

THE LOWER CRETACEOUS BIVALVE MACCOYELLA IN PATAGONIA
AND ITS PALEOGEOGRAPHIC SIGNIFICANCE
FOR CONTINENTAL DRIFT

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ABSTRACT: The subgenus *Gryphaea* (*Mimetostreon*) Bonarelli in Bonarelli and Nágera (1921) is considered to be a junior subjective synonym of *Maccoyella* Etheridge (1892). *Maccoyella bonarellii* (Leanza, 1963) is redescribed, and shown to be similar to *Maccoyella incurvata* Waterhouse 1959 from New Zealand (Aptian? or Albian?) and *M. rockwoodensis* (Etheridge) from Australia (Albian). The age of the Patagonian species is probably Aptian. This genus is important paleogeographically. By restoring the three regions with *Maccoyella* to their probable lower Cretaceous positions, based on paleomagnetic, faunal and structural analyses, it is shown that *Maccoyella* inhabited a restricted paleolatitudinal belt, close to 50° S to 60° S. It is now found over a much wider spread of latitudes, ranging from nearly 10° S to 50° S.

RESUMEN: Se considera al subgénero *Gryphaea* (*Mimetostreon*) Bonarelli (in Bonarelli y Nágera, 1921) como un sinónimo de *Maccoyella* Etheridge (1892). Se redescrive *Maccoyella bonarellii* (Leanza, 1963), señalando su similitud con *M. incurvata* Waterhouse, 1959, de Nueva Zelandia (Aptiano? o Albiano?) y *M. rockwoodensis* (Etheridge) de Australia (Albiano). La edad de la especie patagónica es probablemente aptiana. Este género es importante paleogeográficamente. Situando las tres regiones con *Maccoyella* en sus probables posiciones en el Cretácico inferior, de acuerdo con datos paleomagnéticos, faunísticos y estructurales, se observa que *Maccoyella* habitó un faja paleolatitudinal restringida, ubicada entre 50° S y 60° S. En la actualidad se la encuentra en sedimentos distribuidos en una gama más amplia de latitudes, desde casi los 10° S a 50° S.

INTRODUCTION

Maccoyella is a short-ranged Lower Cretaceous bivalve genus, first discovered in Australia, and later found in two other parts of the Southern Hemisphere, South America and New Zealand.

The paleogeographic implications, taxonomy and systematics of the South American species are discussed in this paper.

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SYSTEMATIC DESCRIPTION

Family OXYTOMIDAE Ichikawa 1958
(nom. transl. Cox 1961, p. 592)

Genus *Maccoyella* Etheridge 1892

TYPE SPECIES: (by original designation) *Avicula barklyi* Moore 1870.

SYNONYM: *Mimetostreon* Bonarelli 1921, type species *Avicula corbiensis* Moore 1870.

DIAGNOSIS: Medium-sized to large acline or prosocline shells with submedium or anteriorly placed umbones, left valve moderately to strongly convex, right valve flat, or weakly convex or concave, posterior wings obtuse, may be poorly defined or absent from right valve, anterior left ear small, right anterior ear small and thick,

usually with narrow interior subauricular notch, left byssal gape small to large. Costae of two to four orders, subspinose in some species, growth lines prominent. Ligament area on plate in left valve, on posterior rim in right valve, both with opisthocline resilifer, large anterior left tooth and right socket, posterior adductor large submedian in each valve, pallial line pitted.

DISCUSSION: *Mimetostreon* with type species *Avicula corbiensis* Moore 1870 was proposed by Bonarelli (in Bonarelli and Nágera, 1921) in the course of describing Cretaceous fossils from Patagonia. Bonarelli was apparently unaware that Etheridge (1892) had included *Avicula corbiensis* in his genus *Maccoyella*, based on an allied species *Avicula barklyi* Moore. The two species differ considerably in shape, *A. barklyi* being much larger with a less convex left valve and less incurved umbo. It may eventually be decided that such incurved species form a distinct lineage of generic or subgeneric rank. But present evidence suggests that such "gryphaeation" recurred several times, possibly from different stocks, so that placement of all incurved *Maccoyella* into *Mimetostreon* would obscure rather than clarify phylogeny.

Leanza (1963, 1967b) correctly showed that affinities of *Mimetostreon* lay with *Oxytoma* rather than *Gryphaea*, and Cox (1969, p. L346) and Day (1969, p. 159) synonymized *Mimetostreon* with *Maccoyella*.

The Liassic species *Gryphaea striata* Phillipi (in Behrensden 1891-2, p. 394, pl. 22, figs. 5-6) was included in *Mimetostreon* by Bonarelli. The specimens are poorly known, but the right valve does not appear to be like that of *Maccoyella*. Nor is the Callovian species *Gryphaea nebrascensis*. Meek and Hayden 1862 (cf. Imlay, 1948, p. 18; 1967, p. 81) congeneric, though also referred to *Mimetostreon* by Bonarelli.

MORPHOLOGY: Speden (1968, 1969) has described the shell of *Maccoyella* as "plicate". It must be stressed that the valves of *Maccoyella* are not plicate in the normal sense of the

word. The ornament is costate (or costellate), and the inner surface of the shell is smooth at maturity, though not of course in early growth stages. In our experience costae frequently affect the entire shell in juvenile stages, and so are like small plicae.

Maccoyella bonarellii (Leanza 1963)

Pl. 1, figs. 1-10

- 1921 *Gryphaea* (*Mimetostreon* n. subgen.) cfr. *corbiensis* (Moore)-Bonarelli, p. 21, pl. 2, figs. 5a-b, 6.
1938 *Gryphaea* cfr. *corbiensis* (Moore)-Piatnitzky, p. 74, pl. 5, figs. 24, 25.
1963 *Mimetostreon bonarellii* n. sp., Leanza p. 222.
1967 *Mimetostreon bonarellii* Leanza, p. 64, pl. 1, figs. 1-6.

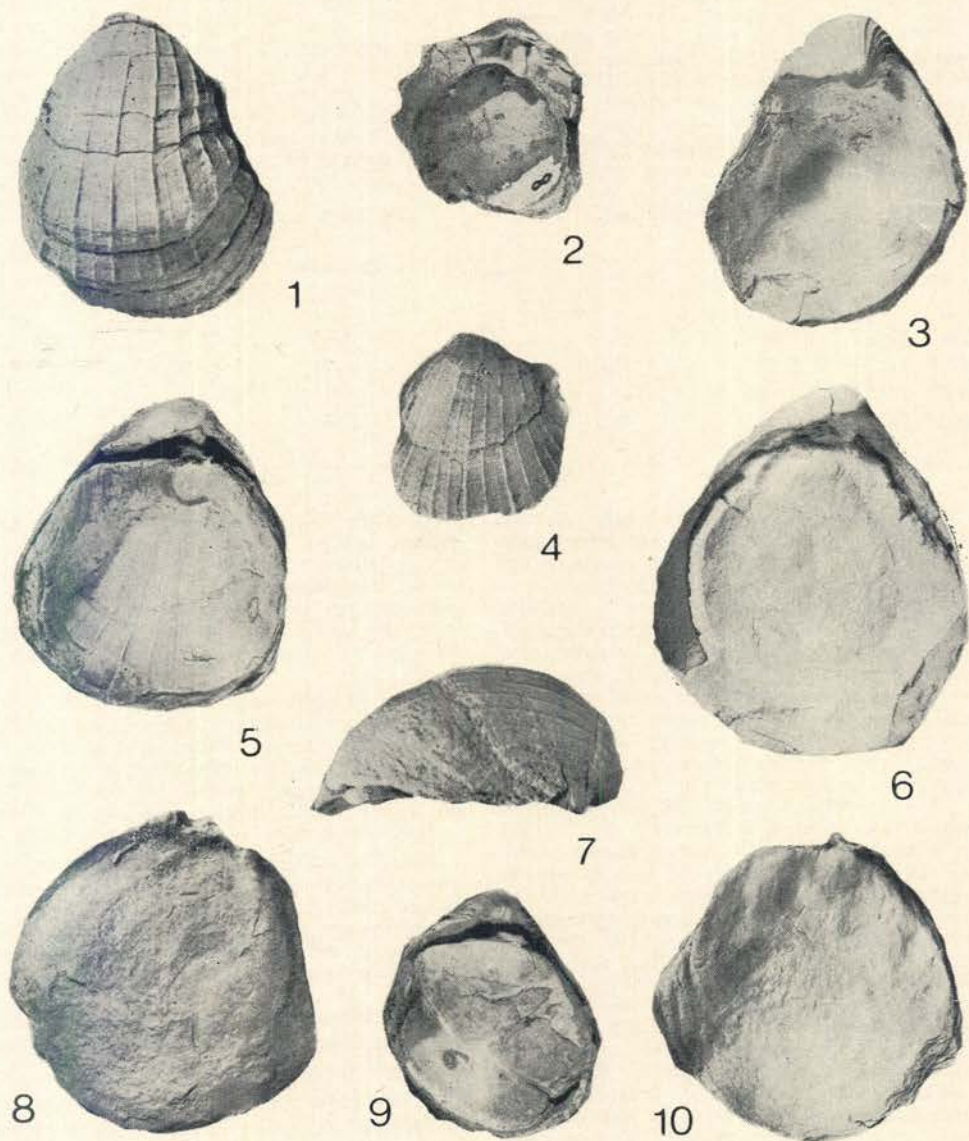
NEOTYPE: The type material of the species *M. bonarellii* is amongst that described by Bonarelli (in Bonarelli and Nágera, 1921), if we are to give priority to the first designation (Leanza, 1963, p. 222; 1967b, p. 63) over later designations of another specimen (Leanza, 1967b, pp. 64, 65, pl. 1, figs. 1, 2). Unfortunately, the two specimens figured by Bonarelli seem to be lost. A neotype should be chosen from topotype material. We therefore designate as neotype, specimen MLP 11220, here figured on pl. 1, figs. 1, 3.

DIAGNOSIS: Medium-sized *Maccoyella*, left valve convex with incurved umbo and wide byssal notch, right valve concave, costae moderately numerous (12-14 primaries), very fine and well-spaced, secondaries inconspicuous. Resilifers highly opisthocline under the umbo, notch in front of right hinge obscure.

MATERIAL: Three specimens with valves conjoined and seven left valves collected by A. C. Riccardi (MLP 11220-11229) and a composite mould of a left valve (MLP 2831) collected by Dr. J. Frenguelli, all kept at Museo de La Plata, Argentina.

LOCALITIES: Upper part of a small creek, west of Arroyo Calafate, south-east of Bahía de la Lancha (49° S, 72° 10' W), Lago San Martín, Santa Cruz, Argentina, in the upper part of the shaly Rio Mayer Formation, with *Aioloceras argentinum* (Bonarelli).

This locality matches the one located on the Geological Map of Bonarelli & Nágera (1921),



Maccoyella bonarellii (Leanza): 1, 3. External and internal view of neotype, MLP 11220; left valve; 2, 4. External and internal view of left valve MLP 11221; 5. Right aspect of MLP 2831; 6. Right aspect of MLP 11222, right exterior worn; 7. Lateral view of left valve MLP 11223; 8, 10. Internal and external aspects of right valve MLP 11222; 9. Right aspect of MLP 11225. All specimens save MLP 2831 from upper part of small creek west of Arroyo Calafate, SE of Bahía de la Lancha, Lago San Martín, coll. A. C. Riccardi. MLP 2831 from probably same locality, coll. J. Frenguelli. All specimens natural size.

immediately to the north of "Puesto Martin", in the "Serie arcilloso-margosa...", close to the contact with the "Cretaceo". The same locality, probably, has yielded one of the specimens here described (MLP 2831), and those described by Bonarelli (in Bonarelli & Nágera, 1921 under *Gryphaea* (*Mimetostreon* n. subgen.) cfr. *corbiensis* (Moore) (p. 21, pl. 2, figs., 5a-b, 6). The latter specimens are missing from the collection of Bonarelli and Nágera which is deposited in the Instituto Nacional de Geología y Minería (Buenos Aires, Argentina).

One of the specimens described by Leanza (1967b, pl. 1, fig. 6) came from the same area and horizon.

DISTRIBUTION: In Patagonia this species, or forms referred to *Gryphaea* cf. *corbiensis* (Moore), has been mentioned from San Martin Lake, in Viedma Lake (north and east shore, Leanza, 1967b) and a borehole in Punta Norte, 8 km north of Puerto Coig, Atlantic Ocean, approximately 51° S (Feruglio, 1949, T. 1, p. 179).

DIMENSIONS (in mm):

Specimen	Length	Height	Width	Umbonal angle	Umbo from anterior	Maximum length distance below umbo
MLP 11222	44	48	21	105°	14	29
MLP 11220	36	43	22	110°	14	27
MLP 11223	40	46	23	100°	15	25.5
MLP 2831	37	43	20.5	113°	13	24

DESCRIPTION: *External*: The shells are medium-sized for the genus, the left valve moderately convex, with incurved anteriorly placed prosogyrous umbo, the right valve gently concave. Anterior byssal gape in left valve lamellose, very large, up to 7 mm deep from commissure, largely infilled when valves shut by right valve, which lies partly in the concavity, and has a flange-like extension. Posterior wing moderately long, gently convex in left valve, varying a little in length in different specimens, and probably often broken, feebly developed or absent from right valve as now preserved.

Nine to fifteen, usually 12 primary costae extend from close to umbonal tip of left valve to ventral margin with narrow convex crests, not divided longitudinally, and broadly concave interspaces. Secondary costae arise 15-35 mm from the umbo and tertiary costae arise on the anterior and posterior flanks, and probably around the ventral margins of large shells. Both sets remain finer than the primaries. Valve crossed by low growth lines, 3-5 per mm, occasionally forming long "spines" across the costae. Growth steps 3-10 mm apart. Only traces of costellae seen on right valves from the Bahía de la Lancha. A better preserved specimen MLP 2831 from Lago San Martin seems to have only primary costae on the right valve opposing those of the left valve.

The shell is lamellate, and 3-4 mm thick.

Internal: Hinge plate of left valve roofs an umbonal chamber, extending further from the hinge with increase in size, and infilled dorsally with callus. Byssal gape bordered by a ridge in some shells, not in others; tooth lies just in front of or below the umbonal tip, varies in inclination in different specimens, being generally

opisthocline (80°) or vertical, or sometimes prosocline. Behind lies resilifer, opisthocline, generally bordered by low ridges, and marked by strong cross-ridges, with its dorsal first formed part curving and widening posteriorly from under the umbo. Remainder of the hinge plate, including the tooth, lightly striated by growth lines.

Hinge of right valve thickened, large socket enclosed by two elevated ridges, anterior ridge merges with anterior flange to help close the byssal notch of left valve. Posterior ridge of socket fits into gap between left tooth and left pit, adjoins feebly depressed, posteriorly facing resilifer pit of right valve.

Musculature feebly impressed. Posterior adductor of left valve lies near middle of valve, behind ligament pit, below mid-height, close to anterior hinge plate. Posterior adductor clearly defined on right valve in corresponding position. Three-four pits exposed along pallial line.

RESEMBLANCES: This species resembles *M. incurvata* Waterhouse 1959 of New Zealand in its elongated outline, and moderately incurved left valve, but the Argentinian form is larger with a wider umbo and an entirely concave right valve, whereas the right valve of the New Zealand species is often partly convex. Costae are finer and less spinose and more widely spaced with more numerous primaries and fewer tertiaries. On the New Zealand species, primary costae are fewer, 8-10 usually, and coarse. Secondary costae

arise sooner on the New Zealand form and grow stronger. Growthlines are comparable. In the right valve the anterior notch in front of the tooth buttress is less incised than in *M. incurvata*, and the resilifer of the left valve curves more sharply back from under the umbo.

Speden (1968, p. 706) claimed that a "higher number" of "plicae", as many as 18-22, were present around the ventral margin of a new found left valve of *M. incurvata*, in alleged contrast to the report by Waterhouse (1959, p. 493) of 8-10 costae. But Waterhouse had reported these as primary costae, correctly in our opinion, and had counted in addition secondary and tertiary costae, to make a total of about 20-24 costae around the ventral margin. Dr. Speden seems to have failed to consider the likelihood that his "high number" of so-called plicae around the ventral margin included secondary and perhaps tertiary as well as primary costae.

The Patagonian species was originally compared to *Maccoyella corbiensis* Moore by Bonarelli (1921), and regarded as the contemporaneous Patagonian counterpart of this Australian species by Day (1969, p. 159). The two are distinct. *M. corbiensis* is a slightly smaller species with less convex left valve, and convex rather than concave right valve. The posterior wings are slightly better defined, with slightly alate cardinal extremities, and the byssal gape of the left valve is smaller than in the Patagonian form. Concentric ornament seems to be slightly more prominent on *M. corbiensis* (2-3 per mm) and spines possibly less evident, but this needs verification. Costae are more numerous at 17 or so, with 3-4 more arising in front of the posterior wing, and more closely spaced. This number may include a few secondaries that arise close to the umbo. Other intercalated costae rapidly become almost as strong as the primary costae. Costae on the right valve are very numerous.

Speden (1968, p. 708) reported 14-16 growth lines per mm in *M. corbiensis*,

but this is an error by a factor of 10 to 12. Speden also counted 9-11 growth lines per mm in *M. incurvata*, yet his figure (fig. 6), admittedly with no scale given in the caption, suggests only 2 per mm, or if the specimen is twice natural size, 4 per mm. Dr. I. G. Speden, New Zealand Geological Survey, has kindly re-examined his material for us, and writes that 4-5 lamellae per mm occur on *M. incurvata* (TM 3913), and 3-4 per mm in *M. corbiensis* (WM 9047, UFQ 35518; WM 9048-UFQ 35520) noting that the number increases to 4-6 per mm in bands, related to seasonal changes. (Dr. I. G. Speden letter, January, 1970).

The anterior auricular notch is more incised in *M. corbiensis*, and the resilifer apparently less opisthocline. All these differences suggest that *M. corbiensis* was less adapted to an attached habit. A specimen figured as *M. corbiensis* by Ludbrook (1966, pl. 14, fig. 25, 28) from South Australia is almost as incurved as the Patagonian form.

M. cf. corbiensis of Skwarko (1966, p. 74, pl. 6, figs. 1-11) from late Neocomian and early Aptian beds of Northern Territory, Australia, are somewhat closer to the Patagonian species in incurvature and number and strength of the ribs. The shells are smaller, and the posterior wing much better developed. The right valve was described as straight (meaning flat?) or slightly convex. The specimens are not conspecific with *M. corbiensis*, but come closer to *M. rockwoodensis* Etheridge, which Skwarko erroneously synonymised with *M. corbiensis*.

The type specimen of *Maccoyella rockwoodensis* (Etheridge, 1892, p. 448, pl. 24, fig. 15) is a left valve with narrower umbo, longer posterior wing and coarser, more close-set costae, noted by Waterhouse (1959 p. 496) to be close to *M. incurvata*. Specimens figured by Ludbrook (1966, pl. 14, figs. 22-24, 26) from Albian beds of South Australia verify this similarity. They are smaller with a more rounded outline, but agree in having a

flat or concave right valve, and relatively well spaced slender costae. It thus appears to be closest of the Australian forms though many details have not been described. It is one of the younger species in Australia, Day (1969) listing it as upper Albian.

M. simplex (Moore, 1870, pl. 11, fig. 3) is slightly incurved with few well spaced costae.

AGE OF *M. BONARELLII*

a) MACCOYELLA AFFINITIES: *M. bonarellii* appears to be relatively "advanced" in its gryphaeoid morphology, but this may reflect adaptation to substratum rather than a young age.

M. bonarellii, *M. incurvata* and *M. rockwoodensis* all occur in silty or muddy sediment, though *M. cf. corbiensis* cf. Skwarako (1966) is found in sandstones. *Maccoyella incurvata* Waterhouse from New Zealand is moderately close. Waterhouse (1959, 1965), preferred a Lower Cretaceous, possibly Aptian age on faunal evidence, but noted that *M. incurvata* was relatively advanced in incurvation and ornament so that it could prove younger. The recent discovery by Norris and Waterhouse (1970), that the so-called Jurassic Hawk Crag Breccia, is in fact, Upper Albian, may require some upward revision of the *Maccoyella*, to perhaps as young as Albian.

Speden (1968) also supported a Lower Cretaceous age for *M. incurvata*, but stated that "an Upper Jurassic age should not be completely discounted". However, it is difficult to see a good reason for such an early age, especially since earlier reports of supposed *Maccoyella* in the Australian Jurassic, questioned by Waterhouse (1959) and corrected by Brunnschweiler (1960), have been shown false (confirmed by Dr. R. Brunnschweiler, pers. comm. to J. B. W., letter, 1960; letter to Dr. I. G. Speden, 1966, quoted in Speden 1968, p. 709).

b) AMMONOID EVIDENCE: The specimens of *Maccoyella bonarellii* (Leanza) here described were collected in beds with *Aioloceras argentinum* (Bonarelli) and *Neobibolites* cf. *semicanaliculatus* (Blainville); the beds lie above the horizons of *Aconeceras* sp. and "*Ancyloceras*" *patagonicum* Stolley, and below the horizon of *Sanmartinoceras patagonicum* Bonarelli.

The age of *M. bonarellii* has been considered as Albian by Leanza (1963, p. 222, 1967b, p. 69) following Piatnitzky (1938, p. 50). This was based on the wrong assignation by Bonarelli (in Bonarelli and Nágera, 1921) of his material from San Martin Lake, to the Albian genera *Cleoniceras* Parona and Bonarelli, *Beudanticeras* Hitzel, and *Ubligella* Jacob. These specimens are now placed in *Aioloceras* Whitehouse (cf. Whitehouse, 1926, p. 206; Casey, 1961b, p. 132) a genus known only from South Patagonia and Australia. The lower Albian occurrence reported by Collignon, 1949, from Madagascar, and quoted in Arkell *et al.* (1957, p. L394) has been discounted by Casey (1961b, p. 169).

According to Day (1969, p. 159), *Aioloceras* is late Aptian because of its stratigraphic occurrence in proximity to *Sanmartinoceras* s. s. at San Martin Lake, Patagonia, and because of its association near Tambo, Australia, with *Tropaeum* Sowerby which shows crioceratid coiling. Day (1969), quoting Casey (1961b, p. 132), considered that *Sanmartinoceras* s. s. was restricted to the Upper Aptian. Day (1967, 1969) also considered the Australian *Tropaeum* and *Australiceras* Whitehouse as of late Aptian age, following Casey's (1961a) dating of the extra-Australian occurrences of species with crioceratid coiling.

An exclusively late Aptian age of *Sanmartinoceras* s. s. is not firmly established. Originally, Bonarelli and Nágera (1921) considered *S. patagonicum* Bonarelli as Upper Albian-Lower Cenomanian, because of its occurrence at San Martin Lake above

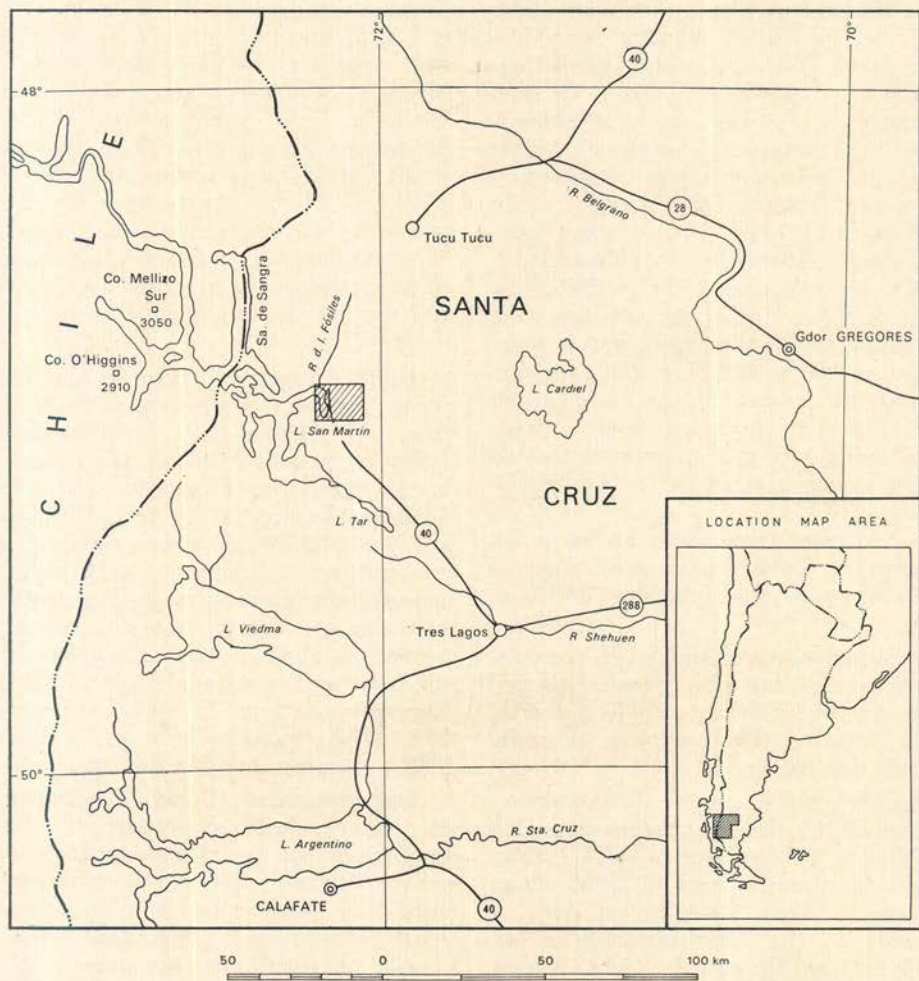


Fig. 1. — Locality map of Patagonia, showing Lago San Martin

ammonites referred to Albian genera. In 1924, Spath (p. 74) mentioned that *S. trautscholdi* Sinzow belongs to the Upper Aptian Aschiltaensis Subzone. The same age was accepted by Whitehouse (1926, p. 197) for *Sanmartinoceras*, who therefore considered *Aioloceras* Whitehouse as Aptian. Although most authors have placed *Sanmartinoceras* in the Upper Aptian since 1924, Maync (1949), still reported the Patagonian occurrence as

Cenomanian while Arkell *et al.* (1957) and Leanza (1967c) gave an Upper Aptian-Lower Albian age.

Two subgenera of *Sanmartinoceras* are Lower Aptian: *S. (Theganeceras)* Whitehouse is known from the Weissi Zone of northern Germany (Casey, 1961b, p. 132) and the type species of *S. (Sinzovia)* Sazonova, *Ammonites trautscholdi* Sinzow, comes from the Lower Aptian of Russia (*cf.* Casey, 1961b, p. 133). Upper Aptian

is suggested by the report of *S. pusillum* with *Hamites* sp. indet. by Frebold (1935, p. 17, fig. 16) from Greenland, since *Hamites* is of late Aptian-late Albian age (Arkell et al. 1957, p. L 216). Of *Sanmartinoceras* s. s., neither *S. groenlandicum* Rosenkrantz nor "*Garnieria*" *pusilla* Ravn [probably a synonym of *groenlandicum* according to Spath (1946, p. 7) and Casey (1961b, p. 131)] from Greenland, were collected *in situ* (Ravn, 1911, p. 493; Rosenkrantz, 1934, p. 20). The assigned Upper Aptian age was based on that supposed for the genus, but as pointed out by Maync (1949, p. 261) the presence of the Lower Aptian *Deshayesites* cf. *D. deshayesi* (Leymarie) and *D. boegvadi* Rosenkrantz in the same area could suggest Lower Aptian for *S. groenlandicum*.

In Australia there seems to be no direct support for an Upper Aptian age of *Sanmartinoceras* s. s. (cf. Day, 1969, p. 159).

In Alexander Land and South Georgia, Antarctica, *S. patagonicum* was considered Upper Aptian (Wilckens, 1947; Howarth, 1958) because this age was generally accepted for the genus.

Doubtful references to *Sanmartinoceras* include 1) the *Sanmartinoceras* (*S.*) sp. (Casey, 1954), later called *S.?* (*Sinzovia?*) sp. nov. (Casey, 1961b), from the Lower Albian Tardefurcata Zone of England; 2) the *Sanmartinoceras* n. sp. mentioned by Breistroffer (1947) from the Upper Aptian "Clansyesian" of France; 3) the dubious reports of this genus from imprecisely dated beds in Venezuela (Rod and Maync, 1954) and Papua (Australasian Petr. Co., 1961).

Some dubious evidence suggests an Albian age for *Sanmartinoceras*: Leanza (1967c, p. 167) reported *S. patagonicum* together with *Feruglioceras piatnitzkyi* Leanza. The statement refers to the San Martin Lake area (Leanza, 1967c, p. 171, 173; 1970, p. 251). In the latter paper both species were reported together with *Lechites imlayi* Leanza. The presence of

Lechites Nowak, a genus of U. Albian-L. Cenomanian age (cf. Arkell et al., 1957, p. L 218) and the fact that *F. piatnitzkyi* was mentioned with unidentifiable *Turrilitidae* from Argentino Lake (Leanza, 1967c, p. 173) suggest at least a Middle Albian age for the assemblage. However, in his latest paper Leanza (1970, p. 199, 252) considered *Sanmartinoceras* Bonarelli as U. Aptian, which would mean, on his identifications, a downward extension of the stratigraphical range of *Lechites* and the *Turrilitidae* as given in the Treatise (1957).

Another important point is the transfer of "*Silesites*" *desmoceratoides* Stolley, from San Martin Lake, to *Parasilesites* Imlay by Leanza (1967a). This genus is known from the Albian of Alaska and Sardinia (Imlay, 1959, 1960; Wiedmann and Dieni, 1968). However, different species are involved. Leanza (1970, p. 251) reported the patagonian species from levels also containing *Sanmartinoceras patagonicum* of U. Aptian age in San Martin Lake, and associated with (?U.) Albian ammonoids in Estancia La Vega (p. 252). This would indicate an U. Aptian-(?U.) Albian range for this species.

Sanmartinoceras Bonarelli, therefore, can be considered as Aptian, while any restrictions and/or extensions of its range are doubtful. The stratigraphic proximity of *S. patagonicum* to *Aioloceras argentinum* (Bonarelli) and *Maccoyella bonarellii* (Leanza) does not necessarily indicate a late Aptian age for the last species.

Casey's (1960) demonstration of a general phyletic trend in the ancyloceratids from ancyloceratid to crioceratid coiling during the Aptian, agreeing with the evolution of the heteromorphs as proposed by Wiedmann (1969), was given as evidence by Day (1967, 1969) for a late Aptian age for *Aioloceras*. At San Martin Lake, "*Crioceras*" [= *Tropaeum*] *deeckeii* Favre with crioceratid coiling occurs below *Aioloceras* (cf. Feruglio, 1949, p. 173). This would indicate an age not older than late Aptian for *Aiolo-*

ceras argentinum and consequently for *Sanmartinoceras patagonicum*. However, Wiedmann (1969) also reported a recoiling trend in the crioceratids in the Hauterivian-Barremian; the material of "*Crioceras*" *deecke* Favre, therefore, needs to be re-examined in order to establish its position with regard to the iterative evolution of the heteromorphs during the early Cretaceous. Moreover, during the change from ancyloceratid to crioceratid coiling of the ancyloceratids, different degrees of uncoiling probably coexisted as illustrated by the Lower Aptian *Tropaeum bowerbanki* Sowerby as figured by Casey (1960, text-fig. 7, pl. IV, fig. 1-3). Crioceratid coiling, therefore, occurred also in the Lower Aptian and it seems rather difficult to draw a line between the Lower and Upper Aptian based on the degree of coiling of the ancyloceratids.

Day (1967) suggested that an Upper Aptian age for *Australiceras* was indicated by its association with *Lithancyclus australis* Day; but the late Aptian age of *L. australis* is uncertain. *Lithancyclus* ranges from Barremian to the Lower Aptian, according to Casey (1960); Upper Aptian, therefore, seem unlikely in the absence of strong supporting evidence. The alleged similarity to two Californian species noted by Day (1967) is not convincing evidence for Upper Aptian; the "*Hemibaculites*" *mirabilis* figured by Anderson (1938) appears to be of middle to late Aptian age (Popenoe *et al.*, 1960) to judge from the associated fossils (Murphy, 1956); the "*Hemibaculites*" *neleus* is associated, according to Anderson (1938), with "*Acroteuthis*" *aboriginalis* of Hauterivian-Barremian age (Stevens 1965, p. 166; Murphy 1956, Text fig. 6; Popenoe *et al.* 1960, chart 10 e), and with "*Parahoplites*" cf. "*P*" *cerrosensis* of late Aptian age (Popenoe *et al.*, 1960, p. 1508).

The microflora, particularly the spores, occurring together with and above *Sanmartinoceras* at San Martin Lake is very similar to that in the Baqueró Formation

(Archangelsky, 1967). According to Dr. Archangelsky this flora is dominated by a new species of *Classopollis*, and considering the absence of angiosperms, the horizon cannot be younger than early Albian (pers. comm. 1970).

In summary, it seems reasonable to accept an Aptian age for the *Aioloceras* assemblage with *Neobibolites* cf. *N. semicanaliculatus* (Blainville) and *Maccoyella bonarellii* (Leanza). The association of *M. bonarellii* with *Hatchericeras* Stanton reported by Leanza (1967b, p. 69) does not contradict this conclusion, since the *Hatchericeras* occurrence above *Aioloceras* at Posadas Lake does not establish an Albian age for *Hatchericeras* as postulated by Leanza (1963, 1967c). Day (1969) agreed with Woods' dating of *Hatchericeras* in Australia as Neocomian (*vide op. cit.*).

However, there exist the possibility of an extension of the stratigraphical range of *Maccoyella bonarellii* upwards, according to the report of this species with (?U.) Albian ammonoids in Estancia La Vega (Leanza, 1970, p. 252).

PALEOGEOGRAPHY

Maccoyella in Australia, New Zealand and Patagonia is one of many faunal and floral links between these countries. Authors have particularly stressed the increase of common genera in the upper Jurassic (Howarth, 1958) and Cretaceous (Casey 1960; Fleming, 1962; Stevens 1965; Day 1969), coupled in at least New Zealand with weakening Cretaceous affinities to faunas from south Asia-Mediterranean (Fleming, 1967). This latter phenomenon may have been related to Lower Cretaceous cooling, which emphasized climatic zonation, discovered through oxygen isotope work on samples from Europe by Bowen (see 1966) and Australia and New Zealand (Dorman and Gill, 1959; Clayton and Stevens, 1965). This lower Cretaceous cool episode is reinforced by ana-

lysis of faunas in Queensland (Day, 1969). Paleogeographers have thus been encouraged to look for landlinks or shallow sea-links between these regions, in the belief that similarity of life betokens either geographic proximity, or ready access, either along continental bridges (Fleming 1962), now foundered, or along pathways now displaced and disorganized by continental drift (Melville, 1966). Reconstructions by continental drift also show New Zealand, Tasmania and eastern Australia in close juxtaposition (Carey 1958, Waterhouse and Vella, 1965, Waterhouse, 1967a) shortening the migration distance for *Maccoyella* by 1000 miles. Oceanographic surveys have suggested that New Zealand is linked to Antarctic by oceanic ridges (Brodie 1964), Cullen (1968), Summerhayes (1967), Wright (1966), and van der Linden (1968) have proposed that New Zealand in the Mesozoic lay close to the Antarctic, off Marie Byrd land, or the Ross Sea, this in turn being a short geological step from the Malvinas Islands and on to Patagonia. Halpern (1968) has shown that Cretaceous granites extend in a chain from South America into Western Antarctica, and on into New Zealand (Aronson, 1965). This view must be counterposed with other evidence, that New Zealand was linked with south-east Asia, through the Indonesian and Melanesian arcs (Carey, 1958; Waterhouse, 1967a). To us, it appears feasible that Australia formed part of Gondwana, and that the South Asian, Indonesian-Melanesian-New Zealand geological belt lay to the north and east and continued through western Antarctica, Graham Land and Scotia arc into South America. More faunal and paleomagnetic analyses are needed to show the exact relative positions of New Zealand along this belt.

The significant aspect of the similarities between east Australian, New Zealand and South American faunas does not lie only in the possibility of interconnection of shallow seas, or geographic juxta-

position. Both these are debatable, and overlook the fact that animals can cross most barriers, given time (Waterhouse, 1969).

One writer (Stevens, 1965) proposed that animal migrations along shallow marine shelves were obstructed periodically by submarine canyons. He overlooked the fact that such canyons must have been bordered by water shallow enough for life to have slipped around. Prevention of such migration must have been due to additional factors, such as temperature.

In our view, similarity of fauna means similarity of living conditions, including temperature, and similar temperature is at least on a world scale, likely to have reflected similar paleolatitude. At present the three major occurrences of fossil *Maccoyella* are within 12°-30° S in north Australia, South Australia, Queensland; 38° S. in New Zealand, and 49° S-51° S in Patagonia, this is a comparatively wide scatter for a discontinuously distributed and locally restricted sessile genus. As a general hypothesis geographically restricted and short-ranged animals inhabited similar latitudes. It is possible to test this hypothesis from the distribution of *Maccoyella*.

Paleomagnetic data in Irving (1964), Creer (1967), show that Queensland lay across the parallels 50° and 60° S in the Cretaceous. Faunal support for this position is given by Day (1969). Paleomagnetic data (Irving, 1964, Creer, 1967; Valencio, 1969; Valencio and Vilas, 1969); show that South America and therefore Patagonia has not changed its latitude much since Mesozoic (Irving, 1964; Creer et al, 1969; Francheteau and Sclater, 1969; Vilas and Valencio 1970a, b). This is to be expected, in view of its position between the South Pacific and South Atlantic centres of sea-floor spreading oriented longitudinally.

Thus Patagonia probably lay at much the same Cretaceous latitude as Queensland.

New Zealand is now in an intermediate

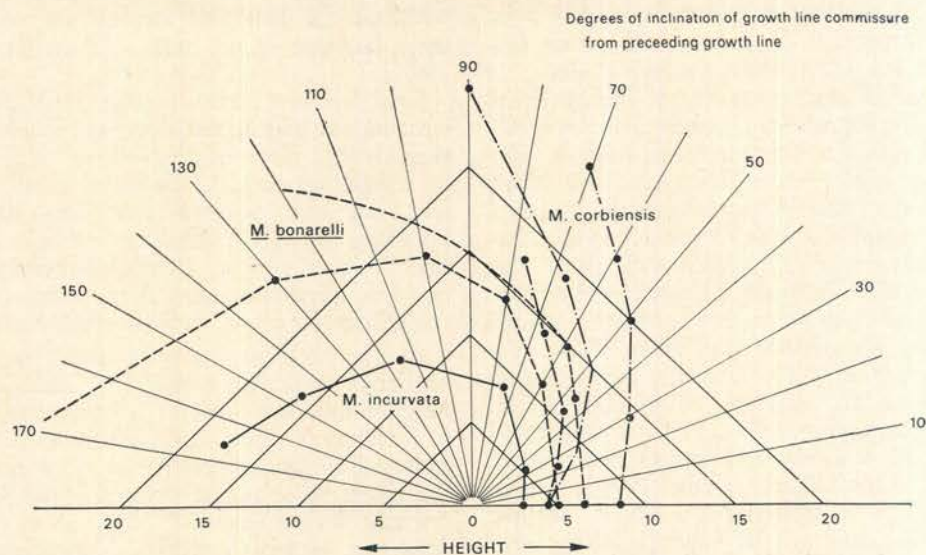


Fig. 3. — Comparison of curvatures of left valves of various *Maccoyella*, based modelled on Waterhouse (1959, fig. 4)

position. There is no published paleomagnetic data for its Cretaceous position.

The summary of Permian faunas by Waterhouse (1967; 1969, 1970, in press) showed that eastern New Zealand lay at a paleolatitude of approximately 55° S, probably north of Queensland and South Australia, and higher than the paleolatitude of Western Australia. Western New Zealand formed part of Gondwana, being similar in rocks and faunas to Tasmania.

Cretaceous faunas of New Zealand have not been analysed for diversity or paleolatitude. It is our impression that the faunas are not quite as diverse as those of either Australia or Patagonia. Although authorities have implied that this might be due to isolation, we suggest it may reflect a more southerly, higher latitude, by 5° to 10° than present, i. e. 45-55-60°S.

General faunal assemblages, and absence of dolomite and reefs or salt suggest that it has occupied temperate latitudes since the Mesozoic and Tertiary (Wellman, 1959, p. 126).

Paleotemperature work does not suggest

much similarity. Oxygen-isotope analyses on Patagonian samples by Bowen (1961) indicates high temperatures of 23.7° C and 25.7° C for Hauterivian-Barremian faunas, as interpreted by us (though assigned to the Aptian by Leanza 1963, 1967c). Another determination (Bowen, 1963) based probably on *Neobibolites* cf. *semicanaliculatus* (Aptian) yielded temperatures of 30.7° to 32.7° C. Both ages and identifications lack certainty, because of inattention to precise age or precise identification.

Such temperatures are considerably higher than those of Australia. From Lake Eyre, central Australia, specimens of *Peratobelus* gave average values of 13.8° C and 16.5° C, comparable to temperatures found at about 40° south, and accepted as reasonable by Day (1969). There is no result for this part of the column in New Zealand. Such a wide difference between these results would suggest very low latitudes for Patagonia, in contrast to high latitudes for Australia, in conflict with reconstructions based on paleomag-

netic and paleontologic data. Most authors agree that the Patagonian results seem anomalously high (Bowen, 1966), and note must be taken of criticisms of poor procedures in analyses and reliability of the samples, possibly applicable to the Patagonian results (Stahl and Jordan 1969; Longinelli 1969).

ACKNOWLEDGEMENTS

We thank Dr. R. W. Day, Australian National University, Canberra, and Dr. I. G. Speden, New Zealand Geological Survey, Lower Hutt, for information as acknowledged in the text, and gift of duplicates. We also acknowledge helpful exchange of information about the ammonite ages with Dr. M. R. A. Thomson, British Antarctic Survey. Photographs are by Mr. B. O'Donovan, and two text figures by Mr. F. Jurgenheit, Department of Geology, University of Toronto. In the text, systematics is principally by J. B. Waterhouse, the ammonite ages by A. C. Riccardi and the paleogeography by the both of us.

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NOTA DEL EDITOR

En el trabajo de C. S. Churcher, "OBSERVACIONES SOBRE EL STATUS TAXONÓMICO DE *Epieuryceros* AMEGHINO 1889 Y SUS ESPECIES *E. truncus* Y *E. proximus*", publicado en el número 10 del tomo IV de AMEGHINIANA, con respecto al párrafo de la página 353 donde dice: "...Más aún: describió una especie nueva, *E. proximus*, fundada en un buen ejemplar de muda de cornamenta recogida por el señor Edgardo Rohn, en 1944, en la playa de las barrancas derechas del Río Paraná...". la Dra. Pierina Pasotti nos envió una nota donde aclara que "el ejemplar de *E. proximus* fue exhumado por el señor Edgardo Rohn, en 1944, de la barranca de la ribera derecha del río Paraná".