

<i>Tertiary Research</i>	14 (3)	117-126	1 Plate, 2 Text-figs, 1 Table	Leiden April 1993
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Late Miocene and Early Pliocene fish assemblages from the north central coast of Chile

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Abstract: Collections from late Miocene and early Pliocene marine sandstones on the north-central coast of Chile have produced two assemblages of fossil fishes consisting of eight taxa of sharks, two taxa of batoids, and at least two taxa of teleosts. *Cetorhinus maximus*, *Galeorhinus galeus*, *Carcharhinus albimarginatus*, Rajidae indet., and *Thunnus* sp. are recorded from the Neogene of the southeast Pacific (western South America) for the first time.

These are the first Neogene fish localities adequately described from Chile, and are the southernmost fossil fish localities from the eastern Pacific. The faunal compositions of these localities are similar to the late Miocene and early Pliocene localities of Pisco, Peru, but suggest a slightly cooler temperate marine climate

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INTRODUCTION

It is surprising that few fossil fish localities have been reported from the western coast of South America given the great extent of the coastline. Detailed assemblages from only two Neogene fish localities have been published from the entire Pacific coast of South America. Longbottom (1979) recorded ten taxa of sharks and one ray from a Miocene locality on the coast of Ecuador between the Equator and latitude 1° south (Table 1). De Muizon & De Vries (1985) recorded eleven taxa of sharks, one ray, and ten taxa of teleosts from several late Miocene and early Pliocene localities from the Pisco Basin along the south-central coast of Peru between latitude 14° and 15° south (Table 1). Oliver-Schneider (1937) reported *Carcharocles megalodon* from a Neogene locality in Chile, but no other Neogene shark or fish faunas have since been described.

In this report, I document two new Neogene fossil fish localities from the north-central coast of Chile that produced eight taxa of sharks, two batoids, and at least two taxa of teleosts. Undescribed fossils of pinnipeds, small odontocetes, large cetaceans, and seabirds have also been collected from the same deposits. These new localities are the first accurately documented Neogene fish localities from Chile, and are the southernmost fossil fish locality from the eastern Pacific.

The specimens cited in this paper are to be curated into the palaeontology collection of the Museo Nacional de Historia Natural in Santiago, Chile.

LOCALITIES

The Chilean specimens described herein were collected by surface prospecting by various American and Chilean workers from unconsolidated marine sandstone and gravel outcrops along the north-central coast of Chile at two localities (Text-fig. 1).

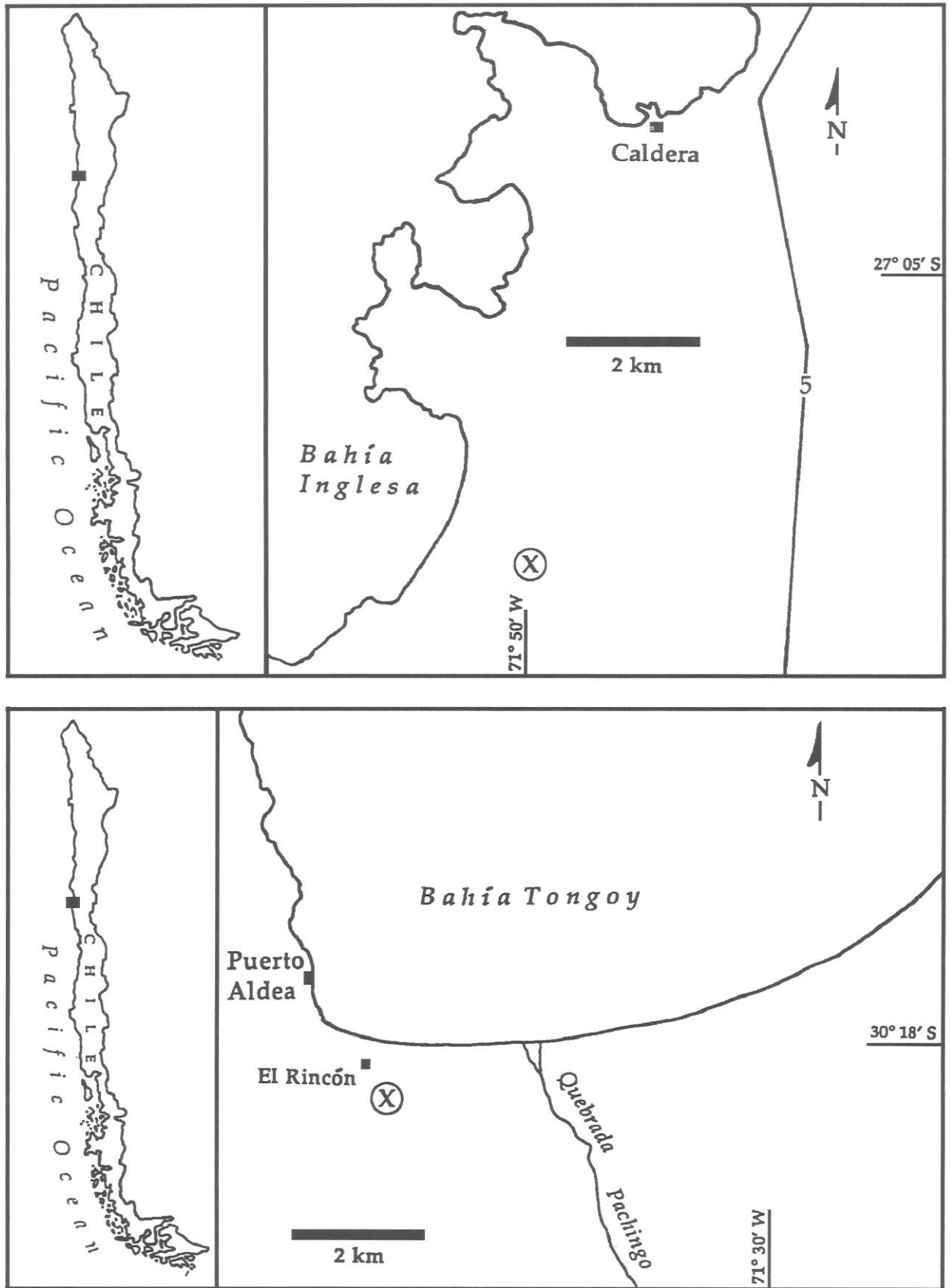
The first locality (27° 8'S : 070° 50'W) is about 1km inland from Bahía Inglesa, and about 7km south of the town of Caldera.

The second locality (30° 18'S : 071° 36'W) is about 1km inland from Bahía Tongoy, and 0.5km south of the town of El Rincón. A 4kg bulk sample of sediment from this locality was screenwashed for small bones and teeth.

AGES

The Bahía Inglesa locality has been dated on the basis of diatoms at between 4.5 and 2.6 MYBP (Tsuchi *et al.* 1988). The shark assemblage from this locality supports this date. As with the Pisco localities (De Muizon & De Vries 1985), the abundance of *Carcharodon carcharias* and the absence of *Isurus hastalis* from Bahía Inglesa suggest a Pliocene age.

The El Rincón locality been dated on the basis of diatoms at between 13.9 and 12.1 MYBP (Tsuchi *et al.* 1988); I agree with the approximate age of this locality because of the presence of *I. hastalis* and absence of *C. carcharias*.



Text-fig. 1. Maps of the fossil fish localities described in this report; positions of the localities shown on the Chilean coast are on the left, and magnified maps of the inset are at the right. The Pliocene Bahía Inglesa locality is at top, and the Miocene El Rincón locality is below. Collecting sites are indicated by the circled "X".

SYSTEMATIC PALAEOONTOLOGY

CLASS CHONDRICHTHYES

SUBCLASS ELASMOBRANCHII

ORDER HEXANCHIFORMES Compagno 1973

FAMILY HEXANCHIDAE Gray, 1851

GENUS *Hexanchus* Rafinesque, 1810***Hexanchus griseus* (Bonnaterre, 1788)**

(Plate 1f)

Material: A single incomplete lower left lateral tooth with the primary cusp showing coarse serrations on the lower portion of the mesial cutting edge, four distal cusplets, and a portion of the root.

Locality: Bahía Inglesa.

Discussion: This hexanchid shark has also been collected from the Pisco Formation of Peru where it is restricted to the Pliocene. The Chilean fossil represents the second record of this species in South America, and is also the southernmost fossil occurrence of this species.

Comments: I agree with Welton (1979) and Cappetta (1987) that *Hexanchus griseus* (Sismonda, 1857) is synonymous with the extant *H. griseus*. The wide range of ontogenetic and individual variability seen in the lower teeth of *H. griseus* includes characters previously used to distinguish *H. gigas*

ORDER LAMNIFORMES

FAMILY LAMNIDAE Müller & Henle, 1838

GENUS *Carcharodon* Smith, 1838***Carcharodon carcharias* (Linnaeus, 1758)**

(Plate 1 a-b)

Material: Many teeth from juveniles, sub-adults, and adults representing anterior and lateral tooth positions of upper and lower jaws.

Locality: Bahía Inglesa.

Discussion: *Carcharodon carcharias* is well represented from this locality, and examples comprise the majority (59%) of the total sample. This species may be abundant here because the many marine mammals that inhabited this area would have been suitable prey. As discussed by De Muizon & De Vries (1985) and Cappetta (1987), *Carcharodon carcharias* is a cosmopolitan species in the Pliocene, and has not been confirmed from any pre-Pliocene localities on the Pacific Rim. Therefore, this abundant species supports the Pliocene age of the Bahía Inglesa locality established by Tsuchi *et al.* (1988). This is the southernmost fossil occurrence of *Carcharodon carcharias* in the eastern Pacific.

GENUS *Isurus* Rafinesque, 1810***Isurus oxyrinchus* Rafinesque, 1810**

(Plate 1d)

Material: Many specimens of adult and juvenile, anterior and lateral teeth.

Localities: Fifteen teeth from the Bahía Inglesa locality, one from the El Rincón locality.

Discussion: *Isurus oxyrinchus* is known from the Pisco localities where it occurs only in the Miocene (De Muizon & De Vries, 1985). The Chilean specimens extend the geologic range of *I. oxyrinchus* into the Pliocene of South America, and the geographical range further south than previously documented.

Isurus hastalis Agassiz, 1843

(Plate 1e)

Material: One nearly complete lateral tooth, missing a portion of the mesial root lobe.

Locality: El Rincón.

Discussion: This shark occurs primarily in the Miocene (De Muizon & De Vries, 1985), and its presence in the El Rincón locality (and absence of *Carcharodon carcharias*) is a criterion for supporting the Miocene age to this locality.

FAMILY OTODONTIDAE Gluckman, 1964

Genus *Carcharocles* Jordan & Hannibal, 1923

Carcharocles megalodon (Agassiz, 1843)

(Plate 1c)

Material: A mesial half of a large upper lateral tooth, broken along the centre.

Locality: Bahía Inglesa.

Discussion: *Carcharocles megalodon* has a cosmopolitan distribution in the Miocene and Pliocene (Cappetta 1987). First reported from Chile by Oliver-Schneider (1937), it is also known in western South America from the Miocene of Ecuador (Longbottom 1979) and from the Miocene and Pliocene of Peru (De Muizon & De Vries, 1985).

FAMILY CETORHINIDAE Gill, 1862

GENUS *Cetorhinus* Blainville, 1816

Cetorhinus maximus (Gunnerus, 1765)

(Plate 1h)

Material: A single, incomplete gill raker missing the distal end.

Locality: El Rincón.

Discussion: Although incomplete, this single gill raker is identifiable as *Cetorhinus*. Oligocene and Miocene *Cetorhinus* fossils are usually assigned to *C. parvus* (Leriche, 1908), and post-Miocene *Cetorhinus* fossils are assigned to the extant *C. maximus* (Cappetta 1987). I saw no difference between the rakers of this late Miocene Chilean specimen and those of the extant species, so I refer this specimen to *C. maximus*. This is the first fossil record of *Cetorhinus* from the Southern Hemisphere.

ORDER CARCHARHINIFORMES Compagno, 1973

FAMILY TRIAKIDAE Gray, 1851

GENUS *Galeorhinus* Blainville, 1816

Galeorhinus galeus Linnaeus, 1758

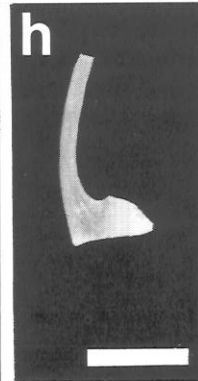
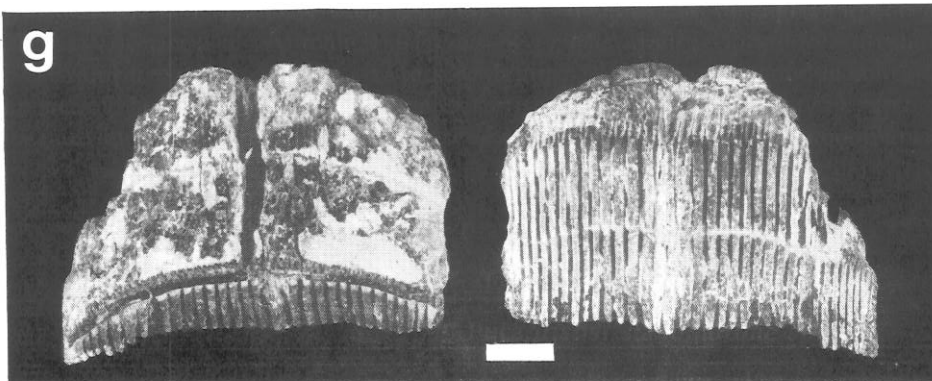
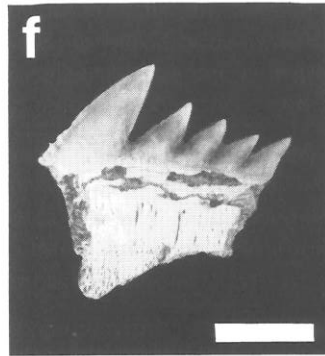
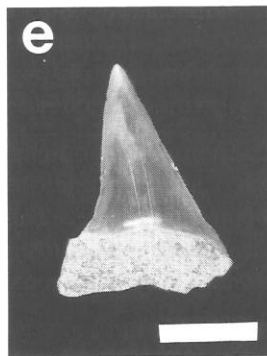
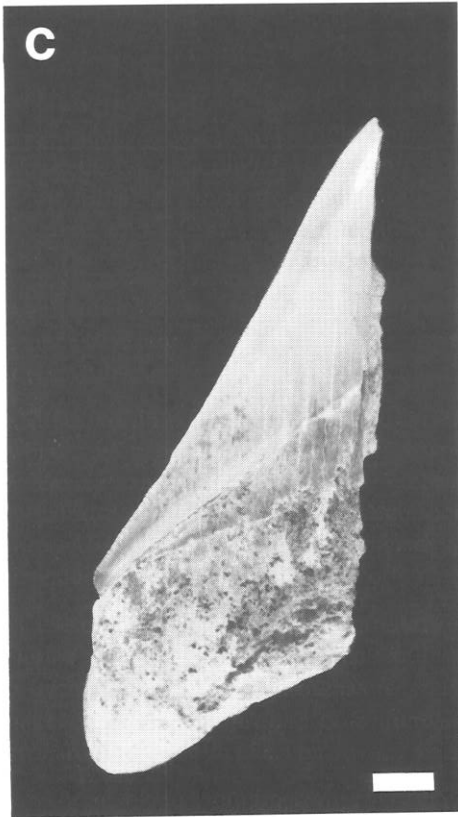
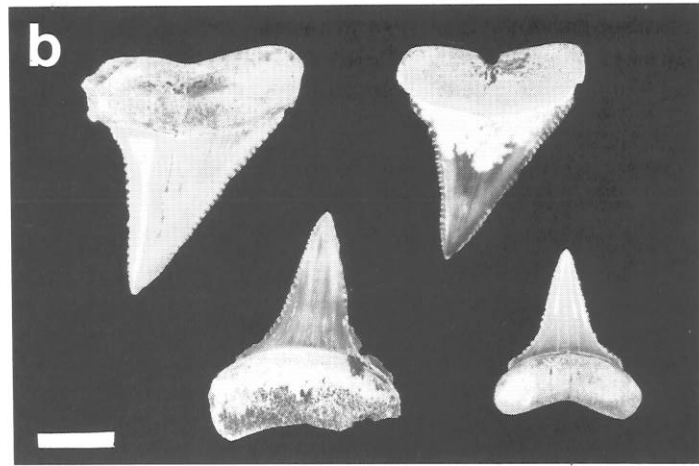
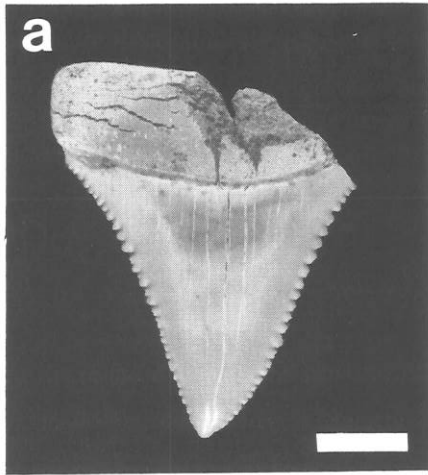
(Text-fig. 2 c-d, e-f)

Material: Several upper and lower lateral, anterior, and symphyseal teeth.

Plate 1. Elasmobranch teeth from Neogene deposits in north-central Chile.

- a. upper lateral adult *Carcharodon carcharias* tooth. b. upper and lower lateral teeth from *C. carcharias*.
 c. broken upper lateral *Carcharocles megalodon* tooth. d. lower anterior and upper lateral *Isurus oxyrinchus* teeth
 e. upper lateral *Isurus hastalis* tooth. f. incomplete lower lateral *Hexanchus griseus* tooth.
 g. apical and basal views of an incomplete *Aetobatus* sp. dental plate. h. portion of a *Cetorhinus maximus* gill raker.

White scale bar in all photos equals 1 cm.



Locality: One specimen surface collected from the Bahía Inglesa locality, eight more recovered from screenwashing a 4kg sediment sample from the same locality.

Discussion: The fossil history of this genus is confusing because many teeth previously attributed to it are now assigned to other genera of triakids and carcharhinids. Nonetheless, the Chilean teeth appear to be from of the extant *Galeorhinus galeus*. Although there is some debate as to the validity of certain local species, the extant *Galeorhinus galeus* is considered a cosmopolitan species (Compagno, 1984). This is the first fossil record of *G. galeus* from the west coast of South America.

FAMILY CARCHARHINIDAE Jordan & Evermann, 1896

GENUS *Carcharhinus* Blainville, 1816

***Carcharhinus albigarginatus* Rüppell, 1837.**

(Text-fig. 2 a-b)

Material: A single, nearly complete upper left lateral tooth.

Locality: Bahía Inglesa.

Discussion: Although this tooth approximates to the morphology of teeth referred to *C. egertoni* (Agassiz, 1843), I believe that this taxon actually represents several species of Neogene carcharhinids with similar tooth morphologies, and I question its usefulness.

In close comparison to dried jaws (author's collection) and dental illustrations of extant species of *Carcharhinus* (Garrick, 1982), this tooth is very similar in morphology to the upper lateral teeth of *C. albigarginatus*. Upper teeth of this species are characterized by the number of serrations on the cutting edges, and by the abrupt change in the size of the serrations at the crown notch along the first 1/3 of the cutting edge of the crown. This is the first confirmation of this extant circumtropical species in the fossil record.

ORDER RAJIFORMES Berg, 1940

FAMILY RAJIDAE Bonaparte, 1831

Rajidae indet.

(Text-fig. 2 g-i, j-l)

Material: Two teeth, one dermal spine.

Locality: A dermal spine was surface collected from the Bahía Inglesa locality, two teeth were recovered by screenwashing a 4kg sample from the same locality.

Discussion: One tooth (Text-figure 2 g-i) has a rounded, apically flattened crown with a single foramen between the two root lobes. The second tooth (Text-figure 2 j-l) has a low crown apex, and has five foramina between the root lobes. Since shape of the crown and the number of foramina may vary with respect to sex, ontogeny, wear and placement on the tooth row, the lack of specific diagnostic features of the generalized Chilean skate teeth prohibits identification beyond the family level. They most closely resemble either *Raja* or *Bathyraja*, which, unfortunately, are the two largest genera in the family Rajidae. Moreover both genera show a wide range of dental variability in an otherwise generalized dentition. However, these teeth are important because they represent the first Neogene record of the Rajidae from South America and indeed from the Southern Hemisphere.

ORDER MYLIOBATIFORMES Compagno, 1973

FAMILY MYLIOBATIDAE Bonaparte, 1838

GENUS *Aetobatus* Blainville, 1816

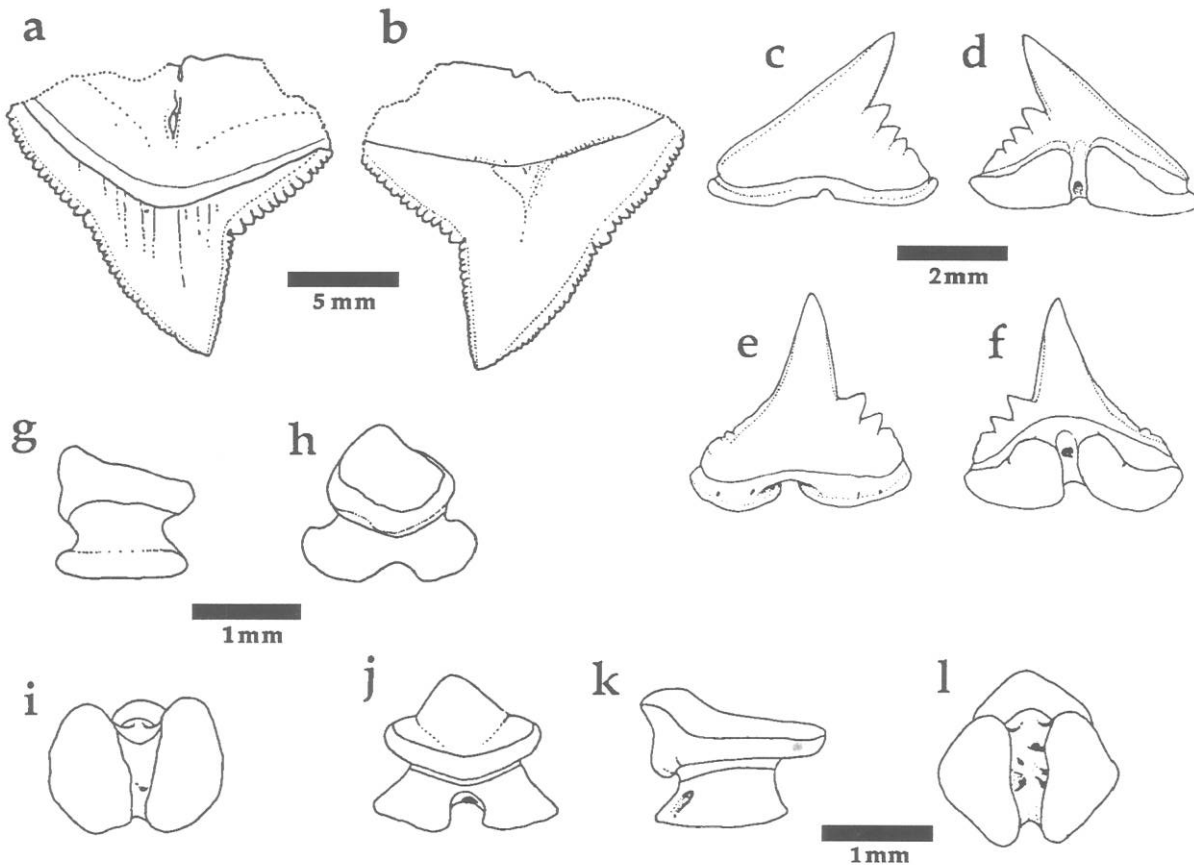
***Aetobatus* sp.**

(Plate 1g)

Material: A partial lower dental plate containing two articulated pavement teeth.

Locality: El Rincón.

Discussion: The mesial arch of the upper teeth, characteristic of *Aetobatus*. Although a nominal Miocene species of *Aetobatus* (*A. arcuatus* Agassiz, 1843) is known from western Europe and eastern North America, the Chilean specimens show a closer resemblance the extant *A. narinari* Euphrasen, 1790, but a specific identification is hampered by the incompleteness of this specimen. Fossil *Aetobatus* in the Eastern Pacific are also known from the Miocene of Ecuador (Longbottom, 1979).



Text-fig. 2. Camera-lucida drawings of elasmobranch teeth from Neogene deposits in north-central Chile.

- a - b lingual and labial views of an upper lateral *Carcharhinus albimarginatus* tooth.
- c - d labial and lingual views of a lateral *Galeorhinus galeus* tooth.
- e - f labial and lingual views of an anterior *Galeorhinus galeus* tooth.
- g - i lateral, antero-oblique, and basal views of the first Rajidae indet. tooth.
- j - l antero-oblique, lateral, and basal views of the second Rajidae indet. tooth.

CLASS OSTEICHTHYES
 SUBCLASS ACTINOPTERYGII
 SUBDIVISION TELEOSTEI
 ORDER PERCIFORMES
 FAMILY SCOMBRIDAE Rafinesque, 1815
 GENUS *Thunnus* South, 1845
Thunnus sp.

Material and localities: Four caudal vertebrae from Bahía Inglesa, and one caudal vertebra from El Rincón.

Discussion: These large caudal vertebrae are recognizable as *Thunnus* on the basis of the low, compressed dorsal arch and the wide, thin, lateral spine that forms the keeled caudal peduncle. This is the first record of fossil *Thunnus* sp. from South America, although some fossils listed as Scombridae indet. by De Muizon & De Vries (1985) may actually be *Thunnus* sp.

FAMILY SERRANIDAE Swainson, 1839

Serranidae indet.

Material and locality: One vertebra from Bahía Inqlesa.

Discussion: This single large anterior caudal vertebra, identified the basis of its large size, slightly oblong articulating surface, and fine lattice-like lateral structure, was collected from this locality. It is referred to the family Serranidae based on comparisons the vertebrae of extant forms, but because of the lack of diagnostic characters, is not identified beyond the family level.

Many isolated teleost teeth, vertebrae and fragments of bone have been collected by surface collecting and screenwashing from the Caldera locality, but have not been identified.

PALAEOECOLOGY

All of the taxa of fishes recovered from the Bahía Inglesa and El Rincón localities are indicative of a temperate marine climate and an inshore coastal habitat. The assemblages from these localities indicate a slightly cooler marine climate than localities of similar ages from Peru (De Muizon & De Vries 1985). The Chilean assemblages lack *Odontaspis* and have very few *Carcharhinus*, both common in subtropical and warm-temperate waters today. The occurrence of *Cetorhinus*, *Galeorhinus*, and Rajidae (lacking in the Peruvian localities) suggests that the climate at the Chilean localities was cooler than at the contemporaneous northern localities in Peru.

Many of these taxa in the late Miocene-early Pliocene Chilean fish assemblages are still found in Chilean waters today. *Hexanchus griseus* (sixgill shark) *Carcharodon carcharias* (white shark), *Isurus oxyrinchus* (mako shark),

LOCALITY		TAXON
El Rincón	Bahía Inglesa	
	X	<i>Hexanchus griseus</i>
	X	<i>Carcharodon carcharias</i>
X	X	<i>Isurus oxyrinchus</i>
X		<i>Isurus hastalis</i>
	X	<i>Carcharocles megalodon</i>
X		<i>Cetorhinus maximus</i>
	X	<i>Galeorhinus galeus</i>
	X	<i>Carcharhinus albimarginatus</i>
	X	Rajidae indet.
X		<i>Aetobatus</i> sp.
X	X	<i>Thunnus</i> sp.
	X	<i>Serranidae</i> indet.

Table 1 Distribution of fossil fish taxa in the late Miocene El Rincón locality and the early Pliocene Bahía Inglesa locality on the coast of north-central Chile.

Galeorhinus galeus (tope or soupfin shark), rajids (skates), *Thunnus* (tunas), serranids (sea basses) still live in the coastal and offshore waters of Chile. *Carcharhinus albimarginatus* (silvertip shark) and *Aetobatus* (eagle ray) live in warmer waters off Ecuador and Peru.

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