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Chimaeroid fish remains from Seymour Island, Antarctic Peninsula

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Abstract: *Ischyodus dolloi* Leriche 1902, the youngest record of the species, and *Chimaera seymourensis* sp. nov. are described from the La Meseta Formation, Late Eocene of Seymour Island, Antarctic Peninsula.

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Key words: Antarctica, *Chimaera*, Chimaeridae, Holocephali, *Ischyodus*

Introduction

A number of isolated dental plates of chimaeroid fish were found in the Late Eocene La Meseta Formation of Seymour Island (Fig. 1) in 1984 by members of the University of California at Riverside. These are the first fossil chimaeroids recorded from Antarctica and were reported by Grande & Eastman (1986).

Chimaeroid fishes are represented in the fossil record by their dental plates, dorsal fin spines and, under rare circumstances, skeletal remains. Each dental plate, of which there are three pairs, consists of a mass of acellular bone in which are set a number of bodies of pleromin (Orvig 1984) known as tritors. A pair of large palatine and much smaller vomerine dental plates comprise the upper dentition, with a single pair of mandibular dental plates in the lower jaw. The tritoral areas, being more durable than the surrounding bone, wear into relief, forming a ridged crushing dentition. There are two forms of tritor; those exposed on the occlusal and post occlusal margins are usually composed of laminated plates of massive pleromin, while those on the lingual surface tend to be long parallel columns of vascular pleromin. In the absence of skeletal remains the shape of the dental plate as well as the size and relative positions of the tritors are the criteria that determine generic and specific determinations. The dental plate grows continuously from the posterior margin, making ontogenetic stage and state of wear important considerations in specific determinations. Dorsal fin spines are difficult to assign to species unless found in direct association with other skeletal or dental elements.

Localities and stratigraphy

All specimens described here are from the Late Eocene La Meseta Formation of Seymour Island. The La Meseta Formation unconformably overlies the late Palaeocene Cross Valley Formation and is interpreted as an erosional valley

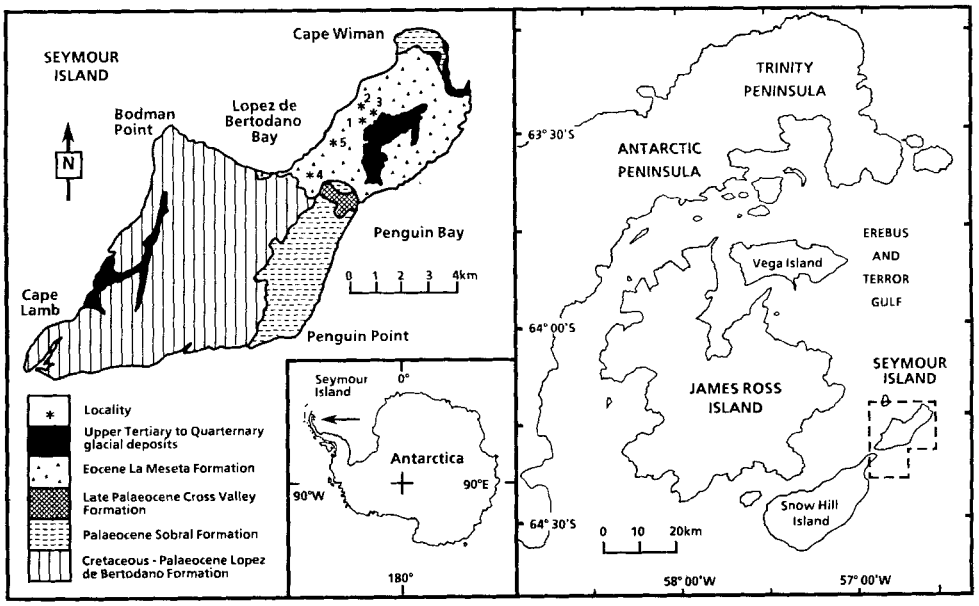

Fig. 1. Sketch maps to show Seymour Island, the outcrop of the La Meseta Formation and the locations of the collecting localities, simplified from Sadler (1988, fig. 1).

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fill. It is divided into seven numbered units; Telms 1–7 (Tertiary La Meseta). These are, to some extent, lenticular; no vertical section displays all the units (Sadler 1988). General localities are given in Fig. 1. More specific locality and stratigraphical information are given below.

Specimens PF 10650 and 10646 are from locality 1, PF 10651–10653 are from locality 2, PF 10648 is from locality 3, PF 10649 is from locality 4 and PF 10647 is from locality 5.

Locality 1 (RV-8200, 64°14' 25"S, 56°39'45"W) is on the south side of a canyon in a fork between the headwaters of two small tributaries that drain the north-facing slope of the canyon (about 0.3 km from the main drainage). This locality is informally referred to as the "mammal site" in "Breakwind Canyon" [unofficial name] (Chaney 1988, p. 21; Case *et al.* 1988, p. 508). Stratigraphically, locality 1 is 500m from the base of the La Meseta Formation, about halfway up Telm 5.

Locality 2 (RV-8424, 64°14' 12"S, 56°39'45"W) is on the north ridge at the mouth of "Breakwind Canyon". Stratigraphically it is about 10m upsection from locality 1.

Locality 3 (RV-8405, 64°14'15"S, 56°3'12"W) is approximately three-quarters of the way up the east wall of the meseta. Stratigraphically it is at the top of unit Telm 6.

Locality 4 (RV-8262, 64°15'15"S, 56°41'37"W) is on a small cuesta on the south side of the Cross Valley drainage, overlooking both the main drainage and the major southern drainage. Stratigraphically it is in unit Telm 2, about one-third to half-way up the section.

Locality 5 (RV-8266, 64°14'50"S, 56°41'05"W) is on the south side of the toe of the major ridge that separates the Cross Valley and "Breakwind Canyon". It is on a small ridge that separates Cross Valley from the small drainage between the two larger drainages. Stratigraphically it is in unit Telm 2, about 45 m up-section from locality 4, or about two-thirds of the way up the section.

Terminology

Almost every fossil chimaeroid description employs a different set of terms to describe the dental plates and their tritors. The terminology applied here is based on that in Woodward (1891, p. 15) and Ward (1973 pp. 315–6). The three dental plates are referred to as mandibular, palatine and vomerine plates. Gurr (1963) transposed the terms palatine and vomerine, which can lead to misunderstanding. The names and abbreviations used for the individual tritors are shown in Fig. 2.

The name "intermediate tritor" for a small posteriorly situated tritor on the mandibular plate was proposed by Applegate (1975). This is the equivalent of the "median tritor" of Gurr (1963) and Case (1978) but not Woodward (1891) and below.

Registration numbers prefixed by "PF" are those of the Field Museum of Natural History, Chicago, USA. Those prefixed by "P" are of the Department of Palaeontology, Natural History Museum, London. Locality numbers prefixed by "RV-" are those of the University of California at Riverside.

Systematic Palaeontology

Class HOLOCEPHALI Bonaparte 1832

Order CHIMAERIFORMES Buen 1926 *sensu* Patterson 1955

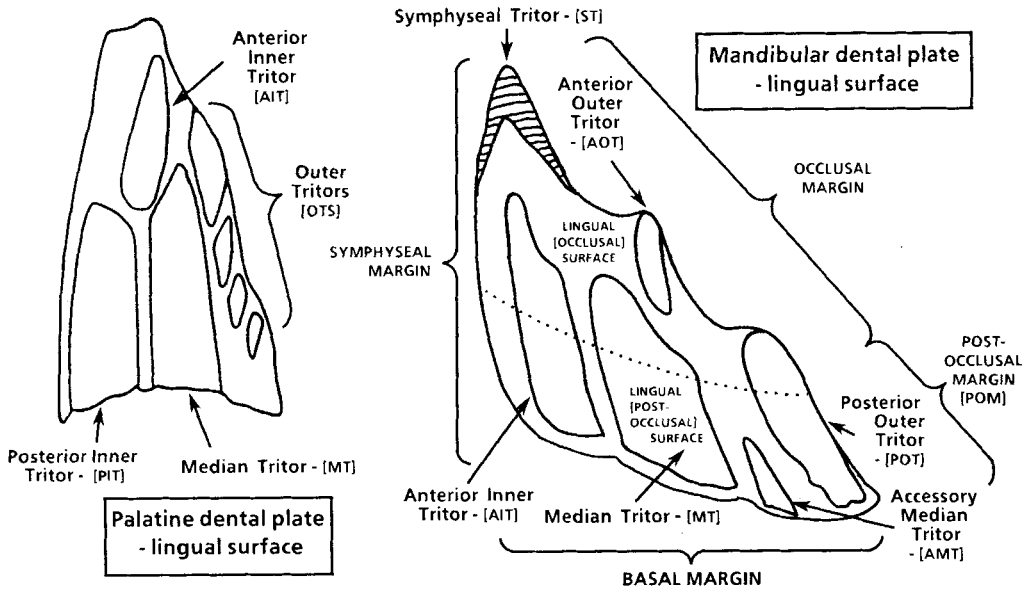

Fig. 2. Terminology applied to chimaeroid palatine and mandibular dental plates.

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Suborder CHIMAEROIDEI Patterson 1955

Family EDAPHODONTIDAE Owen 1846

Diagnosis. (Based on isolated dental plates.) Mandibular dental plates massive and elongated antero-posteriorly with three large tritors composed of vascular pleromin on the occlusal surface, laminated pleromin restricted to the symphyseal tritor. Palatine dental plates have three or four large vascular pleromin tritors only.

Discussion. Garman (1901) divided the suborder Chimaeroidei into three (extant) families; the Chimaeridae, the Callorhinchidae and the Rhinochimaeridae. On dental characters the extinct fossil genera *Edaphodon* and *Ischyodus* differ sufficiently from the three extant families to be placed in a separate family. Dental plates of the Chimaeridae and Rhinochimaeridae have tritors of laminated pleromin on the occlusal surface of their mandibular and palatine plates except for those of *Rhinochimaera*, which are devoid of tritors. Callorhinchids possess no laminated tritors, whereas in the Edaphodontidae laminated pleromin is restricted to the symphyseal tritor on the mandibular dental plate.

The genera *Elasmodus* and *Elasmodectes* and the species "*Ischyodus*" *incisus* Newton 1878 all have occluding tritors of laminated pleromin and are included in the Chimaeridae. The close similarity of the mandibular plates of *Ganodus* to those of *Ischyodus* is because only a single true mandibular of *Ganodus* has been figured; that of *Ganodus dentatus* Egerton 1847, figured by Woodward (1891, plate 1, fig 10). All other "*Ganodus*" mandibular plates seen by the authors appear to be those of *Ischyodus colei* (Agassiz 1843). The familial relationships of *Ganodus* are uncertain at present. Ward & McNamara (1977, p. 593) refer the massively constructed Jurassic genera *Pachymylus* and *Brachymylus* to the Callorhinchidae, a point not pursued here but which still appears likely, as laminated pleromin is absent from the entire dentition.

Referred genera. *Edaphodon* Buckland 1838, *Ischyodus* Egerton 1843

Genus *Ischyodus* Egerton 1843

Type species. Ischyodus townsendi (Buckland 1835).

Emended diagnosis. (Modified after Woodward 1891) Mandibular plate more or less massive, often with a beak-like layer of enameloid immediately labial to the occlusal margin. There is a laminated symphyseal tritor (ST), one or more anterior tritors (AT), one median tritor (MT) and one or more outer tritor (OT); all composed of vascular pleromin.

The palatine dental plate is robust with four or more tritors present; two (ITs), one median tritor (MT) and between one and four outer tritor (OTs); all composed of vascular pleromin.

Vomerine dental plate quadrate in lingual view, with laminated tritors on the occlusal margin; post-occlusal region not laterally expanded.

Dorsal fin spine laterally compressed, smooth or longitudinally striated, with a double series of posterior denticles.

Differential diagnosis. Mandibular dental plates of *Ischyodus* differ from those of *Edaphodon* by their narrower symphyseal margins and labial thickening, and from all other genera of chimaeriform by the presence of outer tritors of vascular (as opposed to laminated) pleromin.

Palatine dental plates of *Ischyodus* differ from those of *Edaphodon* by the presence of a large median tritor (MT) and from *Callorhinchus* by the presence of a laminated symphyseal tritor (ST). They can be separated from all other genera of chimaeroid by the presence of one or more outer tritors of vascular pleromin.

Geological and geographical range. Cosmopolitan, Middle Jurassic-Pliocene.

Discussion. Although *Ischyodus* differs markedly from most other genera, the characters separating it from *Edaphodon* are not well defined and require re-examination. The absence of an MT, in *Edaphodon*, is often given as a feature separating it from *Ischyodus*. However, one is present, albeit small, in *Edaphodon antwerpiensis* Leriche 1926 and *Edaphodon minor* Ward 1973. Woodward (1891, p. 53) separated mandibular dental plates of *Ischyodus* from *Edaphodon* by the presence of "an external thickening along the (labial) oral border". This is a feature present in most of the Jurassic species, becoming less distinct in the Cretaceous and absent in the Palaeogene species *Ischyodus dolloi* .

Ischyodus first occurs in the Middle Jurassic and becomes relatively common in the Upper Jurassic with over a dozen nominal species. Disregarding those species derived from the Upper Jurassic into the Cambridge Greensand (Aptian - UK), Cretaceous records of *Ischyodus* are rather sparse. One cosmopolitan species, *Ischyodus thurmanni* Pictet & Campiche 1858 ranges in the UK from the Aptian to the Turonian. It is also recorded from the Senonian Greensand of New Zealand (Chapman 1918), erroneously reported as Palaeocene by Applegate (1975, p. 29).

Ischyodus dolloi Leriche 1902

Figs. 3, 6, a–h.

1902 *Ischyodus dolloi* Leriche, p. 34, fig. 3, pl. 1, figs 49, 50.
1908 *Ischyodus dolloi* Leriche, Leriche, p. 245, pl. 5, fig. 7.
1951 *Ischyodus dolloi* Leriche, Leriche, p. 589.
1963 *Ischyodus dolloi* Leriche, Gurr, p. 434, 435, pl. 23, 1–3, fig. 6.
1973 *Ischyodus dolloi* Leriche, Ward, p. 324, 325, fig. 4.
1975 *Ischyodus zinsmeisteri* Applegate, pp. 27–30, figs 1,2.
1986 ?*Ischyodus* sp. Grande & Eastman, pl. 25, text-fig. 3, n–p.

Type series.

Syntypes. The three teeth figured by Leriche (1902; text-fig. 3, pl. 1, figs 49, 50).

Locality. Erquellines, Belgium.

Stratigraphic unit. Sables d'Erquellines

Age. Late Palaeocene, Thanetian.

Zones. P 4–5, NP. 8–9.

Depository. Institut Royal des Sciences Naturelles de Belgique, Bruxelles.

Material studied. Associated left palatine dental plate PF 10647a and right mandibular plate PF 10647b. Right mandibular dental plate PF 10648; left mandibular plate PF 10651; left palatine plate PF 10650e; incomplete right palatine plate PF 10652; right mandibular dental plate PF 10653 and (?)dorsal fin spine PF 10646. All from the La Meseta Formation, Seymour Island.

Diagnosis. Ischyodus dolloi is known only by mandibular and palatine dental plates. Mandibular plate relatively elongate, AT slender, AOT anterior to the MT, large POT and small IT present. Enameloid thickening on labial surface of the occlusal margin absent. Palatine plate with distally directed AOT, large MT and PITs and up to five OTs along the occlusal and post-occlusal margins. Enameloid thickening on outer surface of the occlusal margin absent.

Differential diagnosis. Ischyodus dolloi can be separated from all other species of *Ischyodus* by the combination of an intermediate tritor on the mandibular dental plate and presence of multiple outer tritors on the palatine dental plate.

Description. Left palatine dental plate, PF 10647a. (Fig. 6d, e) This is the first complete palatine plate to be described. It is roughly triangular and truncated anteriorly. The AIT lies adjacent to the symphysis and is inclined slightly distally. A large PIT and MT occupy the posterior portion of the plate with three small OTs lining the occlusal and post-occlusal margins. The symphyseal surface is relatively deep; there is no enameloid thickening on the outer occlusal and post-occlusal surfaces.

Left palatine dental plate, PF 10650 (Fig. 6c). This specimen shows considerably more in-life wear than the previous dental plate. The tritors are exposed in sharp relief, the surrounding bone having been removed. The apex of the dental plate is rounded rather than truncated; only two OTs are preserved. The MT and PITs are more slender than in PF 10647a, a feature not attributable to wear alone.

Right palatine dental plate, PF 10652. (Fig. 6f). This is an incomplete dental plate, not too dissimilar to Leriche's (1902, p.34, fig. 2) syntype. The MT and PITs are more slender than Leriche's or either of the two previous Seymour Island specimens, giving an indication of the degree of variation present.

Right mandibular dental plate, PF 10647b. (Fig. 6b). This is rhomboidal with two embayments in the occlusal margin. A laminated ST is exposed at the tip of the lingual surface and extends, parallel to the symphysis, along the outer surface under a thin covering of "bone" (here removed by postmortem abrasion). A thin AIT runs the length of the dental plate, also close and parallel to the symphysis. A depression and an embayment on the occlusal margin separates the ST and AIT from AOT and MT. A similar embayment separates the AOT and MT from a POT which occupies the entire post-occlusal margin. A small IT lies between and slightly posterior to the MT and POT.

Right mandibular dental plate, PF 10648. (Fig. 6a). Although considerably larger and abraded, this demonstrates all the features of PF 10647b. The tritors are worn and relatively smaller than in PF 10647b and show a coarser tubular ornamentation. The AIT is reduced to a mere trace as is the AMT. The POT is overlain by two small OTs.

Left mandibular dental plate, PF 10651. (Fig. 6g). The MT of this specimen is considerably larger on this dental plate than that on the similarly sized PF 10647b. The symphyseal tritor is not visible; the AOT and POT are both well worn.

Dorsal fin spine, PF 10646. (see Grande & Eastman 1986, text-fig. 3n) The spine is heart-shaped in section and hollow. It has a sharp anterior surface and a flattened, slightly concave, posterior surface with a shallow median groove. Except for the basal 2 cm of the spine, on either side of the groove is a row of evenly spaced medio-ventrally directed tubercles. The large size of this specimen makes it probable, but by no means certain, that it belongs to *I. dolloi.*

Occlusion. By orientating left palatine dental plate PF 10647a and left mandibular dental plate PF10651 in relative life positions (Figs 3, 6h) the degree of tritoral occlusion can

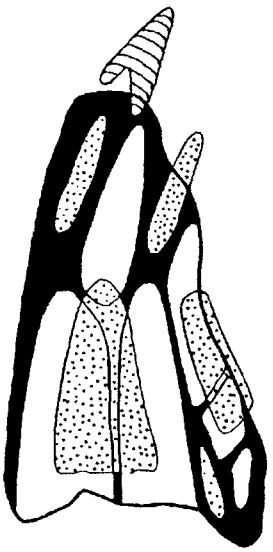

Fig. 3. *Ischyodus dolloi*:; a palatine dental plate with the tritors of a mandibular plate overlain to demonstrate the degree of occlusion. Key: clear = palatine dental plate tritors; stipple = mandibular, anterior, median and outer tritors; cross hatch = Manibular symphyseal tritor.

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be estimated. In general tritors on one dental plate correspond to the bony areas between tritors on the other. The mandibular AIT lies parallel and mesial to the palatine AIT. The palatine 1st OT lies in the depression between the mandibular AOT and POT. The large mandibular MT straddles the palatine PIT and MT. The long mandibular OT along the postocclusal margin corresponds to the palatine multiple outer tritors. The small mandibular IT corresponds to the depression between the palatine MT and OTs. The two embayments on the mandibular occlusal margin correspond to the palatine AIT and 1st OT forming an undulating beak. It appears therefore that in *I. dolloi* differential wear between the resistant tritor and softer bone created a dentition more suited to shearing and grinding than crushing.

Ontogeny and heterodonty. Insufficient material exists to comment on the development of the palatine dental plate. However, the discovery of two mandibular plates of greatly differing size, PF 10647b and PF 10648, allows some observations on their development. Growth took place along the basal surface whilst wear was restricted to the lingual surface. The basal margin of PF 10647b is narrower than the apical margin of PF 10648. This suggests that there is no "overlap" in the growth seen ie. all the bone and tritor seen in PF 10647b had been worn away by the stage demonstrated by PF 10648. By placing them together, so that the curves of the symphyseal and post-occlusal margins correspond (Fig. 4), one can estimate how much tissue has been lost due to wear. It follows also that there must have been anteriorly directed rotation of the mandible during growth, keeping pace with wear. Where wear outstripped growth the palate will be antero-posteriorly narrow, the converse when wear was slow. The antero-posterior length of a plate therefore cannot be used as a taxonomic criterion. Nor can the size and shape of the individual tritors, one can see from PF 10648 (Fig. 6a) that during growth the proportion of the plate occupied by the tritors decreased. In larger plates the stipple-like ornament on the tritor surface is coarser. This may be useful in deciding if a plate is from a young individual of a large species or an old individual of a smaller species.

Palatine dental plates PF10647a and PF10650 are similar in overall size, and thus from individuals of about the same age. The latter, ignoring the ravages of wear, has a narrower PIT and MT with a wider AIT and similar first OT (compare Figs 6c and 6d). There is a similar situation in mandibular dental plates PF10647b and PF10651. There is insufficient material to determine the type of heterodonty exhibited here. It is, however, important to recognize its presence when confronted with potentially new species.

Discussion

These records extend the range of *I. dolloi* from the late Palaeocene into the Late Eocene. In Europe it occurs in relatively shallow water boreal deposits. Its absence from younger European deposits is probably related to the regional warming during the Late Palaeocene and Early Eocene which allows it to survive in the cooler Antarctic waters.

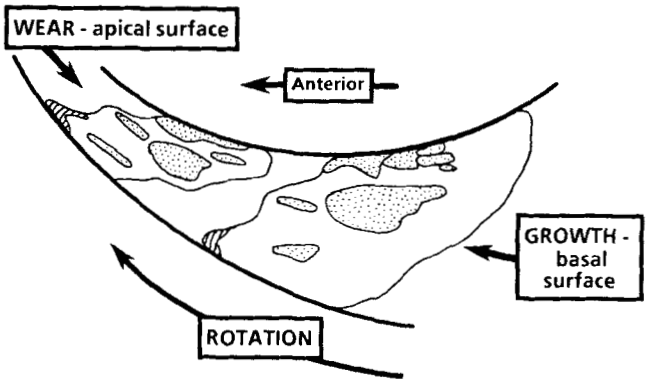

Fig. 4. Wear, growth and dental plate rotation in *Ischyodus dolloi*, based on specimens PF10647a and PF 10648.

Ischyodus zinsmeisteri Applegate 1975, from the Palaeocene of California, USA, was separated from *I. dolloi* by "the large size of the upper part of the beak" and "the small size and low placement of the symphyseal tritor" (Applegate 1975, p.29). The relative size of the beak in chimaeroids is dependent on the degree of wear. The size and position of the symphyseal tritor is an ontogenetic feature, consistent with the dental plate being from a young individual. We thus regard *I. zinsmeisteri* as a junior synonym of *I. dolloi* .

Woodward & White (1930, pp. 579–580) described *Chimaera anomala*, an unusual palatine dental plate, probably from the Pliocene of Beaumaris Bay, near Melbourne, Australia. The shape and arrangement of tritors, however, are more typical of *Ischyodus* rather than *Chimaera*. The palate is antero-posteriorly elongated with AIT, PIT, MT and unlaminated OTs. Unlaminated outer tritors on the palatine dental plate are only seen in the genera *Ischyodus* and *Edaphodon*. *Edaphodon* is excluded as there is a robust median tritor. The possible presence of *Ischyodus* in the Pliocene is not as improbable as it may first appear when you consider that there are well documented occurrences of the related genus *Edaphodon* in the Mio-Pliocene; *Edaphodon antwerpiensis* Leriche 1926 from the Belgian Miocene and *Edaphodon pliocenicus* from the Italian Pliocene.

Family CHIMAERIDAE Rafinesque 1815

Diagnosis. (based on isolated dental plates). A family that differs from all other chimaerid families in having palatine and mandibular plates with numerous laminatedOTs lining the occlusal margin. MT, AITand PIT may be present.

Referred genera. Chimaera Linnaeus 1758, *Hydrolagus* Gill 1862, *Elasmodus* Egerton 1843, *Elasmodectes* Woodward 1888, *Chimaera* Linnaeus 1758

Type species. Chimaera monstrosa Linnaeus 1758.

Emended diagnosis. Palatine dental plates with unlaminated

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symphyseal and median tritors; outer tritors laminated and numerous lining the occlusal margin. Mandibular plate with unlaminated MT which does not impinge on lingual surface; outer tritors laminated and numerous, lining the occlusal margin.

Differential diagnosis. Chimaera is separated from *Elasmodus* by the absence of a long single OT on the palatine plate and a MT on the mandibular plate that impinged on the occlusal margin.

Chimaera can be separated from *Elasmodectes* by the presence of a MT and AITon the mandibular plate. The palatine plate of *Elasmodectes* is undescribed.

In the whole fish *Chimaera* is separated from *Hydrolagus* by the presence of an anal fin. There are insufficient accurate figures of their dentitions to separate them confidently on dental characters. It would appear that the PIT and MT are more developed in *Chimaera* and the batteries of outer tritors more developed and numerous in *Hydrolagus.*

Geological and geographical range. Cosmopolitan, shallow to moderately deep waters, Late Palaeocene - Recent.

Discussion: There are only a few fossil species of *Chimaera* known. The oldest is the Late Palaeocene *Chimaera eophantasma* Ward 1973 from southern England. This is similar to *Chimaera pliocenicus* Woodward 1891, from the Pliocene of Italy. Both sufficiently resemble the Recent species *Chimaera phantasma* to be placed safely in *Chimaera.* The mandibular dental plate, P.55310, attributed to *Chimaera eophantasma* (Ward 1973 fig. 3b) has no laminated OTs and is almost certainly a mandibular dental plate of *Callorhinchus regulbiensis* Gurr 1963. No details are known of *C. javana* Martin 1883 from the Miocene of Java. His specimen is tiny and his figures are too small and indistinct to see the arrangement of the tritors (Martin 1833, pl. 2, figs 25, 26). *Chimaera gosseleti* (Winkler 1880), from the Oligocene of Belgium, has a mandibular dental plate with coarse laminated OT's and a large MT. In this respect it is similar to the extant *Chimaera monstrosa* Linnaeus 1758. The figure of *C. monstrosa* in Dean (1906) is a little misleading in exaggerating the mandibular OT's whilst omitting the MT. The figure of *C. monstrosa* in Storms (1894, pl.VI, fig. 6) is also misleading in showing the MT as laminated instead of tubular pleromin. Ward (1973) referred the holotype of *Chimaera eocenica* Woodward & White 1930, a palatine dental plate, from the Late Palaeocene of the UK, to the rhinochimaerid genus *Amylodon.*

Chimaera seymourensis sp. nov.

Figs 5, 6i, j.

Etymology. Referring to the fact that this species originates from, and is currently restricted to, Seymour Island, Antarctic Peninsula.

Type series.
Holotype. PF10649
Locality. Seymour Island
Stratigraphic unit. Unit Telm 2, La Meseta Formation
Age. Late Eocene
Depository. Field Museum of Natural History, Chicago, USA.
Material studied. The holotype only.

Diagnosis. Chimaera, known only from an isolated mandibular dental plate. It differs from all other species in having six OTs one PIT and one MT.

Differential diagnosis. Compagno (1986) listed six extant species of *Chimaera.* Of these only the dentitions of *C. monstrosa* and *C. phantasma* Jordan & Snyder 1900 are well known. No direct comparison can be made between *C. seymourensis*, based on a mandibular dental plate and *C. eophantasma* and *C. pliocenica* which are only known from a palatine dental plates. Both are similar to the extant *C. phantasma* in having large MT and PITs. It can be reasonably supposed that their mandibular dental plates would bear a corresponding single large MT.

C. seymourensis can be separated from *C. gosseleti* and the extant *C. monstrosa* by the presence of a PIT.

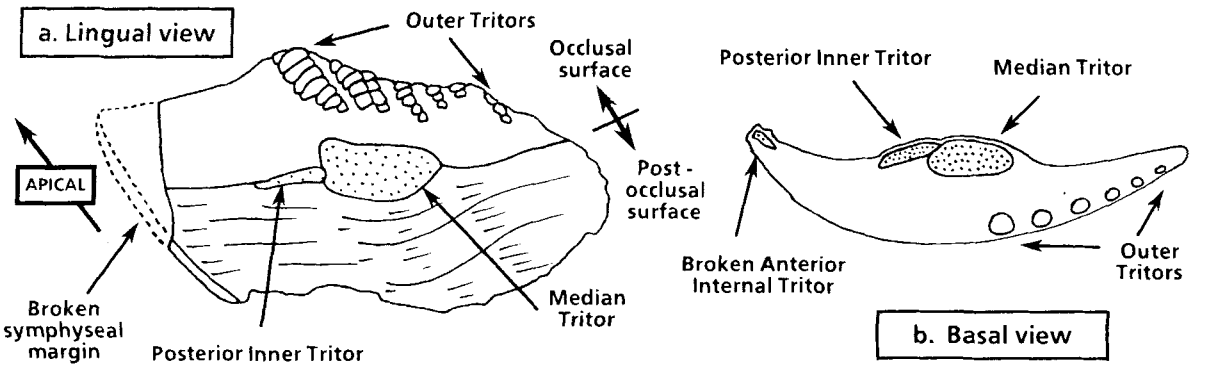

Fig. 5. *Chimaera seymourensis* sp. nov. semi-diagramatic interpretation of the holotype x 2.0.

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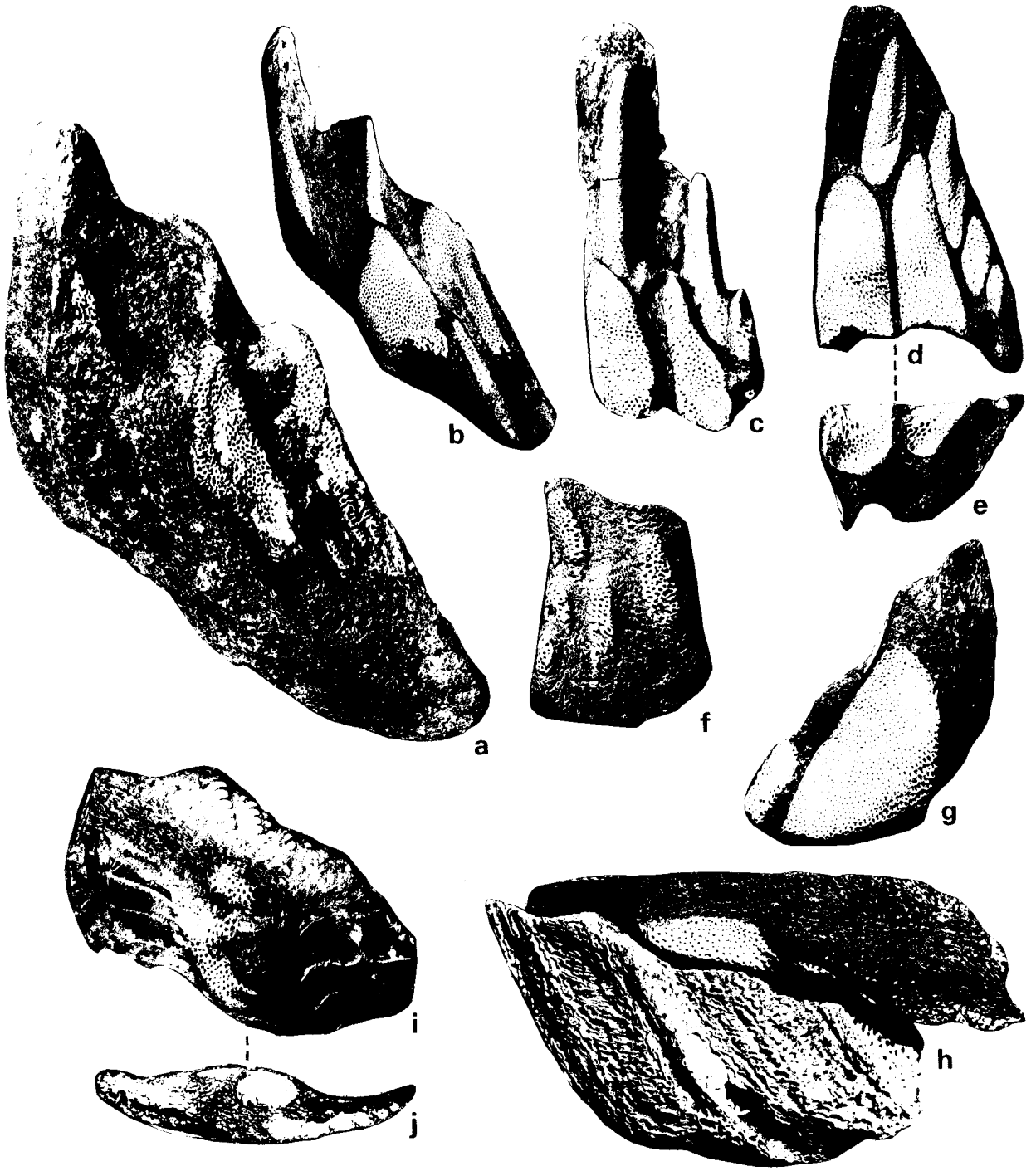

Fig. 6. Chimaeroid remains from the La Meseta Formation, Late Eocene of Seymour Island, Antarctic Peninsula. **a–h**, *Ischyodus dolloi* Leriche 1902, all x 1.5. **a**. PF10648 right mandibular dental plate, lingual view; **b**. PF10647b right mandibular dental plate, lingual view; **c**. PF10650 left palatine dental plate, lingual view; **d**. PF10647a left palatine dental plate, lingual view; **e** PF10647a left palatine dental plate, basal view; **f**. PF10652 Incomplete right palatine dental plate, lingual view; **g**. PF10651 Left mandibular dental plate, lingual view; **h**. PF10647a and PF10651 orientated in mutual occlusion, lateral view. **i–j**, *Chimaera seymourensis* sp. nov., right mandibular dental plate, PF10649 x 2.0. **i**. lingual view; **j**. basal view.

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C. seymourensis can be separated from *Elasmodus hunteri* Egerton 1843 and *Elasmodus kempi* Ward 1977 by the absence of an AOT and MT impinging on the occlusal margin.

C. seymourensis can be separated from *Amylodon* sp., P.I 2345 from the Middle Eocene Barton Clay Formation (Woodward & White 1930) by the presence of a PIT and discrete and separate OTs.

Description. The unique right mandibular dental plate is quite well preserved although lacking its anterior symphyseal region. It is roughly rhomboidal with a prominence formed by the OTs in the middle of the occlusal margin It is 27 mm wide and 22 mm long. Traces of a small AIT can be seen in the symphyseal broken surface. There is a dorso-ventrally flattened PIT lying mesial and parallel to a cylindrical MT. Both are in the mid-region of the dental plate abutting the post-occlusal lingual surface. The PIT is not easy to see where it is exposed on the lingual surface but is clearly visible in basal view (Figs 5b, 6j). Six cylindrical OTs of laminated pleromin line the distal half of the occlusal margin forming a serrated cutting edge.

Discussion. The presence of a diastema, OTs present only distal to the MT, a feature shared by *C. seymourensis* and *Elasmodus*, is probably a primitive character state. *C. gosseleti*, *C. phantasma* and *C. monstrosa* all have OTs all the way along the occlusal margin.

Recent species of *Chimaera* are found in high latitudes and cool water, so the presence of *C. seymourensis* in the Late Eocene Antarctic Peninsula waters, when temperatures were higher than at present, is not surprising. The early history of *Chimaera* is poorly known, probably due to its preference for moderately deep water facies.

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