

Berriasian invertebrate fauna from the Springhill Formation of Southern Patagonia

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With 6 figures in the text

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Abstract: Bivalves, ammonites and belemnites are described from the oil-bearing Springhill Formation of Lago San Martín, Argentina. The ammonites *Jabronella* NIKOLOV, *Neocosmoceras* BLANCHET and *Delphinella* LE HEGARAT indicate a Berriasian age; the bivalves *Megacucullaea* RENNIE and *Protocardia* (*Tendagurium*) DIETRICH are reported for the first time from Patagonia; *Aetostreon* sp. and belemnites, mainly *Belemnopsis* spp. also occur. At the species level the faunas resemble Upper Jurassic-Lower Cretaceous material from east Africa, Madagascar and India.

Key words: Pelecypoda (Arcina, Inocerami, Pteriina, Pectinacea, Ostreacea, Venerida, Carditida), Perisphinctida, Belemnoidea, Berriasian (Springhill Formation); Argentinian Patagonia.

Zusammenfassung: Von der ölführenden Springhill Formation beim See St. Martin werden Bivalven, Ammoniten und Belemniten beschrieben. Die Ammoniten *Jabronella* NIKOLOV, *Neocosmoceras* BLANCHET und *Delphinella* LE HEGARAT zeigen Berriasium an; die Bivalven *Megacucullaea* RENNIE und *Protocardia* (*Tendagurium*) DIETRICH werden erstmalig von Patagonien beschrieben, *Aetostreon* sp. und Belemniten, besonders *Belemnopsis* spp., kommen gleichfalls vor. Die Fauna ähnelt in der Arten-Zusammensetzung den Oberjura-Unterkreide-Faunen von Ostafrika, Madagaskar und Indien.

Resumen: Se describen bivalvos, ammonitas y belemnites hallados en la Formación Springhill en Lago San Martín, Argentina. La presencia de las ammonitas *Jabronella* NIKOLOV, *Neocosmoceras* BLANCHET y *Delphinella* LE HEGARAT indican una edad berriasiense; los bivalvos *Megacucullaea* RENNIE y *Protocardia* (*Tendagurium*) DIETRICH son descriptos por primera vez de Patagonia austral; *Aetostreon* sp. y *Belemnopsis* spp. son relativamente abundantes. A nivel específico existen similitudes con el Jurásico superior-Cretácico inferior de África oriental, Madagascar e India.

Introduction

The important oil-bearing Springhill Formation occurs in the Austral or Magallanes Basin of Southern Patagonia, approximately between latitudes 45° and 55° S, and longitudes 67° and 74° W. Different stratigraphical aspects of this formation have been dealt with by several authors whose works I have recently reviewed (RICCARDI 1976). Most of the formation is buried and it is mainly known from borehole data; its outcrops are restricted to the western and southern margins of the basin. It overlies paraconformably the Jurassic volcanic and pyroclastic rocks of the "El Quemado Complex" and it is generally restricted to the topographic depressions of the latter's irregular surface. It is conformably overlain by Cretaceous marine pelites. The Springhill Formation consists of continental to marine psammites with interbedded arenaceous pelites and has an average thickness of 30—40 m with a maximum of about 130—150 m.

In different wells and outcrops this unit has yielded foraminifers, bivalves, ammonites, belemnites and plants. Although the macrofossil material has been recorded by different authors (cf. RICCARDI 1976) it has never been described or figured, probably because of its generally poor and fragmentary preservation. On the basis of these identifications the formation has been variously dated as Bajocian-Bathonian, Oxfordian-Kimmeridgian, Tithonian-Valanginian, Aptian or lower Upper Cretaceous. The latest studies favoured Oxfordian to Hauterivian-Barremian, with the wide age range being attributed to diachronism. However, the documentation has remained unreliable since the fossil identifications can not be verified.

The Springhill Formation at Lago San Martín

On the eastern margin of Bahía de la Lancha at Lago San Martín (approximately 49° S, 72° 15' W) the Springhill Formation is relatively well represented with a thickness that varies from less than 10 m to about 70 m. At its top, subjacent to the (?)Hauterivian-Aptian pelites of the Rio Mayer Formation, are about 2 m of sandy limestone from which I collected a relatively abundant invertebrate fauna (RICCARDI 1971, fig. 4, sections I to III). The fauna includes: *Megacucullaea* cf. *kraussi* (TATE), *Inoceramus* aff. *anomiaeformis* FERUGLIO, *I.* sp. I and *I.* sp. II, *Oxytoma* (O.) sp., O. (*Hypoxytoma*?) sp. indet., *Entolium* (E.) cf. *argentinum* (STANTON), *Chlamys* (*Aequipecten*) *octoplicoides* (HERTLEIN), *Aestostreton* sp. indet., *Lucina antarctica* LEANZA, L. cf. *neuquensis* HAUPT, *Lucina* sp., *Protocardia* (*Tendagurium*) nov. sp., *Jabronella* aff. *michaelis* (UHLIG), *Neocosmoceras* sp., *Delphinella* sp., *Belemnopsis patagoniensis* (FAVRE), *B.* cf. *madagascariensis* (BESAIRIE) and *Hibolithes* aff. *jaculum* (PHILLIPS).

Most of this material is described below, although some poorly preserved bivalves, probably belonging to different species and genera have been omitted: e. g. (?)*Eriphylla* sp., (?)*Astarte* sp., (?)*Pleuromya* sp., (?)*Panopaea* sp., Lucinidae indet., Inoceramidae indet. and Oxytomidae indet. The presence of the ammonite genera *Jabronella* NIKOLOV, *Neocosmoceras* BLANCHET and *Delphinella* LE HEGARAT indicates a Berriasian age. The bivalves, *Megacucullaea* RENNIE and *Tendagurium* DIETRICH are present in the Upper Jurassic-Lower Cretaceous of East-South Africa and India, whereas *Belemnopsis madagascariensis* is a Tithonian-Valanginian species from Madagascar. The similarities to the Indian Ocean are further enhanced by the presence of *Aetostreon* sp. which bears a very close similarity to *A. imbricatum* (KRAUSS) from the Lower Cretaceous of South Africa, and to *Gryphaea balli* (STEFANINI) from the Oxfordian of East Africa. *Gryphaea balli* has recently been recorded from Southern Chile by CECIONI & CHARRIER (1974) who used it as evidence for a direct connection between East Africa-Madagascar-India and Patagonia through the Mozambique Channel. The microfaunas (SIGAL et al. 1970) and, perhaps, some ammonites (STIPANICIC et al. 1976) point to a similar connection. This study confirms the probable presence of such connection for Berriasian times.

Systematic Palaeontology

Class Bivalvia (BUONANNI 1681) LINNÉ 1758

Subclass Pteriomorphia BEURLEN 1944

Order Arcoida STOLICZKA 1871

Superfamily Arcacea LAMARCK 1809

Family Cucullaeidae STEWART 1930

Genus *Megacucullaea* RENNIE 1936

Type species by original designation: *Cucullaea kraussi* TATE 1867 (= *C. cancellata* KRAUSS 1850, p. 452, pl. 48, figs. 2a—b).

D i a g n o s i s : Large, heavy and inflated shell, ovate to subtrigonal, slightly inequilateral and inequivalue with nearly median, strongly incurved umbo and rounded posterior umbonal carina. Broad triangular cardinal area, amphidetic, duplivincular, with chevron-shaped grooves. Surface ornamented with costellae superimposed on widely spaced radial plications, intersecting with irregularly conspicuous growth lamellae. Hinge line with numerous small transverse teeth, short and vertical near the mid-line but passing laterally into slightly larger and oblique ones; at both ends with larger teeth parallel to the hinge margin.

R e m a r k s : The genus *Megacucullaea* was established by RENNIE (1936, p. 305) for the species *Cucullaea kraussi* TATE from the Neocomian of South Africa.

TATE (1867, p. 161) introduced the specific name for the material originally described by KRAUSS (1850, p. 452, pl. 48, figs. 2a—b) under *C. cancellata*, a name that was already occupied by PHILLIPS (1829). Since then, besides mentions of its occurrence in eastern Africa (DIETRICH 1933, p. 28;AITKEN 1961, p. 34), *M. kraussi* has been illustrated by HOLUB & NEUMAYR (1881, p. 275, pl. 2, fig. 2; refigured in HATCH & CORSTORPHINE 1905, p. 251, fig. 69f), BARRABE (1929, p. 147, pl. 8, fig. 13), RENNIE (1936, p. 305, pl. 44, fig. 2), COX (1940, p. 57, pl. 4, figs. 3—4), and REYMENT & TAIT (1972, pl. 4, fig. 13) from Madagascar, India and South Africa.

COX (1940, p. 59, pl. 4, figs. 5—7) described a new species (*M. eminens*) from India, and the only other figured specimens that undoubtedly belong to the genus are those from South Africa described by RENNIE (1936, p. 308, pl. 37, figs. 1—3) under “*Cucullaea (Megacucullaea)* spp. indet.”. It is also possible that *Cucullaea neuquensis* WEAVER (1931, p. 186, pl. 13, figs. 45—46; cf. DIETRICH 1933, p. 28) from Western Argentina, and *Cucullaea kipandeensis* COX (1965, p. 34, pl. 3, figs. 1a—b) belong to *Megacucullaea*. However, the affiliation of *Noramya* CASEY (1961, p. 575) which includes species such as “*Arca gabrielis* LEYMERIE” (1842, p. 6, pl. 7, fig. 5) and “*Arca dilatata* COQUAND” (1865—66, p. 139, pl. 22, figs. 1—2) remains doubtful (cf. NEWELL, in COX et al. 1969, p. N261).

Distribution and Age: *Megacucullaea* is known from southern and eastern Africa, Madagascar and India. REYMENT & TAIT (1972, p. 65, explanation of pl. 4, fig. 13) also recorded *M. kraussi* from the Neocomian of Argentina but, except for the above mentioned “*Cucullaea neuquensis* WEAVER”, no published material exists from that country that could belong in that genus and species.

The age of *Megacucullaea* in southern and eastern Africa and in Madagascar has been given as Upper Valanginian (cf. BARRABE 1929, p. 148; BESAIRIE & COLLIGNON 1956, p. 31; 1959, p. 164; REYMENT & TAIT 1972, p. 65) and Aptian (RENNIE 1936), possibly ranging into the Oxfordian and Kimmeridgian (cf. AITKEN 1961, p. 34; COX 1965, p. 193). In India *M. kraussi* and *M. eminens* came from Tithonian (COX 1940), and the Patagonian material is associated with Berriasian ammonites.

Megacucullaea cf. *kraussi* (TATE 1867)

Fig. 1a—f

- 1968 ?*Cucullaea* sp. — RICCARDI, p. 288, pl. 18, figs. 2a—b.
 1971 ?*Cucullaea* sp. — RICCARDI, p. 270.
 1976 *Megacucullaea* cf. *kraussi* (TATE) — RICCARDI, p. C45.

Material: One complete specimen and four (?five) left and two right valves (MLP 12369—12376) from the top of the Springhill Formation (cf. RICCARDI 1971, fig. 4, profile III), Lago San Martín.

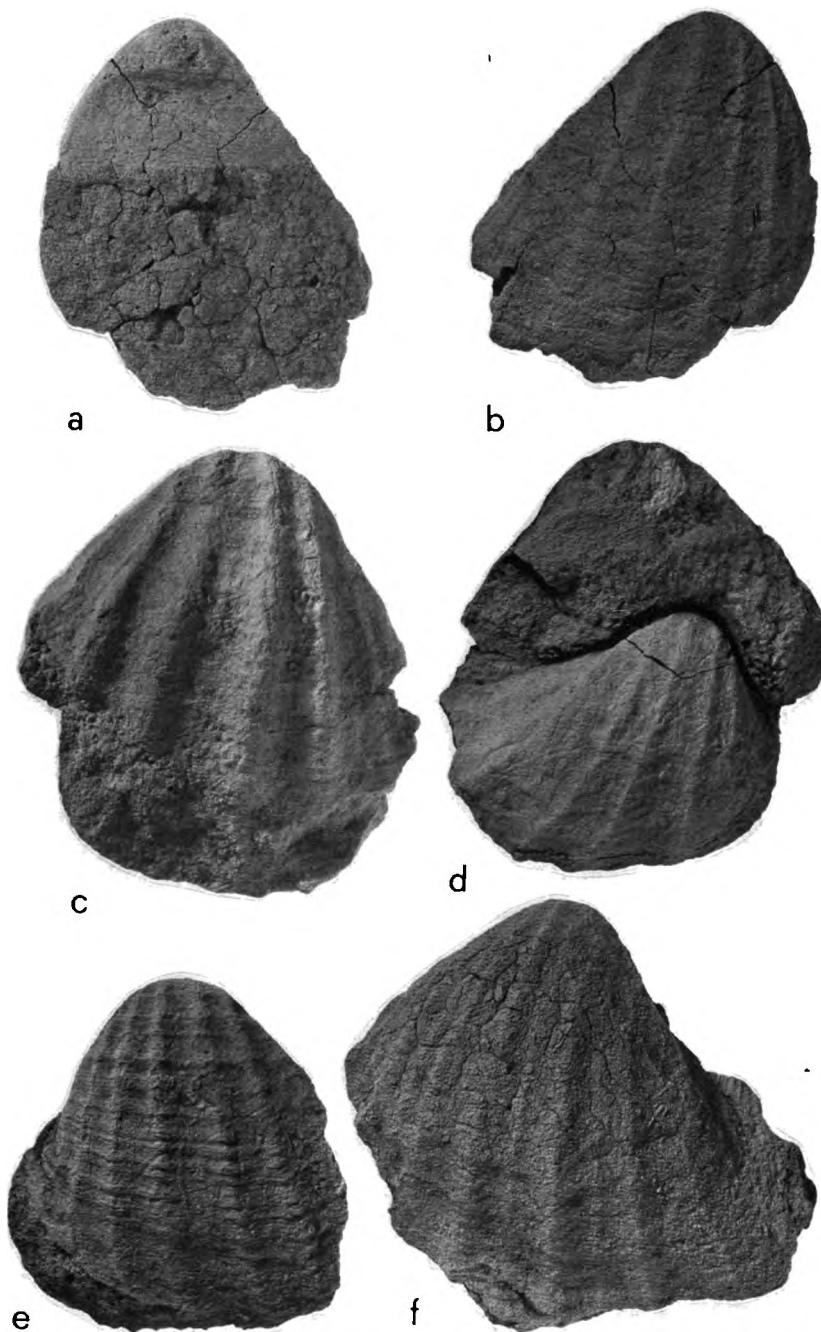


Fig. 1 (Legend see p. 221)

Description: Shell medium to large, slightly inequivalve and inequilateral, evenly inflated with the maximum thickness at center, subtriangular to subovate in outline, slightly larger than high. Anterior margin meeting the hinge line at a slightly acute angle and curving into the ventral margin. Posterior margin short, converging at right angles or obtusely with the hinge line, and meeting the ventral margin in a rounded angle. Posterior carina, slightly concave from the umbo to the postero-ventral angle, similar in strength to the plications of the shell, separating a narrow concave area from the rest of the valve. Umbo broad and prominent, more or less central, orthogyrate and strongly incurvated. Hinge line straight and long, a little shorter than the greatest length of the valve. Cardinal area subtriangular in shape, large, wide and curved. The ligament grooves are faintly preserved on one specimen (MLP 12375) where they seem to be V-shaped and narrowly spaced. The hinge plate and teeth are not preserved.

Valve surface with 6—8 radial plications in front of the posterior carina. Usually only the 5 or 6 central ones are prominent and sharp; they are separated by broad rounded interspaces and form a scalloped ventral margin to the shell. On the anterior slope there are 1 or 2 ribs which are usually barely discernible due to poor preservation; probably for the same reason, no ribs can be seen on the posterior area. On one of the specimens (MLP 12375) a single fine rib is intercalated between each pair of plications. The growth lines are not visible in most specimens. They are irregularly spaced, and form small denticulations where intersecting with the plications.

Measurements in mm:

MLP		Length	Height	Inflation
12369		54.1	34.3	16.1
12370	left	51.9	44.4	—
	right	41.3	36.7	—
12371		~47.5	50.5	—
12372		58.9	53.8	—
12373		~45	45.7	—
12374		~45.9	47.8	—
12375		~66	56	—

Remarks: The specimens described here are weathered, somewhat distorted and incomplete. Likewise, *Megacucullaea kraussi*, which perhaps includes RENNIE's unnamed specimens (1936, pl. 37, figs. 1—3), is poorly

Fig. 1 (natural size).

- a—f: *Megacucullaea* cf. *kraussi* (TATE), internal moulds;
- a—b: Right valve (MLP 12371);
- c—d: Left and right valves (MLP 12370);
- e: Left valve (MLP 12373);
- f: Left valve (MLP 12375).

known; the types and paratypes were figured in drawings and could be inaccurate as far as can be judged from the latter photographs of other material included in the species (cf. BARRABE 1929; RENNIE 1936; COX 1940). With the exception of the specimens figured by REYMENT & TAIT (1972, pl. 4, fig. 13) most of these specimens are weathered and distorted and lack details of the ornament. Comparison is therefore difficult.

Nevertheless, the size and number of radial plications are fairly constant in all material (except for the immature *M. kraussi* of COX 1940, pl. 4, fig. 3) and the Patagonian specimens appear to differ only in their smaller size (with specimens MLP 12372 and 12375 approaching the size of COX's specimens) and possibly in the more elongated outline.

M. eminens COX (1940, p. 59, pl. 4, figs. 5—7) differs from the Patagonian specimens in its somewhat larger size and the larger number of radial plications. The specimens from Lago San Martín are also smaller than *Megacucullaea? neuquensis* (WEAVER), only known from one badly preserved left valve. The latter also has radial plications and a more clearly differentiated posterior area.

Order Pterioida NEWELL 1965

Suborder Pteriina NEWELL 1965

Superfamily Pteriacea GRAY 1847 (1820)

Family Inoceramidae GIEBEL 1852

Genus *Inoceramus* J. SOWERBY 1814

Type species: *Inoceramus cuvierii* J. SOWERBY 1814.

Inoceramus aff. *anomiaeformis* FERUGLIO 1936

Fig. 2a

1968 *Inoceramus* sp. I — RICCARDI, p. 247.

1971 *Inoceramus* spp. — RICCARDI, p. 270 (pars).

1976 *Inoceramus* aff. *anomiaeformis* FERUGLIO. — RICCARDI, p. C45.

Material: One compressed specimen with an almost complete left valve and the dorsal part of the right valve (MPL 12377), from the top of the Springhill Formation (cf. RICCARDI 1971, fig. 4, profile II); (?) one compressed fragment of a ?left valve (MLP 12378), loose. Bahía de la Landra, Lago San Martín.

Description: Shell probably equivalve, slightly inequilateral, about as high as long; umbo central, narrow and slightly prosogyrous; antero-dorsal margin slightly concave forming a wing on the right valve (absent on the left valve probably due to crushing). The antero-dorsal

margin meets the broadly rounded anterior margin with an obtuse angle at about $\frac{3}{4}$ of shell height; ventral and posterior margins rounded; postero-dorsal area forming a wing which, as the anterior, is not clearly differentiated from the body of the valve. Ornamentation consisting of 12–14 irregular, coarse and rounded concentric plications, which are variable spaced and increase in size towards the ventral margin. The growth axis forms an angle of about 80° with the hinge line.

Measurements in mm:

	Length	Height
MLP 12377	~55	58.3

Remarks: The figured specimen (MLP 12377; fig. 2a) is very close to the type material of the species (FERUGLIO 1936, p. 29, pl. 2, figs. 1–2; fig. 1 lectotype, designated by LEANZA 1968, p. 150), although the radial striae reported by FERUGLIO on the anterior and posterior margins appear to be absent. The specimen, from an unknown stratigraphic level of the Bahía de la Landia area, tentatively included in this species, differs in having a length greater than height and a wider umbo. However, these differences may be enhanced by the partially missing umbo.

I. anomiaeformis was reported by FERUGLIO (1936) from the Hauterivian-Barremian of southwest of Cerro de los Fósiles at Lago Argentino.

Inoceramus sp. I

Fig. 2c

- 1968 *Inoceramus* sp. II — RICCARDI, p. 249.
 1971 *Inoceramus* spp. — RICCARDI, p. 270 (pars).
 1976 *Inoceramus* sp. I — RICCARDI, p. C45.

Material: One fragment of a right valve (MLP 12379), from the top of the Springhill Formation (cf. RICCARDI 1971, fig. 4, profile III), Lago San Martín.

Description: Shell mytiliform, equivalve (?), inequilateral, oblique, with height larger than length. Ornamentation consisting of about 15 regularly asymmetric, concentric plicae.

Remarks: This fragment resembles some of the specimens figured by FERUGLIO (1936) under *Inoceramus* sp. ind. (pl. 1, fig. 22) and *I. cf. steinmanni* WILCKENS (pl. 2, fig. 9), although it can not be identified specifically. The latter ones, however, do not belong into WILCKEN's (1907) species as pointed out by LEANZA (1968, p. 148) and THOMSON & WILLEY (1972, p. 8). The specimen identified with *I. concentricus* PARK. by BONARELLI & NÁGERA (1921, pl. 2, fig. 9) seems to differ in shape and in the more widely spaced plicae near the ventral margin.

Inoceramus sp. II

Fig. 2b

- 1968 *Inoceramus* sp. III — RICCARDI, p. 249.
 1971 *Inoceramus* spp. — RICCARDI, p. 270 (pars).
 1976 *Inoceramus* sp. II — RICCARDI, p. C45.

M a t e r i a l : One fragment of a right valve (MLP 12380) from the top of the Springhill Formation (cf. RICCARDI 1971, fig. 4, profile III), Lago San Martín.

D e s c r i p t i o n : Valve trapeziform in outline, slightly inflated; the partially preserved umbo is prosogyrous, acutely subtriangular and situated towards the anterior third of the shell; ?antero-ventral and postero-ventral margins rounded. A depressed area with a small auricle, posterior to the umbo, is not clearly separated from the main body of the shell.

Ornament consists of 8 round, widely spaced concentric plicae separated by flat interspaces, which become coarser and more widely spaced towards the postero-ventral margin. Hinge and musculature unknown.

M e a s u r e m e n t s in mm:

	Length	Height
MLP 12380	~20	17.5

Superfamily Pectinacea RAFINESQUE 1815

Family Oxytomidae ICHIKAWA 1958

Genus *Oxytoma* MEEK 1864

Type species by original designation: *Avicula muensteri* BRONN 1830.

Oxytoma (*Oxytoma*) sp.

Fig. 2f

M a t e r i a l : One incomplete left valve (MLP 12381) from the top of the Springhill Formation (cf. RICCARDI 1971, fig. 4, profile III), Lago San Martín.

D e s c r i p t i o n : Valve subtriangular in outline, inflated, somewhat longer than high, obliquely elongated; umbo protruding, situated about $\frac{1}{3}$, shell length from the anterior margin, slightly elevated above hinge line; hinge straight, about $\frac{1}{3}$, of shell length; posterior wing flat, apparently smooth, truncated subvertically and separated from the main part of the shell by a narrow sinus. Anterior wing about half the size of the posterior one. Hinge and musculature unknown.

Surface ornamented with 10 narrow and rounded radial ribs which become more prominent towards the ventral margin. Secondary ribs are visible only near the ventral margin.

Measurements in mm:

	Length	Height
MLP 12381	~27	~22.2

R e m a r k s : This Patagonian specimen resembles some specimens of *Oxytoma inaequivalvis* (J. SOWERBY) described from the Upper Jurassic of eastern Africa and Cutch (COX 1935, p. 165, pl. 15, figs. 11, 12; 1940, p. 98, pl. 6, figs. 9—12; 1965, p. 47, pl. 5, fig. 7; DIETRICH 1933, p. 98, pl. 7, figs. 99—101). *O. inaequivalvis* is closely affiliated to the type species *O. muensteri* (BRONN) (cf. ICHIKAWA 1958, p. 159—161, pl. 24, figs. 1—7). However, it differs in the more oblique elongated outline and the fewer ribs. The latter feature distinguishes it also from the *O. inaequivalvis* described from the Lower Jurassic of Argentina by GOTTSCHE (1878, p. 22, pl. 6, fig. 15), WEAVER (1931, p. 213, pl. 19, fig. 87) and LEANZA (1942, p. 158, pl. 5, fig. 1), and from *O. tardensis* STANTON (1901, p. 14, pl. 14, figs. 6—7) from the Lower Cretaceous of Patagonia.

The spacing of the primary ribs resembles that reported by WEAVER (1931, p. 214) from the "Avicula cf. costata SOWERBY" found by JAWORSKI (1915, p. 435) in Mendoza Province, and that of *O. censoriensis* (COTTEAU) from the Upper Jurassic of Europe (cf. ARKELL 1933, p. 195, pl. 14, figs. 6—7). However, the posterior auricle is pointed in the patagonian specimen. *O. raricosta* BONARELLI (in BONARELLI & NÁGERA 1921, pl. 5, fig. 2) is smaller and seems to have fewer ribs.

Subgenus *Hypoxytoma* ICHIKAWA 1958

Type species by original designation: *Avicula danica* RAVN 1902.

R e m a r k s : According to ICHIKAWA (1958) *Hypoxytoma* is characterized by the small size, numerous primary costae with narrow interspaces, smooth umbonal region and small byssal notch. However, one of the species included by him, i. e. *Hypoxytoma nebrascana* (EVANS & SHUMARD), reaches a relatively large size and sometimes has a narrow and relatively incised byssal notch (SPEDEN 1970, p. 82).

Oxytoma (*Hypoxytoma?*) sp. indet.

Fig. 2e

1976 *Oxytoma* (?*Hypoxytoma*) nov. sp. — RICCARDI, p. C45.

M a t e r i a l : One incomplete left valve (MLP 12382) from the top of the Springhill Formation (cf. RICCARDI 1971, fig. 4, profile III), Lago San Martín.

D e s c r i p t i o n : Shell inequilateral, obliquely oval to subtriangular in outline; longer than high, moderately inflated; umbo at the anterior $\frac{1}{4}$ — $\frac{1}{5}$ of the length. Hinge line straight, almost $\frac{2}{3}$ of shell length; posterior wing large ($\frac{1}{3}$ of shell length), flat, smooth with a small shallow posterior

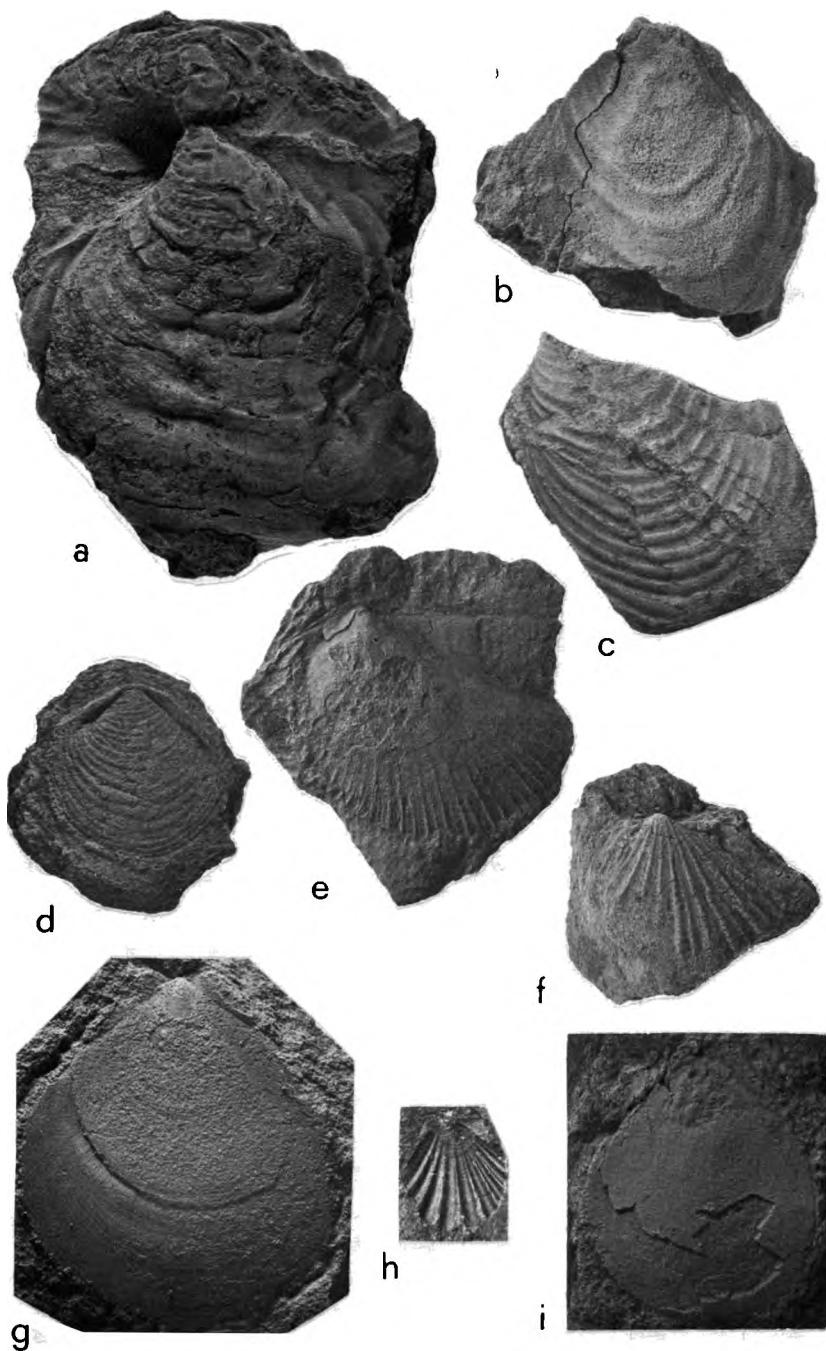


Fig. 2 (Legende see p. 227)

sinus, passing gradually into the main part of the shell; anterior wing very small, about $\frac{1}{4}$ the size of the posterior. Hinge and musculature unknown.

Upper part of the shell smooth. Ribbing, restricted to the lower part, consisting of about 35 prominent and narrow radial ribs; half of them are of the 1st order and appear at about the middle of the shell height; the others are intercalatories of irregular thickness, sometimes resembling the 1st order ribs, and restricted to the ventral margin.

Measurements in mm:

	Length	Height
MLP 12382	35	30

Remarks: This specimen is larger than the species included by ICHIKAWA (1958, p. 164) in *Oxytoma (Hypoxytoma)*. It has also a more acute umbo and fewer ribs than *O. (H.) danica* (RAVN) (cf. VOIGT 1954, pl. 17, figs. 1—7; ICHIKAWA 1958, pl. 24, fig. 9); *O. (H.) seminuda* (DAMES 1874, p. 765, pl. 21, fig. 3; cf. COX 1939, p. 17, pl. 1, figs. 4—13) has also a broader umbo and an acute posterior wing; *O. (H.) tenuicostata* (ROEMER) (cf. WOODS 1905, p. 61, pl. 8, figs. 17—23) lacks a persistent large smooth area in the umbo; *O. (H.) pectinata* (SOWERBY) (cf. WOODS 1905, p. 59, pl. 8, figs. 8—14) also has an acute posterior wing; *O. (H.) spitiensis* (OPPEL 1863, p. 297, pl. 88, figs. 5 a—b; HOLDHAUS 1913, p. 400, pl. 97, fig. 1) is also smaller, has a more rounded umbo and an acute posterior wing; *O. (H.) nebrascana* has denser costae.

Family Entoliidae KOROBKOV 1960

Genus *Entolium* MEEK 1865

Type species by original designation: *Pecten demissus* PHILLIPS as illustrated by QUENSTEDT 1858.

Fig. 2 (natural size unless otherwise stated).

- a: *Inoceramus* aff. *anomiaeformis* FERUGLIO, almost complete left valve and dorsal part of right valve (MLP 12377);
- b: *Inoceramus* sp. II, fragment of right valve (MLP 12380);
- c: *Inoceramus* sp. I, fragment of right valve (MLP 12379);
- d: *Lucina antarctandica* LEANZA, internal mould of left valve (MLP 12389);
- e: *Oxytoma (Hypoxytoma?)* sp. indet., incomplete left valve (MLP 12382);
- f: *Oxytoma (Oxytoma)* sp., incomplete left valve (MLP 12381);
- g: *Entolium (Entolium) argentinum* (STANTON), holotype, left valve, x 2.
Lago Pueyrredón.
- h: *Chlamys (Aequipecten) octoplicoides* (HERTLEIN), right valve (MLP 12385), x 2;
- i: *Entolium (Entolium) cf. argentinum* (STANTON), left valve (MLP 12383), x 2.

Entolium (Entolium) cf. argentinum (STANTON 1901)

Fig. 2i

1968 *Entolium* cf. *argentinum* (STANTON). — RICCARDI, p. 252.

1971 *Entolium* cf. *argentinus* (STANT.) — RICCARDI, p. 270.

1976 *Entolium (Entolium) cf. argentinus* (STANTON). — RICCARDI, p. C45.

M a t e r i a l : Two valves (MLP 12383-4) from the top of the Springhill Formation (cf. RICCARDI 1971, fig. 4, profile III), Lago San Martín.

D e s c r i p t i o n : The holotype of the species (STANTON 1901, p. 14, pl. 14, fig. 5; here refigured fig. 2g) is a left valve of 23 mm height and 21 mm length. It is subequilateral, subovate, weakly inflated, with a central triangular umbo. Antero-dorsal and postero-dorsal margins straight, meeting at right angle; ventral margin evenly rounded, separated from main body of the shell by well marked lines. Auricules relatively small, anterior larger than posterior, projected above hinge line, with outer margins subvertically truncated and meeting the dorsal margins at right angles; without byssal sinus. Surface ornamented with numerous fine concentric striae of which some are more marked than others, amounting to about 6/mm near the ventral margin and 9/mm near the umbonal region. Internal features unknown.

The two specimens from Lago San Martín are smaller and have a greater height/length ratio. All other features seem to be alike with exception of the umbonal angle which is smaller in the small specimen.

M e a s u r e m e n t s in mm:

		Length	Height
MLP	12383	14.7	17.7
	12384	15.9	18

R e m a r k s : The 2 specimens from Antarctica figured by COX (1953 pl. 2, figs. 3—4) as "Pecten" cf. *argentinus* have a more rounded outline and a larger umbonal angle.

Family Pectinidae RAFINESQUE 1815

Genus *Chlamys* RÖDING 1798Subgenus *Aequipecten* FISCHER 1886

T y p e s p e c i e s : *Ostrea opercularis* LINNÉ 1758.

D i a g n o s i s : Rounded outline, anterior auricle only slightly longer than posterior one, byssal notch small; few, usually not bifurcating radial ribs, and flattened, marginally pointed internal riblets near margin; pair of cardinal crura and auricular denticles present (cf. HERTLEIN et al., in COX et al. 1969, p. 355).

R e m a r k s : *Aequipecten* differs from *Chlamys* s. s. in the more rounded outline, nearly equal auricles, smaller byssal notch and fewer radial ribs.

Chlamys (Aequipecten) octoplicoides (HERTLEIN 1931)

Fig. 2h

- 1901 *Pecten octoplicatus* sp. nov. — STANTON, p. 14, pl. 4, fig. 2—3.
 1931 *Pecten octoplicoides* HERTLEIN, new name. — HERTLEIN, p. 368.
 1968 *Chlamys (Aequipecten) octoplicatus* (STANTON). — RICCARDI, p. 250, lám. 18, fig. 4.
 1971 *Chlamys (Aequipecten) octoplicatus* (STANTON). — RICCARDI, p. 270.
 1976 *Chlamys (Aequipecten) octoplicoides* (HERTLEIN). — RICCARDI, p. C45.

L e c t o t y p e here designated: *Pecten octoplicatus* STANTON (1901, pl. 4, fig. 2), Belgrano Beds, Lago Pueyrredón, Argentina.

M a t e r i a l : The lectotype (right valve, HATCHER collection, Princeton University), and three paralectotypes: one right and two left valves (HATCHER collection, Princeton University), Belgrano Beds, Lago Puerredón. Several internal and external moulds of right and left valves, mostly fragmentary, from the top of the Springhill Formation, profiles II (MLP 12385) and III (MLP 12386) (cf. RICCARDI 1971, fig. 4), Lago San Martín.

D e s c r i p t i o n : Shell inequivalve small, 7—9 mm in height, slightly higher than long, with a subtriangular outline. Right valve with seven to nine subangular to rounded radial ribs, equal or broader than the interspaces and crossed by fine concentric growth lines; anterior auricle subtriangular larger than the posterior one and with a byssal notch. Left valves are apparently represented by molds with relatively narrow ribs, but the auricles are not preserved.

M e a s u r e m e n t s in mm:

	Length	Height
MLP 12385	8	8.8

R e m a r k s : Due to poor preservation of the material from Lago San Martín, only two or three specimens are available for comparison. One of the best preserved right valves (fig. 2h) is more rounded in outline and has broader and more rounded ribs than the lectotype, but the size and number of ribs are almost identical. These differences, however, could be due to crushing of the Lago San Martín specimens. Significantly, a paralectotype from Lago Pueyrredón which is less inflated than the lectotype probably due to crushing, is longer and has broader, more rounded ribs.

Cox (1953, p. 5, pl. 2, fig. 2) described a specimen from Alexander Island, Antarctica, which closely resembles this species in size and number of ribs. According to Cox, however, the Antarctic species is less triangular in shape and has more broadly rounded ribs, while the auricles are not preserved.

Suborder Ostreina FÉRUSSAC 1822

Superfamily Ostreacea RAFINESQUE 1815

Family Gryphaeidae VYALOV 1936

Subfamily Exogyrinae VYALOV 1936

Genus *Aetostreon* BAYLE 1878

Type species: *Gryphaea latissima* LAMARCK 1819.

Aetostreon sp. indet.

Fig. 3b—j

1968 *Gryphaea* sp. — RICCARDI, p. 253.

1971 *Gryphaea* sp. — RICCARDI, p. 270.

1976 *Aetostreon* sp. — RICCARDI, p. C45.

Material: Five left valves from the top of the Springhill Formation (cf. RICCARDI 1971, fig. 4, profile III), Lago San Martín.

Description: Shell of medium size; height slightly exceeding length, varying between 25 and 45 mm; outline triangular. Left valve convex, with umbo prominent, broad and strongly incurved; the beak is opisthogyrous and with exogyrate coiling. The attachment area is on the posterior side of the beak. The posterior margin is concave while the anterior is convex; both pass into a broadly curved ventral margin. Posterior keel rounded and barely visible. Surface with concentric lamella and concentric irregular undulations parallel to growth lines. The right valve is unknown.

Remarks: The proper characterization and identification of this material could not be concluded since it has been lost in the mail. However, the photographs of some specimens are available and publication is considered necessary because of the possible stratigraphic and paleobiogeographic significance owing to its affinities to *Gryphaea balli* (STEFANINI) and *Aetostreon imbricatum* (KRAUSS).

Gryphaea balli was first described by STEFANINI (1925, p. 164, pl. 29, fig. 2) from the Upper Jurassic of Somalia. The figured shells are relatively higher and postero-ventrally more elongate than the specimens described here. The postero-ventral elongation is even more pronounced in the possible synonymous "*Exogyra fourtai*" STEFANINI (1925, pl. 29, figs. 3—4), although some of the specimens assigned to this "species" by DÍAZ ROMERO (1931, pl. 3, figs. 9—10) are almost equilateral. The variability in outline was also illustrated by COX (1935, p. 173, pl. 18, figs. 1—7) by specimens with and without a definite posterior lobe or rostrum-like projection.

Recently, *Gryphaea balli* has been described and figured by CECIONI & CHARRIER (1974, p. 25, pl. 1) from the Coyhaique Formation of Southern Chile. They pointed to the similarities with *Aetostreon imbricatum* (KRAUSS), as was already indicated by COX's (1952, p. 86) tentative identification of a specimen from the Upper Jurassic of Cutch with *Gryphaea balli*, and which had previously been identified by KITCHIN (1929) with *A. imbricatum*. While *A. imbricatum* is a homeomorph of *Gryphaea* (cf. STENZEL 1971, p. N1066), *G. balli* could perhaps belong into *Aetostreon* as suggested by the position of the attachment area. However, the ligamental area is poorly known.

The specimens here described are included in *Aetostreon* on account of the exogyrate coiling and the position of the attachment area. They seem to be very close to those figured by CECIONI & CHARRIER (1974) as *Gryphaea balli*, but the relationships can not properly be assessed without new material from the Lago San Martín area.

Subclass Heterodonta NEUMAYR 1884

Order Veneroida H. ADAMS and A. ADAMS 1856

Superfamily Lucinacea FLEMING 1828

Family Lucinidae FLEMING 1828

Subfamily Lucininae FLEMING 1828

Genus *Lucina* BRUGUIÈRE 1797

Type species by subsequent designation: *Venus jamaicensis* SPENGLER 1784.

Lucina antarctandica LEANZA 1968

Fig. 2d

- 1936 *Lucina neuquensis* HAUPP — FERUGLIO, p. 19, pl. 1, fig. 8, non 11.
- 1968 *Lucina antarctandica* n. sp. — LEANZA, p. 125, 127.
- 1968 ?*Eriphylla agrioensis* WEAVER — RICCARDI, p. 254 (pars).
- 1971 ?*Eriphylla agrioensis* WEAV. — RICCARDI, p. 270 (pars).
- 1976 *Lucina antarctandica* LEANZA — RICCARDI, p. C45.

Material: Three left and possibly two right valves (MLP 12389—12391) from the top of the Springhill Formation (cf. RICCARDI, 1971, fig. 4, profile III), Lago San Martín.

Description: Shell of medium size, oval, about as long as high weakly inflated; antero-dorsal margin slightly concave in front of the umbo and postero-dorsal margin weakly convex, both merging with the rounded ventral margin in obtuse angles. Umbo subtriangular, slightly prosogyrous, slightly anterior of mid-line; bordered at antero- and postero-dorsal

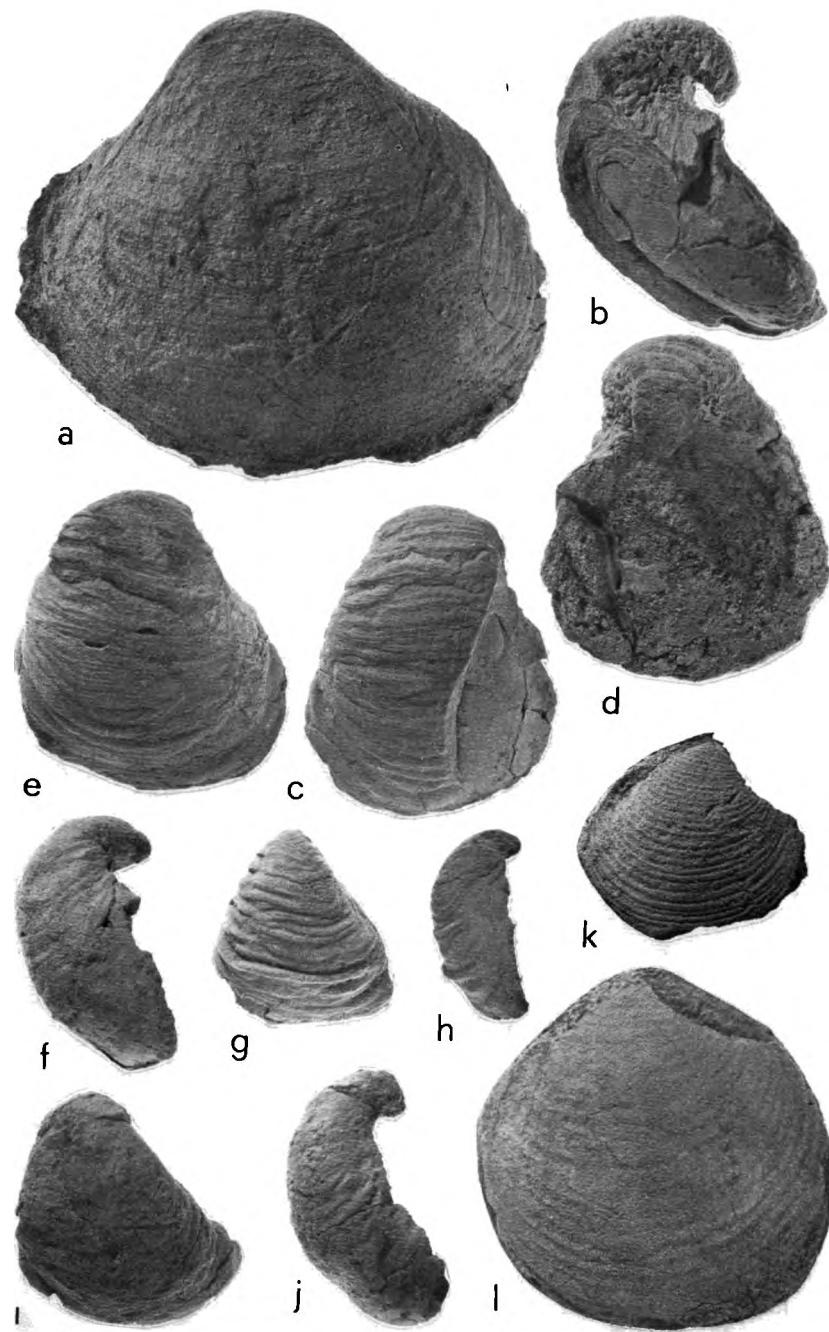


Fig. 3 (Legend see p. 233)

margins by flat to slightly concave areas. Hinge and musculature unknown.

Surface with about 20 narrow concentric lamellae, slightly finer than the smooth concave interspaces.

Measurements in mm:

	Length	Height
MLP 12389	c. 20	24

Remarks: The specimen figured closely resembles that from Lago Argentino figured by FERUGLIO (1936, p. 19, pl. 1, fig. 8) as "*Lucina neuquensis* HAUPT" but included by LEANZA (1968, p. 125, 127) in a new species *L. antarctandica*. HAUPT's species has a more rounded outline, a less acute umbo and more concentric lamellae than *L. antarctandica* (cf. BURCKHARDT 1900, pl. 22, fig. 2; HAUPT 1907, pl. 10, figs. 3a—b; WEAVER 1931, pl. 39, fig. 238—240). Some fragments resemble the specimen figured by FERUGLIO (1936, p. 13, pl. 1, fig. 5) under "*Eriphylla* aff. *agriensis* WEAVER" which indeed seems to differ from WEAVER's species and could be a *Lucina*, although LEANZA (1968, p. 140) described it as "*Eriphylla* (?) sp. indet."

Lucina cf. *neuquensis* HAUPT 1907

Fig. 31

1976 *Lucina* cf. *neuquensis* HAUPT — RICCARDI, p. C45.

Material: One right and possibly two left valves (MLP 12392—12394) from the top of the Springhill Formation (cf. RICCARDI 1971, fig. 4, profile III), Lago San Martín.

Description: Shell of large size, with a circular to ovate outline, the length being the same or slightly greater than height; antero- and postero-dorsal margins weakly concave and convex respectively, merging obtusely with the antero- and postero-ventral margins at about $\frac{1}{4}$ of shell height; rounded ventral margin. Umbo subtriangular, prosogyrous, anterior of mid-line, bordered on the antero- and postero-dorsal margins by flat areas. Inner margin crenulated. Hinge and musculature unknown.

Surface ornamented with about 25 rounded concentric lamellae, as wide as the interspaces.

Measurements in mm:

	Length	Height
MLP 12392	46.3	50
12393	45	45

Fig. 3 (natural size).

- a: *Protocardia (Tendagurium)* nov. sp., left valve (MLP 12387);
- b—j: *Aetostreon* sp. indet., four left valves: b—d, e—f, g—h, i—j;
- k: *Lucina* sp., right valve (MLP 12395);
- l: *Lucina* cf. *neuquensis* HAUPT, right valve (MLP 12392).

R e m a r k s : The specimen figured here resembles *L. neuquensis* HAUPT (1907, p. 217, pl. 10, figs. 3a—b; WEAVER 1931, p. 352, pl. 39, figs. 238—240) in its size and circular to ovate outline, but it is higher with a more protruding umbo. The other two specimens are longer than high and one of them (MLP 12394) has also denser concentric lamellae. They could belong to different species.

Lucina sp.

Fig. 3 k

- 1968 ?*Eriphylla agrioensis* WEAVER — RICCARDI, p. 254 (pars).
 1971 ?*Eriphylla agrioensis* WEAVER — RICCARDI, p. 270 (pars).
 1976 *Lucina* sp. — RICCARDI, p. C45.

M a t e r i a l : Three fragments of right valves and two, possibly three of left valves (MLP 12395—12398) from the top of the Springhill Formation (cf. RICCARDI 1971, fig. 4, profile III), Lago San Martín.

D e s c r i p t i o n : Shell of medium size, inequilateral, with an ovate outline, longer than high; posterior border slightly convex, sloping down to slightly below half of height where it meets the postero-ventral margin with a barely noticeable angularity; anterior margin concave, meeting the antero-ventral margin at about $\frac{2}{3}$ of shell height with an obtuse angle. Umbo prosogyrous, placed at about $\frac{1}{3}$ height from anterior margin and bordered by flat areas. Hinge and musculature unknown.

Surface ornamented by about 25—28 rounded concentric lamellae as wide as the interspaces.

M e a s u r e m e n t s in mm:

	Length	Height
MLP 12395	30	26.8

R e m a r k s : The specimens show some resemblance in shape and ornament to the material figured by WEAVER (1931, pl. 40, figs. 252—253, 255—256) as *Eriphylla agrioensis* and *E. lotenoensis*. However, the best preserved specimen from Lago San Martín has flat dorsal areas which are absent in WEAVER's material.

Superfamily Cardiacea LAMARCK 1809

Family Cardiidae LAMARCK 1809

Subfamily Protocardiinae KEEN 1951

Genus *Protocardia* von BEYRICH 1845

Subgenus *Tendagurium* DIETRICH 1933

Type species by subsequent designation of KEEN (1937): *Cardium (Tendagurium) propebanneianum* DIETRICH (1933, p. 50, pl. 6, figs. 92, 93), Upper Jurassic of east Africa.

D i a g n o s i s : Large cardiid with globose almost equilateral outline, with concentric ornament only and lacking posterior internal ridges.

R e m a r k s : When DIETRICH (1933) proposed *Tendagurium* as a subgenus of *Cardium*, only two species were included, i. e. *Cardium (Tendagurium) propebanneianum* DIETRICH 1933, and *Protocardia rothpletzi* KRENKEL 1910, respectively from the Upper Jurassic and Neocomian of east Africa. DIETRICH noted the similarities between *Protocardia rothpletzi* and *P. sphaeroidea* FORBES (1845, p. 243, pl. 2, fig. 8) from the Aptian of Europe. These two species, however, were separated from *P. (T.) propebanneiana* at the subgeneric level by HAYAMI (1965) who included them in *Globocardium* HAYAMI (cf. also PALMER 1974, p. 173—174). The differences are in the more sharply carinated, subtrapeziform and transversally elongate outline of *Tendagurium* which also lacks the posterior internal ridges of *Globocardium*. *Tendagurium* lacks the posterior radial ribs of *Protocardia*.

In the outline and lack of radial ornamentation and posterior internal ridges, *Tendagurium* seems to be more closely related to *Integricardium* ROLLIER 1912 (cf. AMANO et al. 1958, p. 17; HAYAMI 1965, p. 117, 119; PALMER 1974, p. 168), from which it differs in the almost equilateral shell and posterior carina.

D i s t r i b u t i o n a n d a g e : *Tendagurium* includes the type species known from the Kimmeridgian of east Africa (cf. DIETRICH 1933; COX 1965) and *P. (T.) bannesiana* (CONTEJEAN 1860, p. 276, pl. 14, figs. 1—5) from the Kimmeridgian of Europe and Africa (cf. COX 1965, p. 105), which is probably a senior synonym. *P. (T.) seikaianum* AMANO et al. (1958, p. 19, pl. 1, figs. 1—5) from the Cenomanian of Japan has been included in *Integricardium*. In Patagonia *Tendagurium* is associated with ammonites of Berriasian age. Significantly, *Protocardia* with "no sign of radial ornament" occurs in the Lower Cretaceous of Australia (COX 1961, p. 26, pl. 4, fig. 7). A small inflated equivalve bivalve, identified as *Protocardia* (?) sp. and with a superficial resemblance to the small specimens of *Tendagurium* of Lago San Martín has recently been figured from Antarctica (THOMSON & WILLEY 1975, p. 18, figs. 3c—d).

Protocardia (Tendagurium) nov. sp.

Fig. 3 a

1976 *Protocardia (Tendagurium) nov. sp.* — RICCARDI, p. C45.

M a t e r i a l : One left valve (MLP 12387) and one, possibly two, complete juvenile specimens (MLP 12388) from the top of the Springhill Formation (cf. RICCARDI 1971, fig. 4, profile III), Lago San Martín.

D e s c r i p t i o n : Shell large, inflated, slightly inequilateral, subcircular to subtrapeziform in outline, longer than high. Antero- and postero-dorsal margins slightly concave, meeting the anterior and posterior margins

at about $\frac{2}{3}$ of the shell height. Anterior margin shorter than the posterior, converging in a rounded angle at about $\frac{1}{2}$ shell height with the ventral margin. Ventral margin broadly curved and continuous with posterior margin. Umbo broad and prominent, bluntly rounded, slightly anterior of the half-length, orthogyrate and incurvated. Posterior carina and area obscurely delimited from the rest of valve. Surface ornamented with numerous, densely spaced concentric growth lines of irregular thickness.

The largest specimen has two partially preserved protuberances corresponding to the lateral teeth on the hinge line. These are located between the beak and the anterior and posterior margins. The cardinal teeth are not exposed.

Measurements in mm:

	Length	Height	Inflation
MLP 12387	71.6	64.3	17.7
12388	14.2	13.4	9

Remarks: The Patagonian specimens differ from the holotype of *P. propebanneiana* (DIETRICH) in the more elongate and trapeziform outline, the prominent posterior carina, and the less acute umbo. However, other specimens from Africa, figured by JOUBERT (1960, pl. 10, fig. 6) and COX (1965, pl. 16, fig. 6) and assigned respectively to *P. (T.) bannesiana* (CONTEJEAN) and *P. (T.) propebanneiana* (a probable junior synonym) lack a well-marked carina and are closer in outline to the Patagonian specimen; their umbos, however, are relatively acute. The known material from Africa and Patagonia is insufficient for a proper taxonomic evaluation of the morphologic differences, thus preventing the erection of a new species.

Class Cephalopoda CUVIER 1797

Subclass Ammonoidea ZITTEL 1884

Order Ammonitida ZITTEL 1884

Superfamily Perisphinctaceae STEINMANN 1890

Family Berriasellidae SPATH 1922

Genus *Jabronella* NIKOLOV 1966

Type species by original designation: *Berriasella jabronensis* MAZENOT (1939, p. 120, pl. 18, fig. 1) from the Berriasiian of Noyers-sur-Jabron, France.

Remarks: *Jabronella* NIKOLOV closely resembles *Protacanthodiscus* SPATH and *Malbosiceras* GRIGORIEVA. LE HEGARAT (1973, p. 196) noted the distinctive siphonal tubercles of *Protacanthodiscus* and the fasciculate ribbing in *Jabronella*. The main differences between *Malbosiceras* and *Jabronella* are the more involute coiling and irregular ribbing of the latter.

Since my material is poorly preserved, and since a change of the generic names would not change the specific relationships and age of the material, no attempt has been made to review the status of the above genera. I am, however, sympathetic with WIEDMANN's opinion (in ALLEMAN et al. 1975, p. 16) upholding the comprehensiveness of the genera *Berriasella* and *Protacanthodiscus*.

Jabronella aff. *michaelis* (UHLIG 1902)

Fig. 4 c—e; Fig. 5 a—c

- ? 1936 *Acanthodiscus spitiensis* UHLIG — FERUGLIO, p. 71, lám. 8, fig. 16.
- ? 1968 *Protacanthodiscus feruglioii* n. sp. — LEANZA, p. 130.
- 1968 ?*Favrella* sp. — RICCARDI, p. 297, lám. 21, fig. 5.
- 1971 ?*Favrella* sp.; RICCARDI, p. 270.
- 1976 *Jabronella* aff. *michaelis* (UHLIG) — RICCARDI, p. C45, lám. 1, fig. 1—6; lám. 2, fig. 1.

M a t e r i a l: Forty-nine fragments of whorls and six or seven external moulds (MLP 12311—12315, MLP 12318—12365, MLP 12367), from the top of the Springhill Formation (cf. RICCARDI 1971, fig. 4, profile III), Lago San Martín.

D e s c r i p t i o n : Phragmocone evolute with rounded umbilical rim and shallow umbilicus. Whorl section compressed, subquadrate, with almost parallel flanks and slightly tabulate venter; maximum width at the lower third of the flank.

In fragments of less than 35—40 mm whorl height, corresponding to about 90 mm maximum diameter, the ribs cross the umbilical margin with a weak apertural inclination; some of them show a slight thickening and/or bifurcation. Primaries and secondaries are slightly convex aperturally at mid flank; immediately above some of them bifurcate irregularly. The ribs are slightly projected towards the ventral shoulder and are flattened or interrupted on the venter.

The same irregular ribbing is visible above a whorl height of 45 mm where the umbilical swelling of the ribs becomes conspicuous. Tubercles are sporadically present at the rib divisions above mid-flank where two, or exceptionally three ribs, originate; the ribs cross the venter weakened but uninterrupted. At this stage, strong ribs bearing umbilical and lateral tubercles and bifurcating above mid-flank, are clearly distinct from the weak intercalatories which remain simple over the entire flank. These intercalatories usually occur in pairs between the principal ribs.

Two other whorl fragments (MLP 12364-5) with whorl heights of 84 and 100 mm, respectively, seem to belong to the same species. The first belongs to a phragmocone, the second to a body chamber. Both have compressed ovate whorl sections, and blunt ribs with tubercles and uninterrupted secondaries.

R e m a r k s : My previous inclusion of part of this material in "*?Favrella* sp." (RICCARDI 1968, 1971) was based on the strong projection of the ribs in the upper flanks present in some specimens. However, I also noted its obvious relationship with the material from Lago Argentino, described by FERUGLIO (1936) under "*Acanthodiscus spitiensis* UHLIG". New material has now become available showing that the resemblances with *Favrella* are only superficial.

The poorly preserved fragment of "*Acanthodiscus* cf. *spitiensis* UHLIG", figured by FERUGLIO (1936, pl. 8, fig. 16) and renamed *Protacanthodiscus feruglilioi* by LEANZA (1968, p. 130), appears to show the same features at a similar size to the material here described. However, the known material from Lago Argentino is insufficient for a proper taxonomic evaluation and, therefore, the possibility that they belong to the same species remains doubtful. Similarly, safe taxonomic conclusions about the relationship between LEANZA's species and the apparently closely related *Jabronella spitiensis* (UHLIG 1903) can not be reached. The material here described differs from *J. spitiensis* in having a well definite smooth ventral band and tubercles which appear earlier; in *J. tibetana* (UHLIG) and *J. asiatica* (UHLIG) the tubercles appear earlier still.

J. michaelis (UHLIG 1902, p. 35, pl. 7, figs. 1—4), from the Silesian Carpathians, is also very close to the Patagonian material. According to UHLIG (1903, p. 222) this is the closest European ally of *J. spitiensis*, although they have different suture lines and the tubercles are more regular and more persistent in the Indian species. The Indian specimen, however, is incomplete. Material described by UHLIG (1903, p. 223, pl. 21, fig. 2) and FATMI (1972, p. 355, pl. 2, fig. 1) and considered to be affiliated to *J. michaelis* fails to clarify the relationship between these two species which could be synonymous. Affinity to *J. michaelis* has also been suggested for some material from Mexico described by BURCKHARDT (1906, p. 187, pl. 40, fig. 5, pl. 41, figs. 1—2); indeed, the reported differences in the ribbing may be within the infraspecific variation. The Mexican specimens appear to be the closest to the Patagonian material. *J. michaelis* has also been reported from the Valanginian of Madagascar (BESAIRIE 1930, p. 209, pl. 13, fig. 1; COLLIGNON 1962, p. 27, fig. 834), but the sparse figures and descriptions do not allow safe comparison. Among the species of *Jabronella* figured by MAZENOT (1939) and LE HEGARAT (1973), *J. paquieri* (SIMIONESCU) is closest to the Patagonian species. UHLIG (1902, p. 38) regarded this species as a close relative of *J. michaelis*, although the main and intercalatory ribs are more alike and the tubercles begin in later stages.

The "*Hoplites malbosi*" figured by BURCKHARDT (1900, pl. 28, fig. 1) shows some similarities but seems to belong in *Malbosiceras*.

A g e : UHLIG's (1903) material from India came from the Lochambel Beds or Upper Spiti Shales, which range from the Upper Tithonian to

the Valanginian (cf. ARKELL 1956, p. 407; FATMI 1972, fig. 6, p. 365). It is significant that FATMI's species also came from the Upper Tithonian of the Trans-Indus Ranges. The Mexican material (BURCKHARDT 1906, p. 196-7) was found isolated in the Vereda del Quemado, and was dated as Valanginian merely on the basis of the European occurrence of the species. *Jabronella* NIKOLOV (cf. LE HEGARAT 1973, p. 191) ranges from the Upper Tithonian to the Berriasian, but seems to occur mainly in the Upper Berriasian (*Boissieri* Zone). Significantly, only one closely related species, i. e. *J. paquieri*, reaches upward into the *Callisto* Subzone at the Berriasian-Valanginian boundary.

Genus *Neocosmoceras* BLANCHET 1922

Type species by subsequent designation of ROMAN (1938): *Hoplites sayni* SIMIONESCU 1899—1900.

Neocosmoceras sp.

Fig. 5 d—e

1976 *Neocosmoceras* sp. — RICCARDI, p. C45, lám. 2, figs. 4—5.

M a t e r i a l : One partially distorted fragment of phragmocone (MLP 12316) from the top of the Springhill Formation (cf. RICCARDI, 1971, fig. 4, profile III), Lago San Martín.

D e s c r i p t i o n : The fragment belongs to an evolute specimen. Its intercostal whorl section is apparently almost circular, but it is polygonal on the ornamentation and is apparently wider than high. The strongly rounded flanks merge into the almost vertical umbilical wall and the flattened venter. The ornament consists of blunt ribs which form slight radial protuberances on the umbilical wall and develop round umbilical and lateral tubercles. Both rows of tubercles are very close so that the ribs are almost indistinct. The very prominent lateral tubercles are the origin of 2, exceptionally 3, ribs. These secondaries project slightly on the upper part of the flank, form relatively feeble bullae ventro-laterally and cross the venter with reduced strength.

R e m a r k s : This fragment has a distinctive circular cross section and closely approximated rows of umbilical and lateral tubercles, resembling *Neocosmoceras polyacanthus* (UHLIG 1903, p. 208, pl. 19, figs. 2a—c). The two rows of tubercles, however, are closer and the ventral bullae are less prominent than in the Indian species. No closer comparison is possible due to the lack of material.

A g e : *Neocosmoceras* is restricted to *Occitanica* and *Boissieri* Zones (*Subalpina* to *Paramimounum* Subzones) (cf. LE HEGARAT 1973) of the Berriasian.

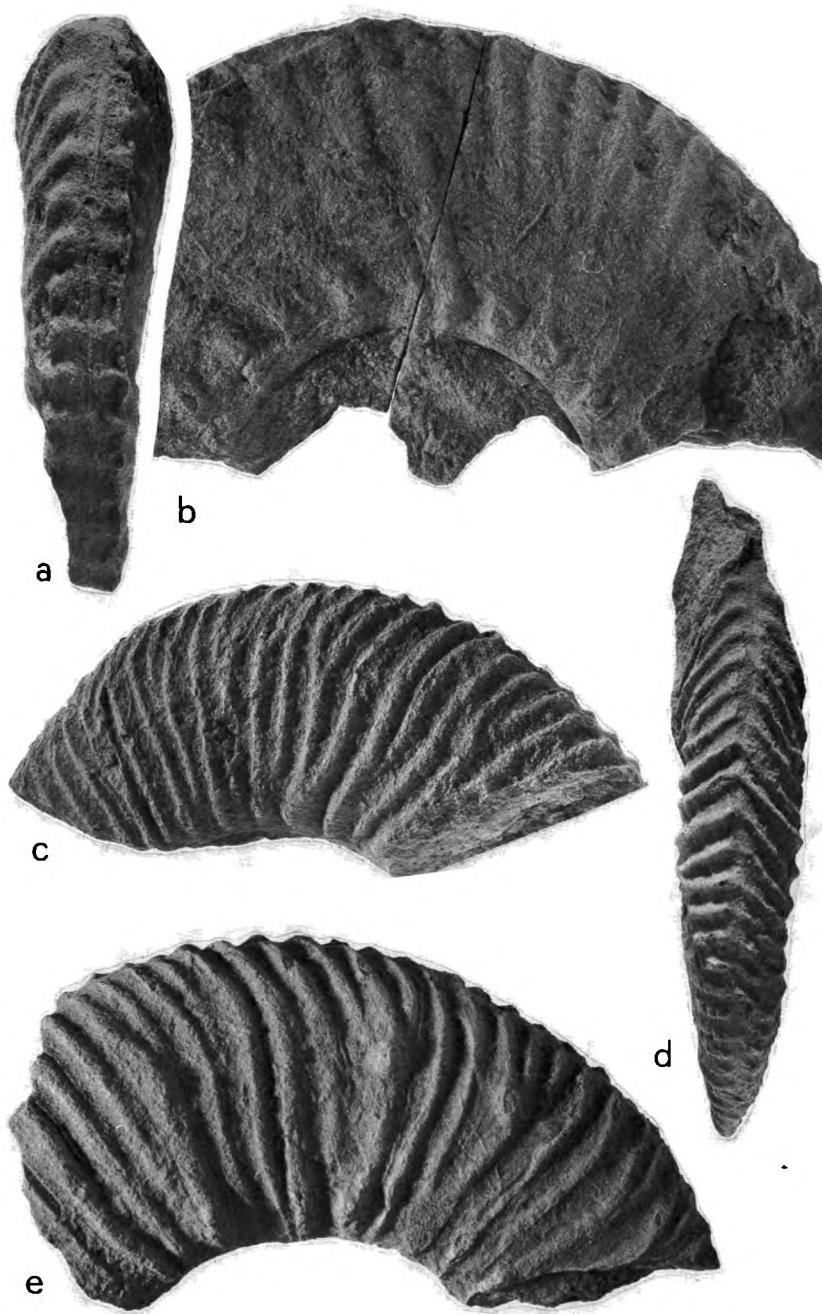


Fig. 4 (Legend see p. 241)

Genus *Delphinella* LE HEGARAT 1973

Type species by original designation (LE HEGARAT 1973, p. 96): *Hoplites delphinensis* KILIAN (1889, p. 662, fig. 1).

D i a g n o s i s : Shell rather evolute coiled with almost trapeziform whorl section. Ribs simple and bifurcate, thickening at points of furcation and ending in small ventrolateral clavi; fading on the middle of the whorl sides of the body chamber.

D i s t r i b u t i o n a n d A g e : Upper Tithonian-Berriasian of Tethys.

Delphinella sp.

Fig. 4 a—b

1976 *Delphinella* sp. — RICCARDI, p. C45, lám. 2, fig. 6.

M a t e r i a l : One, possibly two whorl fragments (MLP 12317, 12366), from the top of the Springhill Formation (cf. RICCARDI 1971, fig. 4, profile III), Lago San Martín.

D e s c r i p t i o n : Fragment of about 120 mm diameter, rather evolute ($U/D = .33$); with a fairly compressed whorl section; flanks parallel to slightly convex; umbilicus shallow with vertical umbilical wall and rounded margin; venter flat to slightly rounded. Ribs born rursiradiate on the middle of the umbilical wall, thickening into tubercles immediately above the umbilical margin and fading away at mid-flank. On the upper part of the flanks are prominent, rounded and distant secondaries forming clavi on the ventrolateral shoulder; they weaken on the ventral area. The other fragment, tentatively included in this species and more poorly preserved, shows the same fading of the lateral ribbing but differs in having a more depressed whorl section.

R e m a r k s : This material shows some resemblance to *Delphinella boisseti* LE HEGARAT and *D. ellenica* (NIKOLOV) as figured by LE HEGARAT (1973, pl. 41, figs. 2, 3). However, both are more involute and have finer ribbing than the present species.

Subclass Coleoidea BATHER 1888

Order Belemnitida ZITTEL 1895

Family Belemnopseidae NAEF 1922

Genus *Belemnopsis* BAYLE 1878

Type species by subsequent designation: *Belemnites sulcatus* MILLER 1823.

Fig. 4 (natural size).

- a—b: *Delphinella* sp., ventral and lateral views (MLP 12317);
- c—e: *Jabronella* aff. *michaelis* (UHLIG);
- c—d: Lateral and ventral views (MLP 12321);
- e: Lateral view (MLP 12315).

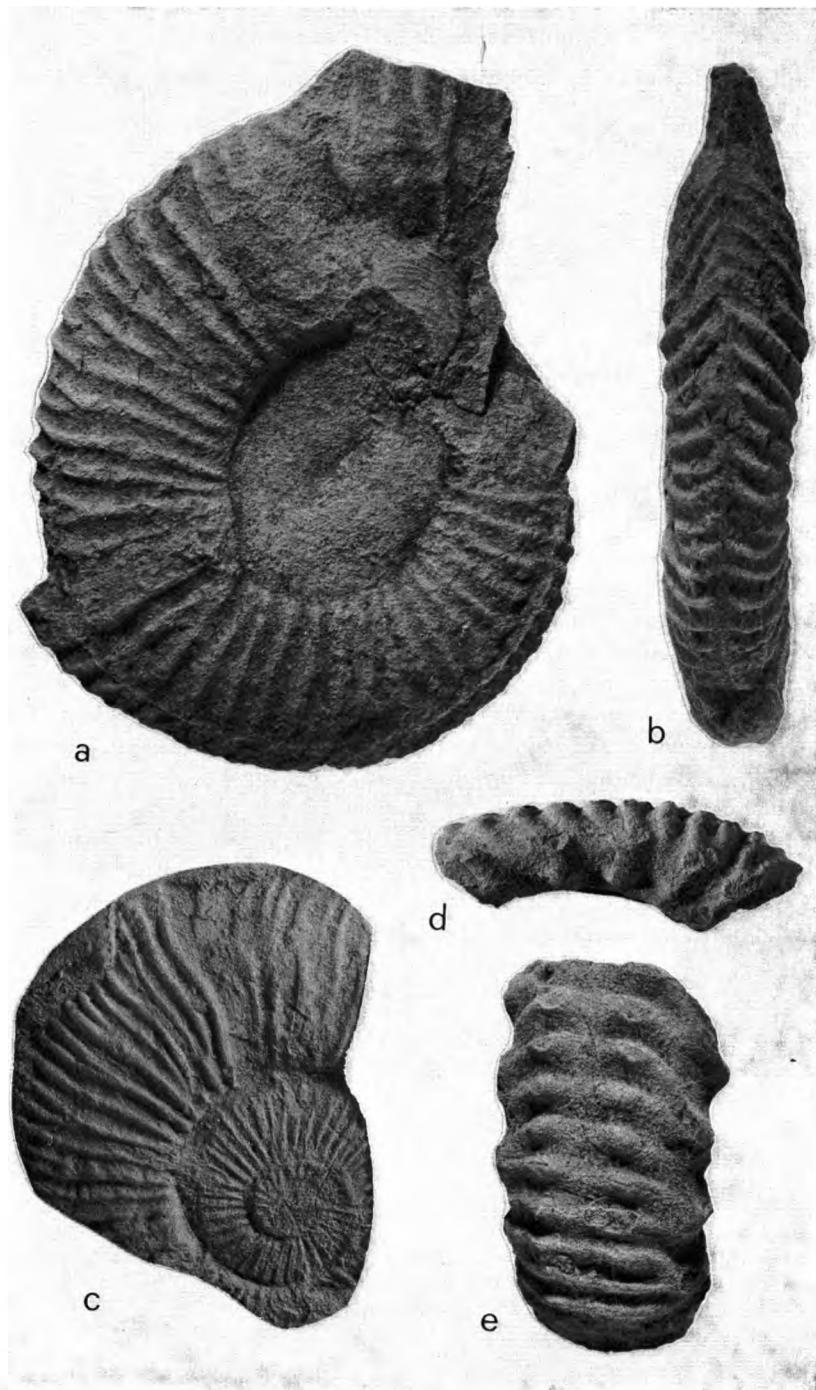


Fig. 5 (Legend see p. 243)

Belemnopsis patagoniensis (FAVRE 1908)

Fig. 6 a—c, g—i

- 1908 *Belemnites patagoniensis* n. sp. — FAVRE, p. 640, pl. 37, figs. 6—7.
 1921 *Belemnites patagoniensis* FAVRE — BONARELLI, in BONARELLI & NÁGERA, p. 17, fig. 2.
 1928 *Belemnopsis patagoniensis* (FAVRE) — STOLLEY, pl. 29, figs. 2a—b.
 non 1936 *Belemnites (Belemnopsis) patagoniensis* FAVRE — FERUGLIO, p. 81, pl. 10, figs. 1, 22, 3, 4.
 1968 *Belemnopsis patagoniensis* (FAVRE) — RICCARDI, p. 320, pl. 26, figs. 4—6.
 1971 *Belemnopsis* sp. — RICCARDI, p. 270.
 1976 *Belemnopsis patagoniensis* (FAVRE) — RICCARDI, p. C45.

Lectotype: The original specimen figured by FAVRE (1908, pl. 37, figs. 6—7) is here designated as lectotype.

Material: Four fragments, and possibly two others, including four juveniles (MLP 12414—12419) from the top of the Springhill Formation (cf. RICCARDI 1971, fig. 4, profile III), Lago San Martín.

Description: Guard cylindro-conical, elongate and robust, about 8 to 10 times as long as the maximum transverse diameter. Outline symmetrical, non-hastate. Profile slightly asymmetrical, with the ventral part of the apical region being more inflated than the dorsal (apex dorsally). Flanks, venter and dorsum gradually tapering to an acute apex. Apical line central to slightly dorsal. Alveolus angle about 15°. Apical and stem section circular or slightly depressed ($A = 100—106$), alveolar cross section circular or slightly compressed ($A = 91—100$). Median ventral groove narrow with angular margins, extending from near the apex where it is shallow, towards the alveolar region where it becomes deeper. It attains a maximum depth of 0.4 mm (where $ds = 19$) and a maximum width of 2.3 (where $dt = 18.5$). Lateral lines were observed on the juveniles but not on the adults probably because of the corroded surfaces.

Measurements in mm (The system of measurement adopted is the one suggested by AVIAS, cf. STEVENS 1965, p. 44):

	L	I	dta	dsa	dtM	dsM	α	A	Rs
MLP 12414	164	79	18.5	18.4	18.4	19	15	96.8	0.47

Remarks: The specimens described here appear to have a narrower and shallower groove than the lectotype of the species. However, similar features are present in a paralectotype (specimen N° 43 deposited in the Geologisch-Paläontologisches Institut der Universität Freiburg) and in topotype material collected by me in the Lago Belgrano area.

Fig. 5 (natural size).

- a—c: *Jabronella* aff. *michaelis* (UHLIG);
 a—b: Lateral and ventral views (MLP 12318);
 c: Lateral view (MLP 12319), plasticine cast;
 d—e: *Neocosmoceras* sp. lateral and ventral views (MLP 12316).

The material from Lago Argentino described by FERUGLIO (1936—37, p. 81, pl. 10, figs. 1, ?2, 3, 4) differs in being slightly hastate and having a broad median ventral groove with rounded margins (cf. STEVENS 1965, p. 159; WILLEY 1973, p. 36). WILLEY (1973, p. 33) included those specimens in *B. gladiatoris* WILLEY, which also occurs in the Berriasian of Alexander Island, Antarctica.

As was pointed out by STEVENS (1965, p. 160), this species is distinct from other *Belemnopsis*, the closest relatives being *B. casterae* and *B. madagascariensis* BESAIRIE spp. of the Upper Jurassic and Lower Cretaceous of Madagascar.

LEANZA (1968, p. 170) tentatively included it in *Mesohibolites* STOLLEY (1919). In his opinion the central position of the apical line and the presence of lateral lines militate against its inclusion in *Belemnopsis* while the long median ventral groove suggests a closer affinity to *Mesohibolites*. However, lateral lines are present in different species of *Belemnopsis* (cf. STEVENS 1965), and the depressed *Mesohibolites* has a median ventral groove restricted to the alveolar region and anterior portion of the stem region (cf. ALIZADE 1964; KRIMHOLZ 1939; STEVENS 1973). Therefore, excepting the position of the apical line, all features favour inclusion in *Belemnopsis*.

Distribution and Age: This species has been mentioned, but not figured, from different areas of Patagonia. It was originally described from Lago Belgrano and implicitly dated as Hauterivian-Barremian by FAVRE (1908, p. 640, 645), based on associated ammonites. Subsequently, finds were made at Lago San Martín which were considered to be Tithonian (BONARELLI & NÁGERA 1921; FERUGLIO 1949, p. 171—176).

Although LEANZA (1968, p. 170—172) considered its age to be Aptian, I considered that his conclusions were doubtful (RICCARDI 1970, 1971; cf. also RICCARDI et al. 1971, p. 114—115) and included the *B. patagoniensis* occurrences at Lago San Martín in the Neocomian suggesting Hauterivian-Barremian as the most probably age.

However, association with Berriasian ammonites does not preclude its wider stratigraphic range.

Belemnopsis cf. *madagascariensis* (BESAIRIE 1930)

Fig. 6 d—f, j—l

- 1968 *Belemnopsis* sp. — RICCARDI, p. 324, lám. 26, fig. 2.
 1971 *Belemnopsis* sp. — RICCARDI, p. 270 (pars).
 1976 *Belemnopsis* sp. — RICCARDI, p. C45.

Material: Seven fragments, including 2 phragmocones and 4 juveniles (MLP 12420—12426) from the top of the Springhill Formation (cf. RICCARDI 1971, fig. 4, profile III), Lago San Martín.

Description: Guard cylindro-conical, elongate and robust, about 8 times as long as its maximum transverse diameter. Outline symmetrical, non-hastate. Profile slightly asymmetrical, with the ventral part slightly inflated. Flanks, venter and dorsum gradually tapering into acute apex. Apical line central to slightly dorsal. Alveolus angle about 20° . Apical and stem cross section circular to slightly depressed ($A = 101-114$), alveolar cross section slightly depressed to compressed ($A = 96-105$). Median ventral groove with rounded margins, extending from near apex where it is shallow and broad, towards the alveolar region where it becomes deeper and narrower. It obtains a maximum depth of 0.8 mm where $ds = 17.3$ mm, and a maximum width of 5 mm, where $dt = 16.4$ mm.

Lateral lines were not observed, probably because of the poor preservation.

Measurements in mm:

	dta	dsa	dtM	dsM	α	A
MLP 12420	20.4	18.8	21.7	20.5	20	105
MLP 12421	—	—	21.3	21.4	—	100

Remarks: These specimens differ from *B. patagoniensis* in being shorter and in their broader and deeper median ventral grooves with rounded margins. They are very close to and probably conspecific with *B. madagascariensis* (BESAIRIE 1930, p. 208, pl. 13, fig. 4). According to BESAIRIE, however, the holotype has a circular cross section. The Patagonian specimens also have a slightly more elongated outline near the apex. *B. madagascariensis* has been reported from the Tithonian-Valanginian of Madagascar.

Hibolithes aff. *jaculum* (PHILLIPS)

Fig. 6 m—o

1936 *Belemnites* (*Hibolithes*) aff. *jaculum* PHILLIPS — FERUGLIO, p. 83, pl. 10, fig. 5—14.

1976 *Hibolithes* aff. *jaculum* PHILL. — RICCARDI, p. C45.

Material: Three, possibly four, specimens (MLP 12427—12429) from the top of the Springhill Formation (cf. RICCARDI 1971, fig. 4, profile III), Lago San Martín.

Description: Guard elongate and slender; at least six or seven times the maximum transverse diameter. The outline is symmetrical and hastate. Maximum transverse inflation (dtM) occurs towards the apex which is moderately obtuse. Apical angle of about 25° . Anteriorly the flanks converge reaching the minimum transverse diameter where the specimen is broken. The phragmocone is missing. Profile symmetrical. Cross section compressed throughout. Median ventral groove indistinct on the apical

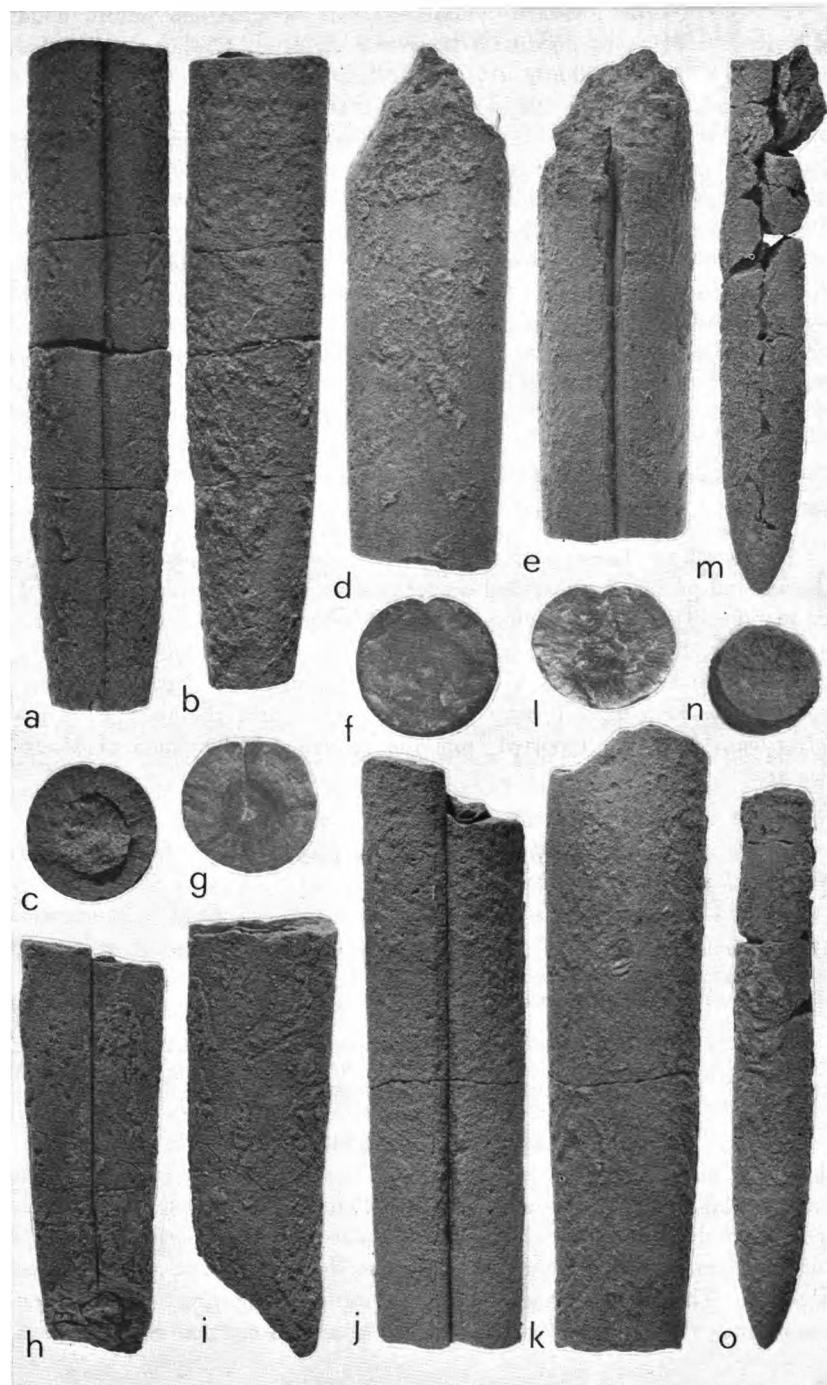


Fig. 6 (Legende see p. 247)

$\frac{2}{3}$ of the preserved guard, and not visible on anterior part probably due to the poor preservation. Traces of lateral lines are visible but not clearly due to preservation. Apical line central in alveolar and stem region.

Measurements in mm:

MLP 12427

1	u	v	dtM	dsM	u/v	dtm	dsm	Ht	Hs	A	Rs
75	45.7	29.3	11.8	10.9	1.56	10	9.2	118	118.4	108.2	0.30

Remarks: The figured specimen is a close match of that illustrated by FERUGLIO (1936, pl. 10, fig. 13). According to STEVENS (1965, p. 159, footnote) the specimen from Lago Argentino could be similar to the stouter forms of *H. compressus* STOLLEY and *H. marwicki marwicki* STEVENS.

H. m. marwicki, however, differs from the Patagonian specimens in having a circular to compressed cross section, in being slender and in having a median ventral groove extending into the posterior part of the stem. *H. m. mangaorensis* STEVENS is less slender but differs in all other mentioned features. *H. aff. marwicki mangaorensis* from the Berriasian of Antarctica (WILLEY 1973, fig. 7b) is rather similar in outline but a close comparison is impossible due to incomplete preservation, although according to WILLEY (1973, p. 50) the cross-section is circular to compressed.

The specimen from Lago San Martín is close to *H. jaculum* (PHIL.) and *H. subfusiformis* RASPAIL. However, *H. jaculum* is compressed near the alveolus and has a comparatively smaller inflation of the apical part of the rostrum, and *H. subfusiformis* has a larger rostrum and inflation of the apical part of the rostrum (cf. KRIMHOLZ 1939). *H. compressus* is very similar in outline (cf. STOLLEY 1934, pl. 4, fig. 2) but it is also compressed (cf. STEVENS 1965). In the depressed cross section this specimen is similar to *H. joleaudi* BESAIRIE (1936, pl. 22, figs. 5—8) from the Lower Cretaceous of Madagascar. However, this last species has a larger and more slender guard.

Fig. 6 (natural size).

- a—c: g—i. *Belemnopsis patagoniensis* (FAVRE);
- a—c: Ventral, lateral and cross section views of a guard fragment (MLP 12414);
- g—i: Cross section, ventral and lateral views of a guard fragment (MLP 12415);
- d—f: j—l. *Belemnopsis* cf. *madagascariensis* (BESAIRIE);
- d—f: Lateral, ventral and cross section views of a guard fragment (MLP 12421);
- j—l: Ventral, lateral and cross section views of a guard fragment (MLP 12420);
- m—o: *Hibolithes* aff. *jaculum* PHILLIPS, ventral, cross section and lateral views (MLP 12427).

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