NEW CRETACEOUS FISH FOSSILS FROM SEYMOUR ISLAND, ANTARCTIC PENINSULA

by LANCE GRANDE *and* SANKAR CHATTERJEE

ABSTRACT. Based on Late Cretaceous fossils from Seymour Island, hexanchiform sharks and a beryciform teleost are reported from the Antarctic region for the first time. The hexanchiform is a species of *Notidanodon*, and the beryciform is a new genus and species of Trachichthyidae. Fragmentary orthacodontid teeth (*Sphenodus*? sp.) are also reported. An abundance and variety of indeterminate teleost bone fragments (e.g. isolated teeth and centra) were also found. During the Late Cretaceous and Early Tertiary of the Antarctic region, the diversity of fossil teleosts is much less apparent than that of the fossil sharks; but this is probably only an artefact of preservation, because skeletal fragments (isolated teeth in particular) normally are much more diagnostic (i.e. identifiable) for chondrichthyans than they are for teleosts.

SEYMOUR ISLAND, located on the north-east side of the Antarctic Peninsula, is potentially of great significance to studies on the history and biogeography of the region's fish fauna. Cretaceous and Tertiary deposits there include the only known fossil teleosts, neoselachians ('modern' chondrichthyans), and holocephalans from the Antarctic region. Nearly all of these fossils belong to extant families or higher taxa that do not live in the Antarctic region today (i.e. Odontaspididae, Lamnidae, Squalidae, Pristiophoridae, Squatinidae, Myliobatidae, Chimaeriformes, Siluriformes) (Grande and Eastman 1986). Two of the Cretaceous fossils described here also belong to higher taxa not found in the region today (Hexanchiformes and Beryciformes).

There is relatively little higher taxonomic diversity in the Recent fish fauna of the Antarctic region. The fauna is dominated by the percomorph suborder Notothenioidei, endemic to the region and comprising at least 67% of the species and 90% of the individuals in the Antarctic region (Grande and Eastman 1986; De Witt 1971). The incidence of endemism for notothenioids is 86% at the species level with only a few species found in New Zealand, southern South America, the Falkland Islands, and Australia. The only chondrichthyans reported from the Recent fauna are in the skate family, Rajidae. In the fossil faunas, to date, no rajids have been discovered, and the only report of a notothenioid (Woodward 1908) was found to be probably in error (Grande and Eastman 1986).

Woodward (1908) was the first to describe fossil fishes from Seymour Island, and he described both Cretaceous and Tertiary material, consisting of isolated centra and scales. He referred some of the material to *Ptychodus* sp., but this was later (Welton and Zinsmeister 1980; Grande and Eastman 1986) referred only to Elasmobranchii indeterminate and Teleostei *incertae sedis*. The Tertiary elasmobranchs were later reported by Elliot *et al.* (1975), De Valle *et al.* (1976), Cione *et al.* (1977), Welton and Zinsmeister (1980), and Grande and Eastman (1986). Grande and Eastman also reported a Tertiary holocephalan and siluriform, and reviewed the work of all previous workers; therefore, previous work will not be reviewed in depth here.

The only Cretaceous fish to have previously been described from Seymour Island, other than the Woodward material described here, is the lamnid shark *Isurus* sp. (Grande and Eastman 1986: p. 122). The specimens described below are from the same formation and locality as that specimen.

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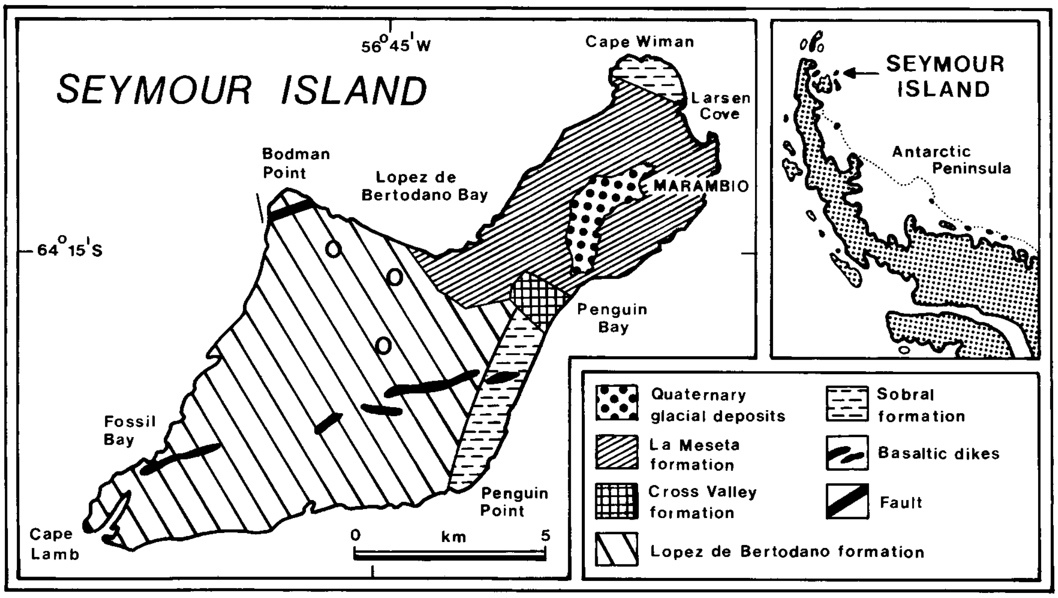


TEXT-FIG. 1. Map showing Seymour Island and Antarctic Peninsula. Circles indicate the Cretaceous fossil fish localities. Ages of rock units: Lopez de Bertodano, Late Cretaceous; Sobral, Late Cretaceous–Palaeocene; Cross Valley, Palaeocene; La Meseta, Eocene; Basaltic dikes, ?Late Tertiary (after Zinsmeister 1982).

GEOLOGICAL SETTING

The thick sequence of fossiliferous marine and non-marine clastics on Seymour Island represent the most complete and well-exposed section of the Upper Cretaceous to Lower Tertiary rocks known in the southern hemisphere. The succession has been divided into two groups: the lower Marambio Group comprised of Lopez de Bertodano and Sobral Formations, and the upper Seymour Island Group consisting of Cross Valley and La Meseta Formations (Bibby 1966; Rinaldi *et al.* 1978; Zinsmeister 1982).

The physical setting of Seymour Island makes it in some ways an ideal place for fossil collection in Antarctica. The island is small—about 20 km long and 9 km wide—and is virtually snow free the year round. The oldest sequence, the Lopez de Bertodano Formation, crops out in the southern two-thirds of Seymour Island (text-fig. 1). It consists of 1200 metres of loosely consolidated greyish sandstones and sandy siltstones, dipping gently eastward. Concretionary horizons occur throughout the sequence. The invertebrate fauna is diverse, consisting of ammonites, echinoids, bivalves, gastropods, arthropods, serpulid worms, and foraminiferans, and suggests Middle Campanian to Maestrichtian age (Howarth 1966; Spath 1953; Macellari and Huber 1982).

Recently a large collection of vertebrate fossils was made from the Lopez de Bertodano Formation. The new material includes the remains of bony fish, sharks, plesiosaurs, mosasaurs, pterosaurs, and possibly birds (Chatterjee and Zinsmeister 1982; Chatterjee *et al.* 1984).

PREPARATION METHODS

The beryciform skull described here was preserved in a hard, calcite-cemented, coase-grained sandstone. The bone is badly fractured and much softer than the matrix, making detailed preparation extremely difficult. Minor preparation was done with needles under a dissecting microscope after immersion in 8% formic acid to soften the matrix.

NEWLY REPORTED CRETACEOUS MATERIAL

Class CHONDRICHTHYES
Subclass ELASMOBRANCHII
Order HEXANCHIFORMES
Family HEXANCHIDAE (*sensu* Ward, 1979)
Genus *NOTIDANODON* Cappetta, 1975
Notidanodon sp.

Referred material. FMNH PF10724 (text-fig. 2A, B), FMNH PF10725 (text-fig. 2C, D), and TTU P9178, 9180, 9182–9185 (all partial isolated tooth fragments). TTU P9182 is in a block of matrix that also has some prismatic cartilage preserved (text-fig. 2E).

Description. The three most complete specimens are FMNH PF10724, 10725, and TTU P9182 (text-fig. 2A–E), and the following description is based on these specimens. Terminology and systematics used for Hexanchidae follow Ward (1979). The teeth are labio-lingually compressed with apically or apico-distally directed principal cusp and distal cusplets. The mesial cusplets are almost as large as the distal cusplets and are mesio-basal to, and distinct and separate from, the principal cusp. Thus, following Ward (1979, p. 122) the tooth fits the diagnosis for the genus *Notidanon* Cappetta 1975. One specimen (TTU P9182: text-fig. 2E) is in a block of matrix that also has some prismatic cartilage preserved, apparently from the same animal. Morphologically, this material most closely resembles *N. lanceolatus*, *N. pectinatus*, and *N. dentatus* (see Ward and Thies 1987) and probably belongs in one of these three very similar looking species. The material differs from *N. loozi* (e.g. Ward 1979, pl. 3, fig. 8) in that the last mesial cusplet points nearly parallel with the principal cusp (text-fig. 2A, B). The species of this genus, known only by isolated teeth, are discussed in Cappetta, 1987.

This is the first report of a hexanchiform from the Antarctic region. The genus is also known from the Palaeocene of Europe, USSR, and from the Upper Cretaceous of North America and New Zealand (Cappetta 1987). Based on available material, monophyly of this 'isolated-tooth genus' seems unsubstantiated.

Order HEXANCHIFORMES? (*sensu* Cappetta, 1987)
Family ORTHACODONTIDAE? (*sensu* Cappetta, 1987)
Genus *SPHENODUS*? Agassiz 1843
Sphenodus? sp.

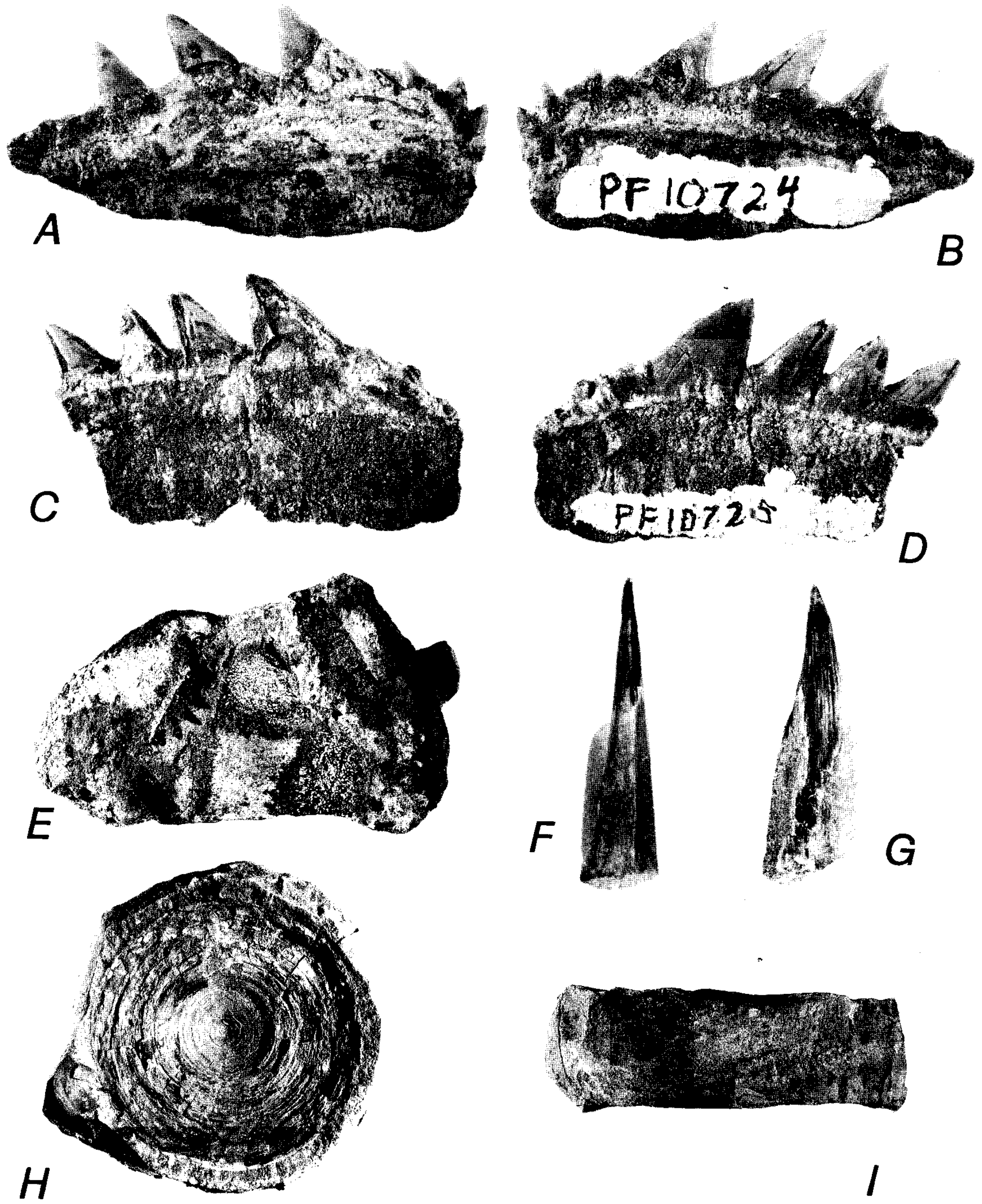
Referred new material. FMNH PF10723 (text-fig. 2F, G) and TTU P9188, 9189, 9191, and 9192 (all partial teeth missing root and base).

Description. Because of incomplete preservation, precise identification of these teeth is not possible. All are somewhat labio-lingually compressed with sharp unserrated mesial and distal cutting edges and sharp points. The teeth were nearly symmetrical in lateral outline, and not curved as in *Isurus*. Their outer surface is smooth, although where the shiny enamel layer is worn off the tooth is striated underneath. They closely resemble fossil species described as *Orthacodus* Woodward, 1889 (e.g. see pl. 1, figs. J, N–P in Uyeno *et al.* 1981 and various figures in a review of the genus by de Beaumont 1960). *Orthacodus* (= *Sphenodus*) is known only by isolated teeth, apart from some skeletal remains from Solnhofen (Cappetta 1977), and the assignment of this poorly known genus to Hexanchiformes is debatable (see Cappetta 1977, p. 50).

Order indeterminate
Family indeterminate
Indeterminate selachian vertebral centra (first reported by Woodward 1908, pp. 1–2)

Referred new material. TTU P9193, 9194, FMNH PF11920, 11921 (two small and two large centra; one of the large illustrated in text-fig. 2H, I).

Description. These centra are identical to those described by Woodward (1908), which he referred to *Ptychodus* [not *Ptychodus* according to Welton and Zinsmeister (1980) and Grande and Eastman (1986)]. One (text-fig. 2H) is so close in size (10 cm diameter) and appearance to a specimen described and illustrated by Woodward that it could possibly be from the same individual. For detailed description see Woodward 1908).



TEXT-FIG. 2. A–E, *Notidanodon antarcti* n. sp., from Upper Cretaceous deposits of Seymour Island. A, B, holotype, nearly complete tooth (FMNH PF10724), ×2·4. A, lateral view (anterior facing right). B, medial view (anterior facing left). C, D, partial tooth (FMNH PF10725), ×2. C, lateral view (anterior facing right). D, medial view (anterior facing left). E, nearly complete tooth in matrix with prismatic cartilage preserved (arrow) (TTU P9182), ×2, anterior facing up. This is the first report of a hexanchiform from the Antarctic region. F, G, *Orthacodus* sp., partial tooth from Upper Cretaceous deposits of Seymour Island (FMNH PF10723), ×2·3. F, anterior view. G, lateral view (anterior facing right). H, indeterminate selachian vertebral centrum (FMNH PF11920), ×2·5. I, dorsal view of FMNH PF11920, ×2·2, from Upper Cretaceous deposits of Seymour Island.

Class OSTEICHTHYES
Subclass ACTINOPTERYGII
Subdivision TELEOSTEI
Order BERYCIFORMES (*sensu* Zehren, 1979)
Superfamily TRACHICHTHYOIDEA (*sensu* Gayet, 1982)
Family TRACHICHTHYIDAE (*sensu* Gayet, 1982)
Subfamily TRACHICHTHYINAE (*sensu* Gayet, 1982)
Genus *ANTARCTIBERYX* gen. nov.
Antarctiberyx seymouri n. sp.

Holotype. TTU P9210. A poorly preserved anterior skull section with partial dentary attached. This is the only known specimen.

Diagnosis. This species differs from all other trachichthyids in the extreme development of the ornamented nasal bridge and in the pattern of radiating spines and serrations on the dorsal surface of the bridge (text-fig. 3D, E).

Etymology. *Antarcti* and *seymouri* refer to type locality; *beryx*—a fish (Latin).

Description. The specimen (text-fig. 3A–E) is poorly preserved and incomplete. It is missing the braincase and gill-cover regions, the postcranial skeleton, and the left side of the skull. Many other bones of the skull are either incomplete, or hidden by overlying rock or bones. Based on the limited information available (described below), the specimen still appears to be identifiable as a trachichthyid of the subfamily Trachichthyinae (*sensu* Gayet 1982).

Bone terminology below is largely after Patterson (1964). The most prominent features of the skull roof (text-fig. 3C, D) are large, well-developed mucus cavities (features derived for 'trachichthyoid beryciforms' according to Rosen 1973, p. 477, and for trachichthyids according to Gayet, 1982, fig. 15).

The frontals (f) are nearly complete, but these are the posteriormost elements of the skull roof that are preserved in the specimen. The frontals are complicated by high crests surrounding part of the mucus cavities. The main (medial) crest of each frontal runs forward beyond the median, posteriormost cavity, and curves medially to meet its counterpart above the anterior edge of the orbit. The crests are highest anteriorly, and they bear small spines along their edges (text-fig. 3D).

The nasals (na) are relatively large bones closely sutured to the frontals. The medial edges of the nasals form a high, spiny crest which is divided anteriorly, forming a V-shaped space which houses the ascending processes of the premaxillae. The wide lateral cavities on the frontal continue anteriorly to the nasals. A bridge over the nasal groove (nabr) is formed anteriorly by a process extending from the lateral and medial edges of the nasal. The lateral edge of the nasal and the dorsal surface of the nasal bridge are highly ornamented with spines and serrations (text-fig. 3E). Of all 'beryciforms' examined here, the form of the nasals in *Antarctiberyx* most closely resemble those of the living trachichthyid, *Paratrachichthys* (e.g. see figs. 49 and 50 in Zehren 1979). The development of the nasal bridge (text-fig. 3D) is more pronounced in *Antarctiberyx* than in any other taxon examined here.

A small, slender unornamented bone (ub1) is present between the nasal and the first antorbital (text-fig. 3B). Although it is possible that it is an antorbital bone (= accessory nasal of Starks 1904, p. 611), it is much deeper in the specimen than the infraorbitals, and positive identification of this bone is not possible.

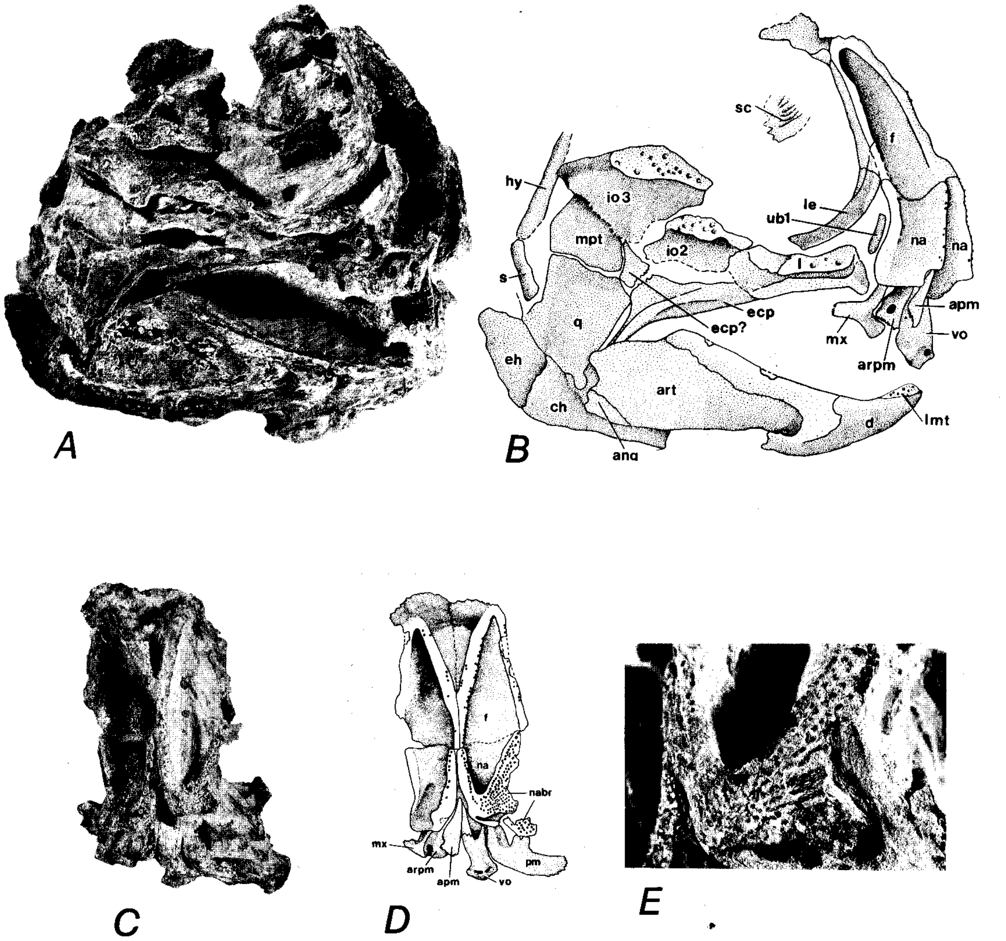
Of the vomer (vo), only the head is visible on the specimen, but the lateral facets for articulation with the maxillae are visible. No teeth are visible on the ventral surface of the vomer, but this could be an artefact of preservation).

The infraorbital bones (io) are not clearly preserved in the specimen, but the first three (or four?) are visible (text-fig. 3A, B). The flanges overhanging the groove for the sensory canal are ornamented. The ventral borders of the infraorbitals are incomplete. The subocular shelf is not visible in the specimen, possibly due to lack of preservation.

Most of the maxilla (mx) is missing, exposing much of the suspensorium. Of the hyomandibula (hy), only a ventral piece is preserved (text-fig. 3B).

The symplectic (s) is a small rod-shaped bone (text-fig. 3B) inclined forward at about forty-five degrees to the ventral limb of the hyomandibula, and articulating with the quadrate. (Due to poor preservation, the details of this articulation are not apparent.)

The quadrate (q) is triangular, with a large condyle for the articular. The ectopterygoid (ecp) joins its



TEXT-FIG. 3. A–E, *Antarctiberyx seymouri* n. sp., holotype, from Upper Cretaceous deposits of Seymour Island (TTU P9210). A, B, right lateral view of skull (photo and drawing), ×1. C, D, dorsal view of skull (photo and drawing), ×0·75. E, enlarged photograph of bridge over nasal groove showing ornamentation pattern, ×2·5.

anterior edge and the metapterygoid (mpt) its dorsal edge. The preopercle (and the rest of the opercular series) is missing.

The ectopterygoid (ecp) is long and curved bone tapering to a point against the quadrate. The anterior edge of the bone is not clear because there are several cracks in the bone, but one could well be a suture with the palatine (as described for other trachichthyids in Patterson 1964).

The metapterygoid (mpt) is a sheet of smooth bone. The anterior and dorsal margins of this bone are hidden (text-fig. 3B).

There is very little left of the upper jaw in the specimen. Only what appears to be the ascending process (apm) and the articular process (arpm) of the premaxilla are preserved on the right side (text-fig. 3A, B), and on the left side there is also part of the body of the premaxilla (text-fig. 3C, D). The ascending process is long and stout, and well separated from the articular process. The maxillary head is too fragmentary to allow detailed description.

The lower jaw, though not well preserved, is nearly complete (text-fig. 3A, B). The dentary (d) tapers from a high coronoid process, and appears to have been toothed to its tip. Near the symphysis, the teeth (indicated primarily by empty sockets in the specimen) extend to the lateral face of the bone (text-fig. 3B). The articular (art) has a large, concave facet for the quadrate posteriorly. This is considered by Gayet (1982) and Stewart (1984) to be a character of trachichthyids.

Two bones of the hyoid arch are also visible on the specimen (text-fig. 3A, B), a triangular posterior ceratohyal (eh) which is closely articulated with the anterior ceratohyal (ch). The dorsal and anterior margins of the anterior ceratohyal are obscured by the lower jaw and the suspensorium.

Scale (sc) fragments are also present in the matrix on the specimen (text-fig. 3B), and are probably from the same individual. They are ornamented and bear spines on their posterior margins.

Taxonomic placement. Following recent revisions of 'beryciforms' by Gayet (1982) and Stewart (1984), *Antarctiberyx* appears to belong in Trachichthyidae based primarily on two characters: the teeth on the labial side of the mandible and the presence of the large mucus cavities on the top of the head. The appearance of the nasal bridge and frontals is also very similar to that in extant trachichthyids (e.g. see illustrations of *Paratrachichthys* sp. in Zehren 1979, figs. 49 and 50).

Order Indeterminate
Indeterminate teleost scraps

Referred new material. About one hunded specimens, mostly isolated centra and bone fragments (deposited at TTU), but including some poorly preserved partial skulls. The presence of such material indicates that more diagnostic material will eventually be found in the Cretaceous deposits of Seymour Island.

DISCUSSION

It seems clear, based on fossil evidence from Seymour Island (Grande and Eastman 1986; and above), that the Antarctic region had a much more diverse chondrichthyan fauna during Cretaceous and Early Tertiary time than it does today. The diversity of fossil teleost fauna is much less apparent, but this may be only an artefact of preservation. The fossils from Seymour Island are mostly isolated teeth, scales, and skull fragments. The most complete teleost found so far (*A. seymouri* n. sp.) is only a partial anterior region of a head (text-fig. 3A–E). The fact that isolated teeth are much more diagnostic for chondrichthyans than they are for teleosts may be the main reason why there appears to be a much larger diversity of fossil chondrichthyans than of fossil teleosts. A wide variety of teleost centra is present in the Tertiary and Cretaceous deposits of Seymour Island (many UCR specimens listed in Grande and Eastman 1986; and many TTU specimens mentioned above), but these appear to be identifiable only as Teleostei indeterminate. It is hoped that with continued collecting on Seymour Island, the Tertiary and Cretaceous teleost faunas will become better known.

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ABBREVIATIONS

In text-figures: ang, angular; apm, ascending process of premaxilla; arpm, articular process of premaxilla; art, articular; ch, anterior ceratohyal; d, dentary; ecp, ectopterygoid; eh, posterior ceratohyal; f, frontal; hy, hyomandibula; io, infraorbital; l, lacrimal (first infraorbital); le, lateral ethmoid; lmt, area on labial side of mandible showing traces of teeth and tooth sockets; mpt, metapterygoid; mx, maxilla; na, nasal; nabr, bridge over nasal groove (see text); pm, premaxilla; q, quadrate; s, symplectic; sc, scale; ub1, unornamented bone; vo, vomer.

Institutional: FMNH PF, Fossil Fish Collection, Department of Geology, Field Museum of Natural History, Chicago, Illinois; TTU, Museum of Texas Tech University, Lubbock, Texas.

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LANCE GRANDE
Department of Geology
Field Museum of Natural History
Chicago, Illinois 60605

SANKAR CHATTERJEE
The Museum
Texas Tech University
Lubbock, Texas 79409

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