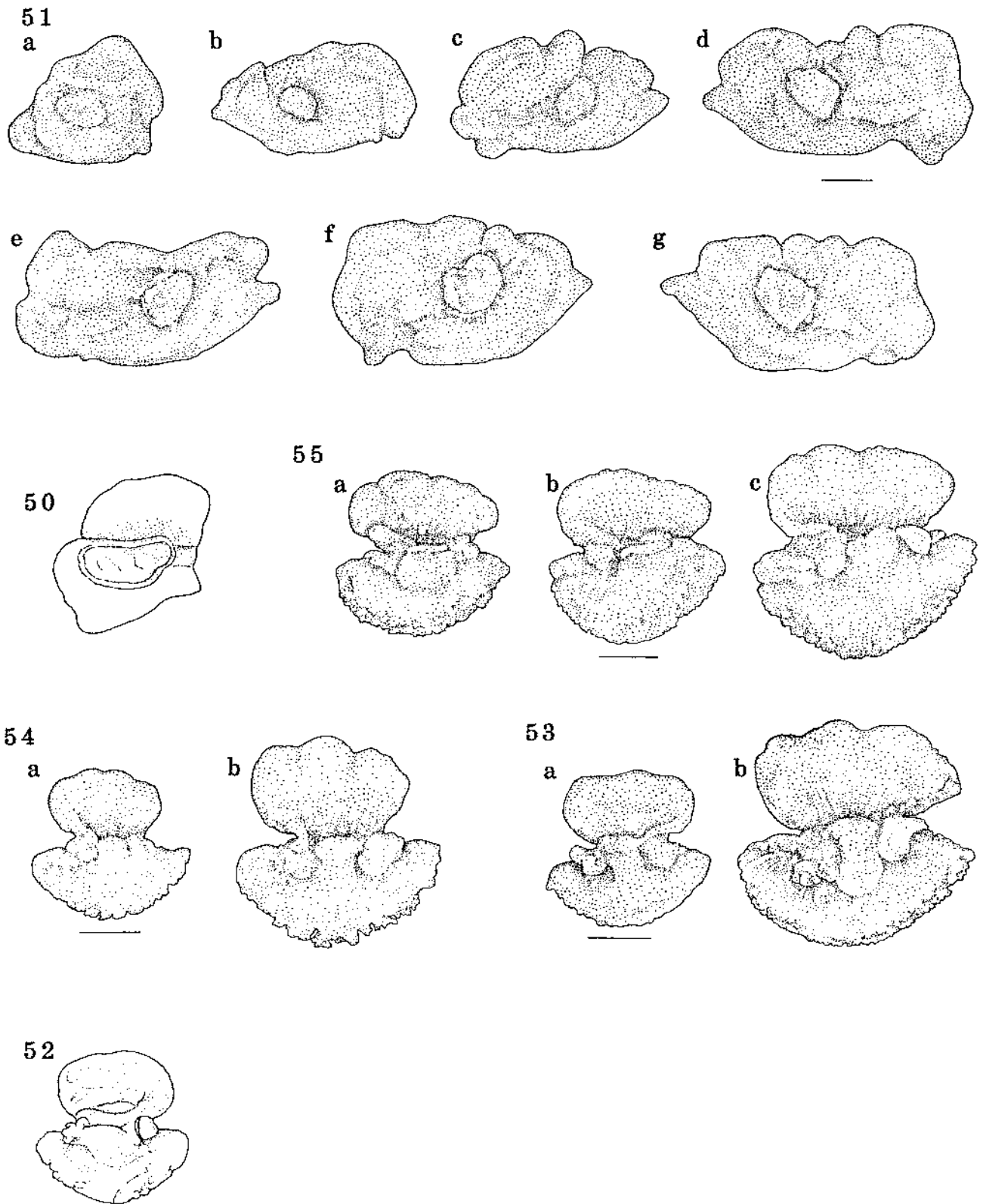


PLATE 12

Figure 50 *Anoplogaster cornuta* - length unknown; Figure 51 *Sio nordenskjoeldii* a - 79 mm, b - 69 mm, c - 88 mm, d - 103 mm, e - 102 mm, f - 119 mm, g - 106 mm TL; Figure 52 *Pseudocytus maculatus* a - 130 mm, b - 162 mm SL; Figure 53 *Xenocytus nemotoi* - length unknown; Figure 54 *Neocytus rhomboidalis* a - 153 mm, b - 190 mm SL; Figure 55 *Alloctytus verrucosus* a - 123 mm, b - 130 mm, c - 162 mm SL.

ridge-like above sulcus acusticus, forming ventral border of oval shaped dorsal area. **Crista inferior** not ridge-like, but broad and prominent below entire cauda. Area below crista inferior distinctly noduliferous. **Rostrum** large, becoming slender with an increase in fish size and rounded to pointed distally. **Antirostrum** either present or absent, if present then small and rounded distally. **Excisura ostii** present with variable angle and situated dorsal to anterior-most extremity of crista superior.

INTRASPECIFIC VARIATION

The presence or absence of the antirostrum and the variable angle of the excisura ostii, otherwise negligible.

DIAGNOSTIC FEATURES

The ovate to fusiform shape, the ostial, homosulcoid and straight sulcus acusticus, the ridge-like and well developed crista superior, the relatively broad and bold crista inferior, the oval shaped dorsal area, the excisura ostii situated above the level of the crista superior and the distinctly noduliferous area ventral to the crista inferior.

MORPHOMETRY

OL / TL Relationship

$$TL = 16,30 OL^{1,18} \text{ mm}$$

$n = 20$; Std Err Est = $5,71 \times 10^{-2}$; Coeff Det = 0,88; Corr Coeff = 0,93

Mass / TL Relationship

$$\text{Mass} = 2,53 \times 10^{-6} TL^{3,48} \text{ g}$$

$n = 20$; Std Err Est = $5,69 \times 10^{-2}$; Coeff Det = 0,99; Corr Coeff = 0,99

SPECIES *Sebastichthys capensis* (Gmelin, 1789)
(Plate 13, Figure 58)

MATERIAL Description based on the otoliths of 13 specimens ranging from 260 – 370 mm TL, made available to the author on loan from the PEM otolith collection. Catch locality: Gough Island. Collected by N. Klages of the PEM.

DESCRIPTION

Otolith ovate. Posteriorly bulbous to squared off. **Dorsal margin** serrate to acutely dentate. **Ventral margin** serrate to weakly dentate. Medially convex with high relief, laterally concave. **Sulcus acusticus** ostial and homo- to heterosulcoid. **Collum** not constricted but distinctly raised. **Ostium** slightly wider than cauda. Posterior end of cauda extended by groove to postero-ventral corner. **Colliculi** heteromorph. **Anterior colliculum** more prominent than **posterior colliculum**. **Crista superior** ridge-like above entire sulcus acusticus, sometimes distinctly noduliferous. **Crista inferior** usually only well developed below central part of sulcus acusticus. **Dorsal area** large, oval and sometimes noduliferous. **Rostrum** proximally broad, distally slender and rounded to pointed distally, comprising c. 28 % of total otolith length. **Antirostrum** absent. **Excisura ostii** absent or present, if present with wide angle.

INTRASPECIFIC VARIATION

Negligible, except for the sculpture of the margin.

DIAGNOSTIC FEATURES

The ovate shape with the squared off to bulbous posterior end, the ostial and homo- to heterosulcoid sulcus acusticus and the postero-ventral groove-like extension of the cauda.

MORPHOMETRY

OL : TL Ratio

1 : 24,76

$n = 13$; Std Dev = 0,72; Range 23,85 – 25,93

FAMILY Congiopodidae

SPECIES *Zanclorhynchus spinifer* Günther, 1880
(Plate 13, Figure 59)

MATERIAL Description based on the illustration presented by Schwarzhans (1980). Catch locality: off South Africa. Fish length unknown.

DESCRIPTION

Otolith elongate and sagitate (characterized by the long and slender elongate rostrum). **Dorsal margin** entire. **Posterior margin** vaguely lobed. Posterior-dorsal corner of otolith distinctly rounded and superior. **Ventral margin** slightly irregular. **Sulcus acusticus** homo- to heterosulcoid and ostial. **Ostium** wide and large. **Cauda** comparatively slender in relation to ostium with slight postero-ventral angle. Raised **collum** in mid-region of sulcus acusticus. **Crista superior** obscure, **Crista inferior** broad and bold below entire sulcus acusticus. **Rostrum** slender, elongate and rounded distally, comprising c. 30 % of total otolith length. **Antirostrum** absent. **Excisura ostii** with wide and rounded angle.

DIAGNOSTIC FEATURES

The slender elongate shape with the prominent and slender rostrum and the up-turned and rounded postero-dorsal corner.

ORDER PERCIFORMES SUBORDER PERCOIDEI

FAMILY Latrididae

SPECIES *Mendosoma elongata* Kner, 1864
(Plate 14, Figure 60)

MATERIAL Description based on the otoliths of four specimens ranging from 67 – 202 mm SL. Catch locality: Gough Island. DIFS otolith catalogue numbers: 2027 – 2030. Collected by N. Klages of the PEM.

DESCRIPTION

Otolith oval to fusiform. **Margin** generally entire. **Dorsal margin** sometimes slightly irregular. Medially convex with reasonable relief, laterally flat to slightly concave. **Sulcus acusticus** long, ostial and near homosulcoid. **Ostium** and **cauda** clearly distinguishable from each other. **Ostium** slightly wider and not as long as cauda. **Cauda** with slight postero-ventral angle. **Crista superior** ridge-like above entire sulcus acusticus. **Crista inferior** broader than crista superior

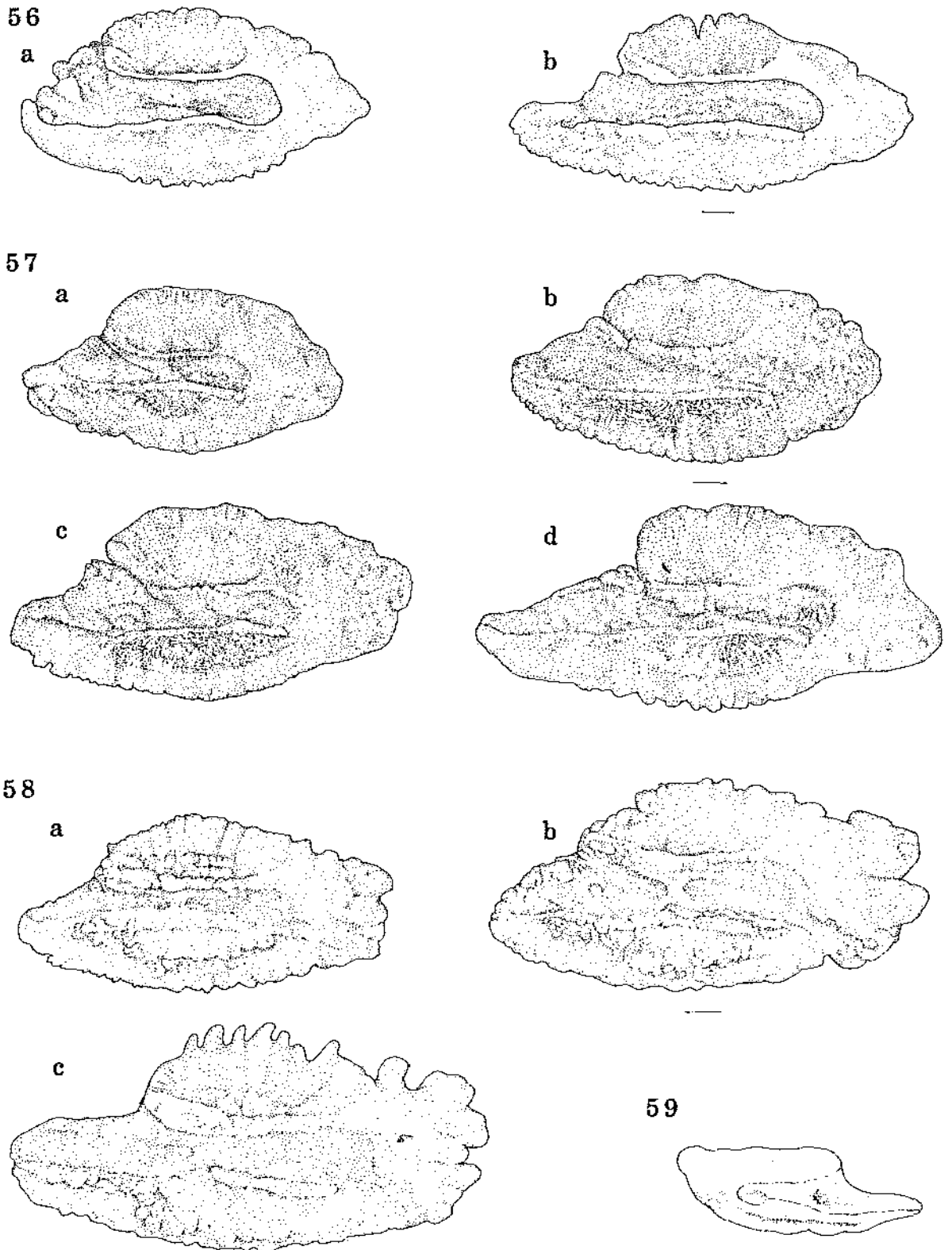


PLATE 13

Figure 56 *Helicolenus mouchezi* a - 350 mm, b - 340 mm TL; Figure 57 *Helicolenus pupillostus* a - 206 mm, b - 276 mm, c - 272 mm, d - 311 mm TL; Figure 58 *Sebastichthys cupensis* a - 290 mm, b - 350 mm, c - 370 mm TL; Figure 59 *Zanctorhynchus spinifer* - length unknown.

and present below entire sulcus acusticus but not as well developed as crista superior. **Colliculi** obscure. **Rostrum** small and rounded distally. **Antirostrum** and **excisura ostii** small to minute.

INTRASPECIFIC VARIATION

Negligible.

DIAGNOSTIC FEATURES

The oval / fusiform shape and the long, ostial and near homosulcoid sulcus acusticus.

MORPHOMETRY

OL : TL Ratio

1 : 41,70

n = 4; Std Dev = 7,22; Range 37,22 – 50,00

FAMILY Cheilodactylidae

SPECIES *Cheilodactylus monodactylus* (Carmichael, 1818)
(Plate 14, Figure 61)

MATERIAL Description based on the otoliths of three specimens of 310, 330 and 410 mm FL and one specimen of 410 mm TL. Catch locality: Gough Island. DIFS otolith catalogue number: 736, the others made available to the author on loan from the otolith collection of the PEM. Collected by W. Uys of DIFS and N. Klages of the PEM.

DESCRIPTION

Otolith elongate and ovate. **Dorsal margin** and **ventral margin** entire to slightly irregular. **Posterior margin** crenate. Medially convex with high relief, laterally concave. **Sulcus acusticus** ostial (although near ostio-caudal) and heterosulcoid. **Ostium** only present on dorsal face of rostrum. **Cauda** elongate with wide postero-ventral angle. **Collum** constricted. Both **cristae** equally well developed and ridge-like. **Colliculi** poorly developed. **Dorsal** and **ventral areas** well developed and elongate. **Rostrum** prominent and pointed distally comprising 40 % of total otolith length. **Antirostrum** also pointed distally but only half size of rostrum. **Excisura ostii** deep with acute angle.

DIAGNOSTIC FEATURES

The ovate shape with a well developed and pointed rostrum, the crenate posterior margin, the ostial to ostio-caudal and heterosulcoid sulcus acusticus and the presence of the elongate dorsal and ventral areas.

MORPHOMETRY

OL : FL Ratio

1 : 50,09

n = 3; Range 46,48 – 54,39

SPECIES *Nemadactylus macropterus* Schneider, 1801
(Plate 14, Figure 62)

MATERIAL Description based on the otoliths of 20 specimens ranging from 299 – 451 mm FL. Catch locality: 43° 05'

S, 144° 56' E. DIFS otolith catalogue numbers: 1004 – 1023. Collected by M.A. Wilson of the DSTADT.

DESCRIPTION

Otolith ovate, slightly elongate. **Dorsal margin** lobed to irregular. **Ventral margin** entire, but dentate in fish >300 mm TL. Medially convex with good relief, laterally concave. **Sulcus acusticus** generally ostio-caudal (sometimes ostial) and heterosulcoid. **Collum** slightly constricted, separating ostium from cauda. **Ostium** generally restricted to dorsal face of rostrum. **Cauda** elongate with wide postero-ventral angle. Prominent **colliculum** present in collum. Both **cristae** well developed and ridge-like, although crista inferior is more robust than crista superior, which is only well developed over the collum. **Dorsal area** present over anterior portion of cauda. **Ventral area** absent. Distinct **ventral groove** present. **Rostrum** usually elongate and pointed distally, comprising c. 36 % of total otolith length. **Antirostrum** rounded to pointed distally and usually c. half size of rostrum. **Excisura ostii** deep with acute angle.

INTRASPECIFIC VARIATION

Size of rostrum varies in association with the depth of the excisura ostii.

DIAGNOSTIC FEATURES

The ovate shape, the elongate and pointed rostrum, the distinct ventral groove, the generally ostio-caudal sulcus acusticus and the single knob-like colliculum in the collum.

MORPHOMETRY

OL : FL Ratio

1 : 45,84

n = 10; Std Dev = 5,44; Range 35,73 – 52,95

SUBORDER ZOARCOIDEI

FAMILY Zoarcidae

SPECIES *Lycodichthys antarcticus* Pappenheim, 1911
(Plate 15, Figure 63)

MATERIAL Description based on the otoliths of five specimens ranging from 193 – 247 mm TL. Catch locality : South Georgia. 70° 26' S, 8° 39' W and 60° 30' S, 8° 04' W. DIFS otolith catalogue numbers: 1599 – 1603. Collected by the BAS and K.-H. Kock of the BAF.

DESCRIPTION

Otolith obovate. **Margin** entire to lobed. Medially flat, laterally convex. **Sulcus acusticus** ostial and homosulcoid, not differentiated into **ostium** and **cauda**. **Colliculum** single and poorly developed. **Crista superior** ridge-like and posteriorly continuous with **crista inferior**, although crista inferior poorly developed. **Dorsal area** present, generally V-shaped, but shallow. **Ventral area** absent. **Rostrum** short and rounded distally, comprising c. 10 % of total otolith length. **Antirostrum** indistinct and rounded distally. **Excisura ostii** minute with wide angle.

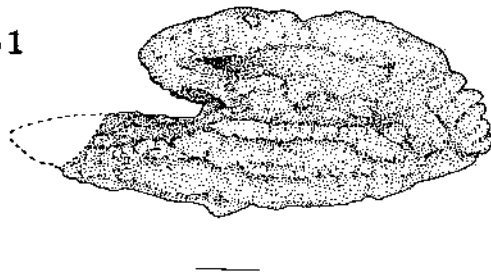
INTRASPECIFIC VARIATION

Negligible.

60



61



62

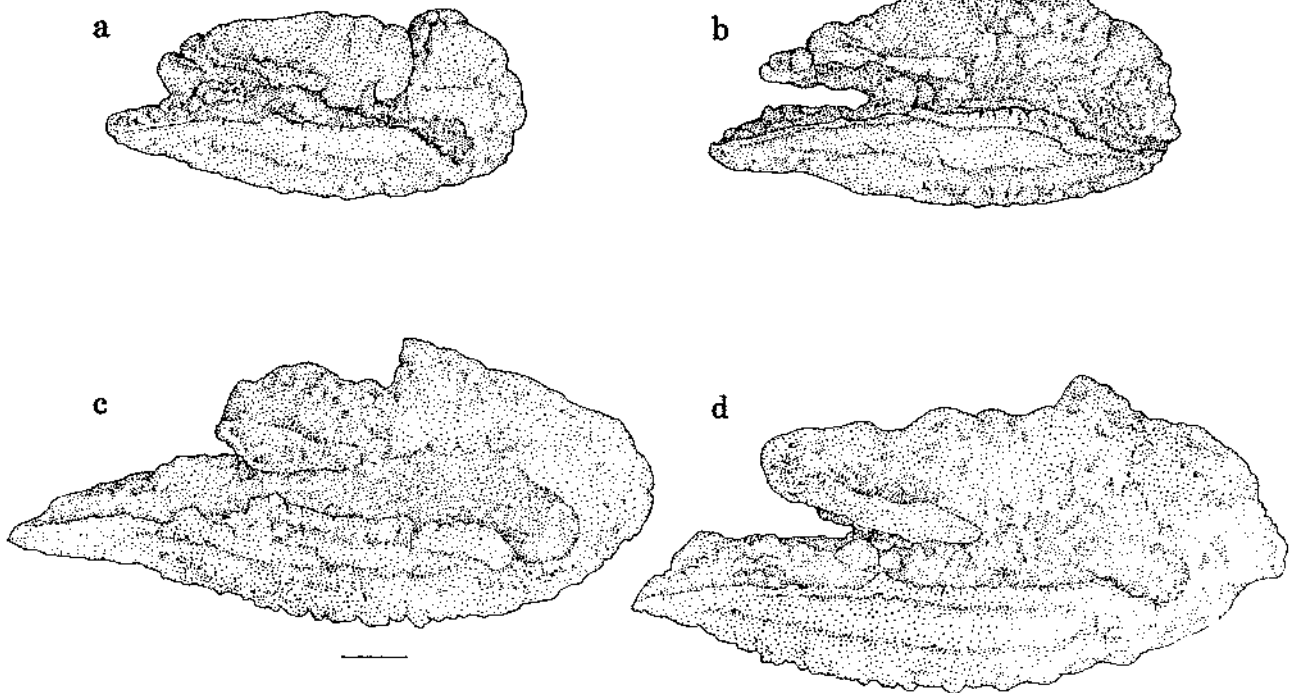


PLATE 14

Figure 60 *Menosoma elongata* a - 67 mm, b - 102 mm, c - 202 mm SL; Figure 61 *Cheilodactylus monodactylus* 410 mm TL; Figure 62 *Nemadactylus macropterus* a - 299 mm, b - 368 mm, c - 404 mm, d - 451 mm FL.

DIAGNOSTIC FEATURES

The obovate shape, the ostial and homosulcoid sulcus acusticus, which is not differentiated into ostium and cauda.

ONTOGENY

Otoliths of fish <200 mm TL more triangular than obovate, whereafter the shape becomes obovate. In fish >240 mm TL the margin becomes slightly irregular.

MORPHOMETRY**OL : TL Ratio**

1 : 76.18

n = 5; Std Dev = 5.87; Range 71.33 – 85.77

SUBORDER NOTOTHENIOIDEI**FAMILY Bovichthyidae**

SPECIES *Bovichthys diacanthus* (Carmichael, 1818)
(Plate 15, Figure 64)

MATERIAL Description based on the otoliths of four specimens ranging from 190 – 240 mm TL. Catch locality: Gough Island. Collected and made available on loan to the author by N. Klages of the PEM.

DESCRIPTION

Otolith roughly ovate. **Ventral margin** entire. **Dorsal margin** entire to lobed and somewhat domed. Distinct notch in postero-dorsal margin. Medially strongly convex with extremely high and prominent relief, laterally slightly concave to flat. **Sulcus acusticus** deep, ostio-caudal and heteromorph. **Collum** raised and constricted. **Ostium** and **cauda** of near equal size in length, although ostium broader than cauda. Both **anterior** and **posterior colliculi** obscure. **Crista superior** high, ridge- and pinnacle-like in mid-region. **Crista inferior** high and ridge-like. Distinct **dorsal** and **ventral grooves**. **Rostrum** prominent, proximally broad, becoming slender and rounded distally, comprising c. 30 % of total otolith length. **Antirostrum** minute and rounded distally. **Excisura ostii** with acute angle.

INTRASPECIFIC VARIATION

Negligible, except for the notch in the postero-dorsal margin which varies in size.

DIAGNOSTIC FEATURES

The essentially ovate shape, the high relief of the medial side, the pinnacle-like shape of the crista superior, the ostio-caudal sulcus acusticus, the notch in the postero-dorsal margin and the distinct dorsal and ventral grooves.

MORPHOMETRY**OL : TL Ratio**

1 : 60.4

Std Dev = 2.14; Range 58.9 – 64.9

FAMILY Nototheniidae

SPECIES *Aethotaxis mitopteryx* De Witt, 1962
(Plate 16, Figure 65)

MATERIAL Description based on the otoliths of one specimen of 320 mm SL. Catch locality: 77° 42' S, 36° 48' W. DIFS otolith catalogue number: 2003. Collected by G. Hubbard of the AWI.

DESCRIPTION

Otolith ovate with distinct V-shaped notch in posterior margin. **Margin** entire to lobed. Medially flat to slightly convex with poor relief. Laterally convex. **Sulcus acusticus** ostio-caudal, heterosulcoid and shallow. **Ostium** and **cauda** not completely separated by dorsally directed isthmus from crista inferior. **Collum** constricted. **Colliculi** heteromorph. **Crista superior** divided into anterior and posterior sections, forming ventro-lateral margins of the **dorsal area**. Anterior section of **crista superior** well developed. **Crista inferior** small and present only below mid-section of sulcus acusticus. **Rostrum** prominent although short and squared-off distally. **Antirostrum** approximately one quarter the size of rostrum and rounded distally. **Excisura ostii** present with relatively acute angle.

DIAGNOSTIC FEATURES

The ovate anterior shape, the notched posterior margin, the squared-off rostrum and the shallow ostio-caudal and heterosulcoid sulcus acusticus.

MORPHOMETRY**OL : TL Ratio**

1 : 58.9

OL : SL Ratio

1 : 50.3

SPECIES *Dissostichus eleginoides* Smitt, 1898
(Plate 16, Figure 66)

MATERIAL Description based on the otoliths of 47 specimens ranging from 350 – 1500 mm TL. Catch locality: Kerguelen, Crozet and South Georgia Islands and from the Patagonian Shelf. DIFS otolith catalogue numbers: 342 – 352, 693 – 712, 770, 810 – 812, 1405, 1425 – 1434, 1591. Collected by the MNINP, MIRP, IAA and the BAS.

DESCRIPTION

Otolith ovate to fusiform. **Margin** sinuate. Medially slightly convex with good relief, laterally concave. **Sulcus acusticus** ostio-caudal (sometimes ostial) and heterosulcoid. **Ostium** and **cauda** distinctly separated by constricted and deep **collum**. **Colliculi** heteromorph and well developed. Both **cristae superior** and **inferior** well developed, forming distinct high ridges above and below sulcus acusticus. **Crista superior** crenate and extremely bold in specimens >800 mm TL. **Dorsal area** prominent. **Rostrum** prominent, large and generally rounded distally. The percentage size of the rostrum in total otolith length is variable. **Antirostrum** minute in relation to rostrum and rounded distally. **Excisura ostii** minute with wide angle.

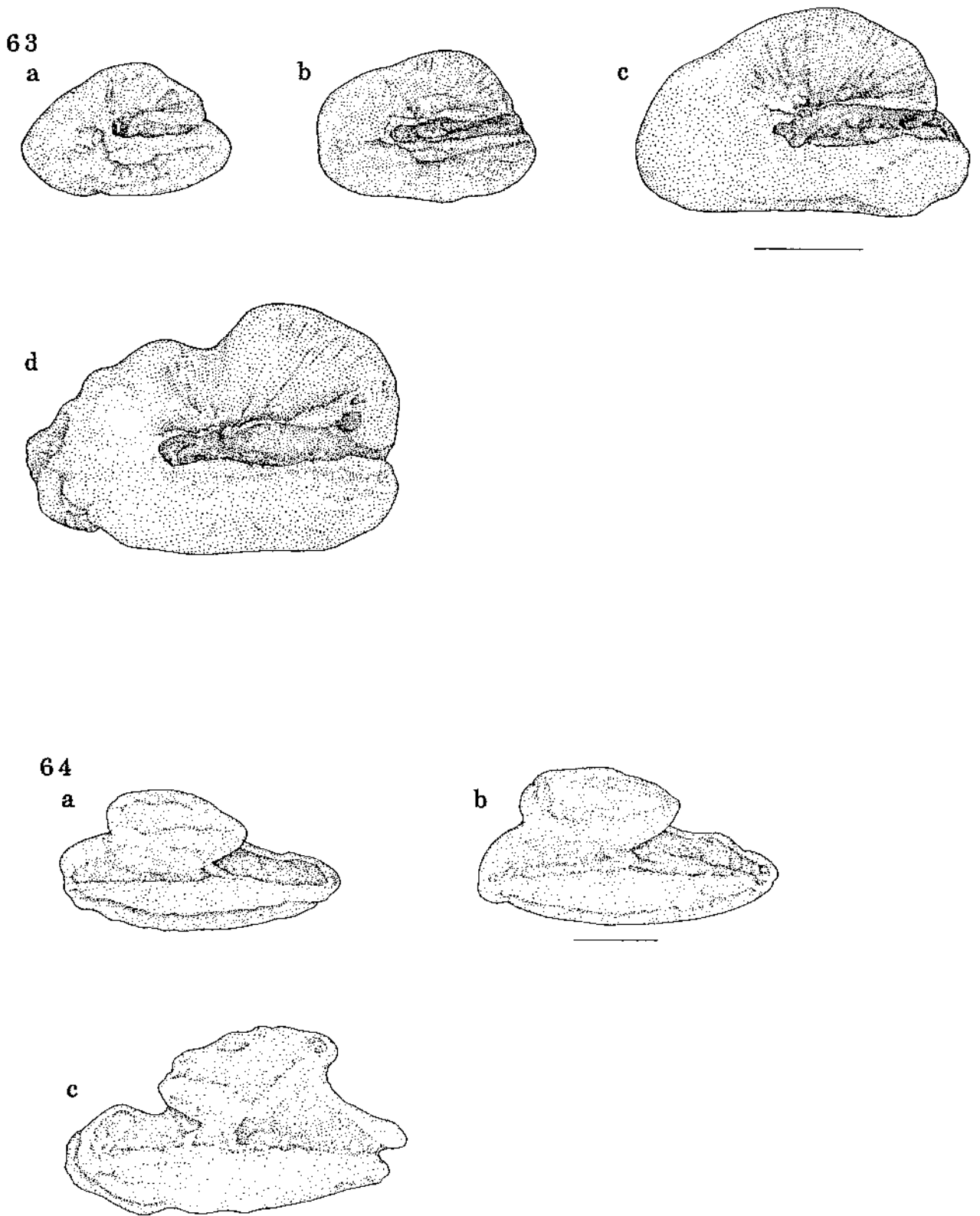


PLATE 15

Figure 63 *Lycodichthys antarcticus* a - 193 mm, b - 214 mm, c - 223 mm, d - 247 mm TL; Figure 64 *Bovichthys diacanthus* a - 190 mm, b - 220 mm, c - 230 mm TL.

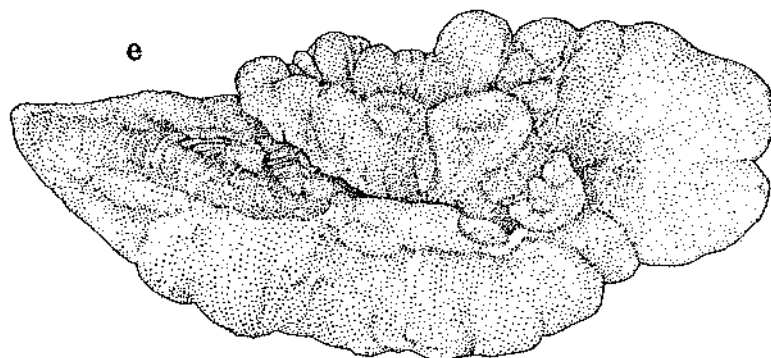
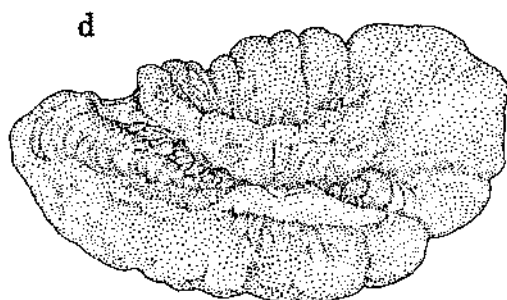
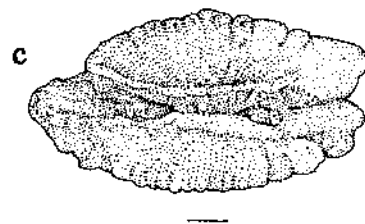
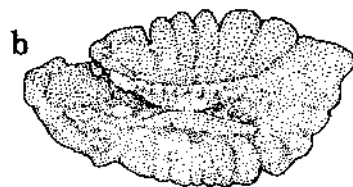
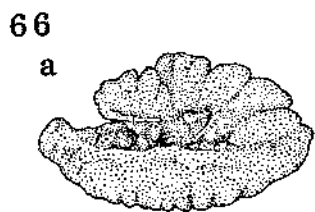
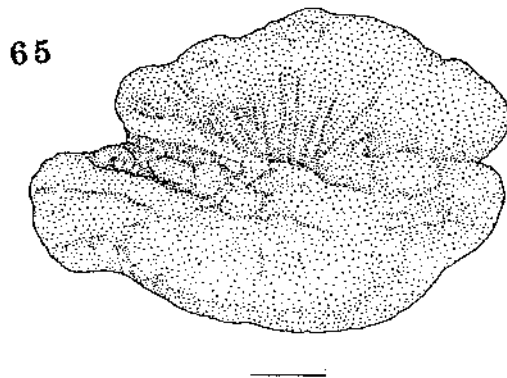


PLATE 16

Figure 65 *Aethotaxis mitopteryx* 375 mm TL; Figure 66 *Dissostichus eleginoides* a - 390 mm, b - 400 mm, c - 410 mm, d - 1040 mm, e - 1830 mm TL.

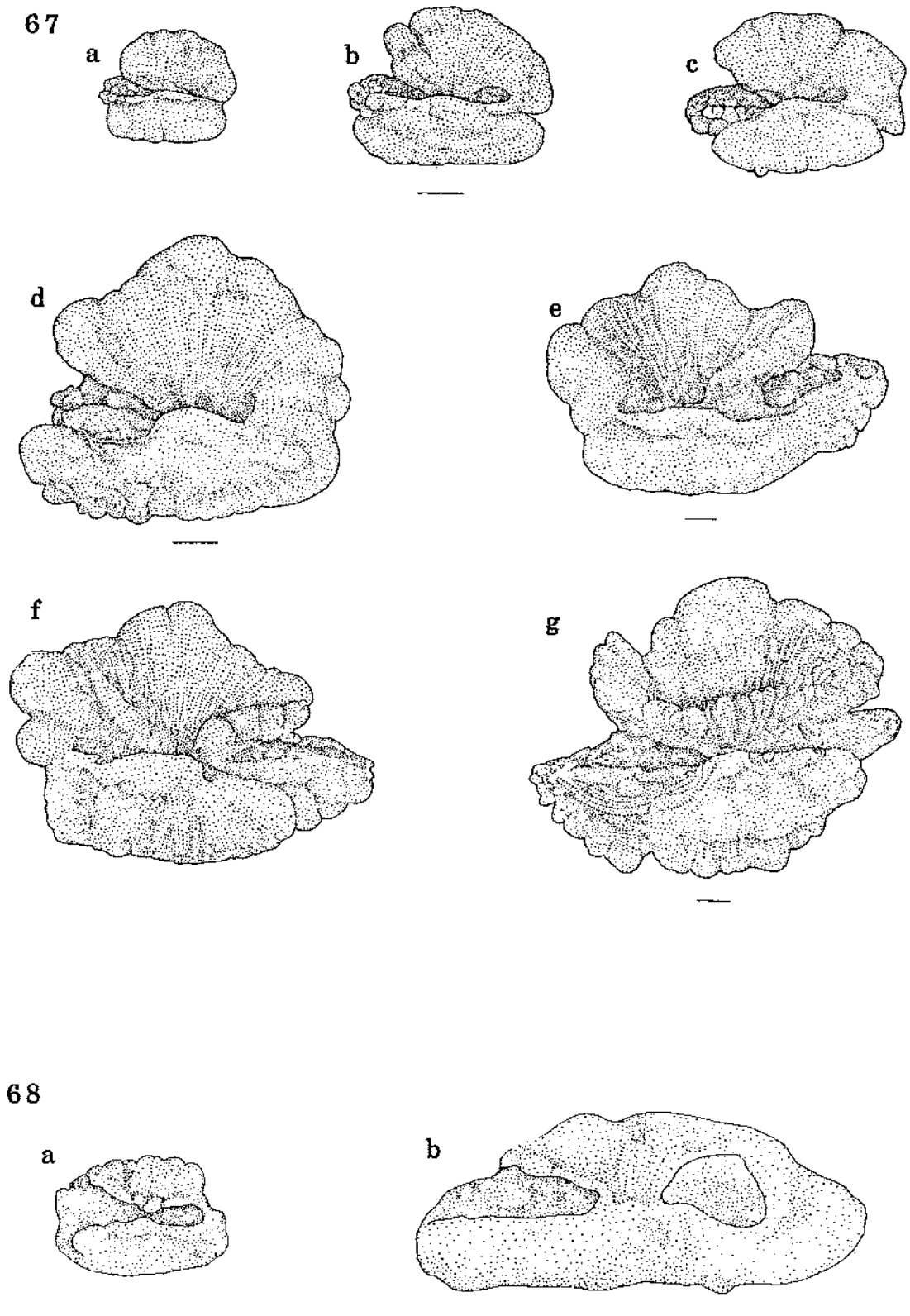


PLATE 17

Figure 67 *Dissostichus mawsoni* a - 204 mm, b - 276 mm, c - 325 mm, d - 700 mm, e - 1380 mm, f - 1450 mm, g - 1405 mm TL; Figure 68 *Notothenia acuta* a - length unknown.

INTRASPECIFIC VARIATION

Variation quite marked, but the various types illustrated should eliminate any misidentification. Rostrum length varies as does the otolith length/depth ratio. Also, the position, length and robustness of the cristae are variable.

DIAGNOSTIC FEATURES

The generally ovate to fusiform shape, the distinct collum, the well developed cristae and the prominent crenate margin.

ONTOGENY

The crista superior becomes crenate and more robust in fish >800 mm TL.

MORPHOMETRY

OL / TL Relationship

$$TL = 9.94 OL^{1.85} \text{ mm}$$

$n = 30$; Std Err Est = 0.199; Coeff Det = 0.82; Corr Coeff = 0.90

Mass / TL Relationship

$$\text{Mass (g)} = 0.0026 TL \text{ (cm)}^{3.36} \text{ (Messtorff \& Kock 1978)}$$

SPECIES *Dissostichus mawsoni* Norman, 1937
(Plate 17, Figure 67)

MATERIAL Description based on the otoliths of seven specimens ranging from 276 – 1450 mm TL and one specimen of 135 mm SL. Catch locality: South Georgia and 61° 12' S, 55° 52' W. DIFS otolith catalogue numbers: 813 – 815, 1586 – 1590. Collected by the BAS and K.-H. Kock of the BAF.

DESCRIPTION

Otolith generally discoid to subquadrate. **Margin** irregular. **Dorsal margin** generally less well sculptured than **ventral margin**. Medially slightly convex with good relief, laterally slightly concave to flat. **Sulcus acusticus** ostial to ostio-caudal in fish >600 mm TL and heterosulcoid. **Collum** constricted. **Ostium** deeper than **cauda**. **Colliculi** heteromorph but poorly developed. **Crista superior** only present over ostium and poorly developed in specimens <700 mm TL. In specimens >800 mm TL crista superior becomes more robust and in specimens over 1400 mm TL dorsal margin of the crista superior becomes crenate. **Crista inferior** relatively broad and best developed below collum. **Dorsal area** present only in specimens >1400 mm TL. **Rostrum** of specimens <800 mm TL appearing as distinctly separate projection from anterior margin and in specimens >1000 mm TL rostrum becomes prominent and rounded to pointed distally. Size of rostrum is variable in total otolith length. **Antirostrum** small and rounded distally, usually with notch above in dorsal margin. **Excisura ostii** with relatively acute angle in comparison to *Dissostichus eleginoides*.

INTRASPECIFIC VARIATION

The sculpture of the margin varies from irregular to lobed in specimens of all lengths.

DIAGNOSTIC FEATURES

The discoid to subquadrate shape, the irregular margin, the deep ostium and the notch in the dorsal margin above the antirostrum.

ONTOGENY

The most distinguishing ontogenetic feature is the change in the shape of the rostrum from being a separate projection on the anterior margin in specimens <800 mm TL to being prominent in specimens >1000 mm TL. In specimens <800 mm TL the sulcus acusticus is ostial but becomes ostio-caudal in larger specimens. The geometric shape of the otolith also changes from square to discoid/subquadrate with an increase in fish size.

MORPHOMETRY

OL / TL Relationship

$$TL = 42.78 OL^{1.39} \text{ mm}$$

$n = 7$; Coeff Det = 0.85

Mass / TL Relationship

$$\text{Mass (g)} = 2.25 \times 10^{-5} TL \text{ (mm)}^{2.916}$$

$r^2 = 0.96$; $n = 52$. (Burchett *et al.* 1984).

SPECIES *Notothenia acuta* Günther, 1880
(Plate 17, Figure 68)

MATERIAL Description based on the otoliths of two specimens of unknown length. Catch locality: Kerguelen Island. DIFS otolith catalogue numbers: 247, 249. Collected by J.-C. Hureau of the MNHN.

DESCRIPTION

Otolith oval in small fish to fusiform in larger fish. Medially flat to slightly convex with poor relief, laterally concave. **Margin** entire to lobed. **Sulcus acusticus** ostial and heterosulcoid. In large fish **ostium** and **cauda** separated by raised and constricted **collum**. **Crista superior** split into anterior and posterior sections, but poorly developed and forming ventrolateral borders of the V-shaped **dorsal area**. **Crista inferior** narrow and present below entire sulcus acusticus. **Colliculi** heteromorph, poorly developed to absent. **Rostrum** prominent and rounded distally, comprising c. 18 % of total otolith length. **Antirostrum** minute. **Excisura ostii** small with wide angle.

DIAGNOSTIC FEATURES

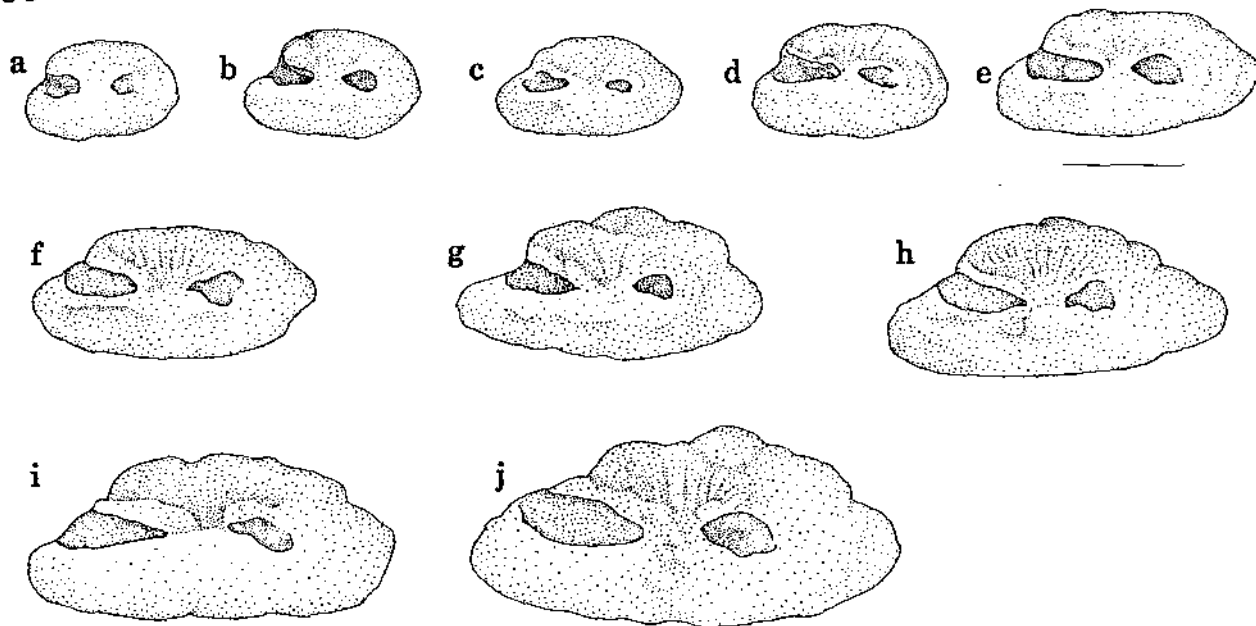
The fusiform shape, the distinctly separated ostium and cauda, the narrow crista inferior in association with the split crista superior.

ONTOGENY

Otolith of small fish slightly rectangular with crenate margin, becoming entire to lobed in larger fish and the geometric shape changes to become fusiform and the ostium and cauda become separated in larger fish.

SPECIES *Notothenia angustifrons* Fischer, 1885
(Plate 18, Figure 69)

69



70

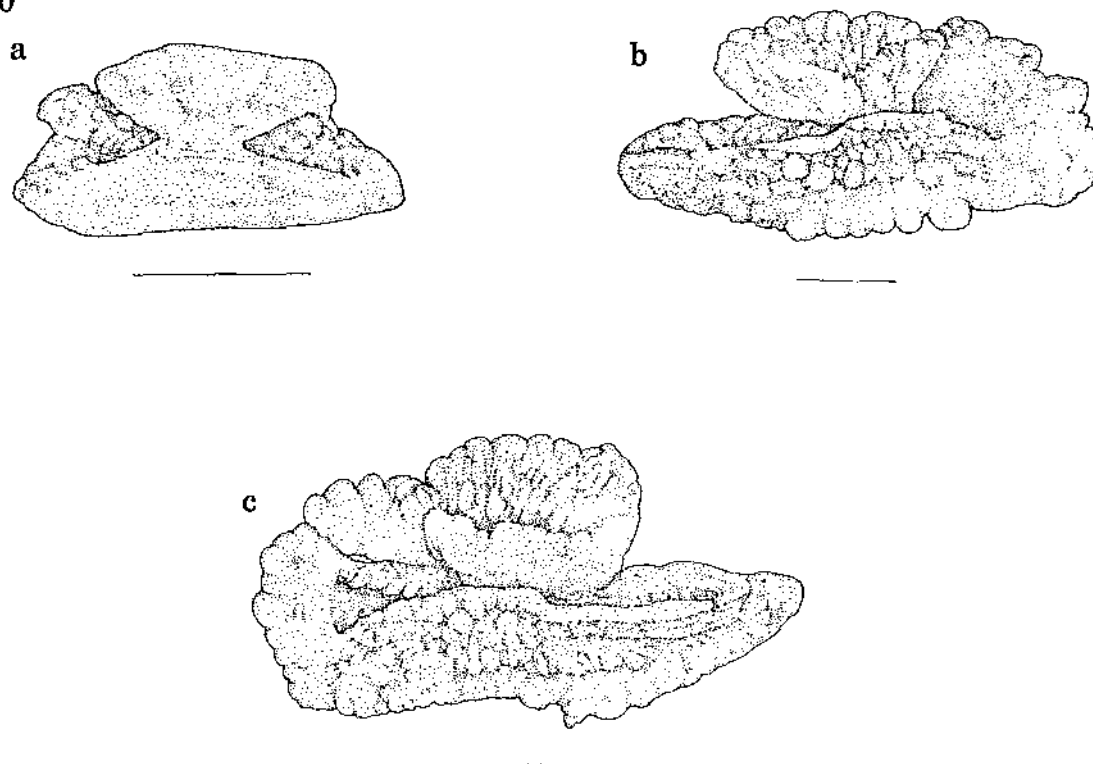


PLATE 18

Figure 69 *Notothenia angustifrons* a - 51 mm, b - 55 mm, c - 53 mm, d - 64 mm, e - 68 mm, f - 84 mm, g - 74 mm, h - 87 mm, i - 105 mm, j - 127 mm TL; Figure 70 *Notothenia coriiceps* a - 116 mm, b - 326 mm, c - 370 mm SL.

MATERIAL Description based on the otoliths of 24 specimens ranging from 44 – 137 mm TL. Catch locality: South Georgia. DIFS otolith catalogue numbers: 796, 797, 1507, 1511, 1516, 1517, 1520, 1536, 1538, 1544, 1545, 1547, 1549 – 1556, 1558, 1560, 1561, 1564. Collected by the BAS.

DESCRIPTION

Otolith generally fusiform. **Ventral margin** generally straight and entire. **Dorsal margin** domed, entire to lobed in fish 120 mm TL. **Sulcus acusticus** ostial and heterosulcoid. **Ostium** and **cauda** separated by constricted **collum** and dorsal isthmus from **crista inferior**. Cauda generally triangular in shape. **Anterior colliculum**, usually present, **posterior colliculum** poorly developed. **Crista superior** separated into anterior and posterior portions, forming ventro-lateral borders of V-shaped **dorsal area**. **Crista inferior** prominent, particularly below **collum**. **Rostrum** prominent and rounded distally, comprising c. 30 % of total otolith length. **Antirostrum** minute and sometimes absent, if present rounded distally. **Excisura ostii**, if present, with wide angle.

INTRASPECIFIC VARIATION

Negligible, except that the anterior colliculum and the excisura ostii can either be present or absent.

DIAGNOSTIC FEATURES

The distinctly fusiform shape, the separated ostium and cauda in association with the prominent **crista inferior**.

ONTOGENY

The sculpture of the margins change from being totally entire to dorsally lobed in fish >120 mm TL and the otolith becomes more fusiform with increasing size.

MORPHOMETRY

OL / TL Relationship

$$TL = 41,42 OL^{0,768} \text{ mm}$$

n = 22; Std Err Est = $9,65 \times 10^{-2}$; Coeff Det = 0,91; Corr Coeff = 0,95

Mass / TL Relationship

$$\text{Mass} = 3,73 \times 10^{-6} TL^{3,18} \text{ g}$$

n = 24; Std Err Est = 0,161; Coeff Det = 0,98; Corr Coeff = 0,99

SPECIES *Notothenia coriiceps* Richardson, 1844
(Plate 18, Figure 70)

MATERIAL Description based on the otoliths of five specimens ranging from 116 – 370 mm SL. Catch locality: 62° 24' S, 61° 00' W (South Shetland area) and Marion Island. DIFS otolith catalogue numbers: 52, 742, 750, 751, 752. Collected by Y. Naito of the NIPRT and M.T.T. Davies of the DIFS.

DESCRIPTION

Otolith ovate. Medially slightly convex, laterally slightly concave. Medial face with high relief. **Margin** sinuate to dentate, except in fish <120 mm SL. **Sulcus acusticus** ostial and heterosulcoid. **Collum** distinct, acutely constricted and slightly raised. **Ostium** and **cauda** of approximately equal

size. Cauda with distinct but slight postero-ventral angle. **Colliculi** poorly developed. **Crista superior** continuous above entire **sulcus acusticus**, although sometimes obscured by relief of medial face. **Crista inferior** broad and prominent and present below entire **sulcus acusticus**. Dorsal surface of **crista inferior** crenate. **Dorsal area** present but obscured by prominence of **crista superior**. **Rostrum** prominent, either rounded or pointed distally, comprising c. 25 % of total otolith length. **Antirostrum** also prominent and rounded distally, c. half size of rostrum. **Excisura ostii** present with variable angle.

INTRASPECIFIC VARIATION

Rounded posterior margin sometimes entire, rostrum either pointed or rounded distally.

DIAGNOSTIC FEATURES

The ovate shape, the crenate dorsal surface of the **crista inferior**, the crenate to sinuate margin and the partially divided ostium and cauda.

ONTOGENY

In fish <120 mm SL the margin is entire, whereafter it becomes sinuate to dentate. The raised **collum** becomes more constricted in fish >120 mm SL.

MORPHOMETRY

OL / SL Relationship

$$SL = 50,91 OL^{1,16} \text{ mm}$$

n = 5; Std Err Est = 0,108; Coeff Det = 0,96; Corr Coeff = 0,98

OL / Fish Mass Relationship

$$\text{Mass} = 2,96 OL^{3,88} \text{ g}$$

n = 5; Std Err Est = 0,311; Coeff Det = 0,96; Corr Coeff = 0,98

SPECIES *Notothenia cyanobranchia* Richardson, 1844
(Plate 19, Figure 71)

MATERIAL Description based on the otoliths of 15 specimens ranging from 84 – 197 mm TL. Catch locality: Kerguelen Island. DIFS otolith catalogue numbers: 227 – 246. Collected by J.-C. Hureau of the MNHN.

DESCRIPTION

Otolith generally oval. **Margin** entire to gently lobed posteriorly and dorsally. **Ventral** and **dorsal margin** usually with characteristic indentation in the middle. **Sulcus acusticus** deep, ostial and heterosulcoid. In specimens >120 mm TL the **ostium** and **cauda** are completely separated. **Cauda** triangular in shape although somewhat rounded posteriorly. **Colliculi** homomorph but indistinct. **Collum** constricted and together with dorsal projection of **crista inferior** separating ostium from cauda. **Crista superior** usually distinct, somewhat V-shaped and forming ventro-lateral borders of V-shaped **dorsal area**. Posterior half of **crista superior** sometimes absent. **Crista inferior** broad with dorsally projecting isthmus. **Rostrum** prominent, proximally and distally broad and rounded distally. **Antirostrum** rounded distally and c. quarter size of rostrum. **Excisura ostii** present with variable angle.

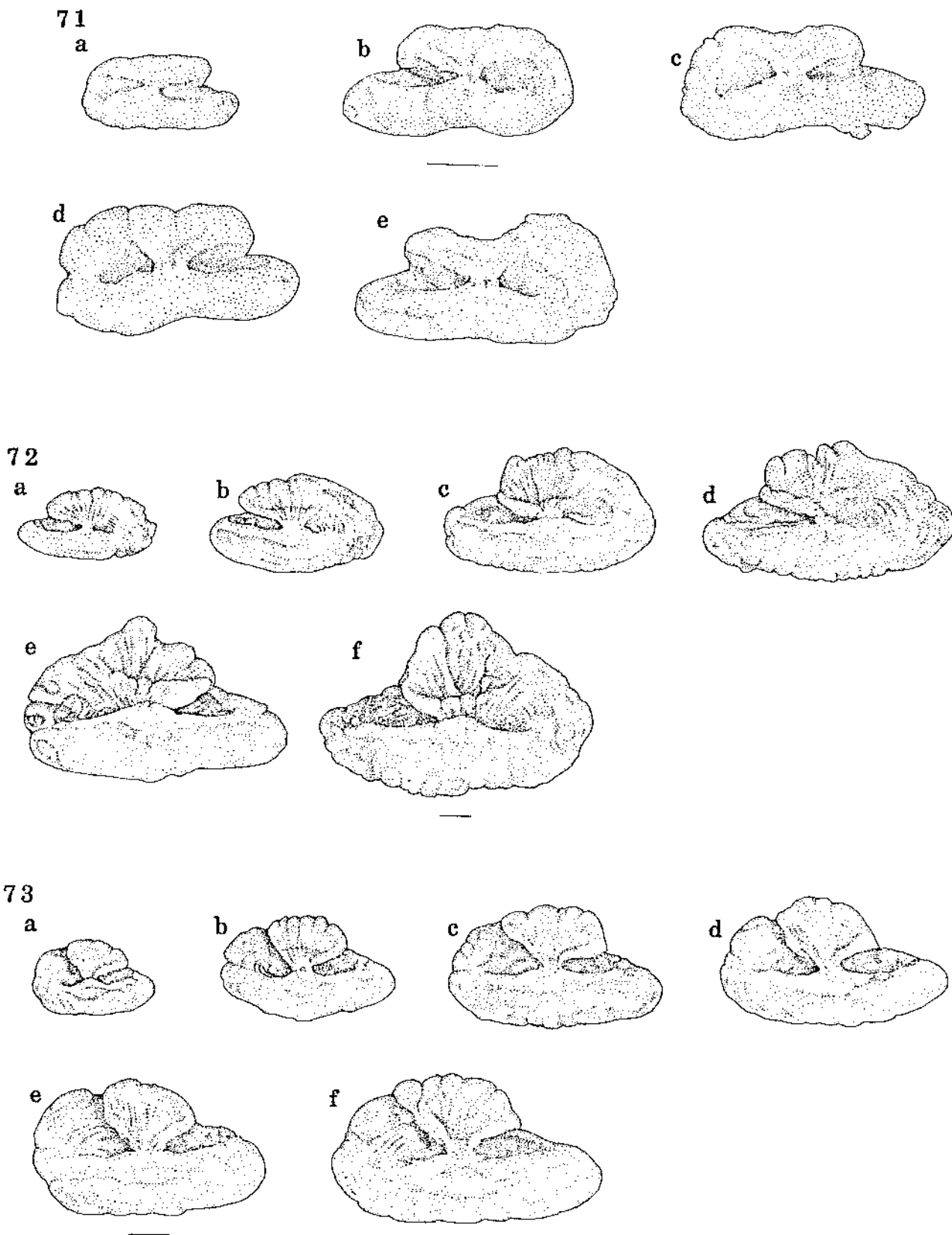


PLATE 19

Figure 71 *Notothenia cyanobrancha* a - 100 mm, b - 182 mm, c - 170 mm, d - 189 mm, e - 177 mm TL; Figure 72 *Notothenia gibberifrons* a - 150 mm, b - 241 mm, c - 302 mm, d - 393 mm, e - 394 mm, f - 456 mm TL; Figure 73 *Notothenia kempfi* a - 97 mm, b - 158 mm, c - 232 mm, d - 227 mm, e - 279 mm, f - 297 mm TL.

INTRASPECIFIC VARIATION

Mid-dorsal and ventral marginal indentation sometimes absent, otherwise negligible.

DIAGNOSTIC FEATURES

The oval shape, the separate ostium and cauda in specimens 100 mm TL and the generally occurring mid-dorsal and mid-ventral marginal indentations.

MORPHOMETRY**OL : TL Ratio**

1 : 54,42

n = 14; Std Dev = 10,21; Range 39,07 – 58,81

SPECIES *Notothenia gibberifrons* Lönnberg, 1905
(Plate 19, Figure 72)

MATERIAL Description based on the otoliths of 65 specimens ranging from 150 – 490 mm TL. Catch locality : 62° 24' S, 61° 01' W (South Shetland and Elephant Island area), South Georgia, 61° 05' S, 56° 03' W; 61° 18' S, 55° 38' W; 70° 26' S, 8° 39' W. DIFS otolith catalogue numbers: 1 – 25, 264, 433 – 452, 773, 774, 789, 790, 1126 – 1129, 1134, 1135, 1138, 1142 – 1144, 1146, 1147, 1151, 1155, 1158, 1162, 1163, 1168 – 1171, 1174 – 1180, 1183, 1184, 1187, 1702 – 1715. Collected by the BAS, Y. Naito of the NIPRT, A. Tomo of the IAA and K.-H. Kock of the BAF.

DESCRIPTION

Otolith generally ovate, although fusiform in fishes <150 mm TL. Medially flat, laterally convex. **Dorsal margin** sinuate in mid-dorsal region, otherwise lobed and becoming domed in fish >350 mm TL. **Ventral margin** entire to partly crenate. **Posterior margin** generally lobed. **Sulcus acusticus** ostial and heterosulcoid. **Collum** constricted and raised. Both **ostium** and **cauda** somewhat triangular in shape, although cauda is rounded posteriorly. Ostium and cauda partially separated by dorsally projecting isthmus from crista inferior. **Colliculi** generally homomorph. **Crista superior** split into anterior and posterior sections in fish <200 mm TL. In larger fish crista superior not split, prominent and ridge-like above entire sulcus acusticus and forming ventral border of prominent **dorsal area**. **Crista inferior** fusiform, more prominent than crista superior with dorsally projecting isthmus into sulcus acusticus. **Rostrum** prominent and rounded distally, comprising c. 20 % of total otolith length in fish <280 mm SL, then increases to c. 31 % of total otolith length. **Antirostrum** present but minute in fish <380 mm SL and absent in fish >390 mm SL. **Excisura ostii** absent in fish >390 mm SL with variable angle.

INTRASPECIFIC VARIATION

Negligible.

DIAGNOSTIC FEATURES

The fusiform to ovate shape, the constricted and raised collum, the triangular shaped ostium and cauda, the prominent mid-section of the crista inferior and domed dorsal margin and ridge-like crista superior in larger fish.

ONTOGENY

The shape of the otolith changes from fusiform to ovate with an increase in fish size. The dorsal margin becomes more dome shaped in specimens >280 mm SL and the antirostrum is absent in specimens >400 mm TL and the crista superior becomes ridge-like in larger fishes.

MORPHOMETRY**OL / TL Relationship**

TL = 17,64 OL^{1,468} mm

n = 85; Std Err Est = 0,103; Corr Coeff = 0,96; Coeff Det = 0,93

Mass / TL Relationship

Mass = 2,98x10⁻⁶ TL^{3,20} g

n = 78; Std Err Est = 5,50x10⁻²; Coeff Det = 0,98; Corr Coeff = 0,99

OL / SL Relationship

SL = 17,65 OL^{1,35} mm

n = 22; Std Err Est = 9,366x10⁻²; Corr Coeff = 0,92; Coeff Det = 0,84

Mass / SL Relationship

Mass = 2,54 x 10⁻⁶ SL^{3,34} g

n = 25; Std Err Est = 8,98x10⁻²; Coeff Det = 0,99; Corr Coeff = 0,99

OL / Fish Mass Relationship

Mass = 3,82x10⁻² OL^{3,57} g

n = 69; Std Err Est = 0,326; Corr Coeff = 0,96; Coeff Det = 0,91

SPECIES *Notothenia kempj* Norman, 1937
(Plate 19, Figure 73)

MATERIAL Description based on the otoliths of 37 specimens ranging from 97 – 350 mm TL. Catch locality: South Georgia and 61° 12' S, 56° 10' W. DIFS otolith catalogue numbers: 493 – 512, 1618 – 1634. Collected by K.-H. Kock of the BAF, the BAS and the MIRP.

DESCRIPTION

Otolith generally oval to ovate. Medially convex, laterally flat. **Dorsal margin** sinuate. **Ventral margin** generally entire. Characteristic notch in **postero-dorsal margin**. **Sulcus acusticus** extremely shallow, ostial and heterosulcoid. **Ostium** and **cauda** partially separated by constricted and raised **collum**. Cauda near triangular in shape. Both **anterior** and **posterior colliculi** present, although poorly developed and heteromorph. **Crista superior** well developed and split into anterior and posterior sections, forming ventro-lateral borders of V-shaped **dorsal area**. **Crista inferior** fusiform in shape, prominent and occurs below entire sulcus acusticus. **Rostrum** prominent and proximally broad, distally also broad and rounded. **Antirostrum** and **excisura ostii** usually absent, if present then minute.

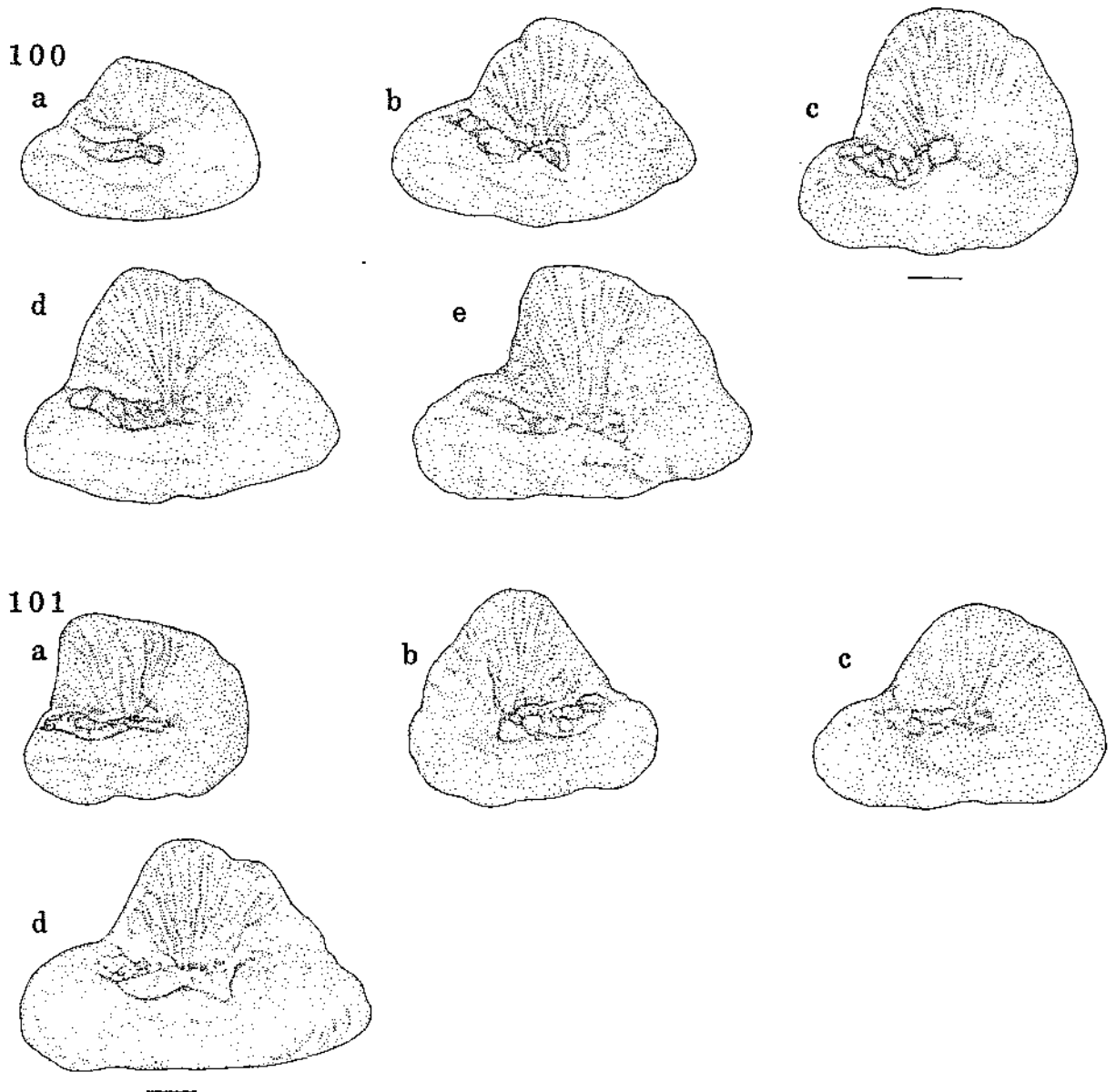


PLATE 28

Figure 100 *Pogonophryne phyllopogon* a - 123 mm, b - 152 mm, c - 218 mm, d - 211 mm, e - 250 mm SL; Figure 101 *Pogonophryne scotti* a - 188 mm, b - 197 mm, c - 246 mm, d - 275 mm SL.

MORPHOMETRY

OL : SL Ratio

1 : 39.99

n = 5; Std Dev = 4.85; Range 35.58 - 48.14

FAMILY Bathyaconidae

SPECIES *Akarotaxis nudiceps* (Waite, 1916)
(Plate 29, Figure 102)

MATERIAL Description based on the otoliths of 14 specimens ranging from 99 - 129 mm SL. Catch locality: 77° 31' S, 41° 36' W. DIFS otolith catalogue numbers: 1879 - 1892. Collected by G. Hubold of the AWI.

DESCRIPTION

Otolith vaguely triangular, although dorsal margin is squared off and indented, ventral margin forming base of triangle. Medially flat with relatively good relief, laterally slightly convex. Margin entire to gently lobed/irregular. Sulcus acusticus ostial and heterosulcoid. Ostium and cauda continuous but clearly distinguishable by constricted collum. Ostium longer than cauda. Colliculi heteromorph. sometimes continuous through collum. Crista superior variable but usually well developed above entire sulcus acusticus. Crista inferior also well developed below entire sulcus acusticus, sometimes knob-like below collum. Dorsal area prominent and V-shaped. Ventral area present below crista inferior. Rostrum broad, short and somewhat variable in shape and rounded distally. Antirostrum minute to absent. Excisura ostii with variable but wide angle.

INTRASPECIFIC VARIATION

Otolith shape and sculpture of margin variable. The development of the crista superior is also variable.

DIAGNOSTIC FEATURES

The generally triangular shape with the squared-off and indented dorsal margin, the well developed cristae and the presence of the dorsal and ventral areas.

MORPHOMETRY**OL : TL Ratio**

1 : 41,61

n = 12; Std Dev = 2,38; Range 37,85 – 45,45

SPECIES *Gerlachea australis* Dollo, 1900
(Plate 29, Figure 103)

MATERIAL Description based on the otoliths of three specimens of 227, 227 and 232 mm TL. Catch locality: 70° 26' S, 8° 39' W. DIFS otolith catalogue numbers: 1717 – 1719. Collected by K.-H. Kock of the BAF.

DESCRIPTION

Otolith ovate, although **ventral margin** straight. Medially flat with poor relief, laterally convex. **Ventral margin** entire, generally straight but with slight mid-ventral notch. **Posterior** and **dorsal margin** sinuate to lobed, sometimes with acute notch in postero-dorsal corner. **Sulcus acusticus** ostial and heterosulcoid. **Ostium** and **cauda** separated by isthmus from crista inferior, giving impression of extremely constricted **collum**. Both **anterior** and **posterior colliculi** present and homomorph. Anterior colliculum sometimes noduliferous. **Crista superior** split and present over ostium and cauda and forming lateral margins of V-shaped **dorsal area**. **Crista inferior** bold and broad with distinct ventral groove below crista inferior. **Rostrum** prominent and rounded distally, comprising c. 22 % of total otolith length. **Antirostrum** either absent or present and rounded distally. **Excisura ostii** present with acute angle.

INTRASPECIFIC VARIATION

Negligible, except for the definition of the postero-dorsal notch.

DIAGNOSTIC FEATURES

The ovate shape with the generally straight ventral margin, the separate ostium and cauda, the split crista superior and the bold crista inferior below which is a distinct ventral groove.

MORPHOMETRY**OL : TL Ratio**

1 : 69,45

n = 3; Range 67,96 – 70,50

SPECIES *Gymnodraco acuticeps* Boulenger, 1902
(Plate 29, Figure 104)

MATERIAL Description based on the otoliths of 10 specimens ranging from 180 – 291 mm TL. Catch locality: Adelle-

land and 60° 57' S, 55° 33' W. DIFS otolith catalogue numbers: 159 – 167, 256. Collected by J.-C. Hureau of the MNHNP and K.-H. Kock of the BAF.

DESCRIPTION

Otolith discoid to oval. **Margin** entire to lobed in specimens >200 mm TL. Medially flat with poor relief, laterally strongly convex. **Sulcus acusticus** heterosulcoid and medial. **Ostium** and **cauda** separated by isthmus from crista inferior, giving impression of extremely constricted **collum**. **Colliculi** heteromorph. **Anterior colliculum** sometimes noduliferous and sometimes projects beyond anterior margin. **Crista superior** only present over ostium. **Crista inferior** broad and present below entire sulcus acusticus. **Rostrum** extremely broad, prominent and rounded distally, comprising c. 12 % of total otolith length. **Antirostrum** sometimes absent, if present usually poorly developed and rounded distally. **Excisura ostii**, if present, with wide angle.

INTRASPECIFIC VARIATION

The sculpture of the margin is highly variable. The antirostrum and the excisura ostii are either present or absent and the anterior colliculum can project beyond the anterior margin.

DIAGNOSTIC FEATURES

The discoid to oval shape and the medial and poorly defined sulcus acusticus.

ONTOGENY

The sculpture of the margins changes from entire to gently lobed in specimens >200 mm TL. The sulcus acusticus also becomes slightly better defined in larger specimens.

MORPHOMETRY**OL : TL Ratio**

1 : 85,47

n = 9; Std Dev = 8,29; Range 70,91 – 95,41

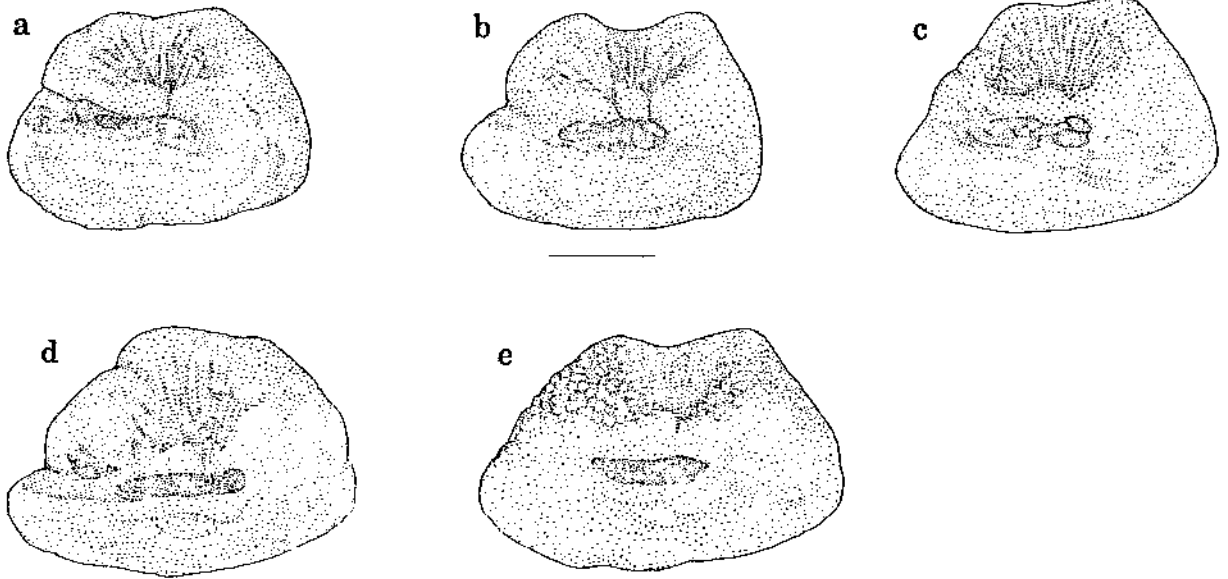
SPECIES *Parachaenichthys charcoti* (Vaillant, 1906)
(Plate 30, Figure 105)

MATERIAL Description based on the otoliths of seven specimens ranging from 105 – 205 mm TL. Catch locality : 60° 57' S, 55° 33' W and 61° 08' S, 55° 44' W. DIFS otolith catalogue numbers: 262, 269, 1597, 1598, 1665 – 1667. Collected by K.-H. Kock of the BAF.

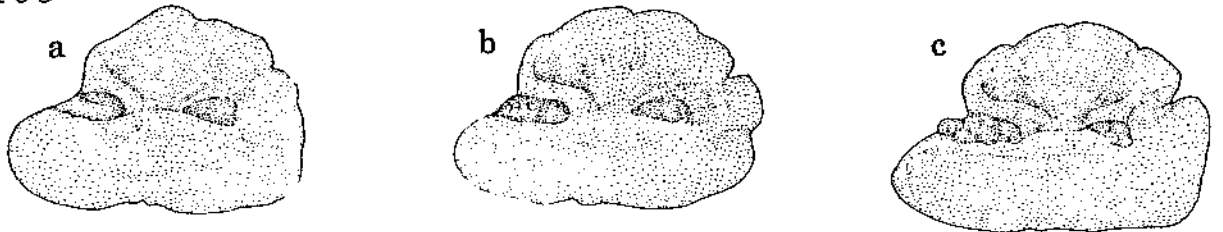
DESCRIPTION

Otolith oval, becoming triangular in larger specimens. Medially flat with poor relief, laterally strongly convex. **Margin** entire. Distinct indentation in **ventral margin** on lateral side. **Sulcus acusticus** ostial and heterosulcoid. **Collum** acutely constricted. **Ostium** and **cauda** distinctly separated by collum and a dorsally projecting isthmus from crista inferior. **Colliculi** generally homomorph and well developed. **Anterior colliculum** sometimes projects beyond the anterior margin. **Crista superior** only well developed over ostium. **Dorsal area** V-shaped. **Crista inferior** more prominent than crista superior and best developed below collum. Distinct **ventral groove** below crista inferior. **Rostrum** short but prominent

102



103



104

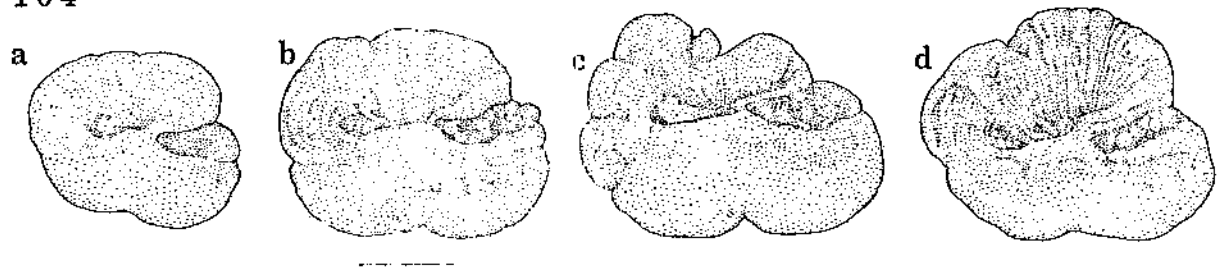


PLATE 29

Figure 102 *Akarotaxis nudiceps* a - 122 mm, b - 128 mm, c - 134 mm, d - 130 mm, e - 138 mm SL; Figure 103 *Gerlachea australis* a - 227 mm, b - 227 mm, c - 232 mm TL; Figure 104 *Gymnodraco acuticeps* a - 180 mm, b - 265 mm, c - 280 mm, d - 291 mm TL.

and rounded distally, comprising c. 15 % of total otolith length. **Antirostrum**, if present, also rounded anteriorly. **Excisura ostii** with wide angle, although sometimes obscured by anterior projection of anterior colliculum.

INTRASPECIFIC VARIATION

Negligible, except for the anterior colliculum which sometimes projects beyond the anterior margin.

DIAGNOSTIC FEATURES

The oval to triangular shape, the entire margin, the clearly separated ostium and cauda, the crista superior which is only developed above the ostium and the notch in the ventral margin on the lateral side.

ONTOGENY

The geometric shape of the otolith is oval in fish <150 mm TL, whereafter the shape tends to become somewhat triangular with the ventral margin forming the base of the triangle.

MORPHOMETRY

OL : TL Ratio

1 : 83,97

n = 7; Std Dev = 6,59; Range 73,74 – 88,89

SPECIES *Parachaenichthys georgianus* (Fischer, 1885)
(Plate 30, Figure 106)

MATERIAL Description based on the otoliths of 25 specimens ranging from 414 – 579 mm TL. Catch locality : South Georgia. DIFS otolith catalogue numbers: 805, 1125, 1130, 1131, 1137, 1145, 1153, 1164, 1188, 1268, 1271, 1273, 1446 – 1448, 1450 – 1459. Collected by the BAS.

DESCRIPTION

Otolith ovate to fusiform (mid-posteriorly vaguely pointed). Medially flat, laterally convex. **Ventral margin** straight and generally crenate to sinuate. **Rostrum** forms prominent anterior projection. **Dorsal margin** sinuate to lobed and dome-like. **Posterior margin** lobed to entire. **Sulcus acusticus** ostial and heterosulcoid. **Ostium** and **cauda** separated by raised and constricted **collum**. **Colliculi** heteromorph. **Crista superior** split and present over ostium and cauda, forming ventro-lateral margins of V-shaped **dorsal area**. **Crista inferior** broad and robust with distinct horizontal groove. **Ventral area** elongate but shallow. **Rostrum** prominent, elongate and rounded distally, comprising c. 30 % of total otolith length. **Antirostrum** either present or absent. Angle of **excisura ostii** c. 90 degrees.

INTRASPECIFIC VARIATION

Negligible.

DIAGNOSTIC FEATURES

The ovate shape, the elongate and prominent rostrum, the sinuate to crenate dorsal and ventral margins, the robust crista inferior with a distinct horizontal groove and the split crista superior.

MORPHOMETRY

OL : TL Ratio

1 : 84,28

n = 23; Std Dev = 8,23; Range 76,06 – 103,82

SPECIES *Prionodraco evansi* Regan, 1914
(Plate 31, Figure 107)

MATERIAL Description based on the otoliths of one specimen of 143 mm TL. Catch locality unknown. DIFS otolith catalogue number: 778. Collected by A. Tomo of the IAA.

DESCRIPTION

Otolith generally fusiform. Anteriorly and posteriorly generally pointed, with domed **dorsal margin**. Medially flat, laterally slightly concave. **Margin** entire to gently lobed. **Sulcus acusticus** ostial and homosulcoid. **Collum** constricted. **Ostium** c. three times size of **cauda** in length. **Colliculi** heteromorph. **Crista superior** only present over ostium, relatively broad but poorly developed. **Crista inferior** broad and well developed, particularly below mid section of sulcus acusticus. Distinct **ventral groove** below crista inferior. **Rostrum** prominent and rounded distally, comprising c. 25 % of total otolith length. **Antirostrum** c. one quarter of rostrum size and rounded distally. **Excisura ostii** present with acute angle.

DIAGNOSTIC FEATURES

The fusiform shape, the homosulcoid sulcus acusticus, the crista superior which is only present over the ostium and the distinct ventral groove.

MORPHOMETRY

OL : TL Ratio

1 : 35,75

SPECIES *Psilodraco breviceps* Norman, 1937
(Plate 31, Figure 108)

MATERIAL Description based on the otoliths of two specimens of 148 and 150 mm TL. Catch locality: South Georgia. DIFS otolith catalogue numbers: 1190, 1435. Collected by the BAS.

DESCRIPTION

Otolith subquadrate and divided into distinct dorsal and ventral halves. **Ventral margin** straight and entire. **Dorsal margin** dome-like and irregular. Distinct notch in **posterior margin**. **Sulcus acusticus** ostio-caudal and heterosulcoid. **Ostium** and **cauda** separated by long and constricted **collum**. **Colliculi** heteromorph. Both **anterior** and **posterior colliculi** well developed. **Crista superior** split into anterior and posterior sections over ostium and cauda, forming ventro-lateral margins of the V-shaped **dorsal area**. **Crista inferior** extremely prominent and present below entire sulcus acusticus. Narrow **ventral area / groove** present below crista inferior. **Rostrum** and **pseudo-rostrum** of near equal size. Similarly **antirostrum**, **pseudo-antirostrum**, **excisura ostii** and **pseudo-excisura ostii** also of equal size.

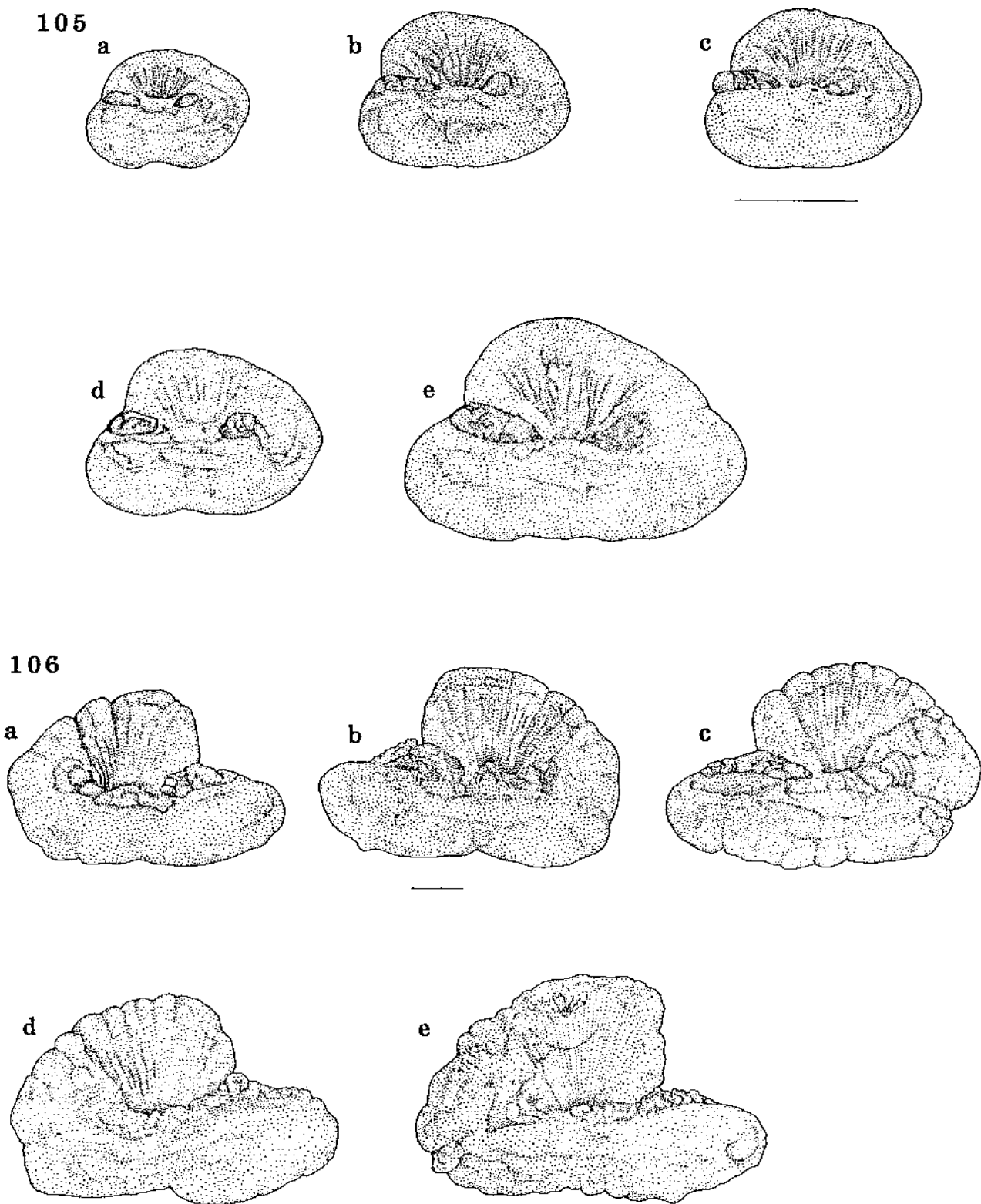


PLATE 30

Figure 105 *Parachaenichthys charcoti* a - 105 mm, b - 148 mm, c - 158 mm, d - 153 mm, e - 205 mm TL; Figure 106 *Parachaenichthys georgianus* a - 414 mm, b - 488 mm, c - 512 mm, d - 579 mm, e - 556 mm TL.

INTRASPECIFIC VARIATION

Negligible.

DIAGNOSTIC FEATURES

The subquadrate shape, the ostio-caudal sulcus acusticus, the split crista superior and the continuous and broad crista inferior below the entire sulcus acusticus.

MORPHOMETRY**OL : TL Ratio**

1 : 80,21

n = 2; Range 80,00 – 80,43

SPECIES *Racovitzia glacialis* Dollo, 1900
(Plate 31, Figure 109)

MATERIAL Description based on the otoliths of 16 specimens ranging from 173 – 260 mm SL. Catch locality: 73° 15' S, 20° 21' W and 60° 24' S, 45° 40' W. DIFS otolith catalogue numbers: 272, 1830 – 1844. Collected by G. Hubold of the AWI and K.-H. Kock of the BAF.

DESCRIPTION

Shape variable, although generally triangular with **ventral margin** forming the base of the triangle. Medially flat, laterally slightly convex. **Margin** entire to lobed. **Ventral margin** straight. **Sulcus acusticus** ostial and generally homosulcoid (somewhat allantoid in shape). **Ostium** and **cauda** poorly separated. **Collum** constricted. **Colliculi** heteromorph (development variable). **Crista superior** clearly separated into anterior and posterior sections, forming ventro-lateral margins of V-shaped **dorsal area**. **Crista inferior** continuous below entire sulcus acusticus and bulbous below **collum**. Distinct **ventral groove** below crista inferior. **Rostrum** rounded distally and variable in size, comprising c. 20 % of total otolith length. **Antirostrum** also rounded distally but small. **Excisura ostii** with wide but variable angle, although always >90 degrees.

INTRASPECIFIC VARIATION

The geometric shape is somewhat variable but there is hardly any variation in the medial microstructure.

DIAGNOSTIC FEATURES

The generally triangular shape, the ostial and homosulcoid sulcus acusticus, the clearly separated crista superior into anterior and posterior sections and the ventral groove below the crista inferior.

MORPHOMETRY**OL : TL Ratio**

1 : 50,43

n = 16; Std Dev = 2,56; Range 47,21 – 57,70

FAMILY Channichthyidae

SPECIES *Chaenichthys rhinoceratus* Richardson, 1844
(Plate 32, Figure 110)

MATERIAL Description based on the otoliths of 15 specimens ranging from 185 – 500 mm TL. Catch locality: Ker-

guelen Island. DIFS otolith catalogue numbers: 301 – 315. Collected by J.-C. Hureau of the MNHNP.

DESCRIPTION

Otolith near discoid, except for rounded rostral projection. **Dorsal margin** entire to gently lobed. **Ventral margin** entire to sinuate in fish >300 mm TL. **Sulcus acusticus** ostial and heterosulcoid. **Collum** pit-like. **Colliculi** well developed and homomorph. Ventral half of otolith is medio-laterally thicker than dorsal half. **Crista superior** split into anterior and posterior sections forming lateral margins of V-shaped **dorsal area**. **Crista inferior** present below entire sulcus acusticus but most prominent and broad below acutely constricted and pit-like **collum**. **Dorsal area** V-shaped from mid-medial focal point to dorso-lateral shoulders. **Rostrum** broad and prominent comprising c. 22 % of total otolith length and rounded distally. **Antirostrum** also rounded distally. **Excisura ostii** present with wide angle. **Pseudo-rostrum** and **-antirostrum**, if present, well developed. Pseudo-antirostrum more prominent than pseudo-rostrum. **Pseudo-excisura ostii** with acute angle.

INTRASPECIFIC VARIATION

Negligible, except for presence or absence of pseudo-rostrum and pseudo-antirostrum.

DIAGNOSTIC FEATURES

The near discoid shape, the pit-like collum and the well developed homomorph colliculi.

ONTOGENY

The sulcus acusticus becomes deeper and the colliculi, the rostrum, the antirostrum as well as the dorsal area become more prominent and larger with an increase in fish size.

MORPHOMETRY**OL / TL Relationship**

$TL = 129,66 OL^{0,679}$ mm

n = 11; Std Err Est = $5,72 \times 10^{-2}$; Coeff Det = 0,86; Corr Coeff = 0,93

Mass / TL Relationship

Mass (g) = $9,023 \times 10^{-4} TL$ (mm)^{3,5221}

$r^2 = 0,99$; n = n364 (Duhamel 1981).

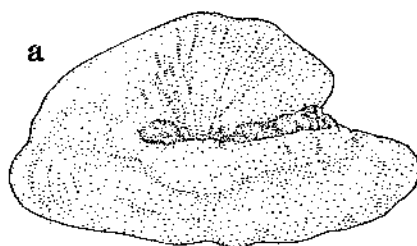
SPECIES *Chuenocephalus aceratus* Lönnberg, 1906
(Plate 32, Figure 111)

MATERIAL Description based on the otoliths of 62 specimens ranging from 136 – 454 mm TL. Catch locality: South Shetland Islands, South Georgia and 54° 07' S, 36° 48' W; and 62° 07' S, 59° 55' W. DIFS otolith catalogue numbers: 101 – 110, 263, 267, 613 – 632, 767, 800 – 801, 1124, 1133, 1136, 1140 – 1141, 1148 – 1150, 1152, 1154, 1156 – 1157, 1160 – 1161, 1172 – 1173, 1177, 1181 – 1182, 1185 – 1186, 1189, 1270, 1277 – 1278, 1404. Collected by Y. Naito of the NIPRT, K.-H. Kock of the BAF, A. Tomo of the IAA, by the MIRP and the BAS.

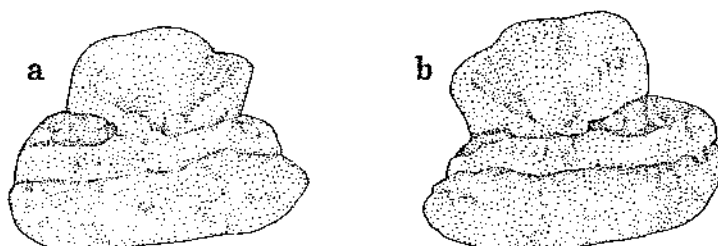
DESCRIPTION

Otolith square to discoid in smaller fish to broadly fusiform in larger fish. Medially flat with poor relief, laterally convex.

107



108



109

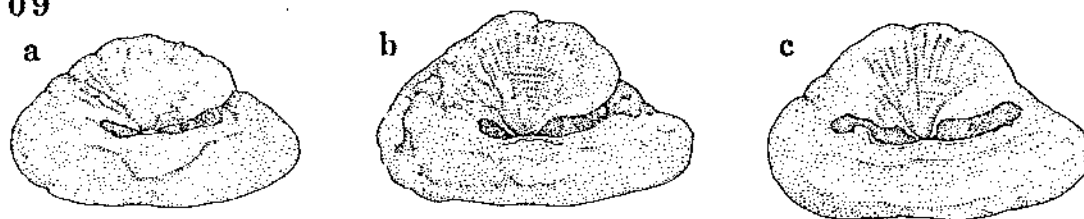


PLATE 31

Figure 107 *Prionodraco evansi* 143 mm TL; Figure 108 *Psilodraco breviceps* a - 148 mm, b - 150 mm TL; Figure 109 *Racovitzia glacialis* a - 218 mm, b - 227 mm, c - 241 mm SL.

The ventral half of the otolith is medio-laterally distinctly thicker than the dorsal half. **Margin** of otolith entire to lobed in fish <220 mm TL, to crenate in fish >250 mm TL. **Sulcus acusticus** poorly defined, ostial (sometimes ostio-caudal) and heterosulcoid. **Colliculi** heteromorph but poorly defined. **Collum** highly constricted. **Crista superior** usually split into anterior and posterior sections. Anterior section more prominent than posterior section. **Crista inferior** prominent below entire sulcus acusticus. **Rostrum** prominent and rounded distally, comprising c. 23 % of total otolith length. **Antirostrum** poorly defined, pointed to rounded distally. Angle of **excisura ostii** wide, becoming more acute in fish >320 mm TL. **Pseudo-rostrum** and **-antirostrum** sometimes present.

INTRASPECIFIC VARIATION

Negligible, except for ontogenetic changes, particularly as regards the sculpture of the margin.

DIAGNOSTIC FEATURES

The poorly defined sulcus acusticus, the thick ventral half and the comparatively thin and flat dorsal half.

ONTOGENY

The most distinguishing ontogenetic feature is the change in the sculpture of the dorsal margin, from entire to lobed to crenate in fish >250 mm SL. Excisural angle becomes more acute with an increase in fish size and the geometric shape changes from square to fusiform.

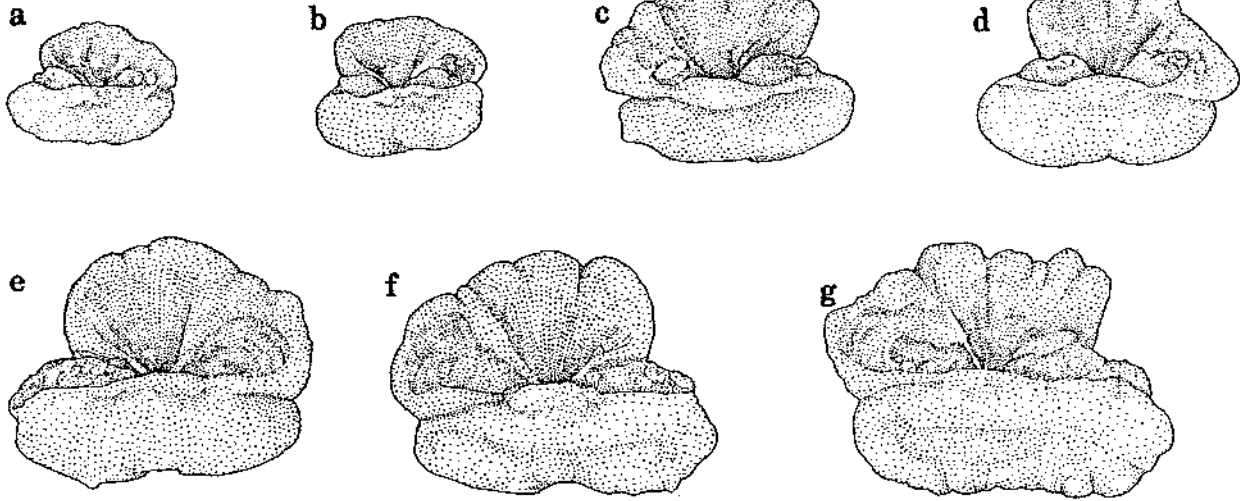
MORPHOMETRY

OL / TL Relationship

$$TL = 76,59 OL^{1,22} \text{ mm}$$

n = 49; Std Err Est = 0,116; Coeff Det = 0,87; Corr Coeff = 0,93

110



111

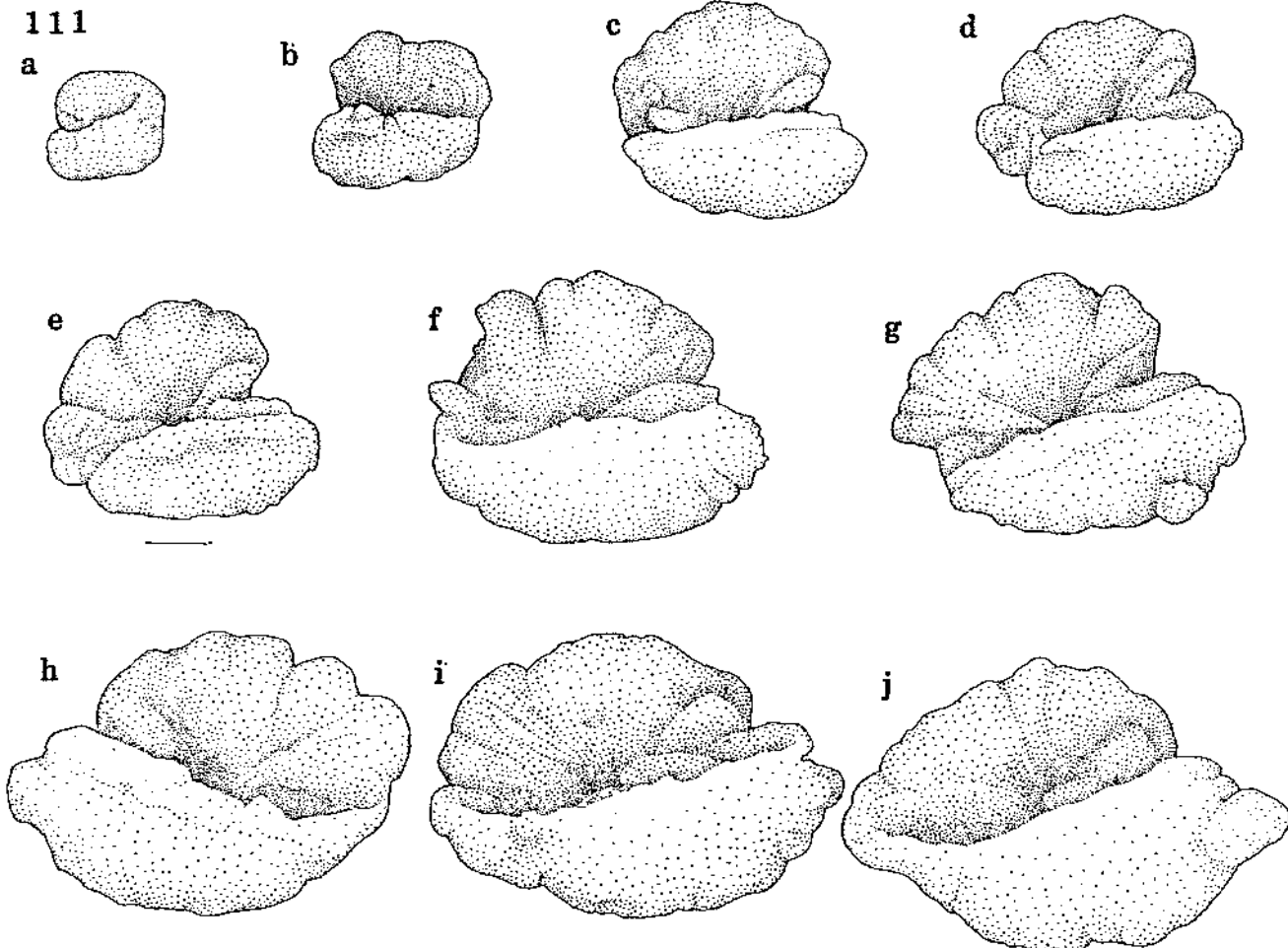
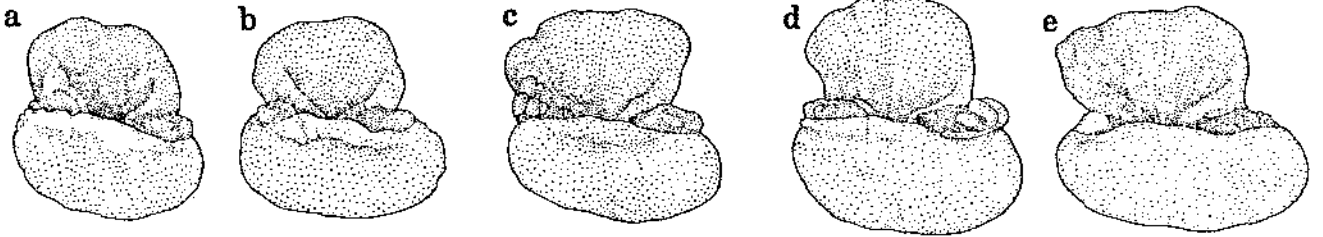


PLATE 32

Figure 110 *Chaenichthys rhinoceratus* a - 183 mm, b - 215 mm, c - 245 mm, d - 290 mm, e - 320 mm, f - 395 mm, g - 500 mm TL; Figure 111 *Chaenocephalus aceratus* a - 157 mm, b - 230 mm, c - 340 mm, d - 330 mm, e - 380 mm, f - 580 mm, g - 520 mm, h - 675 mm, i - 652 mm, j - 700 mm TL.

112



113

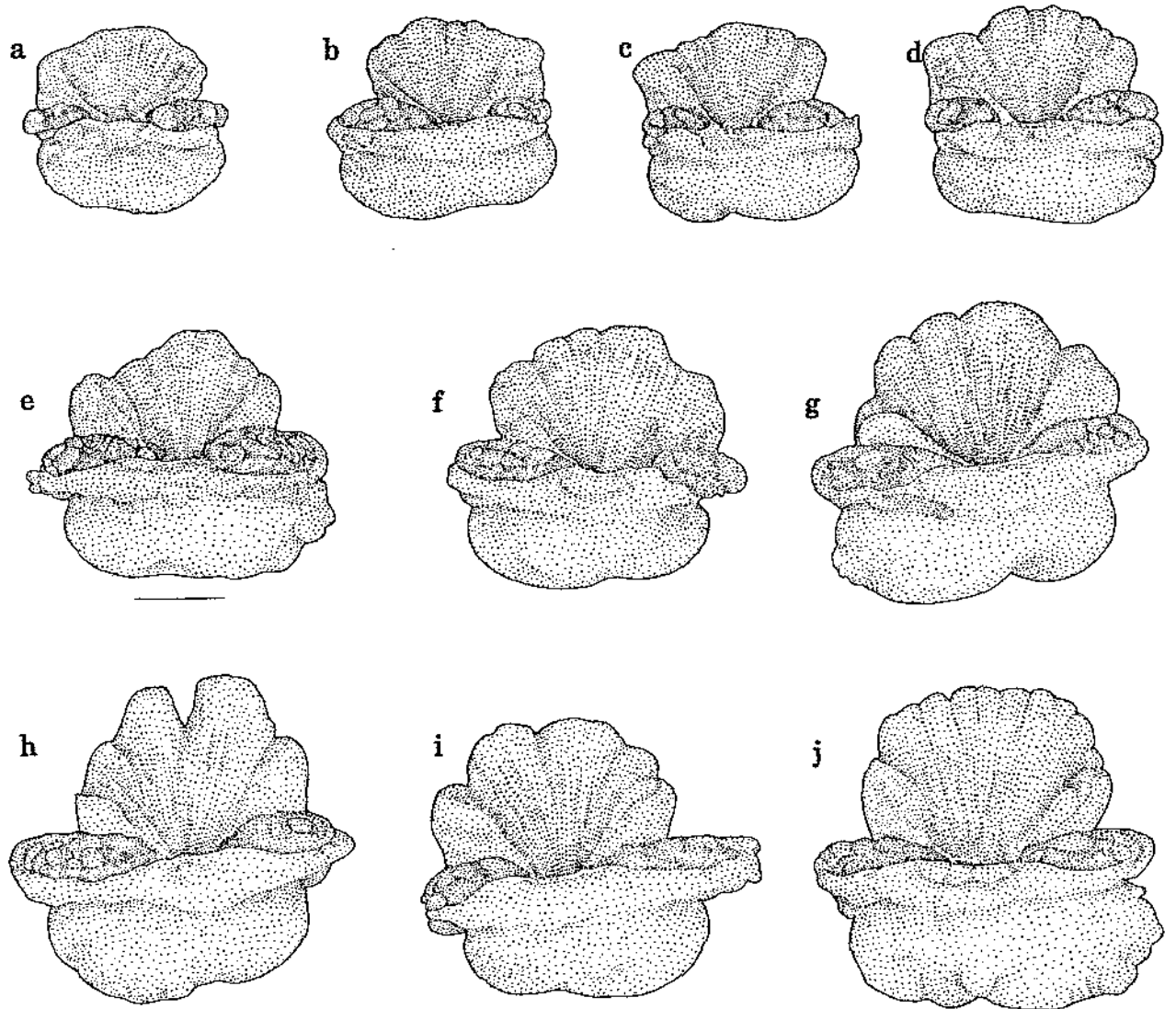


PLATE 33

Figure 112 *Chaenodraco wilsoni* a - 240 mm, b - 280 mm, c - 270 mm, d - 310 mm, e - 320 mm TL; Figure 113 *Champsocephalus gunnari* a - 240 mm, b - 236 mm, c - 236 mm, d - 278 mm, e - 350 mm, f - 341 mm, g - 431 mm, h - 492 mm, i - 451 mm, j - 500 mm TL.

Mass / TL Relationship

$$\text{Mass} = 4,33 \times 10^{-7} \text{ TL}^{3,44} \text{ g}$$

n = 52; Std Err Est = 0,122; Coeff Det = 0,99; Corr Coeff = 0,99

SPECIES *Chaenodraco wilsoni* Regan, 1914
(Plate 33, Figure 112)

MATERIAL Description based on the otoliths of 20 specimens ranging from 240 – 320 mm TL. Catch locality: Joinville. DIFS otolith catalogue numbers: 653 – 672. Collected by the MIRP.

DESCRIPTION

Otolith greater in height than in length. Ventral half of otolith larger in antero-posterior axis than dorsal portion, but dorsal half greater in dorso-ventral aspect than ventral half. Margin entire to vaguely lobed. **Sulcus acusticus** ostio-caudal, homosulcoid and situated in lower third of otolith. **Collum** acutely constricted. **Colliculi** clearly separated and homomorph, sometimes extending beyond anterior and posterior margins. **Crista superior** split into anterior and posterior sections forming lateral margins of V-shaped dorsal area. **Crista inferior** prominent below entire sulcus acusticus, although less distinct in larger fish. **Rostrum** prominent and rounded distally, comprising c. 22 % of total otolith length. **Antirostrum** poorly defined, to absent. **Pseudo-rostrum** and **-antirostrum** prominent. **Excisura ostii** and **pseudo-excisura ostii** deep with acute angles.

INTRASPECIFIC VARIATION

Negligible.

DIAGNOSTIC FEATURES

The dorso-ventrally oval shape, the prominent distally rounded rostrum, pseudo-rostrum and pseudo-antirostrum, as well as the clearly defined excisura ostii and pseudo-excisura ostii, the acutely constricted collum and the well developed colliculi.

ONTOGENY

The excisura ostii and the pseudo-excisura ostii become deeper and the crista inferior becomes less distinct with an increase in fish size.

MORPHOMETRY**OL : TL Ratio**

1 : 102,92

n = 15; Std Dev = 5,34; Range 89,00 – 107,60

SPECIES *Champscephalus gunnari* Lönnberg, 1905
(Plate 33, Figure 113)

MATERIAL Description based on the otoliths of 52 specimens ranging from 200 – 510 mm TL. Catch locality: South Shetland, Kerguelen, South Georgia and Elephant Islands and 54° 07' S, 36° 48' W. DIFS otolith catalogue numbers 83 – 96, 259, 271, 275, 283 – 300, 393 – 432, 768 – 769, 802 – 803, 1132, 1397 – 1402, 1408 – 1421, 1445, 1449. Collected by Y. Naito of the NIPRT, A. Tomo of the IAA, by the

BAS and the MIRP, by J.-C. Hureau of the MNHNP and K.-H. Kock of the BAF.

DESCRIPTION

Otolith generally discoid, except for the distinct anterior and posterior projections of the colliculi. **Dorsal margin** sinuate to lobed. **Ventral margin** gently lobed to entire. **Sulcus acusticus** situated in lower third of medial face, ostio-caudal and homosulcoid. **Collum** acutely constricted, separating **ostium** from **cauda**. **Colliculi** homomorph, prominently raised and extend beyond the anterior and posterior margins. The anterior colliculum occupies the entire **excisura ostii**. **Pseudo-excisura ostii** present but minute. **Crista superior** split into anterior and posterior sections forming lateral margins of V-shaped dorsal area. **Crista inferior** broad and prominent below entire sulcus acusticus. **Rostrum** and **antirostrum** rounded distally. Rostrum more prominent than antirostrum. **Pseudo-rostrum** and **pseudo-antirostrum** present in fish >250 mm TL. **Ventral groove** below sulcus acusticus prominent.

INTRASPECIFIC VARIATION

Negligible, except for the anterior and posterior projections of the colliculi, which in some specimens are more prominent than in others.

DIAGNOSTIC FEATURES

The generally discoid shape and the anterior and posterior projections of the colliculi beyond the anterior and posterior margins.

ONTOGENY

The most distinguishing ontogenetic features are the collicular projections. In specimens <230 mm TL the projections are absent, whereafter they become more prominent with an increase in fish length. The geometric shape also changes with the development of the collicular projections.

MORPHOMETRY**OL / TL Relationship**

$$\text{TL} = 125,46 \text{ OL}^{0,88} \text{ mm}$$

n = 93; Std Err Est = 0,138; Coeff Det = 0,71; Corr Coeff = 0,92

Mass / TL Relationship

$$\text{Mass} = 8,97 \times 10^{-7} \text{ TL}^{3,35} \text{ g}$$

n = 78; Std Err Est = 0,119; Coeff Det = 0,98; Corr Coeff = 0,99

SPECIES *Chionodraco myersi* (DeWitt & Tyler, 1960)
(Plate 34, Figure 114)

MATERIAL Description based on the otoliths of one specimen of 279 mm TL. Catch locality: Elephant Island. DIFS otolith catalogue number 119. Collected by Y. Naito of the NIPRT.

DESCRIPTION

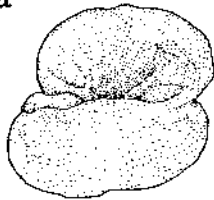
Otolith greater in height than in length. Dorsal half higher than ventral half, but ventral half longer than dorsal half. Ventral half also medio-laterally thicker than dorsal half.

114

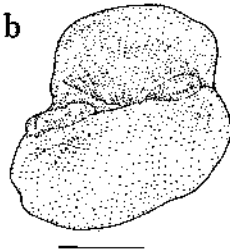


115

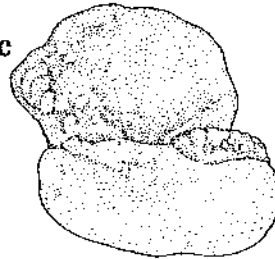
a



b



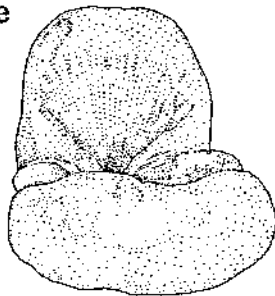
c



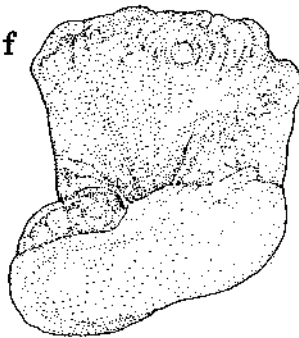
d



e

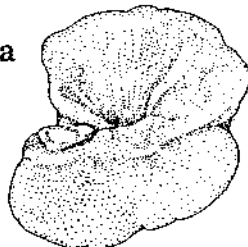


f

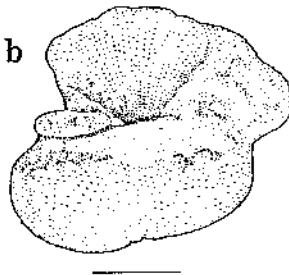


116

a



b



c



PLATE 34

Figure 114 *Chionodraco myersi* 279 mm TL; Figure 115 *Chionodraco rastrospinosus* a - 282 mm, b - 312 mm, c - 370 mm, d - 360 mm, e - 395 mm, f - 430 mm TL; Figure 116 *Cryodraco antarcticus* a - 281 mm SL, b - 310 mm TL, c - 370 mm TL.

Laterally strongly convex, medially flat with poor relief. **Margin** entire. **Sulcus acusticus** ostio-caudal and heterosulcoid. **Ostium** and **cauda** clearly separated by acutely constricted **collum**. **Colliculi** homomorph and prominent. **Crista superior** separated into anterior and posterior sections, forming ventro-lateral margins of distinct V-shaped **dorsal area**. **Crista inferior** bold and present below entire sulcus acusticus. Distinct **ventral groove** below crista inferior. **Rostrum** prominent and rounded distally, comprising 24 % of total otolith length. **Antirostrum** absent. **Excisura ostii** and **pseudo-excisura ostii** present with wide angle. **Pseudo-rostrum** and **pseudo-antirostrum** well developed and rounded distally.

DIAGNOSTIC FEATURES

The dorso-ventrally oval shape, the homomorph and well developed colliculi, the separated ostium and cauda and the presence of the pseudo-rostrum and pseudo-antirostrum.

MORPHOMETRY

OL : TL Ratio

1 : 93

OL : SL Ratio

1 : 81.67

SPECIES *Chionodraco rastrospinosus*
DeWitt & Hureau, 1979
(Plate 34, Figure 115)

MATERIAL Description based on the otoliths of 28 specimens ranging from 246 – 395 mm SL. Catch locality: Elephant Island, Shetland Island, Joinville and 64° 57' S, 66° 04' W. DIFS otolith catalogue numbers: 112 – 118, 279, 633 – 652. Collected by Y. Naito of the NIPRT, K.-H. Kock of the BAF and the MIRP.

DESCRIPTION

Otolith greater in height than in length and near rectangular. Ventral half of otolith medio-laterally thicker than dorsal half. **Margin** generally entire. Laterally convex. Dorsal half of medial surface is relatively flat, but ventral half is bulbous. **Sulcus acusticus** ostial to ostio-caudal and heterosulcoid. Sulcus acusticus situated mid-medially in fish <275 mm TL, whereafter dorsal portion above sulcus acusticus becomes larger than ventral half. Sulcus acusticus is generally pit-like. **Collum** acutely constricted. **Colliculi** generally homomorph and well developed, occupying entire **ostium** and **cauda**. Sometimes colliculi extend beyond anterior and posterior margins. **Crista superior** split into anterior and posterior sections over ostium and cauda, forming lateral margins of generally V-shaped **dorsal area**, radiating dorsally from constricted collum to dorso-lateral shoulders. **Crista inferior** generally fusiform. **Rostrum** short but prominent and generally rounded distally, comprising c. 23 % of total otolith length. **Antirostrum** absent. **Excisura ostii** and **pseudo-excisura ostii** present but minute. **Pseudo-rostrum** and **-antirostrum** sometimes present.

INTRASPECIFIC VARIATION

Negligible, except for the ontogenetic changes.

DIAGNOSTIC FEATURES

The greater height than length of the otolith and the resultant near rectangular shape, the fusiform crista inferior, the split crista superior and the well developed colliculi.

ONTOGENY

The size of the dorsal half of the otolith, above the sulcus acusticus, increases with increasing fish size and becomes squared off.

MORPHOMETRY

OL / SL Relationship

$$SL = 117,77 OL^{0,756} \text{ mm}$$

n = 7; Std Err Est = $7,37 \times 10^{-2}$; Coeff Det = 0,88; Corr Coeff = 0,94

Mass / SL Relationship

$$\text{Mass} = 1,38 \times 10^{-5} SL^{1,97} \text{ g}$$

n = 7; Std Err Est = 0,131; Coeff Det = 0,96; Corr Coeff = 0,98

SPECIES *Cryodraco antarcticus* Dollo, 1900
(Plate 34, Figure 116)

MATERIAL Description based on the otoliths of three specimens, 218, 310 and 370 mm TL. Catch locality: 62° 07' S, 60° 35' W (Shetland Island area) and 60° 24' S, 45° 40' W. DIFS otolith catalogue numbers: 111, 261, 280. Collected by Y. Naito of the NIPRT and K.-H. Kock of the BAF.

DESCRIPTION

Otolith slightly greater in height than in length. Medially flat with poor relief, laterally slightly convex. **Margin** entire to lobed. **Sulcus acusticus** situated mid-medially, ostial and heterosulcoid. **Collum** acutely constricted such that mid-section of sulcus acusticus is pit-like. **Ostium** and **cauda** completely occupied by **anterior** and **posterior colliculum** respectively. **Colliculi** homo- to heteromorph. **Anterior colliculum** sometimes projects beyond anterior margin. **Crista superior** split into anterior and posterior portions over ostium and cauda, forming ventro-lateral margins of prominent V-shaped **dorsal area**. **Crista inferior** bold, broad and near fusiform below entire sulcus acusticus. Distinct ventral groove below crista inferior. **Rostrum** prominent and blunt to rounded distally, comprising c. 16 % of total otolith length. **Antirostrum** present but situated relatively high on anterior margin and generally pointed distally. **Excisura ostii** present with wide angle.

INTRASPECIFIC VARIATION

Negligible as regards geometric shape, but sculpture of margin variable as well as the anterior colliculum which sometimes projects beyond the anterior margin.

DIAGNOSTIC FEATURES

The slightly dorso-ventral rectangular shape, the extremely constricted collum resulting in a pit-like central portion of the sulcus acusticus, the split crista superior and the ventral groove below the crista inferior and the well developed colliculi.

MORPHOMETRY**OL : TL Ratio**

1 : 97,58

n = 3; Range 92,50 - 103,33

SPECIES *Dacodraco hunteri* Waite, 1916
(Plate 35, Figure 117)

MATERIAL Description based on the otoliths of 17 specimens ranging from 96 - 260 mm TL. Catch locality: 77° 42' S, 36° 48' W. DIFS otolith catalogue numbers: 1819 - 1829, 1845 - 1850. Collected by G. Hubold of the AWI.

DESCRIPTION

Otolith generally dorso-ventrally oval to rectangular, although ventral margin is slightly rounded. Margin entire to gently lobed. Medially and laterally convex, with poor medial relief. Sulcus acusticus ostio-caudal and heterosulcoid. Ostium and cauda separated by dorsal isthmus of crista inferior and constricted collum. Colliculi well developed and homomorph. Both anterior colliculum and posterior colliculum occupy entire ostium and cauda respectively. Crista superior divided into anterior and posterior sections, forming lateral margins of V-shaped dorsal area. Crista inferior broad, occupying most of ventral half of otolith. Anterior and posterior ends of crista inferior project beyond anterior and posterior margins. Anterior projection of crista inferior obscures excisura ostii. Distinct ventral groove present. Rostrum short and rounded distally. Antirostrum and excisura ostii absent.

INTRASPECIFIC VARIATION

Negligible, except for ontogenetic changes.

DIAGNOSTIC FEATURES

The dorso-ventral oval to rectangular shape, the ostio-caudal and heterosulcoid sulcus acusticus, the ostium and cauda with well developed homomorph colliculi, the broad crista inferior with an associated broad ventral groove.

ONTOGENY

The shape of the otolith changes from near discoid to dorso-ventrally oval to rectangular with an increase in fish size.

MORPHOMETRY**OL : TL Ratio**

1 : 115,37

n = 17; Std Dev = 13,15; Range 92,26 - 133,78

SPECIES *Neopagetopsis ionah* Nybelin, 1947
(Plate 35, Figure 118)

MATERIAL Description based on the otoliths of one specimen of 460 mm TL. Catch locality: 62° 07' S, 60° 35' W (South Shetland Island area). DIFS otolith catalogue number: 97. Collected by Y. Naito of the NIPRT.

DESCRIPTION

Otolith roughly triangular with rounded corners. Medially and laterally convex. Medial face with poor relief. Otolith

divided into distinct dorsal and ventral halves. Ventral half more robust and longer than dorsal half, which is thin and narrow, but higher. Margin generally entire, although slightly irregular on posterior side. Sulcus acusticus ostio-caudal and heterosulcoid. Collum wide but constricted. Anterior and posterior colliculi prominent extending beyond anterior and posterior margins. Crista superior poorly developed and present only over ostial portion of sulcus acusticus. Dorsal area prominent. Crista inferior broad and prominent, particularly below collum. Distinct horizontal groove below crista inferior. Rostrum broad and rounded distally, antirostrum absent and excisura ostii occupied by anterior colliculum.

DIAGNOSTIC FEATURES

The geometric shape is very distinct with the broad and robust ventral half and the thin and narrower dorsal half. The anterior and posterior colliculi project beyond the anterior and posterior margins.

MORPHOMETRY**OL : SL Ratio**

1 : 155,33

SPECIES *Pagetopsis macropterus* (Boulenger, 1907)
(Plate 35, Figure 119)

MATERIAL Description based on the otoliths of two specimens of 250 and 330 mm TL. Catch locality : 63° 03' S, 57° 39' W. DIFS otolith catalogue numbers: 268, 278. Collected by K.-H. Kock of the BAF.

DESCRIPTION

Otolith vaguely triangular with rounded corners. Otolith divided into distinct dorsal and ventral halves. Ventral half longer and thicker than dorsal half. Dorsal half entirely devoid of relief. Medially flat, laterally strongly convex. Margin entire. Sulcus acusticus ostio-caudal and heterosulcoid. Collum relatively elongate and acutely constricted. Ostium and cauda distinctly separated by collum. Colliculi homomorph. Crista superior absent. Crista inferior robust and present below entire sulcus acusticus, particularly well developed below collum. Distinct ventral groove below crista inferior. Rostrum broad and rounded distally. Antirostrum small and also rounded distally. Excisura ostii with acute angle, although somewhat obscured by anterior colliculum.

INTRASPECIFIC VARIATION

Negligible.

DIAGNOSTIC FEATURES

The vaguely rounded triangular shape, the entire margin, the homomorph colliculi and the absence of relief on the dorsal half of the otolith.

MORPHOMETRY**OL : TL Ratio**

1 : 150

SPECIES *Pagetopsis maculatus* Barsukov & Permitin, 1958
(Plate 35, Figure 120)

MATERIAL Description based on the otoliths of 19 specimens ranging from 134 – 198 mm TL. Catch locality: 73° 43' S, 20° 59' W and 75° 10' S, 27° 20' W. DIFS otolith catalogue numbers: 1800 – 1818. Collected by G. Hubold of the AWI.

DESCRIPTION

Ventral half of otolith longer in antero-posterior axis than dorsal half and slightly thicker. Otolith also greater in depth than in length. **Margin** entire. **Sulcus acusticus** ostio-caudal and heterosulcoid. **Ostium** and **cauda** of approximately equal size and clearly separated, by ventrally directed isthmus from **dorsal area**. **Collum** acutely constricted. **Colliculi** homomorph. **Crista superior** split into anterior and posterior sections and poorly developed to absent. **Crista inferior** broad and robust below entire sulcus acusticus. Distinct **ventral groove** below crista inferior. **Rostrum** short and rounded distally. **Antirostrum** absent. **Pseudo-rostrum** present, also rounded distally but smaller than rostrum.

INTRASPECIFIC VARIATION

Negligible, except for ontogenetic changes.

DIAGNOSTIC FEATURES

Top hat shaped with a ostio-caudal and heterosulcoid sulcus acusticus, the separated ostium and cauda, the absence of a crista superior, the broad and prominent crista inferior and the distinct ventral groove below the crista inferior.

ONTOGENY

The dorsal half of the otolith becomes higher and more slender with increasing fish size.

MORPHOMETRY

OL : TL Ratio

1 : 83,30

n = 19; Std Dev = 11,69; Range 55,28 – 101,53

SPECIES *Pseudochaenichthys georgianus* Norman, 1937
(Plate 35, Figure 121)

MATERIAL Description based on the otoliths of 31 specimens ranging from 302 – 510 mm TL. Catch locality: 62° 07' S, 60° 35' W and 62° 07' S, 59° 55' W (South Shetland area) and South Georgia. DIFS otolith catalogue numbers: 98 – 100, 274, 281, 673 – 692, 804, 1265, 1266, 1288, 1291, 1403. Collected by Y. Naito of the NIPRT, J.-C. Hureau of the MNHNP, K.-H. Kock of the BAF, by the MIRP and the BAS.

DESCRIPTION

Otolith dorso-ventrally oval to rectangular. **Margin** entire to gently lobed. Medially flat to concave, laterally convex. Ventral portion of otolith below sulcus acusticus thicker than dorsal portion. **Sulcus acusticus** ostio-caudal and homosulcoid and situated slightly below mid-medial line. Characteristic single allantoid **colliculum**, with raised anterior and posterior extremities. Distal ends of colliculum extend

beyond anterior and posterior margin in specimens >300 mm SL. Small pseudo-colliculum present below colliculum. **Dorsal area** V-shaped. **Rostrum**, **antirostrum** and **excisura ostii** absent.

INTRASPECIFIC VARIATION

Anterior and posterior projections of colliculum sometimes absent.

DIAGNOSTIC FEATURES

The dorso-ventrally oval to rectangular shape and the anterior and posterior projections of the colliculum beyond the margin.

MORPHOMETRY

OL / TL Relationship

TL = 136,74 OL^{0,746} mm

n = 22; Std Err Est = 0,113; Coeff Det = 0,66; Corr Coeff = 0,82

Mass / TL Relationship

Mass = 4,79x10⁻⁹ TL^{4,23} g

n = 28; Std Err Est = 0,498; Coeff Det = 0,69; Corr Coeff = 0,83

SUBORDER SCOMBROIDEI

FAMILY Gempylidae

SPECIES *Thyrsites atun* (Euphrasen, 1791)
(Plate 36, Figure 122)

MATERIAL Description based on the otoliths of seven specimens ranging from 140 – 990 mm TL. Catch locality: 34° 42' S, 20° 31' E and Gough Island. DIFS Indian Ocean otolith catalogue numbers: 0060, 0075, 0076, 0077, 1471, 1472, 1473. Collected by the author and W. Uys of the DIFS.

DESCRIPTION

Otoliths of small fish generally ovate. In larger fish dorsal portion of otolith becomes constricted and dome-shaped. Medially slightly convex, laterally slightly concave. **Margin** sinuate. **Sulcus acusticus** ostio-caudal and homomorph. **Collum** constricted. **Colliculi** heteromorph and indistinct. Both **crista superior** and **crista inferior** ridge like but poorly defined, to absent. **Rostrum** prominent, either rounded or pointed distally. **Antirostrum** small and rounded distally. **Excisura ostii** deep, with acute angle.

INTRASPECIFIC VARIATION

Negligible, except for ontogenetic changes.

DIAGNOSTIC FEATURES

The generally ovate shape, the prominent rostrum, the sinuate margin and the ostio-caudal and homosulcoid sulcus acusticus.

ONTOGENY

The geometric shape of the otoliths of fish >380 mm TL

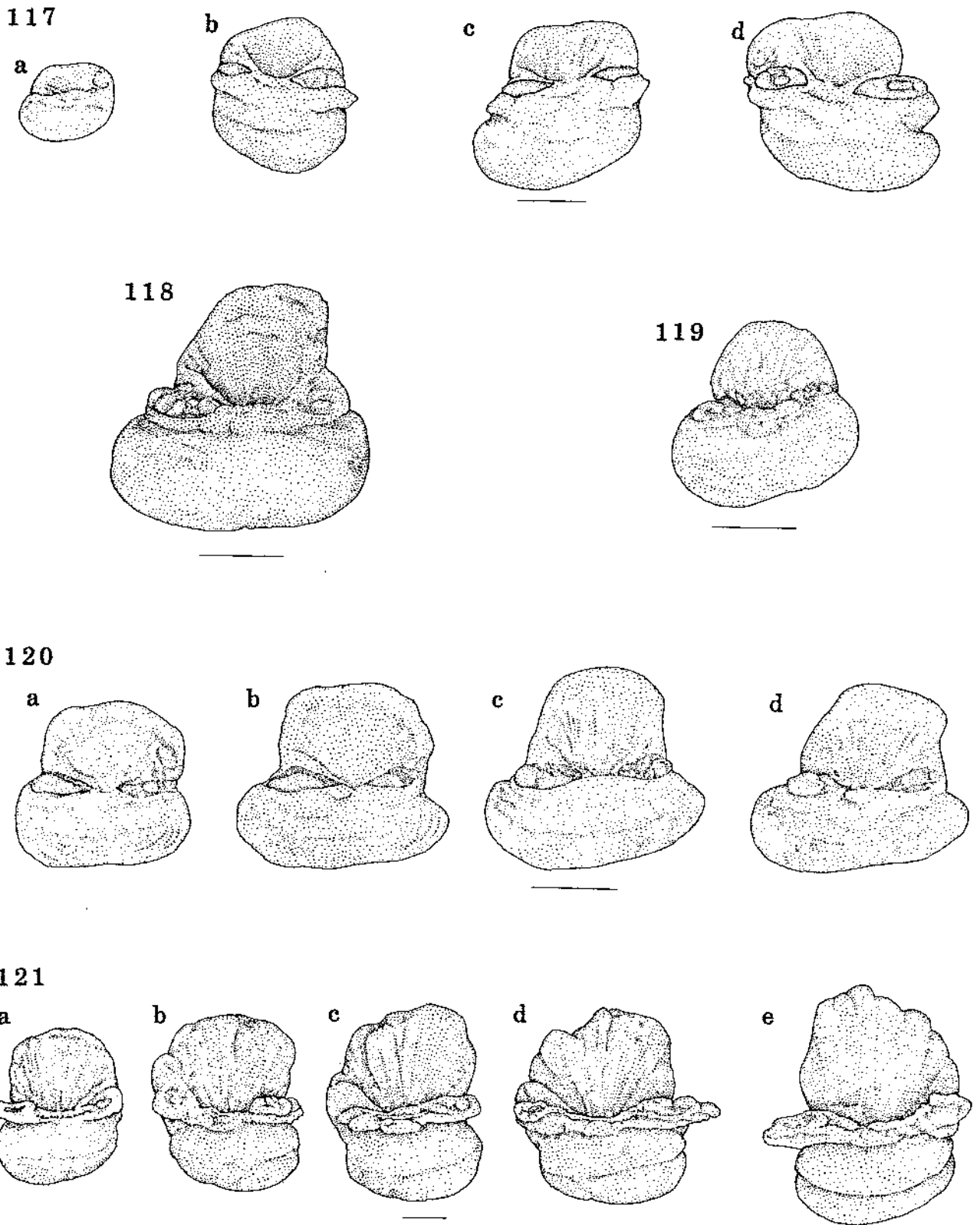


PLATE 35

Figure 117 *Dacodraco hunteri* a - 111 mm, b - 218 mm, c - 262 mm, d - 242 mm TL; Figure 118 *Neopagetopsis ionah* 460 mm SL; Figure 119 *Pagetopsis macropterus* 330 mm TL; Figure 120 *Pagetopsis maculatus* a - 171 mm, b - 184 mm, c - 176 mm, d - 198 mm TL; Figure 121 *Pseudochaenichthys georgianus* a - 305 mm, b - 310 mm, c - 422 mm, d - 440 mm, e - 510 mm TL.

changes from ovate to one in which the dorsal half is dome shaped.

MORPHOMETRY

OL : TL Ratio

for fish >800 mm TL - 1 : 82

n = 4; Range 75,20 - 86,0

for fish <200 mm TL - 1 : 48,69

n = 3; Range 46,70 - 50,00

FAMILY Trichiuridae

SPECIES *Paradiplospinus gracilis* (Brauer, 1906)
(Plate 36, Figure 123)

MATERIAL Description based on the otoliths of one specimen of 388 mm TL. Catch locality: off Mawson Station, Antarctica. DIFS otolith catalogue number: 1743. Collected by O. Gon of the RUSI

DESCRIPTION

Otolith fusiform, due to shape of rostrum and a posterior projection. Medially flat with poor relief, laterally slightly convex. **Margin** entire to slightly lobed. **Sulcus acusticus** pseudo-ostial and homosulcoid, not differentiated into **ostium** and **cauda**. **Colliculum** single. **Crista superior** ridge-like. **Crista inferior** absent. **Rostrum** rounded to pointed distally. **Antirostrum** and **excisura ostii** absent.

DIAGNOSTIC FEATURES

The fusiform shape, the pseudo-ostial and homosulcoid sulcus acusticus, the single colliculum and the presence of only the crista superior.

MORPHOMETRY

OL : TL Ratio

1 : 114,92

SPECIES *Paradiplospinus* sp.
(Plate 36, Figure 124)

MATERIAL Description based on the otoliths of one specimen of 377 mm TL. Catch locality: South Georgia. DIFS otolith catalogue number: 1336. Collected by the BAS.

DESCRIPTION

Otolith also fusiform. Medially slightly concave with poor relief, laterally slightly convex. **Dorsal margin** entire. **Ventral margin** sinuate. **Sulcus acusticus** medial and homosulcoid, not differentiated into **ostium** and **cauda**. **Colliculum** single. **Crista superior** absent. **Crista inferior** present but poorly developed. **Rostrum**, **antirostrum**, and **excisura ostii** absent.

DIAGNOSTIC FEATURES

The fusiform shape, the medial sulcus acusticus, the single colliculum and the absence of the rostrum, antirostrum and the excisura ostii.

MORPHOMETRY

OL : TL Ratio

1 : 116,18

SUBORDER STROMATEOIDEI

FAMILY Centrolophidae

SPECIES *Hyperoglyphe antarctica* (Carmichael, 1818)
(Plate 36, Figure 125)

MATERIAL Description based on the otoliths of two specimens of 570 and 590 mm TL. Catch locality: Gough Island. DIFS otolith catalogue numbers: 733, 744. Collected by W. Uys of the DIFS.

DESCRIPTION

Otolith oval, except for rostral projection. Medially convex, laterally concave. **Margin** serrate. **Sulcus acusticus** elongate, ostial, heterosulcoid and shallow. **Ostium** and **cauda** not separated. **Collum** indistinct. **Cauda** extremely elongate with distinct postero-ventral angle. **Colliculi** heteromorph. **Anterior colliculum** slightly noduliferous. **Posterior colliculum** elongate and narrow in mid-section of cauda. **Crista superior** ridge-like above cauda. **Crista inferior** poorly developed, but also ridge-like below cauda. **Dorsal area** present above entire cauda. **Ventral area** absent. **Rostrum** relatively small and pointed distally, comprising c. 18 % of total otolith length. **Antirostrum** pointed distally. **Excisura ostii** deep with acute angle.

INTRASPECIFIC VARIATION

Negligible.

DIAGNOSTIC FEATURES

The oval shape, the elongate sulcus acusticus with a slight postero-ventral angle and the serrate margin.

MORPHOMETRY

OL : TL Ratio

1 : 48,13

n = 2; Range 47,50 - 48,76

ORDER PLEURONECTIFORMES SUBORDER PLEURONECTOIDEI

FAMILY Bothidae

SPECIES *Mancopsetta maculata* (Günther, 1880)
(Plate 37, Figure 126)

MATERIAL Description based on the otoliths of six specimens ranging from 253 - 355 mm TL. Catch locality: Kerguelen Island and off Mawson, Antarctica. DIFS otolith catalogue numbers: 336 - 341. Collected by J.-C. Hureau of the MNHN and O. Gon of the RUSI

DESCRIPTION

Otolith discoid. **Margin** entire to acutely dentate in larger fish. Medially and laterally generally flat. **Sulcus acusticus**

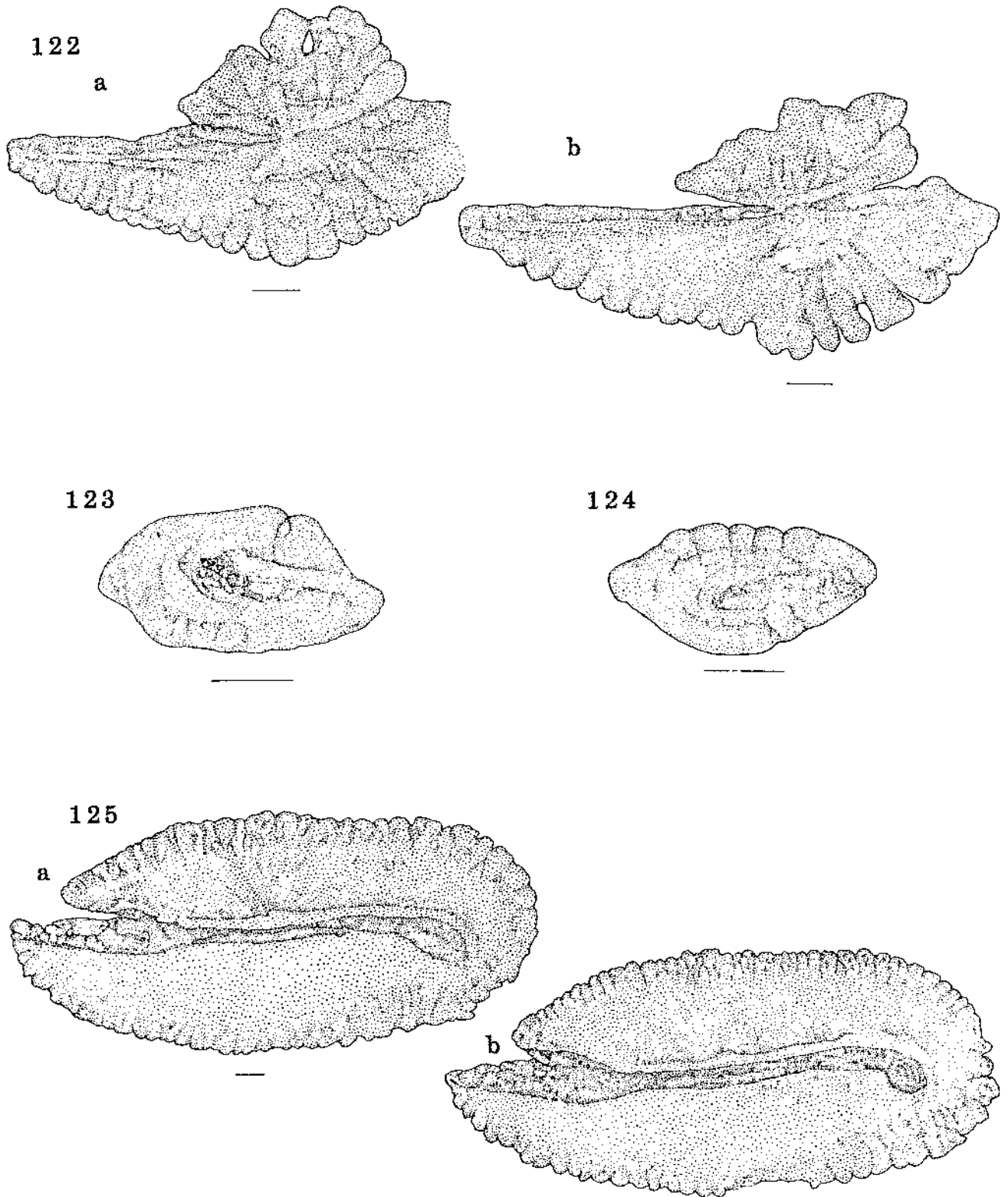


PLATE 36

Figure 122 *Thyrsites atun* a - 980 mm, b - 990 mm TL; Figure 123 *Paradiplospinus gracilis* 388 mm TL; Figure 124 *Paradiplospinus* sp. 377 mm TL; Figure 125 *Hyperglyphe antarctica* a - 570 mm, b - 590 mm TL.

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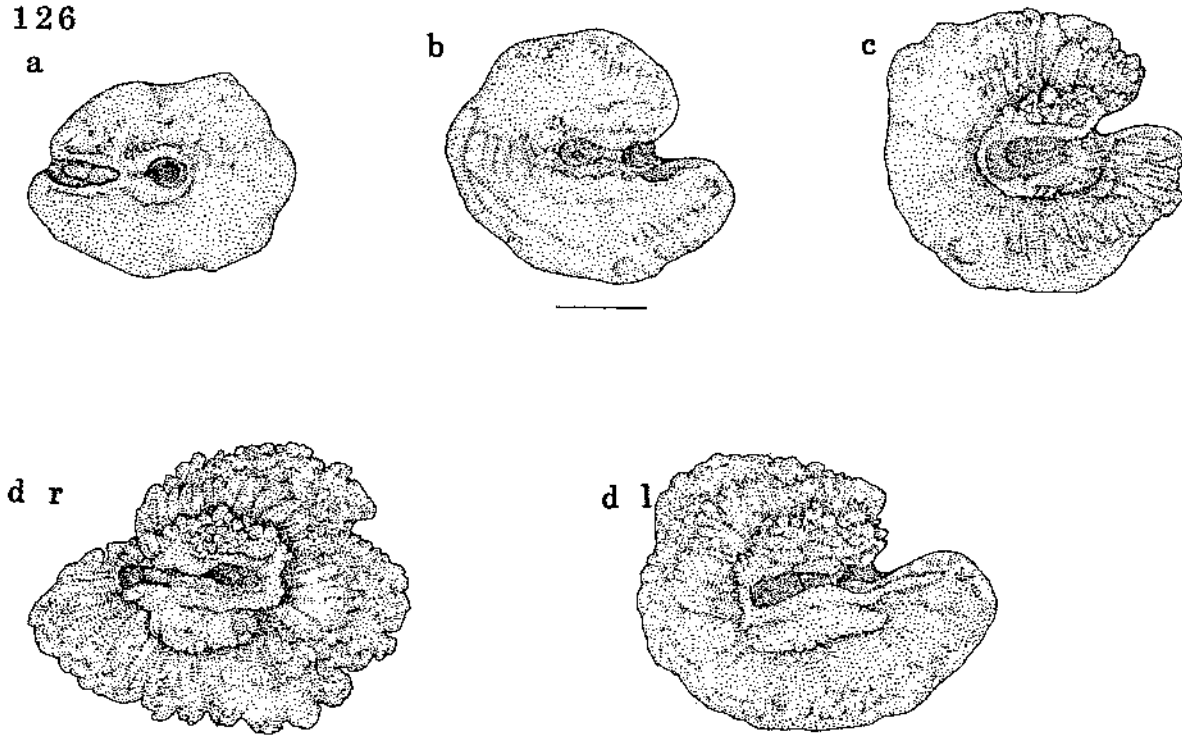


PLATE 37

Figure 126 *Muncopsetta maculata* a - 253 mm, b - 290 mm, c - 326 mm, d (right & left otoliths) - 355 mm TL.

heterosulcoid and ostial. **Colliculi** well developed but difficult to distinguish from each other. **Crista superior** and **inferior** posteriorly continuous, forming crescent-like ridge around entire sulcus acusticus. Depressed area around continuous cristae. **Rostrum** and **antirostrum** prominent and rounded distally. Antirostrum c. half size of rostrum. **Excisura ostii** prominent, deep and rounded with acute angle.

INTRASPECIFIC VARIATION

Negligible, except for ontogenetic changes such as the dentate margin of larger fish.

DIAGNOSTIC FEATURES

The discoid shape of the otolith, the continuous crescent like cristae around the sulcus acusticus and the depressed area around the continuous cristae.

ONTOGENY

The margin of the otoliths of fish >325 mm TL becomes acutely dentate. The margin of smaller otoliths is entire.

MORPHOMETRY

OL : TL Ratio

1 : 113.95

n = 5; Std Dev = 9.76; Range 97,28 - 121,28

KEY TO THE OTOLITHS OF SOUTHERN OCEAN FISHES

Introduction

All otoliths found in the stomach contents of predators have undergone some degree of attrition, which makes their identification more difficult. This must be born in mind when using the key. All identified material should in any case be cross checked with the descriptions and the illustrations. For some genera (e.g. *Notothenia*), the otoliths of several species could not be incorporated into the key. Where this has been the case the otoliths have been lumped and the user is advised to consult the illustrations and the descriptions. Also, wherever drastic ontogenetic changes were evident the otoliths of only the largest fishes were incorporated into the key.

The most probable cause of error in the use of this key will arise when having to decide on the shape of the otolith. The user should therefore first of all become fully acquainted with the descriptive terms of the various shapes. An example of each shape is given at the beginning of the key and schematic outlines are presented in Figure 3. Moreover, it is advised that the salient features of otoliths, as illustrated in Figures 4 to 6, be well understood before attempting to use the key. The first step in using the key is to identify the general shape of the otolith to be identified and only thereafter to proceed to the dichotomous section of the key.

Key

OTOLITH SHAPE

- 1a Otolith discoid/square e.g. *Cynomacrurus piriei* (Pl. 11, Fig. 45) and *Champscephalus gunnari* (Pl. 33, Fig. 113) 2
- 1b Otolith oval e.g. *Macrourus holotrachys* (Pl. 11, Fig. 47)..... 11
- 1c Otolith fusiform e.g. *Helicolenus mouchezi* (Pl. 13, Fig. 56)..... 23
- 1d Otolith ovate e.g. *Notothenia squamifrons* (Pl. 21, Fig. 78)..... 28
- 1e Otolith rectangular, usually with semi rounded corners and sometimes with slightly raised dorsal dome e.g. *Macroparalepis macrogeneion* (Pl. 3, Fig. 15)..... Paralepididae
- 1f Otolith greater in height than in length e.g. *Lampanycthus achirus* (Pl. 8, Fig. 31)..... 36
- 1g Otolith obovate – e.g. *Lycodichthys antarcticus* (Pl. 15, Fig. 63) and *Parachaenichthys charcoti* (Pl. 30, Fig. 105) 42
- 1h Otolith pyriform e.g. *Antimora rostrata* (Fig. 40)..... Moridae (Plate 9)
- 1i Otolith hour glass shape Oreosomatidae (impossible to distinguish between species. Pl. 12, Figs 52 – 55)

- 1j Otolith triangular..... *Pogonophryne* spp (check illustrations and descriptions. Plates 27 & 28, Fig. 99 – 101)

DISCOID/SQUARE OTOLITHS

- 2a. Sulcus acusticus ostial..... 3
- b. Sulcus acusticus medial *Cynomacrurus piriei* (Pl. 11, Fig. 45)
- c. Sulcus acusticus ostio-caudal 9 (Nototheniidae and Channichthyidae in part)
- 3a. Collum acutely constricted, crista inferior bold and anterior and posterior colliculum sometimes project beyond anterior and posterior margins Bathydraconidae and Channichthyidae in part (*Gymnodraco acuticeps*, *Chaenichthys rhinoceratus* and *Chaenocephalus aceratus* – (check illustrations and descriptions – Plates 29 & 32)
- b. Collum not acutely constricted..... 4
- 4a. Colliculi homomorph 5 (Myctophidae in part)
- b. Colliculi heteromorph and crista inferior and superior posteriorly continuous *Mancopsetta maculata* (Pl. 37, Fig. 126)
- 5a. Margin entire *Krefflichthys anderssoni* (Pl. 7, Fig. 30)
- b. Margin not entire 6
- 6a. Posterior margin with notch *Protomyctophum choriodon* (Pl. 8, Fig. 35)
- b. Posterior margin not with notch 7
- 7a. Ventral margin V-shaped..... *Protomyctophum normani* (Pl. 8, Fig. 36)
- b. Ventral margin not V-shaped 8
- 8a. Pseudo-colliculum with crenate dorsal margin..... *Electrona carlsbergi* (Pl. 5, Fig. 23)
- b. Pseudo-colliculum not with crenate dorsal margin *Electrona subaspera* (Pl. 6, Fig. 24)
- 9a. Collum noduliferous *Pleuragramma antarctica* (Pl. 23, Fig. 86)
- b. Collum not noduliferous 10
- 10a. Anterior and posterior colliculi project beyond anterior and posterior margins..... *Champscephalus gunnari* (Pl. 33, Fig. 113)
- b. Only anterior colliculum projects beyond anterior margin *Chaenodraco wilsoni* (Pl. 33, Fig. 112)

OVAL OTOLITHS

11a. Ostium and cauda distinctly separated *Trematomus newnesi* (Pl. 24, Fig. 89) 12

b. Ostium and cauda not separated 12

12a. Rostrum and antirostrum present 13

b. Rostrum and antirostrum absent 18 (Gadiformes in part)

13a. All margins crenate with long and slender cauda (width of cauda c. 10 times in maximum height).... *Hyperoglyphe antarctica* (Pl. 36, Fig. 125) 14

b. All margins not crenate 14

14a. Colliculi prominent and near homomorph 15 (Myctophidae in part)

b. Colliculi heteromorph *Mendosoma elongata* (Pl. 14, Fig. 60) 16

15a. Ventral margin crenate 16

b. Ventral margin not crenate.... *Gymnoscopelus fraseri* (Pl. 6, Fig. 26) 17

16a. Rostrum and antirostrum of near equal size 17

b. Rostrum much longer than antirostrum *Gymnoscopelus nicholsi* (Pl. 7, Fig. 27) 19

17a. Posterior margin distinctly sinuate *Notoscopelus resplendens* (Pl. 8, Fig. 33) 20

b. Posterior margin not sinuate but with single notch *Gymnoscopelus piabilis* (Pl. 7, Fig. 29) 21

18a. Maximum height in length <3 21

b. Maximum height in length >3 *Micromesistius australis* (Pl. 10, Fig. 43) 22

19a. Margin entire *Lionurus filicauda* (Pl. 11, Fig. 46) 22

b. Margin not entire 22

20a. Dorsal margin lobed 21

b. Dorsal margin sinuate 22

21a. Colliculi homomorph *Macrourus whitsoni* (Pl. 11, Fig. 48) 23

b. Colliculi heteromorph (anterior colliculum near 2x size of posterior colliculum)..... *Nematomurus armatus* (Pl. 11, Fig. 49) 24

22a. Full length of dorsal margin sinuate *Macrourus novaezealandiae* (Pl. 11, Fig. 44) 24

b. Only central portion of dorsal margin sinuate *Macrourus holotrachys* (Pl. 11, Fig. 47) 24

FUSIFORM OTOLITHS

23a. Sulcus acusticus medial Trichiuridae (Plate 36) 24

b. Sulcus acusticus ostial 24

24a. Sulcus acusticus near homosulcoid 25

b. Sulcus acusticus heterosulcoid 26

25a. Crista inferior noduliferous *Helicolenus papillosus* (Pl. 13, Fig. 57) 27

b. Crista inferior not noduliferous *Helicolenus mouchezi* (Pl. 13, Fig. 56) 27

26a. Ostium and cauda separated by raised collum and dorsal isthmus-like projection of crista inferior 27

b. Ostium and cauda not separated *Chaenocephalus aceratus* (Pl. 32, Fig. 111) 27

27a. Crista superior present only over ostium *Notothenia acuta* (Pl. 17, Fig. 68) 29

b. Crista superior although split into anterior and posterior sections present over entire sulcus acusticus *Notothenia angustifrons* (Pl. 18, Fig. 69) 29

OVATE OTOLITHS

28a. Sulcus acusticus ostial 29

b. Sulcus acusticus medial (both colliculi present) *Artedidraco* species (Plates 25 & 26), *Melanonus gracilis* (Pl. 10, Fig. 41), *Harpagifer velifer* (Pl. 27, Fig. 98) and *Pogonophryne barsukovi* (Pl. 27, Fig. 99) (check illustrations and descriptions) 30

c. Sulcus acusticus medial (only single well developed colliculum present) *Sio nordenskjoldii* (Pl. 12, Fig. 51) 30

29a. Sulcus acusticus near homosulcoid 30

b. Sulcus acusticus heterosulcoid 31

30a. Pseudocolliculum present with short rostrum *Lobianchia gemellari* (Pl. 8, Fig. 32), *Ceratoscopelus townsendi* (Pl. 5, Fig. 20) and *Ceratoscopelus warmingii* (Pl. 5, Fig. 21) 31

b. Pseudocolliculum absent with long and pointed rostrum *Bathylagus* spp. (Plates 1 & 2) 31

31a. Greatest height in length >3 *Nansenia* sp. (Pl. 2, Fig. 11) 32

b. Greatest height in length <3 32

32a. Colliculi homomorph *Muraenolepis* spp. (Plate 9) 33

b. Colliculi heteromorph 33

33a. Otolith with distinct dorsal indentation in dorsal margin *Notothenia cyanobrancha* (Pl. 19, Fig. 71), *N. rossii* (Pl. 20, Fig. 75), *N. rossii marmorata* (Pl. 20, Fig. 76), *N. rossii rossii* (Pl. 21, Fig. 77) and *Paranotothenia magellanica* (Pl. 23, Fig. 85) 34

b. Otolith without distinct indentation in dorsal margin 34

34a. Otolith with distinct notch in posterior margin 35

- b. Otolith without distinct notch in posterior margin rest of Nototheniidae species (check illustrations and descriptions)
- 35a. Margin entire to irregular *Bovichthys diacanthus* (Pl. 15, Fig. 64)
- b. Margin sinuate *Thyrstites atun* (Pl. 36, Fig. 122)

OTOLITH GREATER IN HEIGHT THAN IN LENGTH

- 36a. Sulcus acusticus ostial 37
(Myctophidae, Plates 5 – 8; Melanonidae, Plate 10 and Channichthyidae, Plate 32 – 35 – in part)
- b. Sulcus acusticus ostio-caudal 40
(Channichthyidae in part)
- 37a. Rostral structures present 38
- b. Rostral structures absent *Lampanychthys achirus* (Pl. 8, Fig. 31)
- 38a. Collum constricted 39
- b. Collum not constricted *Melanonus zugmayeri* with characteristic excisural projection (Pl. 10, Fig. 42), *Gymnoscopelus braueri* (Pl. 6, Fig. 25) and *Protomyctophum bolini* (Pl. 8, Fig. 34)
(check illustrations and descriptions)
- 39a. Ventral portion of otolith distinctly thicker than dorsal portion, which is flattened *Chionodraco rastrispinosus* (Pl. 34, Fig. 115) and *Cryodraco antarcticus* (Pl. 34, Fig. 116)
(check illustrations and descriptions)
- b. Ventral and dorsal halves of otolith of equal thickness ... *Protomyctophum tenisoni* (Pl. 8, Fig. 37)
- 40a. Sulcus acusticus in upper third of otolith and ventral half of otolith thicker than dorsal half *Dacodraco hunteri* (Pl. 35, Fig. 117)
- b. Sulcus acusticus situated below or in mid dorso-ventral plane, ventral half of otolith also thicker than dorsal half 41
- 41a. Colliculi project beyond anterior and posterior margins *Pseudochaenichthys georgianus* (Pl. 35, Fig. 121)
- b. Colliculi do not project beyond anterior and posterior margins ... *Chionodraco myersi* (Pl. 34, Fig. 114), *Neopagetopsis ionah* (Pl. 35, Fig. 118), *Pagetopsis macropterus* (Pl. 35, Fig. 119) and *Pagetopsis maculatus* (Pl. 35, Fig. 120)
(check illustrations and descriptions)

OTOLITH OBOVATE

- 42a. Collum constricted 43
- b. Collum not constricted *Lycodichthys antarcticus* (Pl. 15, Fig. 63)

- 43a. Cauda distinctly triangular *Pagothenia bernacchii* (Pl. 22, Fig. 82) and *Pagothenia hansonii* (Pl. 23, Fig. 84) and check illustrations and descriptions
- b. Cauda not triangular *Parachaenichthys charcoti* (Pl. 30, Fig. 105)

Acknowledgements

Since its conception the success of this project has been totally dependent on international cooperation. Its completion is a tribute to all those of my colleagues who made available their material to me from their private or Institutional otolith collections as well as to my students who collected fishes for me on Southern Ocean cruises. I sincerely thank (in alphabetical order) John Cooper, Martin Davies, Art De Vries, Hugh DeWitt, Guy Duhamel, Pieter Gaemers, Ofer Gon, Gerd Hubold, Butch Hulley, Jean-Claude Hureau, Christine Karrer, Norbert Klages, Karl-Herman Kock, Laurie Laurenson, Tomas Linkowski, Y. Naito, Dirk Nolf, Tony North, Werner Schwarzhans, Wiesław Słosarczyk, Tim Targett, Aldo Tomo, Wynand Uys, Martin White, M.A. Wilson. I am also grateful to the chairman of the BIOMASS Working Party on Fish Ecology, Dietrich Sahrhage, who persuaded (or coerced) me to undertake this task. Also, my thanks to Andy Scholtz who painstakingly logged all the information onto computer files and to Wynand Uys for creating the Otolith Programme. To my wife, Ann, for her accurate illustrations of all the material I am indeed thankful. I also gratefully acknowledge the financial support for this project from the South African National Antarctic Research Programme (Department of Environment Affairs) through the South African Scientific Committee for Antarctic Research.

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