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Aalenian (Jurassic) Ammonite Faunas and Zones of the Southern Andes[1])

By

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With 10 figures in the text and 10 plates

ABSTRACT

The stratigraphically most complete Aalenian sections of the southern Andes lie in the Chilean Precordillera between the Salar de Pedernales and the Rio Transito. Of particular importance are sections in the area east of Potrerillos, in the Quebrada El Bolito and about the Haciende Manflas. The best sections in west-central Argentina are near Malargue and Zapala.

In contrast to Europe, Hammatoceratidae are much more abundant in the South American Aalenian than Graphoceratidae. It is therefore mainly the Hammatoceratidae that furnish the biozonation in South America. Correlation with the European lower Aalenian is possible with representatives of the Leioceratinae of the Graphoceratidae as well as *Bredyia* of the Hammatoceratidae. Important for upper Aalenian correlations are cosmopolitan Hammatoceratidae as well as *Tmetoceras* known to range only to the Aalenian/Bajocian boundary.

The following ammonite zones are distingushed (from below): (1) Assemblage zone of *Bredyia manflasensis* [nov.] ≃ Opalinum + Scissum Standard Zones; (2) Assemblage zone of *Zurcheria groeberi* (in Chile with abundant *Parammatoceras jenseni* n. sp.) ≃ Murchisonae Standard Zone; (3) Assemblage zone of *Puchenquia malarguensis*, with range-subzones of (a) *P. compressa* [nov.] ≃ lower Concava Standard Zone, and (b) *P. mendozana* [nov.] ≃ upper Concava Standard Zone, as well as the (c) zonule (horizon) of *Podagrosiceras maubeugei* [nov.] ≃ Aalenian/Bajocian boundary.

The systematic part particularly describes the Chilean ammonites of the Aalenian. *Bredyia* is represented with two new species; *Parammatoceras* with one new species; the abundant *Puchenquia (Gerthiceras)* yielded one new subspecies; partly new representatives of *Leioceras* occur scarcely; one specimen could belong to a new species of *Ludwigia*. Representatives of *Tmetoceras*, *Planammatoceras*, *Eudmetoceras*, *Fontannesia?*, *Podagrosiceras* and *Zurcheria* are placed in previously known species.

KURZFASSUNG

Die sowohl sedimentär als auch biostratigraphisch vollständigsten Profile des Aalenium der südlichen Anden liegen in der chilenischen Präkordillere zwischen dem Salar de Pedernales und dem Rio Transito. Besonders wichtige Profile liegen im Gebiet östlich von Potrerillos, in der Quebrada El Bolito und im Gebiet der Hacienda Manflas. Die besten und vollständigsten Abfolgen des argentinischen Aalenium befinden sich im Malargue-Gebiet der südlichen Provinz Mendoza und im Gebiet von Zapala der südlichen Provinz Neuquén.

Im Gegensatz zu Europa sind Hammatoceratidae im südamerikanischen Aalenium sehr viel häufiger als Graphoceratidae. Vor allem Hammatoceratidae sind es deshalb, die zur Biozonierung des südamerikanischen Aalenium herangezogen werden können. Ein Vergleich mit Europa ist im tieferen Aalenium mit seltenen Vertretern der Leioceratinae der Graphoceratidae und *Bredyia* der Hammatoceratidae möglich. Für den Vergleich des höheren Aalenium sind weltweit auftretende Hammatoceratidae wichtig sowie das letzte Vorkommen von *Tmetoceras* im Aalenium/Bajocium-Grenzbereich.

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Die folgenden Ammoniten-Zonen werden unterschieden (von unten): (1) Faunizone der *Bredyia manflasensis* [nov.] ≃ Opalinum + Scissum Standard-Zonen; (2) Faunizone der *Zurcheria groeberi* (in Chile häufig *Parammatoceras jenseni* n. sp.) ≃ Murchisonae Standard-Zone; (3) Faunizone der *Puchenquia malarguensis*, mit den Subzonen der (a) *P. compressa* [nov.] ≃ untere Concava Standard-Zone und (b) *P. mendozana* [nov.] ≃ obere Concava Standard-Zone sowie (c) der Horizont (Zonule) des *Podagrosiceras maubeugei* [nov.] ≃ Aalenium/Bajocium-Grenzbereich.

Im systematischen Teil werden hauptsächlich in Chile auftretende Ammoniten des Aalenium beschrieben. *Bredyia* ist mit zwei, *Parammatoceras* mit einer neuen Art vertreten. Das häufige *Puchenquia (Gerthiceras)* lieferte eine neue Unterart, Vertreter von *Leioceras* sind selten. Nicht mit Sicherheit war ein Exemplar *Ludwigia* zuzuordnen. Vertreter von *Tmetoceras*, *Planammatoceras*, *Eudmetoceras*, *Fontannesia?*, *Podagrosiceras* und *Zurcheria* lassen sich mit bereits bekannten Arten vergleichen.

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1. INTRODUCTION

We describe Aalenian ammonites most of which were collected by v. Hillebrandt and found especially in Chile. They were examined in their entirety by Westermann in Berlin and his expenses were financed by the National Sciences and Engineering Research Council of Canada. The Chilean sections were measured during a stay as visiting professor at the Department of Geology of the University of Chile in Santiago de Chile (1966–1968) and during later expeditions to Chile (1971/72, 1979) which were supported by the Deutsche Forschungsgemeinschaft. The ammonites of the Argentinian Aalenian have already been described by Westermann & Riccardi (1972, 1975, 1979, 1982) who also included some Chilean collections. Some additional collections (v. Hillebrandt) from Argentina are also examined here.

Zonal names are printed differently here according to their meaning. The names of standard zones, defined by "golden spikes" at their base in type sections, are capitalized and in Roman, without the generic part (e. g. Opalinum Zone); names of formal zones, defined by faunal assemblages and species ranges, use the normal, italicized and complete form of the species, with the word Zone capitalized (e. g. *Emileia* / or *E. giebeli* Zone); informal zonal names would be written like the latter with "zone" in lower case (e. g. *P. alanus* zone).

We thank all colleagues, friends and institutions for their support and help during in field and laboratory. The photographs of the ammonites were taken by Mr. B. Kleeberg and most of the textfigures were drawn by Mrs. B. Dunker (Institut für Geologie und Paläontologie der Technischen Universität Berlin).

The recorded and figured specimens were reposited in the following collections under the catalogue numbers listed in the text and plate explanations:

BSTM Bayerische Staatssammlung für Paläontologie und Historische Geologie, München.

MCM Department of Geology, McMaster University, Hamilton, Ontario, Canada.

Field numbers mentioned in the text belong to collections made by v. Hillebrandt.

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2. STRATIGRAPHY

(v. Hillebrandt & Westermann)

2.1 FOSSIL LOCALITIES IN CHILE

Sediments of Aalenian age are unknown from the Coastal Cordillera. Within the Precordillera and the High Cordillera three different regions may be distinguished.

2.1.1 Northernmost Chile (18°30′ to 26° latitude South)

Between the border with Peru and the southern end of the Cordillera Domeyko (26° latitude south) localities with Aalenian ammonites are very rare, and it is usually difficult to document the Aalenian.

Biese (1957, 1961) described the Jurassic of the Cerritos Bayos region and also mentioned Aalenian sediments. Baeza (1979) revised the Jurassic of this region but was unable to document the Aalenian. Although uncontestable Aalenian ammonites have not been described from Cerritos Bayos, trigonids and other pelecypods from Biese's "lower and upper *Ctenostreon* beds" (probably the same beds) suggest Aalenian. However, a revision of Biese's collections is necessary.

Cecioni (in Garcia 1967) recorded *Leioceras* sp. from Jurassic sediments east of the Moctezuma Observatory (southeast of Calama), but the identification has not been verified and this could also be a Middle or Upper Toarcian ammonite. In the region of the Cordillera Domeyko most Jurassic sections seem to be complete and without hiatus, but it is usually difficult to document the Aalenian by ammonites or other fossils.

3,5 km northwest of Cerro Bayo (topographic map 1:100000, Augusta Victoria) a series of more or less arenaceous marls and limestones yields very rare ?*Puchenquia* and belemnites of Aalenian age.

7,2 km westsouthwest of Cerro Guanaco and 1 km eastsoutheast of point 3616 (topographic map 1:100000, Sierra de Varas) a dark limestone has yielded *Puchenquia (Puchenquia) malarguensis* (Burckhardt) and *Sonninia (Euhoploceras) amosi* Westermann & Riccardi of Upper Aalenian age (*P. malarguensis* Zone).

Recently the Jurassic of this region was mapped in detail by V. Bogdanić (Universidad del Norte, Antofagasta). He found at different sections *Puchenquia (Gerthiceras).*

At Quebrada de Los Burros and southeast of this Quebrada (southernmost part of topographic map 1:100000, Exploradora) a very complete and thick Jurassic section is exposed. The first horizon with ammonites belongs to Middle Sinemurian and the section ends with Oxfordian limestones. Sandy limestones with marly layers and *Phlyseogrammoceras tenuicostatum* (Jaw.) are followed by nodular limestones with *Pleydellia.* This series is approximately 50 m thick and belongs to the Upper Toarcian. The uppermost bank of this series is rich in rhynchonellids and terebratulids, and *Bredyia manflasensis* n. sp. is found together with *Sphaerocoeloceras* sp. This horizon is Lower Aalenian (*B. manflasensis* Zone). The following, more or less calcareous marls with concretions contain in the lower part only indeterminable ammonites. In younger horizons several layers with concretions have yielded *Dorsetensia, Chondroceras, Stephanoceras* and *Teloceras* of late Early Bajocian age.

2.1.2 Salar de Pedernales to Rio Transito (26° to 29° latitude South) (Text-fig. 1a)

The best localities with the most complete Aalenian sections occur in the Precordillera between the Salar de Pedernales, in the North, and the Rio Transito, in the South. Only those sections and localities are described here which have yielded identifiable Aalenian ammonites. Most of the sections have been described previously (Hillebrandt 1973, 1977; Hillebrandt & Schmidt-Effing 1981) so that we will refer to these works. Most specimens then referred to *Eudmetoceras* Buckman are now identified with the new subgenus *Puchenquia (Gerthiceras)* Westermann & Riccardi.

Not all localities or sections include the entire set of Aalenian assemblage zones or subzones established here for South America. The best sections with all or nearly all zones are found in the Potrerillos area, the Quebrada El Bolito and in the area of Hacienda Manflas. In this entire region, the Aalenian begins with a bioclastic limestone, more or less sandy and fossiliferous. At different sections the lower part of this limestone belongs to the uppermost Toarcian and the upper part to the *B. manflasensis* Zone. At some localities a hiatus is present between this limestone and the underlying beds (Hillebrandt 1971, Fig. 5). In the Manflas areas the *B. manflasensis* Zone is represented by a Fe-oolite, more or less sandy or calcareous. At different localities the following limestone bed is rich in *Entolium* and an ammonite assemblage of the *Z. groeberi* Zone. The sediments of the *P. malarguensis* Zone consist at most localities of a series of more or less micritic limestones with marly layers, at least in the central part of this area, while the easternmost localities have predominantly bioclastic limestones. The Aalenian sediments of some westernmost sections (Quebrada Paipote near Redonda, Quebrada Cortaderita (Hillebrandt & Schmidt-Effing 1981) are more sandy and also contain conglomeratic layers.

2.1.2.1 Salar de Pedernales

From the western margin of the Salar, Hillebrandt & Schmidt-Effing (1981) have described a section extending from the Pliensbachian to the Callovian. Several meters of limestones near the base of the Aalenian have yielded abundant rhynchonellids and terebratulids, less abundant bivalves and rare *Pleydellia* cf. *fluitans* and *Bredyia manflasensis* n. sp. The age of these beds is therefore uppermost Toarcian ("P. fluitans" Zone) to lower Aalenian (*B. manflasensis* Zone). The next ammonite-bearing horizon is 150 m higher up containing a fauna of the *Humphriesianum* Zone as described by Westermann & Riccardi (1979).

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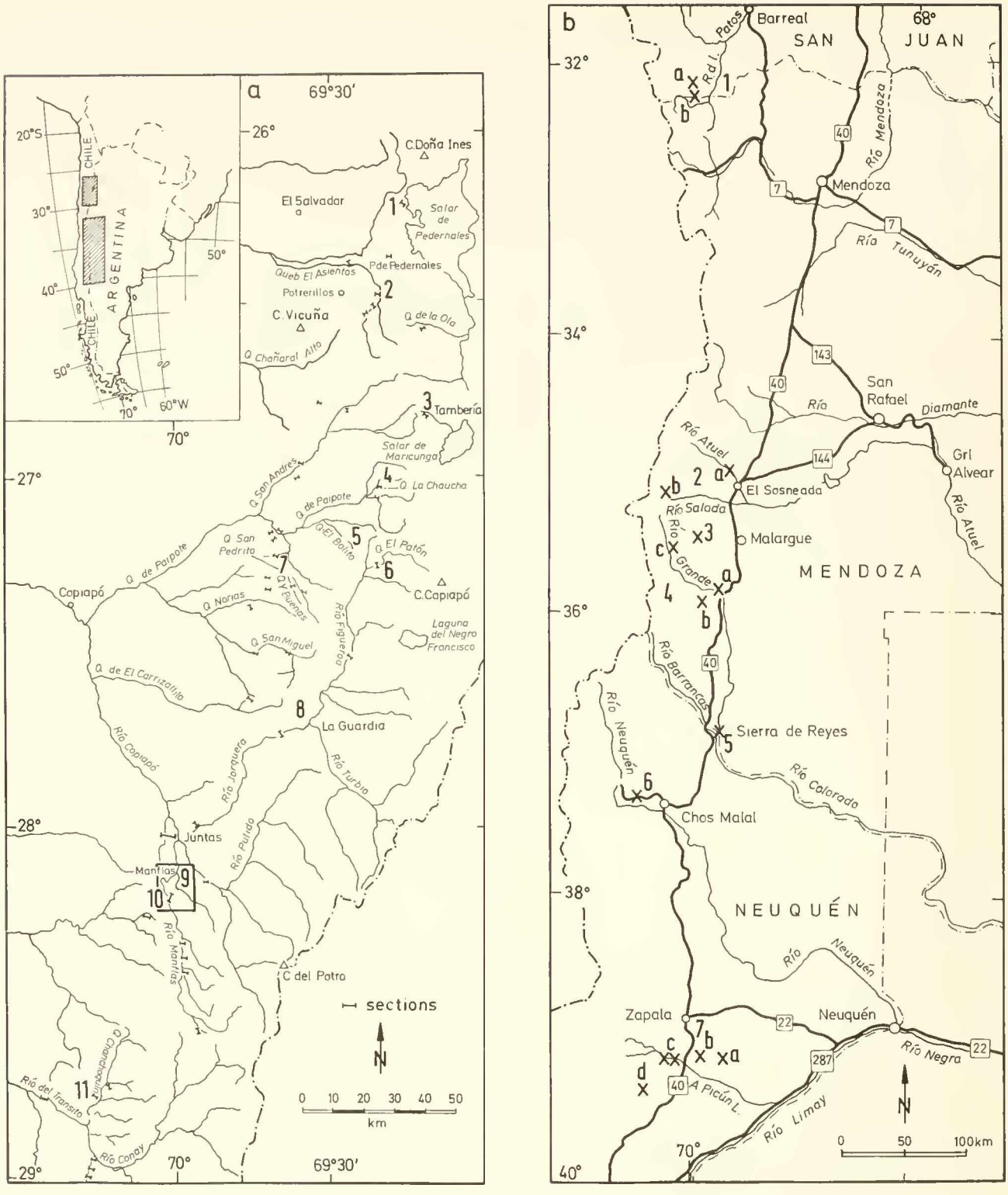

Text-fig. 1. Locality maps; a, Chile; b, Argentina; numbers correspond to numbers in text.

2.1.2.2 Potrerillos area

East of Potrerillos, several Jurassic sections were measured in the Rio de la Sal, at Portezuelo de Pedernales, in the Quebrada El Asiento and in the Quebrada El Hueso (Hillebrandt & Schmidt-Effing 1981, Figs. 2, 3). Several ammonite horizons can be distinguished in the Aalenian. From Portezuelo de Pedernales to Quebrada El Hueso, the nodular limestones of the Middle Toarcian are overlain by 4–6 m of bioclastic limestones. These have 0.3–1.0 m beds and reach with small pockets and burrows up to 0.30 m into the subjacent limestones. A large terebratulid is particularly common in the highest bed, while a level with a rhynchonellid occurs in another section (section 6). Bivalves are less common but often articulated. Regular echinoids are rare.

In the lower part of the bioclastic limestones occurs *Pleydellia* cf. *fluitans* (bed 8); in the upper part *Bredyia manflasensis* n. sp. and *B. delicata* n. sp. (bed 9; Hillebrandt & Schmidt-Effing 1981, Fig. 3). At Portezuelo de Pedernales,

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these bioclastics have also yielded *Catulloceras*, a genus restricted to the Upper Toarcian. While the beds with *Pleydellia* cf. *fluitans* are uppermost Toarcian *(Aalensis* Subzone), the beds with *B. manflasensis* and *B. delicata* belong in the Lower Aalenian *(B. manflasensis* Zone). The Toarcian/Aalenian boundary therefore lies within the 4–6 m thick bioclastic limestones.

Above the bioclastic limestones 4–5 m thick fossiliferous nodular limestones follow with abundant large, partly articulated *Entolium*. About 2–3 m above base, the upper Quebrada El Asiento (sections 1 to 8; Hillebrandt & Schmidt-Effing 1981, Fig. 2; bed 10, Fig. 3) has yielded abundant *Paraammatoceras jenseni* n. sp., *Podagrosiceras athleticum* Maub. & Lamb. and *Zurcheria groeberi* West. & Ricc. In Quebrada El Hueso, section 1, the beds with *P. jenseni* are at least 5 m thick.

The succession continues with nodular to well bedded, partly thick-bedded limestones (bed 11) which are characterized by *Puchenquia (Gerthiceras) compressa* West. & Ricc. and *P. (G.) mendozana spinosa* n. ssp. These beds have also yielded *Podagrosiceras* aff. *athleticum* and *Zurcheria groeberi*. A single *Fontannesia ? austroamericana* Jaw. from section 8 (Hillebrandt & Schmidt-Effing 1981, Fig. 2) probably also originated from this interval. These beds probably also yield *Planammatoceras (Pseudaptetoceras) klimakomphalum* (Vacek), *P. (Ps.) tricolore* West. & Ricc. and *Eudmetoceras eudmetum jaworskii* West. In sections 1 to 6 the lowest beds with *P. compressa* are followed by the 1.5 m bed 12 (Hillebrandt & Schmidt-Effing 1981, Fig. 3) consisting mainly of articulated *Lopha*.

The upper part of the nodular limestones (bed 13) has yielded *Puchenquia (Gerthiceras) mendozana, P. (G.) compressa?, P. (P.) malarguensis, Planammatoceras (Pseudaptetoceras) tricolore, P. (P.) klimakomphalum?*, and *Eudmetoceras* cf. *eudmetum jaworskii*.

Directly above bed 13 (and probably within) *Tmetoceras* ex gr. *scissum* (Ben.) and *T.* cf. *flexicostatum* West. (bed 14) occur. Bed 15 contains *Podagrosiceras maubeugei* West. & Ricc. („*Abbasites*" of Hillebrandt & Schmidt-Effing 1981). Bed 16 at the top of the limestones was probably the source of *Pseudotoites* cf. *sphaeroceroides* (Torn.) indicating basal Bajocian. In sections 3 to 6, 1.5 to 2 m above bed 15, a conglomerate (5 to 10 cm thick) and thinbedded sandstones with rhynchonellids, belemnites, ?*Xenocephalites*, and ? *Epistrenoceras* of Upper Bathonian and ? Callovian age follow disconformably.

In section 8, about 5 m above limestones with ? *Puchenquia* and *Fontannesia ? austroamericana*, there is a bed rich in fossil fragments, *Gryphaea* and *Epistrenoceras* of Upper Bathonian age. The following sandstones with only badly preserved Eurycephalitinae are of Upper Bathonian or Callovian age.

Southwest of Portezuelo de Pedernales, bioclastic and partly nodular limestones with *Puchenquia (Gerthiceras) compressa*, below, and *Planammatoceras (Pseudammatoceras) tricolore*, above, are overlain by ca. 20 m well bedded limestones with *Bositra, Dorsetensia* and *Stephanoceras* of the *Humphriesianum* Zone. In contrast to Quebrada El Asiento, but similar to Salar de Pedernales, this succession reaches into the upper Lower Bajocian.

In the area of Rio de la Sal, section 16 (Hillebrandt & Schmidt-Effing 1981, Fig. 2) has thick-bedded bioclastic limestones (? boundary Toarcian/Aalenian) superjacent to conglomeratic sandstones and nodular limestones with *Phymatoceras* (Upper Toarcian). Above thin-bedded bioclastic limestones follow with sections of ? *Puchenquia (Gerthiceras)* and, about 20 m higher, a bed with rhynchonellids, *Planammatoceras* cf. *klimakomphalum* and *Puchenquia (Gerthiceras) compressa*.

2.1.2.3 Quebrada Caballo Muerto (Text-fig. 2)

Between Portezuelo Codocedo and Salar de Maricunga, upstream from the watering place Caballo Muerto, a Jurassic outcrop crosses the Quebrada Caballo Muerto (Tamberia section in Hillebrandt & Schmidt-Effing 1981, Fig. 1). Subjacent to the fossiliferous Jurassic there is a ca. 35 m series of gray, brown weathering thick-bedded sandstones with white clasts near the base. Below a series of red, light-gray and greenish sandstones follows and conglomerates which rest on volcanites. Both series are unfossiliferous but probably terrestrial Triassic.

The marine Jurassic begins with a ca. 2 m fossiliferous sandstone with 0.1–0.2 m beds (Bed 1, Text-fig. 2). The fauna consists of rhynchonellids, terebratulids, various bivalves and rare *Protogrammoceras* and, like the basal bed of the Jurassic in the Quebrada El Asiento, is placed at the boundary Lower/Middle Pliensbachian. Above bioclastic limestones follow with abundant *Weyla* (bed 2) which intergrade upward into well bedded limestones. They include bed 3 with *Pectinula cancellata* Leanza characteristic of the Pliensbachian/Toarcian boundary (?). Bed 4 consists of 3–5 m gray sandstones with large *Weyla*. Above 1 m coarse sandstone and bed 5 follow a fossiliferous limestone with abundant *Isognomon* sp., *Heterostrea steinmanni* Jaw., *Ctenostreon* cf. *pectiniforme* (Schloth.), *Trigonia* sp., *Neocrassina* cf. *andium* (Gott.), *Trigonastarte* (?) *steinmanni* (Mör.), *Pleuromya* sp. and terebratulids. This fauna is coeval to the beds with *Pleydellia (Walkericeras)* cf. *fluitans* (Dum.) and *Bredyia manflasensis* of other sections and should be placed at the Toarcian/Aalenian boundary.

The superjacent bioclastic limestones (bed 6, Text-fig. 2) yield abundant *Gryphaea* cf. *bilobata* Sow. and some *Puchenquia (Gerthiceras)* cf. *mendozana* West & Ricc. The highest bed (7) of the bioclastic limestones is rich in *Lopha* and *Gryphaea* cf. *bilobata* whereas ammonites are scarce, i. e. *Tmetoceras* cf. *flexicostatum* West. and *Podagrosiceras maubeugei* West. & Ricc. of the uppermost Aalenian. A large *Entolium* and *Pleuromya* have also been found.

Above the bioclastic limestones coarse sandstones follow with reddish interbeds and poorly preserved bivalves. There follows a poorly exposed series of bedded gray sandstones interbedded with bioclastic limestones (0.1–1 m) yielding *Reineckeia* sp., *Gryphaea* sp. and *Pinna* sp. (bed 8), of the Callovian. Thus, Bajocian and Bathonian have not been documented and are probably missing.

2.1.2.4 Quebrada La Chaucha

The Jurassic section was described by Hillebrandt & Schmidt-Effing (1981, Fig. 1, section 5a). The Aalenian has

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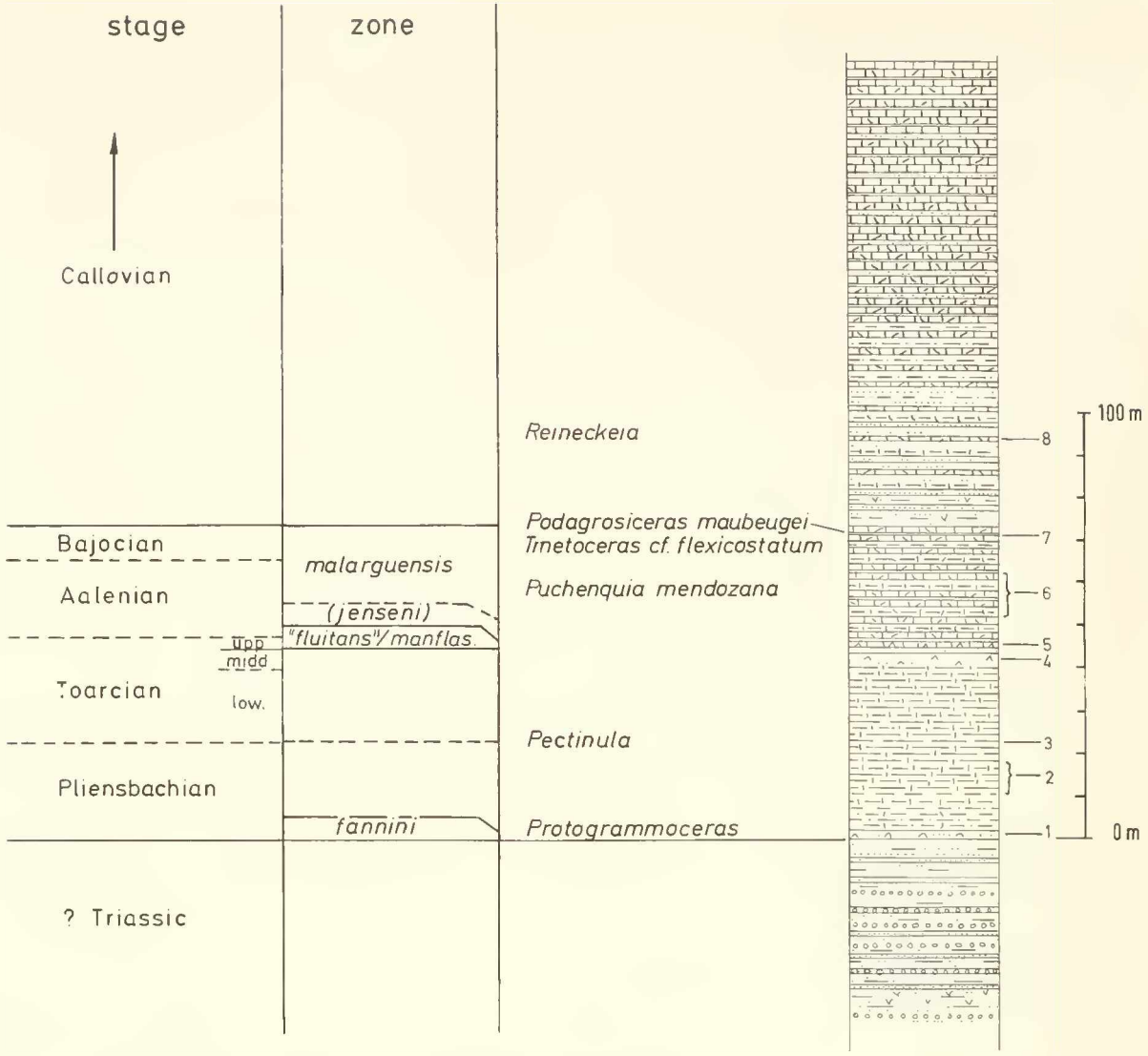

Text-fig. 2. Quebrada Caballo Muerto section, zones/subzones with brackets not proved by ammonites; explication of lithology in v. Hillebrandt & Schmidt-Effing 1981 (fig. 10).

two rich ammonite horizons. The ca. 2 m thick bioclastic limestone at the Toarcian/Aalenian boundary has yielded *Bredyia manflasensis* n. sp. and *B. delicata* n. sp. From the superjacent marly limestones *Tmetoceras* ex gr. *scissum* Ben. came at 1–1.5 m above base, and *Puchenquia malarguensis* (Burck.), *P. (Gerthiceras) compressa* West. & Ricc. and *Podagrosiceras* aff. *athleticum* Maub. & Lamb., at 2–4 m. The next ammonite bearing horizon ca. 30 m above belongs in the *P. singularis* Zone of the Lower Bajocian.

2.1.2.5 Quebrada El Bolito

The Jurassic section was described and illustrated by Hillebrandt & Schmidt-Effing (1981, Fig. 1, section 7; Fig. 5). Several ammonite horizons can be distinguished in the Aalenian. The Middle Toarcian is overlain by 4–4.5 m thick bedded, fossiliferous calcarenites. Near the base occurs abundantly *Pleydellia (Walkericeras)* cf. *fluitans* (Dum.) (bed 11); bed 12, in the middle, has yielded *Bredyia manflasensis* n. sp.; and bed 13, at the top, contains large *Entolium* sp. together with scarce *Parammatoceras jenseni* n. sp. The faunal succession is as in the area east of Potrerillos where the bioclastic limestones contain the "*P. fluitans*" Zone and the *manflasensis* and *jenseni* assemblages (*B. manflasensis* and *Z. groeberi* Zones).

Above the bioclastic limestones two (0.2 and 0.15 m) beds of dense limestone with oysters and poorly preserved ammonites follow. They are overlain by ca. four 0.1–0.3 m beds of reddish limestone (bed 14) with abundant ammonites which are usually fragmented and disoriented. We have identified *Fontannesia* ? cf. *austroamericana* Jaw., *Planammatoceras (Pseudammatoceras) klimakomphalum* (Vacek), *Eudmetoceras eudmetum jaworskii* West., *Puchenquia (Gerthiceras) compressa* West. & Ricc., and *P. (G.) mendozana spinosa* n. ssp. This is the *compressa* assemblage (lower *P. malarguensis* Zone).

Above a series of marls and limestones follows, with 3 thick, gray to reddish limestone beds in the upper part (bed 15) which have yielded *Puchenquia (P.) malarguensis* (Burck.) and *P. (Gerthiceras) mendozana* of the *mendozana* assemblage (middle *P. malarguensis* Zone). The superjacent series of reddish and brownish, middle to coarse sandstones und conglomerates, is unfossiliferous, whereas the following thick series of thick-bedded sandstones and bioclastic limestones belongs already probably to the Callovian.

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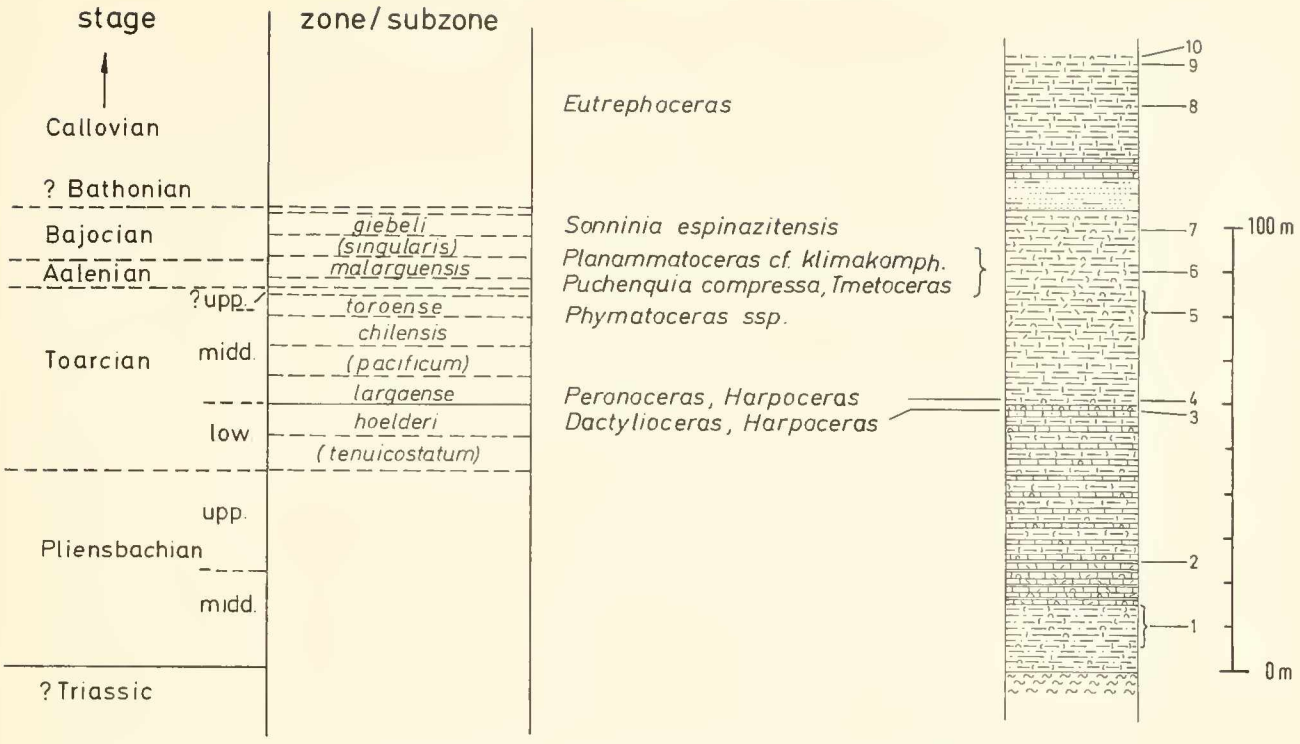

Text-fig. 3. Quebrada El Patón section; zones/subzones with brackets not proved by ammonites.

2.1.2.6 Quebrada El Patón (Text-fig. 3)

This is the northern continuation of the Rio Figueroa (Hillebrandt & Schmidt-Effing 1981, Fig. 1). The section has been described by Hillebrandt (1973, Fig. 1) under Rio Figueroa. The section lies between the tributary Quebradas del Azufre and El Carnero and contains an ammonite horizon in the Aalenian.

Reddish to violet porphyritic tuffs (?Triassic) are overlain by sandy and marly, nodular bioclastic limestones (bed 1, Text-fig. 3) of the Middle Pliensbachian which contain mainly bivalves, rhynchonellids and terebratulids as well as some *Andenipora liasica* GERTH and gastropod steinkerns. This is followed by thick-bedded limestones with large terebratulids and *Weyla*, and thinner bedded, partly nodular limestones with abundant *Entolium* (bed 2) at least in one bed. This series is topped by 5 m brownish weathering limestones of which the upper 1.5 m (bed 3) contain abundant terebratulids, rhynchonellids, bivalves, *Dactylioceras* and *Harpoceras* of the *D. hoelderi* Zone, Lower Toarcian (Hillebrandt & Schmidt-Effing 1981). Above 2 m gray bioclastic limestones (bed 4) follow in sequence with terebratulids, rhynchonellids, *Myophorella, Harpoceras, ?Mercaticeras* and *Peronoceras* of the *P. largaense* or *P. pacificum* Zone, Middle Toarcian; ca. 10 m marly limestones and bioclastic limestones (bed 5) with *Phymatoceras* cf. *iserense* (OPPEL), *P.* cf. *erbaense* (HAUER), *P. toroense* HILLEBRANDT and *Hildaitoides retrocostatus* HILLEBRANDT of the *C. chilensis* and *P. toroense* Zones, Middle Toarcian.

The superjacent nodular bioclastic limestones (bed 6) contain abundant *Gryphaea* cf. *bilobata* SOW. and *Myophorella* sp. as well as the late Aalenian *(compressa* assemblage?) ammonites *Tmetoceras* cf. *flexicostatum* WEST., *Planammatoceras (Pseudammatoceras)* cf. *klimakomphalum* (VACEK) and *Puchenquia (Gerthiceras) compressa* WEST. & RICC.

The superjacent bioclastic limestones (with bed 7) have yielded *Sonninia (Papilliceras)* cf. *espinazitensis* TORN. of the Lower Bajocian (? *E. giebeli* Zone). This is followed by sandstones, limestones and marls containing nautiloids, gastropods, brachiopods and echinoids (beds 8–10), and by a thick series of bioclastic limestones and dense limestones with corals, bivalves and gastropods as well as a few fragments of ?Reineckeiidae in the upper part, indicating ?Upper Bathonian and Callovian. Above arenaceous marls and dense limestones lie, followed by hundreds of meters of red terrestrial sandstones.

2.1.2.7 Quebrada San Pedrito to Quebrada Yerbas Buenas

The Jurassic exposure between these two quebradas were described by Hillebrandt (1973, Fig. 1) and Hillebrandt & Schmidt-Effing (1981, Fig. 6). At the confluence of the Quebradas San Pedrito and Pelado there is a Pliensbachian-Bajocian section. Above the beds with *Phymatoceras* of the lower Upper Toarcian a bioclastic limestone follows which has yielded rare *Bredyia manflasensis* n. sp., *Hudlestonia*(?), *Pleydellia* and terebratulids as well as the abundant bivalves *Heterostrea steinmanni* JAW., *Ctenostreon* cf. *pectiniformis* (SCHLOTH.), *Mesomiltha* spp., *Neocrassina andium* (GOTT.), *Trigonastarte*(?) *steinmanni* (MÖR.), *Protocardia* (?) and *Pleuromya;* the upper 0.5 m is rich in *Entolium*. As in the other sections, this bioclastic limestone belongs to the Toarcian/Aalenian boundary.

Above follow marls with a lenticular limestone containing *Emileia giebeli* (GOTT.), *Sonninia (Fissilobiceras)* sp. and *S. (Papilliceras) espinazitensis* TORN. of the Lower Bajocian *E. giebeli* Zone.

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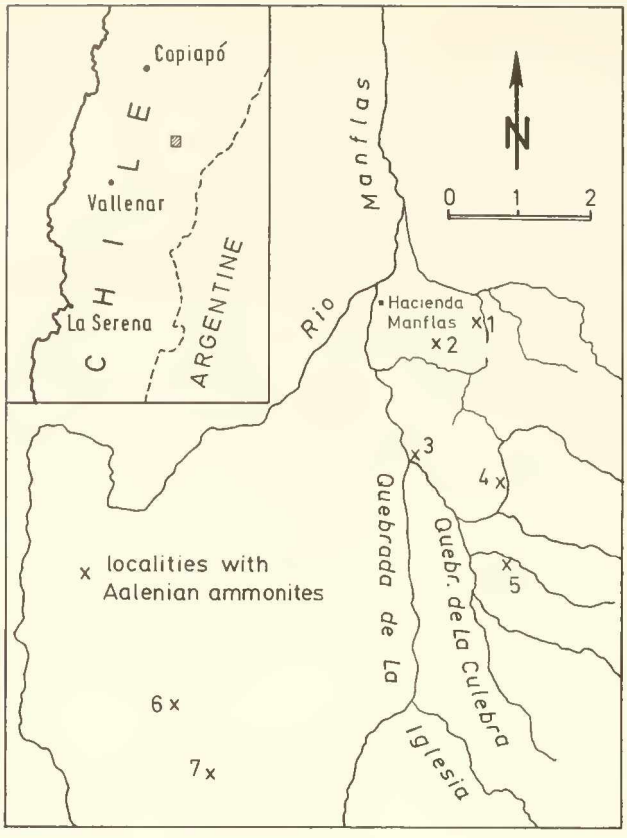

Text-fig. 4. Locality map of the Manflas region and Portezuelo El Padre.

In Quebrada Yerbas Buenas, the section ends in at least 2–3 m bioclastic limestones which contain *Bredyia manflasensis* n. sp. and a bivalve fauna similar to that listed above. As in Quebrada San Pedrito, these beds overlie beds with *Phymatoceras* and part of the Upper Toarcian is absent.

2.1.2.8 Rio Jorquera (La Guardia)

The Jurassic exposures along the upper Rio Jorquera (between Vegas de Chañar and La Guardia) was described by Hillebrandt & Schmidt-Effing (1981). The section 2.5 km west of La Guardia and above Las Banderites (op. cit., Fig. 1, section 14c; p. 23) is continuous from the Lower Pliensbachian to the Callovian.

Nodular calcarenites with *Pleydellia (Walkericeras)* cf. *lotharingica* (Branco), topmost Toarcian, are overlain by 2 m bioclastic limestones with *Bredyia manflasensis* n. sp. of the basal Aalenian. This level also contains abundant Isognomiidae gen. et sp. n. (aff. *Gervilleioperna*), a large and thick-shelled species characteristic for this level in several sections. *Chlamys*, *Ctenostreon* and terebratulids have also been found.

The superjacent ca. 2 m limestones contain abundant *Entolium* and *Chlamys* as well as rare ?*Parammatoceras* (?*Z. groeberi* Zone). This is followed by 3 up to 1 m thick limestone beds with *Gryphaea* and rare fragmented ?*Puchenquia (Gerthiceras)* sp. of the (?) *compressa* or *mendozana* assemblages (*P. malarguensis* Zone).

2.1.2.9 Manflas
(Text-fig. 4)

The Jurassic east and south of the Hacienda Manflas is divided by a N-S fault. At the north end of the fault, ca. 1.5 km east of Manflas, the eastern Jurassic section terminates with the Pliensbachian, but it becomes more complete southward, finally terminating with the Callovian. The two blocks differ little in facies, the western block having a thicker and more arenaceous development particularly in the Sinemurian (western providence). Facies differences are marked only in the Toarcian and Aalenian. The red colouration of the Upper Toarcian is better developed in the west; the Lower Aalenian 3.5 m Fe-oolite of the western block is represented in the east by a single Fe-oolitic bed and thin limestones. A second Fe-oolite is developed at the boundary Lower/Upper Bajocian. The Jurassic of the western block, from the uppermost Toarcian to the Callovian and some of the Bajocian ammonites were described by Westermann & Riccardi (1972) and Hillebrandt (1977).

In both fault blocks, the Jurassic section begins with the Upper Sinemurian and is continuous to the Lower/Upper Bajocian boundary. This is followed by ca. 20 m Callovian limestones, the youngest fossil-bearing Jurassic rocks of the area. Most of the Upper Bajocian and Bathonian are missing. Several sections yielded Aalenian ammonites.

Localities 1 and 2 (Text-fig. 4) lie on the ridge (Cerro de la Cuesta) SE of the Hacienda Manflas. Triassic andesites are

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here in fault contact with Sinemurian or Pliensbachian marls. Brownish weathering Lower Toarcian sandstones with *Propeamussium* are overlain by Middle Toarcian gray and reddish marls. Red marly limestones and marls are predominant in the Upper Toarcian. These become upward increasingly arenaceous and intergrade into the Lower Aalenian Fe-oolite. Several meters of light gray marls and marly limestones above can be placed in the Middle Aalenian. The Fe-oolite is repeated three times by folding. An acidic igneous dyke has intruded into the Aalenian/Bajocian boundary beds and was also folded. Above a series of marly limestones and partly red sandstones follows, overlain by the Bajocian Fe-oolite.

Locality 1 (Text-fig. 4) is 1,5 km ESE of Hacienda Manflas on the north side of Cerro de la Cuesta. Here the easternmost outcrop of the Aalenian Fe-oolite occurs reaching almost to the base of the slope. The section is from the top:

Age	Field-number	Thickness	Facies and Fossils
Aalenian		ca. 4 m	Arenaceous to calcareous Fe-oolite, partly crystalline, massive.
? *Z. groeberi* Z.	670812/5		At the top abundant *Entolium*, upper 2 m fossiliferous: large *Phylloceras* sp.,
B. manflasensis Z.			*Sphaerocoeloceras brochiiforme* Jaw., ? *Zurcheria* sp., *Bredyia manflasensis* n. sp., *B. delicata* n. sp., *Trigonia* sp., *Neocrassina andium* (Gott.), *Trigonastarte* (?)*steinmanni* (Mör.), *Pleuromya*, *Ceratomya* (?).
		2 m	Red calcarenite with shell fragments, *Lopha*.
		0.25 m	Red calcarenite with shell fragments and Fe-ooides.
Upper Toarcian			
"*P. fluitans*" Z.	720105/4	1 m	Red, bedded calcarenite with shell fragments and some Fe-ooides; in middle: *Hammatoceras* sp.
		ca. 24 m	Red, fine-bedded calcarenites, partly nodular, and interbedded marls.
"*P. fluitans*" Z.	720105/3		Above: *Pleydellia* cf. *fluitans* (Dum.)
	/2		Below: *Pleydellia* sp.
"*P. lotharingica*" Z.	/1	ca. 10 m	Red, nodular marls to marly limestones. *Pleydellia* cf. *lotharingica* (Branco).

The light-gray marls and marly limestones above the Fe-oolite are poorly exposed. One *Planammatoceras (Pseudaptetoceras?)* cf. *kochi* (Prinz) probably comes from this interval.

Locality 2 (Text-fig. 4) is on the ridge of Cerro de la Cuesta. The ammonites came from the several meters of marls and marly limestones superjacent to the Fe-oolite (cf. Westermann & Riccardi 1972, p. 20): *Tmetoceras* ex gr. *scissum* (Benecke), *T.* cf. *flexicostatum* West., *Planammatoceras (Pseudaptetoceras)* cf. *klimakomphalum* (Vacek), *P. (Ps.?)* cf. *kochi* (Prinz), *Puchenquia (Gerthiceras) compressa* West. & Ricc., *P. (G.) mendozana* West. & Ricc., *Fontannesia ? austroamericana* Jaw. and *Sonninia (Euhoploceras* ?) sp.; also abundant rhynchonellids, terebratulids and *Pleuromya* sp. These belong in the *P. compressa* and *P. mendozana* Subzones of the Upper Aalenian *P. malarguensis* Zone.

Locality 3 (Text-fig. 4) is near the mouth of Quebrada de la Culebra leading into the Quebrada de la Iglesia. The section begins in the uppermost Toarcian, includes the Bajocian Fe-oolite (Hillebrandt 1977, Fig. 2, locality 3) and ends in the Callovian. The arenaceous Fe-oolite of the Aalenian contains poorly preserved, large *Bredyia*. The uppermost meter is more calcareous and has small *Zurcheria* sp. This layer is probably already *Z. groeberi* Zone. Above the Fe-oolite 5–8 m gray limestones follow, partly with shell fragments. The upper part has yielded a *Puchenquia malarguensis* (Burck.) and is therefore *P. malarguensis* Zone.

Locality 4 (Text-fig. 4) is ca. 100 m west of the pass between the first tributary quebrada to Quebrada de la Culebra and a more northerly quebrada (unnamed) which also leads into the Quebrada de la Iglesia. The section situated in the eastern Jurassic block is as follows:

Age	Field-number	Thickness	Facies and Fossils
? Callovian		ca. 2 m	Strongly faulted gray limestone.
Bajocian		ca. 5 m	Red, thin-bedded calcarenites and marls.

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Age	Field-number	Thickness	Facies and Fossils
P. singularis Z. upper part	720104/9		Above: *Sonninia (Papilliceras) espinazitensis altecostata* Torn., *Pseudotoites sphaeroceroides* (Torn.), *P.* cf. *corona* (Arkell & Playford).
lower part	/8		Below: *Sonninia (Fissilobiceras) zitteli* (Gott.), *Pseudotoites* cf. *argentinus* Arkell, *P. singularis* (Gott.).
Aalenian		ca. 8 m	Dm-bedded dense limestone.
P. malarguensis Z.			Poorly preserved *Puchenquia (Gerthiceras)* sp.
Z. groeberi Z.	/7	ca. 2 m	Bioclastic limestones. *Entolium* and large *Parammatoceras jenseni* n. sp. (<0.5 m D).
B. manflasensis Z.	/6,6 a	ca. 0.5 m	Reddish bioclastic limestone with Fe-ooides. *Sphaerocoeloceras brochiiforme* Jaw., *Bredyia manflasensis* n. sp. (all forms and variants), *B. delicata* n. sp.
	/6		At base: *Leioceras comptum chilense* n. ssp., Leioceratinae n. gen. et n. sp. A., *Trigonia, Mesomiltha* spp., *Protocardia* (?), *Coelastarte andium* (Gott.), *Trigonastarte* (?) *steinmanni* (Mör.).
		ca. 8 m	Nodular, gray, dm-bedded calcarenites with thin marly interbeds.
B. manflasensis Z. or "*P. fluitans*" Z.	/5		At 0.3 m below top: ? *Bredyia*.
Upper Toarcian "*P. fluitans*" Z.	/4		Lower part: *Pleydellia* cf. *fluitans* (Dum.).
"*P. lotharingica*" Z.	/3	ca. 10 m	Nodular limestones interbedded with marls. *Pleydellia* cf. *lotharingica* (Branco).

Locality 5 (Text-fig. 4) is approximately 1 km south and in strike of locality 4, in the second, eastern tributary quebrada of Quebrada de la Culebra. The section begins with Upper Toarcian gray marls and marly nodular limestones containing moderately preserved *Phymatoceras copiapense* (Mör.) of the *P. copiapense* Zone. Above similar but partly reddish beds follow with *Phlyseogrammoceras* cf. *tenuicostatum* (Jaw.) of the *P. tenuicostatum* Zone; reddish nodular limestones with *Pleydellia* cf. *lotharingica* (Branco) and *Hammatoceras* ex gr. *insigne* (Schübler) of the "*P. lotharingica*" Zone; and thick-bedded (to 0.4 m) nodular calcarenites with *Pleydellia* cf. *fluitans* (Dum.), *Dumortieria* and *Hammatoceras* cf. *porcarellense* Bon. of the "*P. fluitans*" Zone.

The superjacent beds contain large, but moderately preserved hammatoceratids (*B. manflasensis* and ?*Z. groeberi* Zones). They are capped by a 0.2 m limestone bed with ammonites of the Late Aalenian *compressa* assemblage: (?) n. gen. et n. sp. A (aff. *Ludwigia crassa* Horn), *Planammatoceras (Pseudammatoceras)* cf. *tricolore* West. & Ricc., and *Puchenquia (Gerthiceras) compressa* West. & Ricc. (*P. malarguensis* Zone).

Above ca. 10 m interbedded dense gray limestone and gray marls follow, one layer with small *Gryphaea*. This is overlain by an approximately 100 m thick series of red, dm-bedded calcarenites and arenaceous limestones also interbedded with red marls. At least two levels have yielded *Sonninia*. The transition to the Bajocian Fe-oolite (Hillebrandt 1977, Fig. 2, locality 6) is not exposed. The oolite is only 2 m thick. The Jurassic section ends with structurally strongly disturbed limestones of the Callovian.

2.1.2.10 Portezuelo El Padre

The Jurassic section between the Rio Manflas and Portezuelo El Padre (Hillebrandt & Schmidt-Effing 1981, p. 24) exposes the Upper Sinemurian to the Lower Bajocian. The youngest beds are at Portezuelo El Padre. Localities 6 and 7 (Text-fig. 4) have yielded Aalenian ammonites. The basal Aalenian Fe-oolite is represented here by ca. 5 m red coarse sandstone with single clasts (< 5 mm) which contains rare and modestly preserved *Bredyia*. Above ca. 4 m gray limestones follow which intergrade into ca. 4 m thin-bedded and partly red marls. Below, the limestones contain abundant li-

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monite grains and *Puchenquia (Gerthiceras) compressa* WEST. & RICC. (Locality 6). Gray limestone beds with abundant shell fragments have yielded *Planammatoceras (Pseudaptetoceras)* cf. *klimakomphalum* (VACEK) and *Puchenquia (Gerthiceras) mendozana spinosa* n. ssp. (Locality 7). From a gray limestone bed with *Bositra* of the same locality *Podagrosiceras maubeugei* WEST. & RICC. came. The gray limestones thus include the *compressa, ?mendozana* and *maubeugei* assemblages of the Upper Aalenian *P. malarguensis* Zone.

The section ends with red, above arenaceous marly limestones containing sonniniids and stephanoceratids of the *P. singularis* and *E. giebeli* Zones, Lower Bajocian.

2.1.2.11 Quebrada Chanchoquin

Numerous sections were studied north and south of the Rio Transito (Hillebrandt 1973; Hillebrandt & Schmidt-Effing 1981) most of which reach into the Aalenian or Bajocian. Identifiable Aalenian ammonites, however, were found only in the section between the Quebradas Chanchoquin and Acevedo. This is the thicker one of the two sections originally described by v. Hillebrandt (1973, Fig. 2) under the name Quebrada La Totora, and again described by v. Hillebrandt & Schmidt-Effing (1981, p. 29). This section extends from the lower Upper Sinemurian to the Lower Bajocian. The upper part is as follows:

Age	Field-number	Thickness	Facies and Fossils
			Porphyrite.
		ca. 7 m	Tuffaceous sandstones.
Bajocian		ca. 5 m	Reddish fine sandstones with bivalve moulds.
E. giebeli Z.	671009/11	ca. 10 m	Gray, partly silty limestones interbedded with reddish marls. *Sonninia (Papilliceras) espinazitensis* TORN., *Emileia* cf. *giebeli* (GOTT.), *Mesomiltha intumescens* (GOTT.).
P. singularis Z.	/10	ca. 10 m	Gray calcarenites. *Sonninia (Papilliceras) espinazitensis altecostata* TORN., *Pseudotoites sphaeroceroides* (TORN.).
Aalenian		2–3 m	Conglomerate (clasts < 5 mm), extending with pockets into basal calcarenite up to 0.25 m.
?*P. compressa* Sz.	/ 9		*Trigonia* sp., *Fontannesia* ? *austroamericana* JAW.
?*Z. groeberi* Z.	/ 8	6–8 m	Red, friable sandstones. *Ceratomya* (?) and large, poorly preserved ?*Parammatoceras.*
		ca. 3 m	Arenaceous bioclastic limestone. Rich fauna (Hillebrandt & Schmidt-Effing 1981, p. 29) and rare *Bredyia manflasensis* n. sp.
B. manflasensis Z.	/ 7		
Upper Toarcian		ca. 20 m	Dm-bedded limestones and interbedded marls. Terebratulids, *Lopha, Modiolus, Pseudolimea, Myophorella, Cercomya, Pleuromya* and *Phlyseogrammoceras* cf. *aalense* MAUBEUGE.
	/ 6		
P. tenuicostatum Z.			
P. copiapense Z.			*Phymatoceras copiapense* (MÖR.).

The highest zones of the Toarcian *(P. fluitans* and *P. lotharingica* Zones) can not be documented in this section. The possibility of a hiatus between lower Upper Toarcian and Lower Aalenian therefore cannot be excluded.

2.1.3 Rio Transito to Rio Grande (29° to 31° latitude south)

Different Jurassic localities and sections in the Cordillera between Rio Transito and Rio Turbio were described by v. Hillebrandt (1973, pp. 184–195). In some sections Aalenian sediments can be proved but ammonites of this age are very rare.

The next locality to the south with Aalenian is found in the High Cordillera north of Rio Grande (southeast of Ovalle). The Jurassic of this area was described by Mpodozis, Rivano & Vicente (1973) and visited by one of us (Hillebrandt). Aalenian with badly preserved ammonites could only be proved at a section near Mina Los Pingos. The section starts with sandstones, slaty limestones with *Bositra* and a coquina with *Coelastarte* cf. *andium* (GOTTSCHE). Sandy slates with *Bositra* alternating with thin-bedded sandstones, a thick-bedded

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sandstone and again slaty limestones are found in the continuation. This series yielded horizons with *Tmetoceras* and ? *Puchenquia* of Aalenian age. The following series is turbiditic. An olistostrome, 4 to 6 m thick, contains limestones with *Sonninia* and *Emileia* of Lower Bajocian age.

More to the North the section starts with Liassic sediments and the Aalenian and part of the Bajocian are represented by vulcanites and conglomerates with reworked Liassic sediments.

2.2 FOSSIL LOCALITIES IN ARGENTINA

The best known and most complete Aalenian successions of Argentina are in the Malargue area of southern Mendoza and the Zapala area of south Neuquén, whereas minor occurrences have been reported mainly from the Chos Malal area of north Neuquén, the Sierra de Reyes at the Neuquén-Mendoza border, and the Espinacito Pass area of San Juan Province (Hillebrandt 1970, 1973; Westermann & Riccardi 1972, 1975, 1979, 1982). The better known occurrences are as follows from north to south (Text-fig. 1b).

2.2.1 Paso del Espinacito area, San Juan

a. The Lower Bajocian is usually disconform on Permo-Triassic (Westermann & Riccardi 1979), but the Aalenian has been documented by Hillebrandt (1970) and earlier fossil finds (Gottsche 1878; Tornquist 1898). At Espinacito Pass, the conglomeratic basal beds underlying the fossiliferous Bajocian have yielded *Tmetoceras scissum* (Ben.) and *Puchenquia malarguensis* (Burck.) of the *P. malarguensis* Zone.

b. The best known section with the Toarcian/Aalenian boundary is at Quebrada Honda, approximately 8 km south of Paso del Espinacito (Hillebrandt 1970, pp. 182–183).

Age	Field-number	Fossils
Aalenian		
P. malarguensis Z.		
?*P. compressa* Sz.	680110/ 1	*Fontannesia* ? cf. *austroamericana* Jaw.
? Z. *groeberi* Z.		Abundant large *Entolium*.
B. manflasensis Z.	680109/15	*Leioceras comptum* cf. *chilense* n. ssp., *Sphaerocoeloceras brochiiforme* Jaw., *Bredyia manflasensis* n. sp.
Upper Toarcian		
	/14	*Hammatoceras* cf. *porcarellense* Bon.
"*P. fluitans*" Z.	/13–12	*Pleydellia* cf. *fluitans* (Dum.), *Dumortieria* cf. *pusilla* Jaw., *Hammatoceras* cf. *clavatum* Fossa Manc., *Sphaerocoeloceras brochiiforme* Jaw.
"*P. lotharingica*" Z.	/11–10	*Pleydellia* cf. *lotharingica* (Branco), *Sphaerocoeloceras brochiiforme* Jaw.
P. tenuicostatum Z.	/ 9–6	*Phlyseogrammoceras tenuicostatum* (Jaw.), *Hammatoceras insigne* (Schübler), *Sphaerocoeloceras* cf. *brochiiforme* Jaw.

This faunal sequence closely resembles that of northern Chile described above.

2.2.2 Rio Atuel, SW Mendoza

a. Aalenian ammonites have been described from the upper valley of the Arroyo Blanco, about 25 km NW of El Sosneado, since Jaworski (1926; Groeber et al. 1953). The detailed sequence is, however, poorly known and disrupted by a fault separating the Toarcian from the Aalenian (Westermann & Riccardi 1979, p. 102). The known fossils are from isolated outcrops or ex situ collections. The questionable *Leioceras opalinum* (Rein.) suggests the presence of the lowermost Aalenian; this identification remains doubtful, since *L. opalinum* is absent elsewhere in the entire Pacific area and the other taxa of the *Bredyia* assemblage (*B. manflasensis* Zone) are unknown from here. A loose concretion (number 9) contained *Zurcheria groeberi* West. & Ricc. together with *Planammatoceras (Pl.)* cf. *planiforme* Buck. [= ? *P. tenuinsigne* (Vacek) = "*Eudmetoceras (Euaptetoceras)* sp. nov. aff. *klimakomphalum*" of Westermann & Riccardi 1972, 1979] and *Tmetoceras scissum* (Ben.) of the *Z. groeberi* Zone (Westermann & Riccardi 1979). *Planammatoceras (Pl.) gerthi* (Jaw.) and *P. (Pseudaptetoceras) moerickei* (Jaw.) described from here by Jaworski (1926), as well as *Eudmetoceras eudmetum jaworskii* West. and *Planammatoceras (Pseudaptetoceras) tricolora* West. & Ricc. are from the latest Aalenian *moerickei* assemblage of the *P. malarguensis* Zone. The Bajocian sequence begins with the *P. singularis* Zone.

In the Rio Atuel region one of us (Hillebrandt) recently found two additional localities with Aalenian ammonites. In

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the lower part of the Arroyo Las Chilcas, Pliensbachian sediments are separated by a fault from the Aalenian. Directly beyond this fault concretions have yielded *Tmetoceras* sp.; about 2 to 4 m higher there is a bed rich in belemnites, and a loose *Zurcheria* was found. The following section with slaty limestones and concretions have yielded *Puchenquia (Gerthiceras)* cf. *compressa* West. & Ricc. and *Sonninia (Euhoploceras) amosi* Westermann & Riccardi. The section continues with similar sediments, in the upper part with large concretions (up to 1 m) yielding *Sonninia (Euhoploceras)* cf. *adicra* (Waagen), *S. (Fissilobiceras) zitteli* (Gottsche) and *S. (Papilliceras)* cf. *espinazitensis* Tornquist of the Lower Bajocian *P. singularis* Zone.

On the eastern slope of the Arroyo Las Piedras a thick series of conglomerates, sandstones and some calcareous siltstones of probably Toarcian age occurs. The following, more marly sequence with concretions has yielded *Tmetoceras scissum* (Benecke) and ? *Puchenquia* of the Aalenian. In concretions of higher horizons *Sonninia (Fissilobiceras) zitteli* (Gottsche) and *S. (Papilliceras)* cf. *espinazitensis* Tornquist of the Lower Bajocian *P. singularis* Zone were found.

b. At Portezuelo Ancho (Rio Salado) the Jurassic section starts with fossiliferous horizons of the Middle and Upper Pliensbachian (type-locality of *Fanninoceras behrendseni* [Jaw.]). The overlying fissile shales have yielded, hildoceratids and dactylioceratids of the Lower and Middle Toarcian in the lower part and, in concretions of the middle part, *Tmetoceras* sp. and ? *Puchenquia* sp. of the Aalenian.

2.2.3 Cerro Puchenque area, SW Mendoza

East and north of the Cerro Puchenque in the Rio Negro and Serrucho valleys, about 35 km west of Malargue a thick argillaceous sequence of Pliensbachian to basal Bajocian occurs placed in the China Muerte Formation (Westermann & Riccardi 1972, 1979; Hillebrandt, unpublished). Both, the (scarce) *Bredyia* assemblage and the (rich) *Puchenquia* assemblage are well developed, whereas there is as yet no evidence of the *Zurcheria* assemblage. This apparently complete, but partly unfossiliferous Aalenian occurrence needs additional collecting. The uppermost Toarcian could not be documented by ammonites.

Age	Field-number	Thickness	Facies and Fossils
Bajocian			
P. singularis Z.	11–13	10 m	Shale with limestone concretions; *Pseudotoites singularis* (Gott.), *P. sphaeroceroides* (Torn.), *Sonninia mirabilis* (Gott.), *S.* cf. *zitteli* (Gott.), *S. (Euhoploceras) amosi* West & Ricc., *S. (Papilliceras)* cf. *peruana* Jaw., *Bradfordia* aff. *costidensa* Imlay.
Aalenian			
P. malarguensis Z.	14	1 m	Shale with concretions and lenticular limestone; *Puchenquia malarguensis* (Burck.).
	15	1.3 m	Lenticular black limestone beds; upper bed with *Puchenquia, Sonninia.*
?*P. compressa* Sz.	16 (6)	1 m	Shale and interbedded impure sandstone; at base *Sonninia (Euhoploceras) amosi* West. & Ricc., *Puchenquia* cf. *malarguensis* (Burck.), ?*P. (Gerthiceras) compressa* West. & Ricc. ["*P.* (?) aff. *malarguensis* ♀" of West. & Ricc. 1972].
(Lower Murchisonae Z.)	17	ca. 8 m	Shale and interbedded impure sandstone; at base (?) *Stauffenia (Costileioceras)* sp.
	5	40–70 m	Shale and silty shale; upper part with *Tmetoceras,* Hildoceratacеae indet., ?*Erycites* or *Podagrosiceras.*
	4	ca. 20–30 m	Shale with concretions and interbedded sandstone; loose and 0.3–0.5 m below base *Bredyia man-*

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Age	Field-number	Thickness	Facies and Fossils
B. manflasensis Z.	790323/5+5a		*flasensis* n. sp. ["*Hammatoceras* cf. *insigne*" of Westermann & Riccardi 1972, 1979], *B. delicata* n. sp., *Leioceras comptum* cf. *chilense* n. ssp., *Sphaerocoeloceras brochiiforme* JAW.
Upper Toarcian			
P. tenuicostatum Z.	4a 790323/4	0.5 m	Limestone bed; *Phlyseogrammoceras tenuicostatum* (JAW.).

2.2.4 Rio Grande area, SW Mendoza

These important Aalenian occurrences are 20 to 50 km west and south of Cerro Puchenque (discussed above). They include the classical outcrops Bardas Blancas, where Highway 40 crosses the Rio Grande, and Cerro Tricolor to the northwest (cf. Westermann & Riccardi 1979), as well as the new section at Rio Potimalal, between the two (Westermann & Riccardi 1982).

a. The Bardas Blancas section has littoral facies of conglomerate, sandstone, marls and shell beds which have yielded abundant bivalves, but poorly preserved and scarce ammonites. The ammonites reported from here since Burckhardt (1900, 1903) and Groeber (1918) were mostly **ex situ**; the *Zurcheria* assemblage however, came from a single place (Westermann & Riccardi 1979, p. 100). Evidence for Lias and Bajocian is poor. The approximate succession of the Puchenque Formation is as follows:

Age	Field-number	Thickness	Facies and Fossils
Bajocian			
?*E. giebeli* Z.	295	9 m	Sandstone and yellowish marl; upper third with *Sonninia* (*Papilliceras*?), ?*Chondroceras*, bivalves and belemnites.
		ca. 27 m	Sandstone and yellowish marls, unfossiliferous.
Aalenian			
Z. *groeberi* Z.	(1)	ca. 22 m	Sandstone and shell beds; loose slab with *Tmetoceras* cf. *scissum* (BEN.), *Zurcheria groeberi* WEST. & RICC., *Planammatoceras (P.)* cf. *planiforme* BUCK. [= ?*P. tenuinsigne* (VACEK) = "*Eudmetoceras (Euaptetoceras)* sp. nov. aff. *klimakomphalum*" of Westermann & Riccardi 1972, 1979], bivalves abundant.
(?Murchisonae Z.)		ca. 40 m	Shales, metamorphosed at base; unfossiliferous (*Planammatoceras tenuinsigne* reported by Groeber et al. 1953, p. 210, from the base of the section suggest a post-*Scissum* age).
Triassic			Andesitic-keratophyric sill and massive red porphyrite of ?Remoredo Formation.

b. A much thicker arenaceous-argillatious section of the Cuyo Group is at Rio Potimalal, 12 km upstream of this tributary of the Rio Grande, and about 15 km SW of Bardas Blancas. It was recently found by C. Gulisano and the ammonite succession was described by Westermann & Riccardi (1982).

Age	Field-number	Thickness	Facies and Fossils
Bajocian			
P. singularis Z.	G/826	90 m	Mudstone with some sandstone and concretions; at 50 m below top: *Sonninia espinazitensis altecostata* TORN., *Pseudotoites* cf. *sphaeroceroides* TORN.

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Age	Field-number	Thickness	Facies and Fossils
Aalenian			
P. malarguensis Z.			
P. mendozana Sz.	F/825 E/824	16 m	Sandstone; at top *Puchenquia (Gerthiceras) mendozana* West. & Ricc.
P. compressa Sz.			1–2 m below top *Puchenquia (Gerthiceras) compressa* West & Ricc.
	D/822–3	22 m	Sandstone, mudstone and shell beds; in top 5 m *Puchenquia (Gerthiceras) compressa*, ?*P. (P.) malarguensis* Burck., ?*Planammatoceras* sp.
	C/821		3–5 m above base: ?*Planammatoceras* sp.
Toarcian			
Variabilis-Thouarsense Z.	B/818	ca. 23 m	Sandstone; at top ?*Phymatoceras* ex gr. *lilli*.
	A/801–2		ca. 3 m above base: *Phymatoceras* ex g. *lilli*.

c. At Cerro Tricolor, 50 km NNW of the Rio Potimalal section and 20 km W of Cerro Puchenque, the classical section of Gerth (1925) and Jaworski (1926) has only recently been revised (Westermann & Riccardi 1982). This relatively thin and only partly marine section is the type locality of *Fontannesia*? *austroamericana* Jaw., *Planammatoceras (P.) gerthi* (Jaw.), *Eudmetoceras (E.) eudmetum jaworskii* West. and the curious *Praeleptosphinctes jaworskii* West. (all based on single specimens). The marine, fossiliferous facies is restricted to the Lias and *P. malarguensis* Zone, with rare sandstone moulds above representing the *E. giebeli* Zone.

Age	Field-number	Thickness	Facies and Fossils
Bajocian			
E. giebeli Z.	G/217	ca. 2 m ca. 40 m	Sandstone; moulds of *Emileia* sp. (Sandstone and covered softer beds).
Aalenian			
P. malarguensis Z.	F/814	ca. 12–15 m	Shales, marls and fossiliferous limestone; near top *Planammatoceras (Pseudammatoceras) moerickei, P. (Ps.) tricolore, Puchenquia malarguensis, P. (Gerthiceras) mendozana*.
Toarcian	D/808	9–10 m	Sandstone; at top ?*Phymatoceras* ex gr. *lilli*.

2.2.5 Sierra de Reyes, Mendoza-Neuquén border

From the western slopes of the Sierra, Groeber et al. (1953, p. 207) reported beds with *Sonninia espinazitensis, Emileia multiformis, E. giebeli submicrostoma* and *Pseudotoites sphaeroceroides* of the *E. giebeli* Zone. The remaining collections of Groeber from this locality, however, contain only *Pseudotoites singularis* (Gott.) of the *P. singularis* Zone.

From approximately 100 m lower in the section, Groeber et al. reported the Middle Aalenian species *Planammatoceras (P.) tenuinsigne* (Vacek) which was tentatively transferred to the closely affiliated species *P. (P.) planinsigne* (Vacek) and illustrated by Westermann & Riccardi (1972, Pl. 2, fig. 5).

From the Aguada de Mula, Westermann & Riccardi (1979, p. 99) reported 154 m sandstones mostly of the *E. giebeli* Zone, but yielding *Podagrosiceras* cf. *athleticum* Maub. & Lamb. below the Aalenian; underlain by 12 m shales, siltstones and some limestone concretions containing *Tmetoceras*.

2.2.6 Chos Malal area, N. Neuquén

From near the base of the famous section at Chacay Melehue, old reports by Jaworski and Groeber (summarized by Groeber et al. 1953, p. 192) list the Aalenian "*Harpoceras*" *klimakomphalum*, "*H.*" cf. *opalinus*, and *Erycites fallifax*. They were said to have come from 150–200 m black limestone overlying Toarcian calcareous sandstone. In the revision of the section, however, Westermann & Riccardi (1979, p. 98) estimated only 34 m of unfossiliferous argillite and black

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shale between the Lower Bajocian *E. giebeli* Zone, and similar Toarcian beds yielding Harpoceratinae and Dactylioceratinae.

2.2.7 Zapala area, S. Neuquén

a. At Cerro Lotena, 50 km SE of Zapala, a thick sequence (?900–1000 m) of sandstone and conglomerate has yielded, *Podagrosiceras maubeugei* WEST. & RICC. below and an early Bajocian *Emilcia-Sonninia* assemblage (Westermann & Riccardi 1979, p. 96) above. Weaver's (1931) "*Sphaerocoeloceras* cf. *brochiiforme*" are juvenile *P. maubeugei*.

b. The nearby section of Carro Quebrado with rich Middle Jurassic ammonite faunas appears to begin with the *P. singularis* Zone.

c. At the Arroyo Picún Leufú, 9 km downstream from the mouth of the Los Molles stream and about 25 km W of Carro Quebrado, there is a ca. 200 m thick section of the arenaceous Los Molles (?Lajas) Formation of Toarcian-Aalenian age (Westermann & Riccardi 1975). This is the approximate type locality of *Podagrosiceras athleticum* MAUBEUGE & LAMBERT, gen. et sp. (holotype re-described by Westermann 1964), and near the Weaver (1931) section number 16 (Westermann & Riccardi 1979, p. 94).

Age	Field-number	Thickness	Facies and Fossils
Lower Bajocian	221	5 m	Claystone, sandstone and concretions; with *Sonninia* sp.
Upper Aalenian/ Basal Bajocian	210		Level with *Puchenquia malarguensis* (BURCK.), *Sonninia (Euhoploceras) amosi* WEST. & RICC., *Podagrosiceras athleticum* MAUB. & LAMB., belemnites and bivalves.
		28 m	Laminated claystone, sandstone and concretions.
Middle Aalenian (ca. *Murchisonae* Z.)	207–9	5 m	Siltstone; *Tmetoceras scissum* (BEN.), (?) *Planammatoceras* sp., (?) *Costileioceras* sp., belemnites, bivalves.
Lower Aalenian/ Toarcian		151 m	Interbedded fissile shale and sandstone, concretions;
	206–4		upper 40 m: poorly preserved Hildoceratacеae;
	202–199		lower 30 m: Harpoceratinae indet.;
	198		at base: plant remains.

A thick section further upstream, above the mouth of the Los Molles stream (Westermann & Riccardi 1979, p. 95) exposes in the lower part ca. 100 m fissile shales with sandstone beds and concretions underlain by 20 m impure sandstone and claystone. The fauna of the *P. singularis* Zone occurs 35–40 m below top (bed 6), and that of the *P. malarguensis* Zone probably near the base of the fissile shales (bed 5) as well as in the claystone (bed 3) near the base of the section. The crushed assemblage of bed 3 is now revised to consist mainly of (?)*Planammatoceras* cf. *gerthi* (JAW.) and ? *Puchenquia*.

d. From the southern end of the Sierra Chacai Co (Arroyo Lapa, A. Maihuem, A. Charahuilla) Hillebrandt (1973a, b) and Volkheimer (1973) described a thick Jurassic section which starts with the Sierra Chacai Co Formation of the Middle and Upper Pliensbachian. The following Los Molles Formation is more than 870 m thick, belongs to the Toarcian and Aalenian and is overlain by the Cura Niyeu Formation of the Lower Bajocian.

The Los Molles Formation is composed of shales, siltstones, calcarenites and thin bancs of limstones. The often fissile shales yielded only crushed ammonites. The Aalenian is documented by *Tmetoceras* sp., *Planammatoceras* sp., *Puchenquia (Puchenquia)* sp. and *Puchenquia (Gerthiceras)* sp. A sample from outside the section yielded *Fontannesia* ? *austroamericana* JAW. Within the Cura Niyeu Formation, several beds with well preserved ammonites of the ?*P. singularis* and *E. giebeli* Zones can be distinguished (Volkheimer 1973, Westermann & Riccardi 1979).

2.3 FOSSIL LOCALITIES IN PERU

The poorly preserved and small Aalenian ammonite assemblages of Peru have recently been summarized and documented by Westermann et al. (1980). Since identification of most species and even many genera are tentative, recognition of the zones is usually also uncertain.

In central Peru, about 250 km E and SE of Lima, the lower part of the Chunumayo Formation at Hacienda Chunumayo has yielded *Puchenquia* aff. *malarguensis* (BURCK.), *Fontannesia* ? cf. *austroamericana* JAW. and *Sonninia* indicating the *P. malarguensis* Zone. Higher in the same section the Early Bajocian ammonite fauna occurs described by Jaworski (1913–15, 1925) and Steinmann (1929).

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In the Paras area, SE of Ayacucho, the upper Pucara Group and lower part of the concordantly overlying Chunumayo Formation have yielded *Tmetoceras* cf. *scissum* (Ben.), *Planammatoceras (Pseudammatoceras)* cf. *klimakomphalum* (Vacek) and ? *Puchenquia*, again indicating the *P. malarguensis* Zone.

In the Nasca-Rio Grande area of coastal southern Peru (?) *Bredyia* sp. (*"Hammatoceras alleoni* Dumortier (?)" of Westermann et al. 1980, p. 34) and *Planammatoceras* aff. *planinsigne* (Vacek) occur, respectively suggesting the presence of the *B. manflasensis* Zone and *Z. groeberi* Zone.

South of Arequipa in southernmost Peru, the San Francisco Formation is said to have yielded *Fontannesia?* and *"Eudmetoceras" klimakomphalum* of the *P. malarguensis* Zone, as well as Early Bajocian ammonite taxa.

The type region of the San Francisco Formation was mapped recently by R. Suarez (University of Arequipa). Near Palca above limestones with badly preserved *Phymatoceras* he found a well preserved fauna with *Bredyia manflasensis* n. sp., *Sphaerocoeloceras brochiiforme* Jaw., *Dumortieria pusilla* Jaw. (very frequent) and *Puchenquia* (very rare). This fauna proves at least the *B. manflasensis* Zone.

3. AMMONITE ZONES

(v. Hillebrandt & Westermann)

In Europe, the Aalenian zonation is based largely on the Graphoceratidae genera *Leioceras, Ludwigia* [incl. *Brasilia*], *Stauffenia* and *Graphoceras*. Graphoceratidae are absent to extremely rare along the eastern Pacific margin and are largely replaced by *Pseudolioceras* and the Hammatoceratidae (cf. Westermann 1981). In Boreal Europe, however, where most standard zones have been established, Hammatoceratidae are rare, being moderately abundant only in the Mediterranean and Submediterranean provinces. Most of the Andean Hammatoceratidae genera and subgenera are also present in Europe, i. e. *Bredyia, Parammatoceras, Planammatoceras* s. s., *P. (Pseudaptetoceras)* and *Eudmetoceras*, whereas *Puchenquia* ss. and *P. (Gerthiceras)* appear to be endemic. (Note, however, that Prof. R. Mouterde has recently found a single *Puchenquia* ss. within a diverse *Euhoploceras-Graphoceras-Fontannesia* assemblage of Portugal, Aalenian/Bajocian boundary; unpublished but confirmed by Westermann.) The use of the European standard zones is therefore difficult and partly impossible and a regional zonal sequence for the Andes is required, in continuation of that established for the higher Aalenian by Westermann & Riccardi (1979) (Text-fig. 5).

Of particular chronostratigraphic interest is the genus *Tmetoceras*. In Europe it was abundant only in the Scissum Zone of the Lower Aalenian, but along the eastern (and ?western) Pacific *Tmetoceras* flourished in the Upper Aalenian and disappeared suddenly at the Aalenian/Bajocian boundary (Westermann 1980).

The Toarcian/Aalenian boundary is defined by the presence of *Pleydellia (Walkericeras)* directly below beds with *Leioceras*. In Chile, between Salar de Pedernales and Rio Transito, this boundary lies within the several meters thick bioclastic limestones which contain a more or less rich mollusc and brachiopod fauna. In several sections, a hiatus exists at the base of these limestones which may represent several zones or subzones of the Upper Toarcian. The lower part of the bioclastic limestones contains the uppermost Toarcian (*"P. fluitans"* Zone) *Pleydellia (Walkericeras)* cf. *fluitans* (Dum.) and the upper part contains *Leioceras comptum chilense* n. ssp. indicating the *Scissum* Zone, as well as *Bredyia* ssp. (indicating the Opalinum and/or Scissum Zones).

The Aalenian of northern Chile and west-central Argentina can be divided into the following formal assemblage zones and subzones (from below).

1. ASSEMBLAGE ZONE OF *BREDYIA MANFLASENSIS* [nov.]

Bredyia manflasensis n. sp. – restricted to zone and most common sp.
B. delicata n. sp.
Leioceras comptum chilense n. ssp.
Leioceratinae gen. et sp. indet. A
Sphaerocoeloceras brochiiforme Jaworski

The *B. manflasensis* Zone can be identified in many sections of northern Chile as well as locally in Mendoza. *Leioceras comptum* is restricted to the Scissum Zone (≈ 'Comptum Zone' auct.) in Europe (Rieber 1963), while *Bredyia* occurs in Europe in the *Opalinum* Zone (rare) and *Scissum* Zone (more abundant) (Senior 1977). – Since the beds immediately subjacent to the *B. manflasensis* Zone already yield ammonites of the uppermost Toarcian, the *B. manflasensis* Zone appears to be coeval to both the Opalinum and Scissum Zones (= 'Opalinum Zone' s. l. in Hillebrandt 1970, 1973, 1981; Westermann & Riccardi 1972–1979). Good evidence for the Opalinum Zone (s. s.), however, is still missing for the entire Pacific area.

2. ASSEMBLAGE ZONE OF *ZURCHERIA GROEBERI* [Westermann & Riccardi 1979]

Parammatoceras jenseni n. sp. – commonest species and restricted to zone
Zurcheria groeberi Westermann & Riccardi
Podagrosiceras athleticum Maubeuge & Lambert
[*?Puchenquia (Gerthiceras)* sp. indet.]

This *jenseni* assemblage is placed in the *Z. groeberi* Zone as established in west-central Argentina where hammatocera-

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<table>
<tr><th colspan="3">EUROPE</th><th>CHILE</th><th>ARGENTINA</th><th>PERU</th></tr>
<tr><td>BAJ.</td><td colspan="2">Discites</td><td colspan="2">Singularis</td><td colspan="2">Singularis</td><td>?</td></tr>
<tr><td rowspan="5">AALENIAN</td><td colspan="2">Concava</td><td rowspan="2">P. malarguensis</td><td>[P. maubeugei]</td><td rowspan="2">P. malarguensis</td><td>?P. maubeugei</td><td rowspan="3">P. malarguensis</td></tr>
<tr><td colspan="2">Gigantea</td><td>P. mendozana</td><td>P. mendozana</td></tr>
<tr><td colspan="2">Murchisonae</td><td colspan="2">Z. groeberi</td><td colspan="2">Z. groeberi</td><td>P. compressa</td><td>P. compressa</td><td>[Planamm. ex gr. planiforme]</td></tr>
<tr><td colspan="2">Scissum</td><td colspan="2" rowspan="2">B. manflasensis
? ?</td><td colspan="2" rowspan="2">B. manflasensis
? ?</td><td rowspan="2">B. manflasensis</td></tr>
<tr><td colspan="2">Opalinum</td></tr>
<tr><td rowspan="3">TOAR.</td><td rowspan="3">Levesquei</td><td rowspan="2">Aalensis</td><td rowspan="2">"P. fluitans"
"P. latharingica"</td><td rowspan="2">"P. fluitans"
"P. latharingica"</td><td rowspan="3">?</td></tr>
<tr><td></td></tr>
<tr><td colspan="2">P. tenuicostatum</td><td colspan="2">P. tenuicostatum</td></tr>
</table>

Text-fig. 5. Correlation table.

tids are scarce (Westermann & Riccardi 1979, p. 114; Riccardi, pers. com.). This assemblage is best developed east of Potrerillos and also characterized by an abundant large *Entolium*. This zone is consistantly superjacent to the *B. manflasensis* Zone.

Significantly, the genus *Zurcheria* appears in the Andes much earlier than in Europe, where it is of (latest Aalenian and) earliest Bajocian age.

The correlation of the *Z. groeberi* Zone with the European standard zones is difficult. The new Chilean evidence and revision of the Bardas Blancas assemblage in Mendoza (with *Planammatoceras* cf. *planiforme* Buckman) indicate an earlier age than Concava Zone as supposed previously (Westermann & Riccardi 1979, p. 112). The approximate correlation with the Murchisonae Zone (s. l.) is strongly indicated.

3. ASSEMBLAGE ZONE OF *PUCHENQUIA MALARGUENSIS* [Westermann & Riccardi 1979]

This zone has been established for Peru, northern Chile and western Argentina.

a) RANGE-SUBZONE OF *PUCHENQUIA COMPRESSA* [NOV.]:

Puchenquia (Gerthiceras) compressa Westermann & Riccardi – most common species but possibly not restricted to subzone.
Tmetoceras ex. gr. *scissum* Benecke
T. cf. *flexicostatum* Westermann
(?) Graphoceratidae n. gen. et n. sp. A (aff. *Ludwigia crassa* Horn)
Planammatoceras (Pseudammatoceras) klimakomphalum (Vacek)
Pl. (Ps.) tricolore Westermann & Riccardi
Eudmetoceras eudmetum jaworskii Westermann
Fontannesia ? *austroamericana* Jaworski
Puchenquia (Puchenquia) malarguensis (Burckhardt)
P. (Gerthiceras) mendozana spinosa n. ssp.
Podagrosiceras aff. *athleticum* Maubeuge & Lambert
? *Zurcheria groeberi* Westermann & Riccardi

This assemblage is found in numerous Chilean sections as well as in southern Mendoza province.

If the single specimen listed above under Graphoceratidae n. gen. et n. sp. A should indeed be related to *Ludwigia crassa*, correlation with the Murchisonae Zone would suggest itself (but is not strongly indicated). *Planammatoceras klimakomphalum*, however, is restricted in the Mediterranean area to the Concava and lower Discites Zones (earlier reports from the upper Murchisonae Zone appear to be erroneous; Elmi, pers. com.). *Eudmetoceras eudmetum* also occurs in the Late Aalenian *E. howelli* Zone of the Alaska Peninsula (Westermann 1964) and around the Aalenian/Bajocian boundary of western Europe indicating a very late Aalenian age. The presence of *Puchenquia malarguensis* identifies this assemblage with the *P. malarguensis* Zone, as earlier defined from west-central Argentina (Westermann & Riccardi 1979). Since the generic affinity of the Andean supposed *Fontannesia* remains uncertain (closer affinity to *Puchenquia* is possible), the true *Fontannesia* from the Aalenian/Bajocian boundary of Europe and east Tethys, cannot be used for dating of the Andean assemblage. Since the superjacent subzone belongs to the Aalenian, the best age correlation appears to be with the early *Concava* Zone.

b) RANGE-SUBZONE OF *PUCHENQUIA MENDOZANA* [NOV.]:

P. (Gerthiceras) mendozana Westermann & Riccardi – restricted to subzone
?*P. (G.) compressa* Westermann & Riccardi
Tmetoceras ex gr. *scissum* Benecke
T. cf. *flexicostatum* Westermann
?*Planammatoceras (Pseudaptetoceras)* cf. *klimakomphalum* (Vacek)
Pl. (Ps.) tricolore Westermann & Riccardi
?*Pl. (Ps.) kochi* (Prinz)
Eudmetoceras cf. *eudmetum jaworskii* Westermann
Puchenquia (Puchenquia) malarguensis (Burckhardt)

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This subzone is present east of Pedernales and in the Quebrada El Bolito of Northern Chile and in the Rio Grande area of Mendoza province.

The associated ammonite fauna is almost identical with that of the underlying *P. compressa* Subzone, including the presence of the Aalenian index *Tmetoceras* and *Puchenquia malarguensis* of the *P. malarguensis* Zone. This subzone therefore belongs into the upper *P. malarguensis* Zone and at or very close to the top of the Aalenian.

c) ZONULE/HORIZON WITH *PODAGROSICERAS MAUBEUGEI* [NOV.]

P. maubeugei WESTERMANN & RICCARDI occurs above the rich *Puchenquia mendozana* assemblage in the Quebrada Caballo Muerto and appears to be associated here with *Tmetoceras* cf. *flexicostatum* WESTERMANN of the Aalenian. The two species, however, could have come from different (although close) stratigraphic levels. In the Manflas area, this small zonule occurs below a fauna of the *P. singularis* Zone (**sensu** Westermann & Riccardi 1979). This faunule may also be present in the Quebrada El Asiento above a level with *P. mendozana*, *P. malarguensis* (BURCK.), *Planammatoceras tricolore* WEST. & RICC. and *Eudmetoceras* cf. *eudmetum jaworskii* WEST.. The age of this faunule horizon closely approximates the Aalenian/Bajocian boundary.

4. TAXONOMY

(G. E. G. Westermann)

SUPERFAMILY ?EODEROCERATACEAE SPATH 1929
FAMILY ?EODEROCERATIDAE SPATH 1929
SUBFAMILY ?COELOCERATINAE HAUG 1910
Genus *Sphaerocoeloceras* JAWORSKI 1926

Sphaerocoeloceras brochiiforme JAWORSKI 1926
Pl. 1, figs. 1–3

Material and distribution – Locality 1, 670812/5, and 4, 720104/6 and 6a, at Manflas, *B. manflasensis* Zone; Quebrada Honda, 680109/15, 680109/13, 680109/10, 680109/7, *B. manflasensis* Zone, "*P. fluitans*" Zone, "*P. lotharingica*" Zone, P.*tenuicostatum* Zone; Arroyo Overas, 790323/5a, b, *B. manflasensis* Zone.

Remarks – A number of complete specimens of this species are now available, ranging in age from Late Toarcian to about the middle part of the Aalenian. The taxonomic and phylogenetic study of this interesting sphaeroconic micromorph is urgently needed. The phragmocone has highly inflated, involute whorls. The end of the phragmocone and the body chamber become rapidly more evolute and contracted, with the simple peristome marked by a constriction. The Aalenian representatives are significantly larger than their Toarcian ancestors, i. e. about 20–25 mm versus 15–20 mm diameter (note that Arkell's figure in the Treatise, p. L256, fig. 1, is enlarged about $2^1/_2$ times). There is appreciable variation in the ornament consisting of elongating primaries and blunt secondaries which become increasingly reduced on the venter. The body chamber bears long, blunt, rursiradiate, somewhat convex primaries and short, very blunt secondaries becoming obsolescent over a narrower or wider area on the broad venter. Yet there is much variation, the secondaries being either clearly present on the outer flanks or obscure. The septal suture is simple ammonitic as originally described by Jaworski (1926).

The Early and Middle Liassic micromorphs are now known for their longevity, with single species of *Cymbites* NEUMAYR ranging through the Sinemurian and/or Pliensbachian (Schindewolf 1961; Donovan & Forsey 1973). While the cymbitids are mostly smooth and classified in the Psiloceratacеae, the Early Pliensbachian Mediterranean genera *Praesphaeroceras* LEVI (incl. *Diaphorites*) and *Pimelites* FUCINI are costate and placed in the Coeloceratinae of the Eoderoceratacеae. Of particular interest is the Late Toarcian micromorph *Onychoceras* WUNSTORF which resembles *Sphaerocoeloceras* also in the convex blunt primaries on the body chamber (Hillebrandt 1970, p. 189; Guex 1975). *Onychoceras* was placed in the Grammoceratinae of the Hildoceratacеae by Arkell et al. (1957, Treatise, p. L262) for no obvious reason. Morphogenetic studies are needed to establish the detailed affinities between Late Toarcian-Aalenian *Onychoceras* and *Sphaerocoeloceras* on the one hand and the Early Pliensbachian *Praesphaeroceras* and *Pimelites* on the other. Even the supposed Early Toarcian Hildoceratids *Peroniceras* HYATT and *Frechiella* PRINZ need consideration in this respect.

SUPERFAMILY HILDOCERATACEAE
FAMILY HILDOCERATIDAE HYATT 1867
SUBFAMILY TMETOCERATINAE BUCKMANN 1892
Genus *Tmetoceras* BUCKMAN 1892

Tmetoceras ex gr. *scissum* (BENECKE 1865)

Material – Quebrada El Asiento, section 3, bed 14, 660707/9, section 4, bed 14, 670305/11, and section 5, bed 14, 670307/2; cf. Quebrada El Hueso, section 1, bed 14?, 670306/12; and cf. Quebrada La Chaucha, 661129/5; Bed 5 of Manflas (McM. J1188: 17, 20).

Distribution – *P. malarguensis* Zone, (?*P. compressa* and) *P. mendozana* Subzone.

Remarks – The group includes species and/or faunas characterized by moderately evolute whorls and stiff prominent ribbing (cf. Westermann 1964).

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Tmetoceras cf. *flexicostatum* Westermann 1964
Pl. 1, fig. 4

(?) 1964 (Aug.) *Tmetoceras kirki flexicostatum* – Westermann, p. 440, pl. 72, figs. 8–10, Text-fig. 37.

? 1964 (Oct.) *Tmetoceras dhanarajatai* – Komalarjun & Sato, p. 155, pl. 6, fig. 1–9, 16–18.

1972 *Tmetoceras* cf. *flexicostatum* West. – Westermann & Riccardi, p. 23, pl. 1, fig. 6.

Material – Single specimens from Quebrada Caballo Muerto, 670304/3; Quebrada El Asiento, section 4, bed 14, 670305/16; Quebrada El Patón, 680220/8; and bed 5 of Manflas (McM. J1346).

Distribution – *P. malarguensis* Zone, *P. mendozana* Subzone (+ ?*P. compressa* Subzone and *P. maubeugei* zonule).

Remarks – This species is characterized by large size (D = 85 mm!), advolute subcircular whorls, dense rectiradiate ribbing ending in minute ventral tubercles, and a broad mid-ventral smooth band.

The stratotype of *P. flexicostatum* is in the upper *E. howelli* Zone (topmost Aalenian) of Wide Bay, Alaska Peninsula. It was originally placed as a subspecies in *T. kirki* (Westermann 1964) (described as having compressed whorls with markedly flexed ribbing). Finds subsequent to that monograph in the *T. tenue* zonule (Westermann 1969), however, indicate that compression of the whorl section and flexing of the ribs is mostly secondary, due to crushing in the mudstone matrix. One of the new specimens also bears a small lappet at 53 mm diameter, indicating that the mature microconch is extremely large.

T. dhanarajatai Komalarjun & Sato from the Aalenian of Thailand is a close match to *T. flexicostatum*, as far as can be determined from its different preservation (non-deformed but small and incomplete). Komalarjun and Sato's name thus becomes a possible junior synonym, postdating Westermann's name by only two months.

The association with *Puchenquia* s. s., *P. (Gerthiceras)* and *Planammatoceras (Pseudaptetoceras)* indicates a similar Late Aalenian age for the Chilean occurrence.

FAMILY ?HILDOCERATIDAE Hyatt 1867 [OR HAMMATOCERATIDAE]
SUBFAMILY ?GRAMMACERATINAE Buckman 1904 [OR HAMMATOCERATINAE]

Genus ?*Fontannesia* Buckman 1902 [or *Puchenquia*]

Fontannesia ? austroamericana Jaworski 1926 (♂)
Pl. 1, fig. 8

Material – Quebrada El Asiento, section 8, 670307/11; cf. Quebrada El Bolito, bed 14, 670222/13; Quebrada Chanchoquin, 671009/9; bed 5 of Manflas (McM. J1188).

Distribution – *P. malarguensis* Zone, *P. compressa* Subzone.

Remarks – For an extensive discussion of this genus and species see Westermann & Riccardi (1972, p. 24). The generic affinity of this probable microconch remains uncertain. The late hammatoceratid *Puchenquia* is certainly another possibility. All Chilean specimens, however, closely resemble the holotype from Argentina. The corresponding macroconchs are uncommon or absent.

FAMILY GRAPHOCERATIDAE Buckman
SUBFAMILY LEIOCERATINAE Spath 1936

Genus *Leioceras* Hyatt 1867

Leioceras comptum (Reinecke 1818)

For complete synonymy see Rieber (1963).

Leioceras comptum chilense Westermann n. ssp. ♀
Pl. 1, fig. 5

1973 *Leioceras* cf. *comptum* (Rein.) – Hillebrandt, p. 176.

Holotype – The almost complete specimen B. St. M. 1983V15 from locality 4, 720104/6, at Manflas.

Diagnosis – A large subspecies of *L. comptum* with sub-rectangular whorls.

Derivatio nominis – Self-explanatory.

Other Material – Locality 4, 720104/6, at Manflas; cf. Quebrada Honda, 680109/15; cf. Arroyo Overas, 790323/5.

Distribution – *B. manflasensis* Zone (lower part).

Description – The mature shell has a diameter of 95–105 mm. The whorls are compressed sub-rectangular. The venter is broad and sub-tricarinate with sharp ventral shoulders and central carina (blunt keel or fastigation). The weak ornament on the shell consists of irregular and flexuous fasciculate bundles of varying prominence. The septal suture is weakly incised and exactly as in the nominate subspecies (Rieber 1963, Text-fig. 13h-l).

Comparison – This Chilean form closely resembles *L. comptum*, index of the western European "Comptum Zone" (upper part of Scissum Zone; Upper Opalinum Zone s. l., above range zone of *L. opalinum;* see Rieber 1963). It differs from the European nominate subspecies in the significantly larger size (95–105 versus 50–80 mm for the macroconch) and in the more strongly sub-rectangular whorl section with better developed ventral shoulders. A sub-tricarinate venter, however, occurs as a variant also in *L. comptum* s. s. (Rieber 1963).

We thank Professor Rieber for lending us comparative material of *L. comptum* s. s. from the Comptum Zone of Schörzingen in the Suebian Jura.

The restriction in Europe of the "*L. comptum* group" of Rieber (including mainly *L. comptum* ♀ and its probable microconchiate dimorphs *L. paucicostatum* Rieber, *L. striatum* (Buckman) and *L. crassicostatum* Rieber) to the "Comptum Zone" and of the genus *Leioceras* to the Opalinum Zone s. s. and "Comptum Zone" permits the dating of the "*Bredyia* bed" (720104/6) at locality 4 of Manflas as Scissum Zone. According to Senior (1975), *Bredyia* is restricted to the "Comptum Zone" (Scissum Zone part.) of Europe.

Cylicoceras stephanovi Sapunov (1970) from the condensed Opalinum Zone of the Central Balkan Range in Bulgaria, appears to resemble our form except for the slightly more prominent ornamentation.

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Measurements (mm)

	D	H	W	U
Holotype, body chamber	91/89	36	22	24.3
phragmocone	78	31.5	17.6	18.9
	52	24.1	13.6	10.7
B. St. M. 1983VI6, aperture	105	41.5	24	28.3
	77	34.6	19	17.5
	55	27.7	15.3	12

LEIOCERATINAE N. GEN. ET N. SP. A
Pl. 1, fig. 6

Material – A single, large, fully septate fragment from locality 4, 720104/6, at Manflas.

Distribution – *B. manflasensis* Zone (lower part).

Description – The phragmocone has a reconstructed diameter of 135 mm. The inner whorls have a compressed sub-rectangular section, with well separated vertical umbilical wall and sub-tricarinate venter (shoulders and carina). The immature ornament consists of prorsiradiate fasciculate bundles of riblets and of folds on the inner flank which extend bluntly with projection onto the outer flank. The last septate whorl has very prominent simple radial folds, slightly flexed, reaching maximum height at mid-flank; and a sub-tricarinate venter.

Comparison – The inner whorls strongly resemble the mature growth stage of *Leioceras comptum* (Rein.) as described above, while the last septate whorl is a blown-up copy of *Pleydellia* ex gr. *fluitans* marking the subjacent assemblage zone in northern Chile. The very simple septal suture also resembles that of *Leioceras* and is close to that of *Pleydellia*.

Measurements (mm)

	D	H	W	U
B. St. M. 1983VI7, phragmocone	c. 135	57	38	—
	125	53	32	40
	85	36	20.5	22
	62	28	16.5	13.8

FAMILY ?GRAPHOCERATIDAE Buckman 1905

(?) N. gen. et n. sp. A [aff. *Ludwigia crassa* Horn]
Pl. 2, fig. 1, Text-fig. 6

Material – A single, large, fully septate specimen from locality 5, 720106/5, at Manflas.

Distribution – *P. malarguensis* Zone, *P. compressa* Subzone.

Description – The septate fragment is about 200 mm in diameter. The whorl section is rounded, compressed sub-rectangular, with rounded umbilical slope meeting the seam vertically, somewhat convex and converging flanks, and a rounded venter. There is no sign of a ventral carina or keel on the inner whorls (section) and certainly not from 65 mm diameter to the end. The ornament is highly ornate, commencing at least at 20 mm diameter. The umbilicus shows a nucleus with prominent but blunt bullate nodes near the umbilical shoulder. On the outer whorls, these become extended to about 2/5 whorl height. There are about 2 fasciculate flexuous secondaries per primary. They project strongly on the ventral shoulders, before dying out leaving a broad smooth ventral band. The septal suture is simple, with markedly oblique umbilical lobes at all stages.

Discussion – This specimen resembles the extremely ornate *Ludwigia crassa* Horn from the lower Murchisonae Zone, Sinon Subzone, of Europe, in all but the missing keel or carina and the larger size. In the absence of additional material, however, the significance of these differences can not be established. Furthermore, the genus *Ludwigia* and the entire subfamily Graphoceratinae are unknown from the entire eastern Pacific. It is also possible that this is a new genus derived from hammatoceratids.

Measurements (mm)

	D	H	W	U
phragmocone	ca. 200	55	—	56
	118	48.5	35/38	34.6
	65	25.4	21.5	20.7

FAMILY HAMMATOCERATIDAE Buckman 1887
SUBFAMILY HAMMATOCERATINAE Buckman 1887
Genus *Bredyia* Buckman 1910

Discussion – The genus and its apparently single European dimorphic species *B. crassornata* (Buckman) ♀ – (?) *B. subinsignis* (Oppel) ♂ was recently studied by Senior (1977). This author, however, missed the several records of the genus from northern Chile (Westermann 1967; Westermann & Riccardi 1972; Hillebrandt 1970, 1973). In Europe, the genus is said to be restricted to the Opalinum (rare) and Scissum Zones (more abundant).

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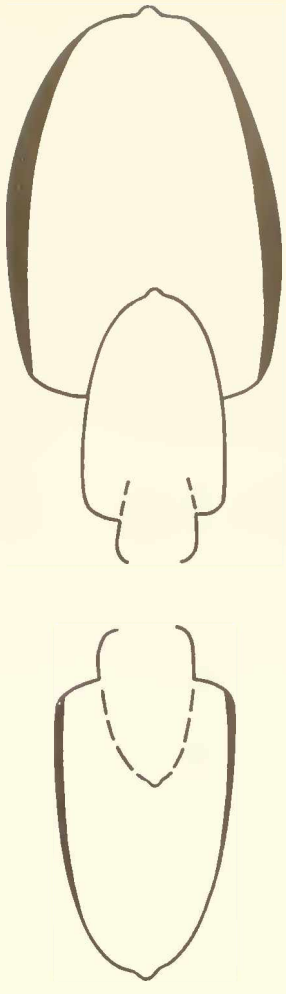

Text-fig. 6. ?Graphoceratidae indet., (?) n. gen. et n. sp. A [aff. *Ludwigia crassa* HORN], fully septate, from *compressa* Subzone of Manflas, B.St.M. 1983VI10 (720106/5), × 1.

While the outer whorls of the large Chilean macroconch of *B. manflasensis* n. sp. are a close match to the European macroconch, with the exception of the reduced ventral fastigation (or carina) in the Chilean forms, the septal suture and the ornamentation of the inner whorls differ significantly. We follow, however, the advice of Dr. Senior (personal communication) to place the Chilean forms in the same genus and subgenus. The juvenile and immature whorls of the Chilean species have more rounded rather than subquadratic whorls owing largely to the different ventral ornamentation; the secondaries reach up to the blunt keel and do not leave smooth bands or shallow furrows beside the keel as in typical *Bredyia* (including ?*Pseudammatoceras* and the microconch *Rhodaniceras*). The juvenile and immature venter is thus similar as in Toarcian *Hammatoceras*. In several Chilean specimens, furthermore, the keel is almost absent and the secondaries alternate. The secondaries may even become sub-continuous with off-set, strongly resembling the ventral ornamentation of the Toarcian-Aalenian *Erycites*. The outer, mature phragmocone whorl of the Chilean macroconchs, however, may assume the inflated trapezoidal cross-section of European *Bredyia* with well developed ventral smooth bands besides the blunt keel. The body chamber becomes rounded, while it remains carinate (fastigate) in European *Bredyia* and most other hammatoceratids.

The septal suture (Text-fig. 10a, b) has consistantly a small and short external lobe E ("ventral"), $^2/_5$ to $^3/_4$ the length of the lateral lobe L, and mostly a slightly reduced external saddle EL, somewhat as is *Erycites* and other erycitins. The umbilical lobe U_2 ("2nd lateral") is about as long as L, a feature untypical for *Erycites, Bredyia* and other hammatoceratins. The umbilical lobes are only weakly to moderately retracted as in *Bredyia* but contrasting with *Erycites* and most hammatoceratins (except *Puchenquia*). The rather high complexity, on the other hand, disagrees with *Bredyia*.

The suture of *Bredyia* (Senior 1977) is proportioned as in other hammatoceratins, with long E and short U_2 while it differs consistantly from other hammatoceratins in its simplicity and more or less radial saddle envelope. The internal suture has a deep I and dominant adjacent saddle IU, followed by a much smaller lobe or lobule and saddle. We are aware, however, of the marked variation within the hammatoceratins and erycitins of most sutural features, including the relative size of the external lobe (cf. Geczy 1966; but note that some drawings appear to be mislabeled or inaccurate when compared to the photographs), and that retraction and complexity in particular are strongly dependent of whorl section, degree of involution, and ontogenetic stage.

The mature ventral ornamentation and the septal suture indicate affinities to the Toarcian-Aalenian *Erycites*. All erycitins differ, however, in the well developed primary ribs, with or without terminal small tubercles, the overall weaker ornamentation and in the retainment of the ventral features to the aperture. Some Toarcian *Hammatoceras* (particularly „*Pachammatoceras*" BUCKMAN 1921) have similar immature ornament and whorl section, but differ in the suture, the bullate (radially extended) rather than round umbo-lateral nodes or spines and in the more compressed and ogival outer whorls.

„*Pseudammatoceras*" ELMI (1963) is based on *Amm. submsignis* OPPEL (♂?) which Senior (1977) considers synonymous with *Bredyia crassomata* (BUCKMAN 1910 – type species ♀), so that Elmi's genus would become a junior synonym of *Bredyia*. Another hammatoceratid bearing resemblances in ornament and ventral features is the late Aalenian Boreal *Erycitoides* WESTERMANN 1964. *Erycitoides* differs in the much less inflated whorls, the longer secondaries and in the normal hammatoceratin septal suture.

These Chilean species are thus intermediate to 3 genera and 2 subfamilies of the Hammatoceratidae, i. e. *Erycites* of the Erycitinae and *Hammatoceras* as well as *Bredyia* of the Hammatoceratinae. Their ontogenetic development indicates that they are a phyletic link between *Hammatoceras* and *Bredyia*, with recapitulation, and a parallel development of *Erycites*. They are thus "primitive" *Bredyia*. Since in Europe, *Bredyia* appears cryptogenetically and in the upper Opalinum Zone s. s., becoming abundant in the Scissum Zone (Senior 1977) migration to Europe, from the southeastern Pacific through the "Hispanic corridor" (Smith 1983) is indicated.

Bredyia manflasensis WESTERMANN n. sp., ♀ and ? ♂
Pl. 2, figs. 2–4, Pl. 3, figs. 1–3, Pl. 4, figs. 1–4, Text-figs. 7–9, 10a, b.

? 1894–95 *Hammatoceras Alleoni* DUM. – Möricke, p. 16, pl. IV, fig. 11.

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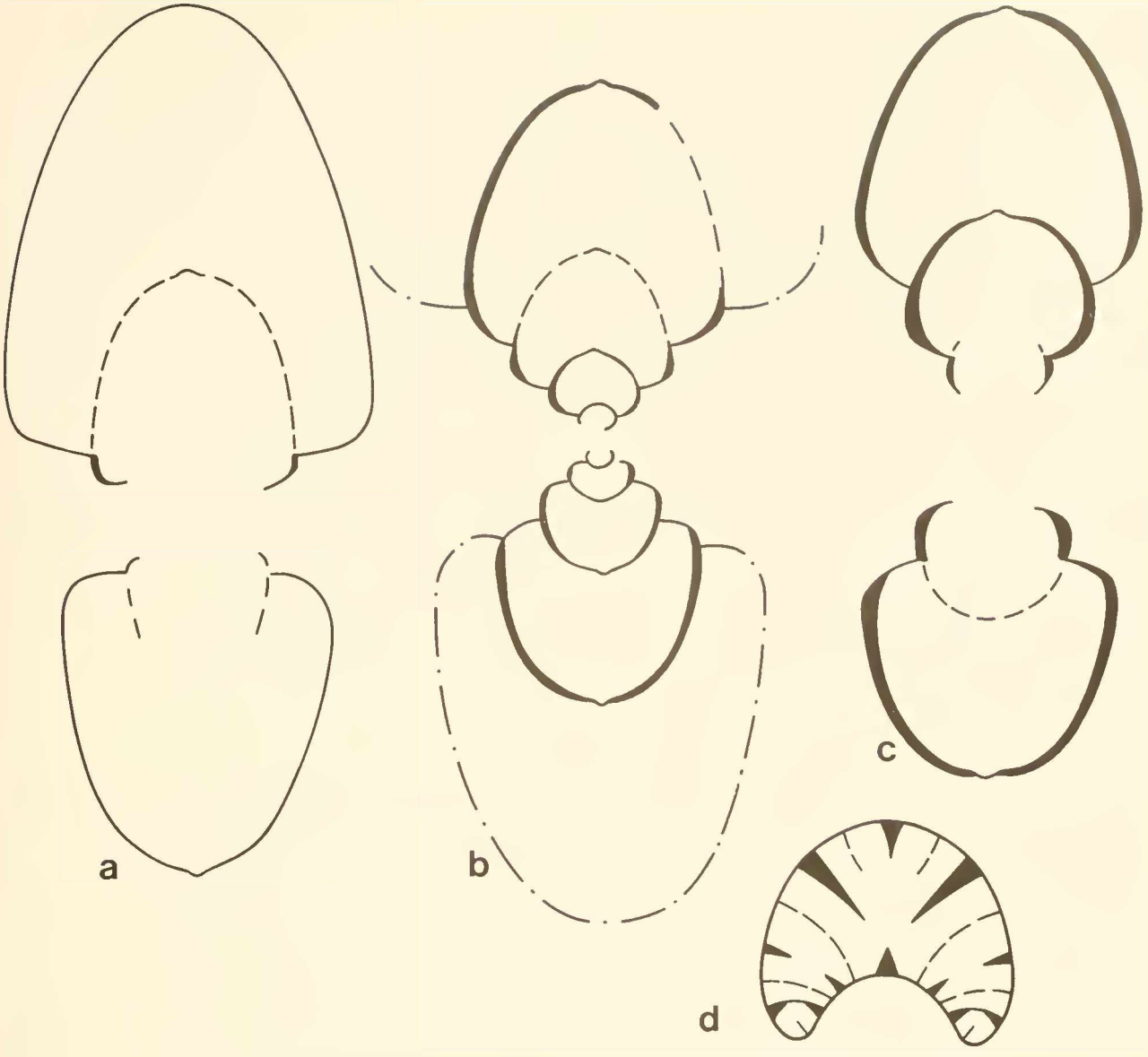

Text-fig. 7. *Bredyia manflasensis* n. sp. – a, discoidal-smooth variant, B. St. M. 1983VI14 (720104/6a); b, holotype (solid lines) and large septate whorl of specimen (dot-dashed), B. St. M. 1983VI20 (720104/6a); c, evolute-ornate variant, B. St. M. 1983VI21 (720104/6a). All fully septate, nat. size; d, septum at 59 mm diameter and 26 mm whorl width, B. St. M. 1983VI22 (661129/4), ×1,5.

1970 *Bredyia* – Hillebrandt, p. 184.

1972 *Bredyia* aff. *crassornata* BUCKMAN – Westermann & Riccardi, p. 28, pl. 2, fig. 2a–b.

Holotype – The well preserved septate specimen B. St. M. 1983 VI11 from locality 4, 720104/6 + 6a, at Manflas.

Diagnosis – A variable species of *Bredyia* with *Hammatoceras*-like juvenile stage, distant ornamentation and short external lobe.

Derivatio nominis – After the Hacienda Manflas, region of Atacama, Chile.

Other material – Salar de Pedernales, 660714/3a; Portezuelo de Pedernales, section 16, 660709/3, 660710/8; Quebrada El Asiento, section 4, bed 9, 670305/8, section 3, bed 9, 660707/13; Quebrada La Chaucha, 661129/4; Quebrada El Bolito, bed 12, 670222/11–12; Quebrada San Pedrito, 711215/5; Quebrada Yerbas Buenas, bed 12, 681221/9; Río Jorquera (La Guardia), 720108/9; Manflas, locality 1, 670812/5 and locality 4, 720104/6 + 6a; Quebrada Chanchoquin, 671009/7; Quebrada Honda, 680109/15; Arroyo Overas, 790323/5; Cerro Puchenque, locality 4.

Distribution – *B. manflasensis* Zone.

Description – The adult macroconchs vary greatly, from planulate-coronate to discoidal-smooth, and have an estimated complete diameter of 150–250 mm (?320 mm). The body chamber, however, is rarely present and poorly known.

The whorls vary from moderately involute (U/D = 0.15; forma involuta) to evolute (U/D = 0.45; forma evoluta), tending to become more tightly coiled at maturity. The whorl section of the nucleus is depressed elliptical; becomes slightly depressed ovate to semicircular at 15–20 mm diameter, with vertical, somewhat rounded umbilical slope and maximum width near the umbilical shoulder; and ovate-ogival at

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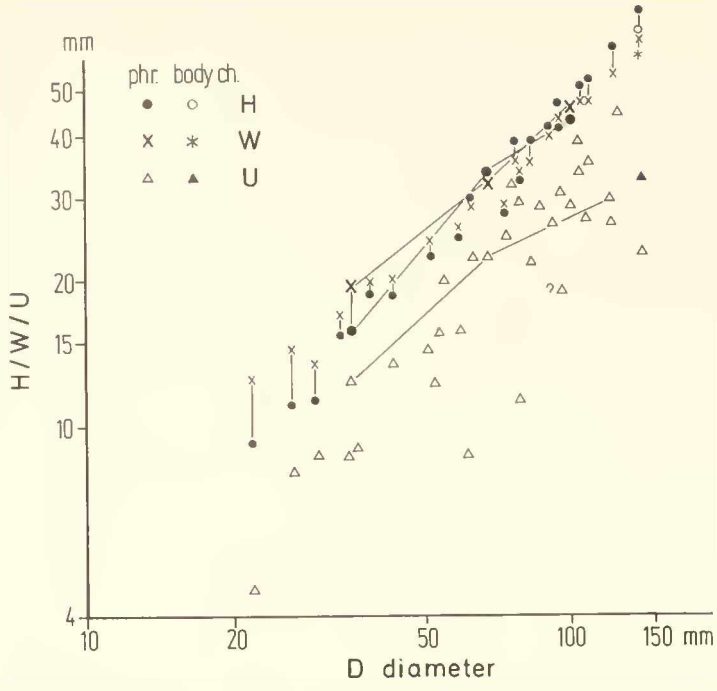


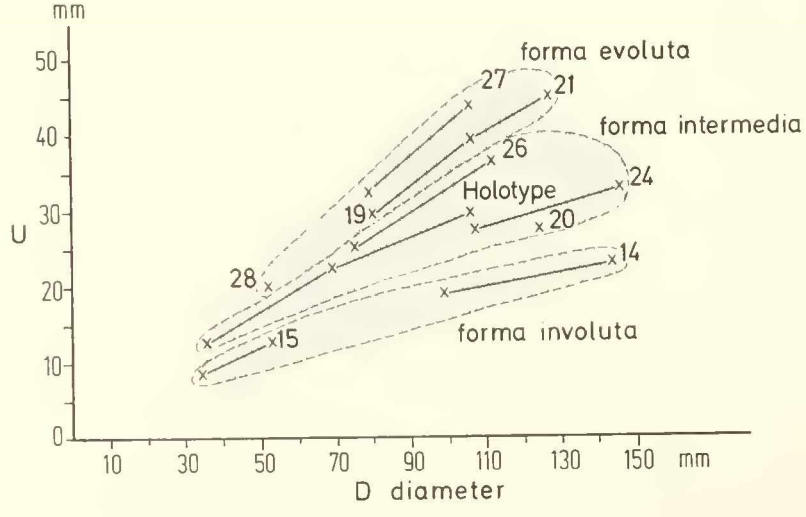
Text-fig. 8. *Bredyia manflasensis* n. sp. – Scatter of whorl height (H), whorl width (W), and umbilical diameter (U). The whorl-section (W/H) is indicated by the connecting line. Ontogeny indicated for holotype only.

40–60 mm diameter. The mature whorls become ovate, slightly depressed to moderately compressed, and somewhat sub-triangular with the body chamber where the ventral carina (fastigation) disappears entirely.

The ornamentation of the inner whorls consists of massive bullate nodes on the umbilical shoulder, between 7 and 10 (11) per half-whorl, and 2 to rarely 3 times as many massive but blunt secondaries, only 15 to 20 per half-whorl. These ribs are usually rectiradiate to somewhat prorsiradiate and reach to almost mid-venter, dying out at the very blunt solid keel or carina where they tend to alternate. Smooth bands beside the keel are usually missing.

On the intermediate whorls, the secondaries tend to project more strongly and may leave narrow smooth bands besides the low keel, a mere carina on the internal mould.

On the outer whorls, the 9 to 15 ($^1/_2$ whorl) bullate nodes become obsolete at 80–120 mm diameter in the evolute and in the average forms, while they disappear already at 60–100 mm diameter in the involute forms. Slightly later, the secondary costae begin to withdraw from the lower flank, with similar inter-correlation with the coiling and whorl section attributes of the shell. The evolute and more inflated (relatively depressed) shells retain much of the ornamentation, at least on the middle and outer flank up to the end of the



Text-fig. 9. Variability of umbilical width (U) against diameter (D) of *Bredyia manflasensis* n. sp.

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phragmocone at about 120–150 mm diameter (the body chambers are poorly known). The involute and more compressed forms become entirely smooth on the entire ultimate phragmocone whorl (and on the body chamber) (Pl. 3, fig. 1). This conforms to the widespread "1st Buckman Law of Covariation" (Westermann 1956).

Several small specimens associated with the large specimens at Manflas (Pl. 2, figs. 3, 4; Pl. 3, fig. 2) are either incomplete, immature or the mature microconchs to the *B. manflasensis* described above. The extremely coarse secondaries which run subcontinuously across the venter of the outer whorl, indicate that the shells are mature. Because of the absence of shell, however, the critical observations on the position and distance of the last septa can not be made.

The septal suture is moderately to rather strongly complicated (Text-figs. 10a, b; note that 10a is somewhat corroded). E is short, only $^1/_3$ to $^3/_5$ of L; E/L saddle is smaller than the L/U_2 saddle; L is usually deep and broad; U_2 deep and narrow, somewhat oblique; U_{3+} begins with a deep oblique element, followed by straight elements with a radial envelope. The internal suture has a deep I, and a single (paired) dominant "internal lateral saddle" I/U, followed by a small lobe (or lobule) and a much smaller second saddle.

Discussion – This species is much more inflated and has a more prominent and distant ornamentation than the associated *B. delicata* n. sp. The European type species (with synonyms; Senior 1975) differs in the presence of ventral bands also on the juvenile whorls, the retaining of the ventral fastigation or carina to the aperture, as well as in the deep external lobe of the septal suture.

Because of the extremely broad variation, particularly in coiling (U/D from 0.15 to 0.45!), several species (two named) were originally distinguished. Improved stratigraphic information on the association of these intergrading forms, however, has convinced me of the genetic homogeneity of the samples. Similar variance in shape and intercorrelated ornamentation are now known from a variety of species, e. g., of the Macrocephalitidae (unpublished) and Cardioceratidae (Callomon, personal communication).

Measurements (mm)

	D	H	W	U	P	S
Holotype, phragmocone ♀	106	45	c. 42	29.5	9	20
	69	33	32	22.5	8	19
	36	15.5	19.7	12.5	7.5	c. 18
B. St. M. 1983VI24 (670222/11),						
body chamber ♀	146	67.5	58.5	33	smooth	
end phragmocone	107	50	45.3	27.5	8–10	c. 20
B. St. M. 1983VI20 (720104/6a),						
phragmocone ♀	124	60.3	53.0	27.5	—	—
	80	32	33	—	10–11	22–23
B. St. M. 1983VI26 (670812/5),						
phragmocone ♀	112	51	47	36.5	10	23.5
	75	27	28	24.7	11 (9–10)	c. 24
f. involuta						
B. St. M. 1983VI14 (720104/6a),						
phragmocone ♀	144	73	64	23	—	—
	99	46	43	c. 19	c. 10	c. 24
B. St. M 1983VI15 (670812/5),						
phragmocone ♀	53	23.6	25	12.8	9	18
	34	15	17.2	8.5	7.5	—
f. evoluta						
B. St. M. 1983VI21 (720104/6a),						
phragmocone ♀	127	46	46	45 +	c. 13	24.5
	106	38	43	39.5–	10.5	23
	80	29.5	33.5	29.5–	9	—
B. St. M. 1983VI27 (720104/6+6a),						
phragmocone ♀	106	36	37	44	9	—
	79	25.5	30.5	32.5	—	—
B. St. M. 1983VI28 (670812/5),						
phragmocone ♀	52	18.5	c. 19	19.9	8	c. 21
B. St. M. 1983VI19 (670812/5),						
?body chamber (♂)	75	25	c. 31	28.5	9	19

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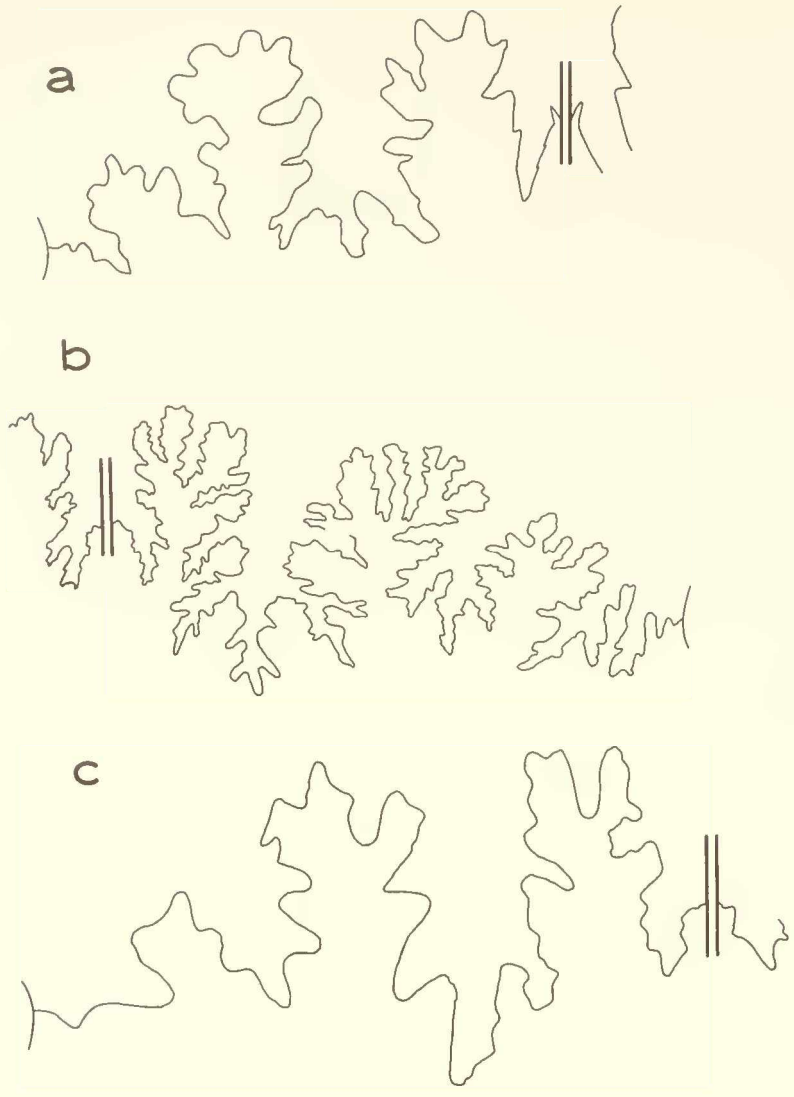

Text-fig. 10. *Bredyia manflasensis* n. sp. – a, external septal sutures (somewhat corroded); discoidal variety, B. St. M. 1983VI23 (720104/6a), ×3; b, evolute variety, B. St. M. 1983VI17 (790223/5), ×3; c, Bredyia delicata n. sp. – external septal suture (strongly corroded), B. St. M. 1983VI30 (661129/4), ×6.

Bredyia delicata WESTERMANN n. sp.
Pl. 5, figs. 1–4, Pl. 6, fig. 1, Text-fig. 10c

1970/73 *Parammatoceras* sp. 1 – Hillebrandt, p. 184, tab. 2.

Holotype – The well preserved phragmocone B. St. M. 1983VI29 from locality 1, 670812/5, at Manflas, *B. manflasensis* Zone.

Diagnosis – A compressed involute species of Bredyia with dense, delicate ornamentation.

Derivatio nominis – Referring to the ornamentation.

Other material – Mostly septate specimens of different sizes from Manflas, locality 1, 670812/5, and cf. locality 4, 720104/6a; Quebrada El Asiento, section 3, bed 9, 660707/13, 670305/22; cf. Quebrada La Chaucha, 661129/4; Arroyo Overas, 790323/5b.

Distribution – *B. manflasensis* Zone.

Description – The macroconch is involute discoidal to medium-coiled planulate (U/D = 0.15–0.25), with compressed sub-triangular to trapezoidal whorl section, as high as broad. The complete macroconch was very large, approximately 300 mm in diameter. Coiling (U/D) is negatively allometric, the outer whorls being more tightly coiled than the inner ones.

The steep umbilical seam borders on a rounded margin or shoulder, while the flanks are flattish converging toward the ventro-lateral shoulders. The venter is broadly rounded and bears a blunt keel on shell and internal mould.

The ornamentation consists of bullate tubercles, sometimes rursiradiate, placed on the umbilical shoulder, and rectiradiate to slightly flexed costae (secondaries) in pairs and irregularly intercalated. They are dense (30–35 / half whorl) and blunt, project slightly on the ventral shoulder and reach close to the keel, without leaving appreciable smooth bands.

The ornament becomes obsolete, beginning in the inner or middle flank, at 60 to 100 mm diameter, so that the ultimate phragmocone whorl and the body chamber are mostly or entirely smooth. The body chamber is poorly known but, judging from the maximum phragmocone diameter of 235 mm, reaches a size of approximately 300 mm.

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The septal suture is complicated and more or less strongly retracted (Textfig. 10c; juvenile and strongly corroded).

Remarks – This species was originally placed in *Parammatoceras* because of its slightly lengthened (bullate) primaries on the holotype. These occur, however, also on typical *Bredyia*, while the juvenile stage of this new species has also the typical umbilical bullate nodes of the associated *B. manflasensis*.

This species is much more finely costate as well as more compressed than even the involute – smooth form of *B. manflasensis*. They have, respectively, 18–25 and 30–35 secondary costae per half-whorl.

One medium-size specimen (D = 107 mm; pl. 5, fig. 3) with 300° body chamber from Manflas (B. St. M. 1983VI31) and ? a nucleus from Quebrada La Chaucha (B. St. M. 1983VI30), both *B. manflasensis* Zone, were originally placed in *Hammatoceras* ex. gr. *speciosum* Janensch. The larger specimen, however, is probably a juvenile, relatively evolute variant of *Bredyia delicata*, differing from typical *Hammatoceras* in the presence of elongated bullae rather than round tubercles (S. Elmi, personal communication); while the small specimen resembles the inner whorls of *B. delicata* from the same assemblage.

The gigantic specimen (Pl. 6, fig. 1) from locality 4 at Manflas (B. St. M. 1983VI33) is entirely smooth on all exposed whorls and can thus be identified only tentatively.

Measurements (mm)

	D	H	W	U	P	S
Holotype, phragmocone ♀	98	56.6	c. 39	15	10	33
	64	30	c. 22.5	9.2	c. 10	c. 30
B. St. M. 1983VI34 (670305/22), phragmocone ♀	67	32.5	c. 24	12.1	c. 11	31
B. St. M. 1983VI35 (660707/13), phragmocone ♀	172	89	53	23.5	smooth	
	82	45	30	14	—	c. 36
B. St. M. 1983VI32 (670812/5), phragmocone ♀	89	41	c. 30	20.5	12	24
	55	23.5	c. 20	13.8	—	—
B. St. M. 1983VI36 (670812/5), phragmocone	46	—	—	10.5	—	—
	32	14.7	14.3	7.4	10	23
B. St. M. 1983VI37 (670812/5), phragmocone	62	29.6	25.8	12.9	—	—
	42	21.3	21.2	9.7	—	—
B. St. M. 1983VI33 (720104/6a), body chamber ♀	260	125	96	55	smooth	
end phragmocone	235	—	—	—	smooth	
	208	97	77	43.5	smooth	
	144	68	58	29.5	8 umbilicus smooth	
	99	48	42	23.5	smooth	
	66	28.5	30	—	smooth	
B. St. M. 1983VI31 (720104/6a), body chamber ♀ juv.	107	45.5	34	30.4	11	26
begin, body chamber	70	27.8	15.4	18.5	9	c. 25
B. St. M. 1983VI30 (661129/4), phragmocone	47	22	18.1	11.5	8	26

Genus *Parammatoceras* Buckman 1925

This (mainly Middle) Aalenian genus is based on the type species *P. obtectum* Buckman from upper Murchisonae Zone of Dorset, England. It is characterized by inner whorls with umbolateral tubercles and low keel as in *Hammatoceras*, but intermediate whorls with elongated primaries and fasciculate, somewhat falcoid ribbing, slightly projected and terminating near the keel. The ornament is retained to considerable size. The umbilicus is steep with well developed margin or shoulder particularly in the outer, usually somewhat involute whorls. The septal suture is as in *Hammatoceras*, with long E, moderate complication and strong retraction.

The Late Aalenian-basal Bajocian *Eudmetoceras* differs in the gentle umbilical slope of the inner whorls, which also have stiffer and coarser ornament, smooth ventral bands and a high hollow-floored keel. The Middle Aalenian *Planammatoceras* Buckman 1922 has more evolute whorls, shorter but persistent primaries bearing lateral tubercles, flexuous ribbing reaching up to the keel and a high, hollow-floored keel.

New excavations are currently underway in the classic Inferior Oolite quarry of Horn Park in Dorset, England (J. Cal-

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lomon, pers. comm.), from which much of Buckman's numerous species (real and ficticeous) were originally described. The type species *P. obtectum* lies in the upper Murchisonae Zone (the new *Bradfordia gigantea* Zone/Subzone), while the genus range appears to encompass most of the Murchisonae and the lower Concava Zone (R. B. Chandler, pers. comm.).

Parammatoceras jenseni Westermann n. sp.
Pl. 7, figs. 1–5

1970 *Parammatoceras* sp. 2. – Hillebrandt, p. 184, tab. 2.

Holotype – The well preserved, but somewhat corroded phragmocone B. St. M. 1983VI38 from Quebrada El Asiento, section 4, bed 10, 670305/14, *P. jenseni* Assemblage.

Diagnosis – A species of *Parammatoceras* with coarse, especially secondary, ribbing; inner whorls tuberculate with moderate density and prominence.

Derivatio nominis – In honour of Mr. and Mrs. Jensen, formerly owner of "Hacienda Manflas".

Other material – Quebrada El Asiento, section 6, 660708/4, and section 3, bed 10, 660707/10, 670305/23, 670306/2; Quebrada El Hueso between sections 1 and 2, bed 10, 670306/13, and section 1, 670306/7, 8; cf. Quebrada El Bolito, bed 13, 670222/12; Manflas, locality 4, 720104/7.

Distribution – Z. *groeberi* Zone.

Description – The inner and intermediate whorls are moderately evolute with rounded, compressed subrectangular section. The umbilical slope is steep, somewhat rounded; the flanks converge slightly toward the rounded venter which bears a blunt solid keel. The outer whorls become rounded trapezoidal to ovate, with more strongly inflated and converging flanks and a narrower venter. The adult size is at least 150 mm.

The ornament of the inner whorls to 30–40 mm diameter consists of blunt, rather prominent nodes near the umbilical shoulder and rectiradiate, prominent secondaries of somwhat irregular coarseness. They project moderately on the ventral shoulder and terminate close to the keel. On the intermediate whorls, the umbilical nodes extend as bullae and, finally, as blunt primaries well onto the inner flank. They bifurcate irregularly at about $^2/_5$ whorl height, and some of the fasciculate bundles and/or primaries finally reach mid-flank. All whorls have about 2 secondaries per primary, with 10–12 primaries and 20–25 secondaries per $^1/_2$ whorl. The slight angulation between secondaries and primaries and ventral projection result in a more or less weakly marked falcoid pattern. The ventral termination of the secondaries is at this stage particularly close to the ventral carina which has become very blunt, and alternation is rather common.

On the outer whorl and large body chamber, costae and keel become very robust and blunt, without disappearing entirely.

The septal suture is moderately complicated and resembles that of typical hammatoceratids, with moderately long E and strong retraction.

Comparison – This species is quite distinct with its extremely coarse secondary ribbing. The inner whorls resemble those of *P. richei* Elmi (1963), and the outer come close to the large *P.* (?) cf. *auerbachense* (Dorn) figured by Elmi (1963, pl. 4, figs. 3a, b). Both compared forms are from the Murchisonae Zone of southeastern France. In the new Horn Park (Dorset) excavations, similar forms occur in the *Bradfordia gigantea* Zone (upper Murchisonae Zone **auct.**) at a similar level as *P. obtectum,* the type species (J. Callomon, pers. comm.).

Measurements (mm)

Holotype, phragmocone

D	H	W	U
98	—	—	23+
75	33	24.2	21
49	21	16.7	15.2

Genus *Planammatoceras* Buckman 1922
Subgenus *Pseudaptetoceras* Géczy 1966

Géczy (1966) placed here the late *Harpoceras*-like hammatoceratids of essentially the Concava-Discites Zones, formerly usually classified in the subgenus *Eudmetoceras (Euaptetoceras)* Buckman, i. e. "*Harpoceras*" *klimakomphalum* Vacek, "*H.*" *amaltheiforme* Vacek and *Eudmetoceras amplectens* Buckman. Related species and/or subspecies are "*H.*" *involutum* Prinz, "*H.*" *discus* Merla and "*Oppelia*" *moerickei* Jaworski. The more inflated "*H.*" *amaltheiforme* Vacek and *E. amplectens* Buckman, however, resemble *Euaptetoceras euaptetum* Buckman, type species of *Euaptetoceras* Buckman, which is placed as a subgenus in *Eudmetoceras* on account of its similar juvenile stage. Because of resemblance in whorl section, ornament and septal suture, *Pseudaptetoceras* is now classified as a subgenus of *Planammatoceras* (Westermann & Riccardi 1982).

Planammatoceras (Pseudaptetoceras) klimakomphalum (Vacek 1886)
Pl. 6, figs. 2–4

Material – Mostly single specimens from Portezuelo de Pedernales, section 16, 670308/3, Quebrada El Asiento, section 3, bed 12 or 13, 660707/10, and section 4, ?bed 13, 670305/14; Quebrada El Bolito, bed 14, 670222/13; cf. Portezuelo El Padre, locality 7, 670106/12; cf. Rio de la Sal, section 14, 720115/4; and cf. Quebrada El Patón, 680220/8.

Distribution – *P. malarguensis* Zone, *P. compressa* (+ ?*P. mendozana)* Subzone.

Description – The large shell (D > 100 mm) is strongly compressed discoidal, remaining very involute up to the outer whorl. The vertical umbilical slope has a sharp margin. The ribbing consists of dense primaries and projected secondaries. The venter is acute with a high keel. The septal suture is complex.

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Discussion – This form is a perfect match to the Mediterranean *P. klimakomphalum* (lectotype refigured by Westermann & Riccardi 1982, Text-fig. 4C-E) and close to the south Alaskan subspecies *discoidale* West. 1969 from the Aalenian-Bajocian boundary of Alaska. The latter subspecies differs by adult rounding of the umbilical shoulder and probably by the more acute venter.

In section 4, Quebrada El Asiento, *P. klimakomphalum* is associated with *P. tricolore* West. & Ricc. *P. tricolore* differs in the wider umbilicus, the rounded umbilical margin and the early reduction of the primary ribs.

Planammatoceras (Pseudaptetoceras) tricolore
Westermann & Riccardi 1982
Pl. 7, figs. 6–7

1982 *Planammatoceras (Pseudaptetoceras) tricolore* – Westermann & Riccardi, p. 26, pl. 4, figs. 1a–4b.

Material – Quebrada El Asiento, section 4, ? bed 13, 670305/14; Portezuelo de Pedernales, section 16, 670308/3; Manflas, locality 1, 670812/5a, ? locality 5, 720106/5.

Distribution – *P. malarguensis* Zone.

Remarks – This form closely resembles the species recently described from Mendoza province, Argentina (Westermann & Riccardi 1982). It is associated with *P. klimakomphalum* at locality 670305/14 and differs clearly in the smaller size, the larger umbilicus, the weaker ribbing on the inner flank and the rounded body chamber.

Planammatoceras (Pseudaptetoceras?) cf. *kochi* (Prinz 1904)

1972 *Eudmetoceras* (?) cf. *kochi* (Prinz 1904) – Westermann & Riccardi, p. 30, pl. 3, figs. 2–3.

Material – Several fragments from bed 5 (McM. J1188) and "Schicht I" of collection Biese, all Manflas, locality 2.

Distribution – *P. malarguensis* Zone, ?*P. mendozana* Subzone.

Remarks – This form with smooth, ogival outer whorls had a hollow-floored keel as indicated by conellae and seen in the section. Primaries are absent beyond about 20–30 mm diameter and no nodes or tubercles are visible in the umbilicus of the cast (Westermann & Riccardi 1972, pl. 3, fig. 2a).

Genus *Eudmetoceras* Buckman 1920

Macroconchs of the type-species *E. eudmetum* Buckman are now believed to include "*Hammatoceras lotharingicum*" of Jaworski (1926, non Benecke = *E. eudmetum jaworskii* Westermann 1964) from Argentina and *E. matisconnensis* Elmi 1963 from France. All come from the Aalenian-Bajocian boundary, the "*Eudmetum hemera*" at the top of the Concava or from the (lower) Discites Zone. Other species are probably *E. achillae* (Hoffmann) (cf. Elmi 1963) from the Discites Zone of Germany; but not "*Hammatoceras*" *gerthi* Jaworski 1926 from Argentina which is now placed in *Planammatoceras* s. s. because of its narrow venter and flexed ribbing.

The microconchs were placed in *Rhodaniceras* Elmi, type-species "*Hammatoceras*" *rhodanicum* C. Renz. It bears lappets and the broad venter has smooth bands as in the immature macroconch. Several species have similar distributions as the macroconchs (cf. Elmi 1963).

Eudmetoceras s. s. is thus redefined as including only evolute forms with highly ornate, subrectangular or subquadratic immature whorls with secondaries and smooth bands or furrows beside the keel.

Eudmetoceras (Eudmetoceras) eudmetum jaworskii
Westermann 1964
Pl. 8, fig. 8

1972 *Eudmetoceras (Eudmetoceras) eudmetum jaworskii* – Westermann & Riccardi, pl. 2, fig. 4 with earlier synonymy.
1982 *Eudmetoceras (Eudmetoceras) eudmetum jaworskii* – Westermann & Riccardi, p. 30, pl. 1, fig. 6.

Material – cf. Quebrada El Hueso, section 1, 670306/12; Quebrada El Hueso, between section 1 and 2, 670306/14; Quebrada El Bolito, bed 14, 670222/13.

Distribution – *P. malarguensis* Zone, *P. compressa* and ? *P. mendozana* Subzones.

Remarks – The specimens closely resemble the holotype from Mendoza province.

Genus *Puchenquia* Westermann & Riccardi 1972

The shell of this Andean genus is compressed, with the minute keel becoming obsolete on the body chamber. The septal suture is moderately complex and somewhat retracted. The microconch and the inner whorls of the macroconch are widely umbilicate with shallow slope, and have flexed, irregularly branching and fasciculate ribs. The outer whorls of the macroconch become involute with distinct, steep umbilical slope, obsolete primaries and dense, gently projected secondaries.

Puchenquia (Puchenquia) malarguensis (Burckhardt 1903)
♀ and ♂
Pl. 8, figs. 1–6

1972 *Puchenquia (Puchenquia) malarguensis* – Westermann & Riccardi, p. 39, (with earlier synonymy).
1982 *Puchenquia (Puchenquia) malarguensis* – Westermann & Riccardi, p. 32, pl. 5, figs. 2–5.

Material – Quebrada El Hueso, section 1, 670306/12, between sections 1 and 2, 670306/14, and cf. section 2, 670306/17; Quebrada La Chaucha, 661129/5; Quebrada El Bolito, bed 15, 670222/14; cf. Quebrada El Asiento, section 5, 670307/1; and cf. Manflas, locality 3, 670810/6a.

Distribution – *P. malarguensis* Zone, *P. compressa* and *P. mendozana* Subzones.

Remarks – Most specimens are macroconchs, except for two which are microconchs (cf. "*Harpoceras puchense*" Burckh.). Both morphs are associated.

Subgenus *Gerthiceras* Westermann & Riccardi 1982

This taxon, based on the type-species *P. (G.) compressa* Westermann & Riccardi (1982), was originally described

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from the "Concava-Sowerbyi Zone (bed 5)" of Manflas under "Hammatoceratidae ? gen et spp. nov. A and B" (Westermann & Riccardi 1972), noting its intermediate morphology between Hammatoceratidae and Sonniniidae as well as its affinity to the Andean *Puchenquia*.

Most specimens described by v. Hillebrandt (1970, 1973) under *Eudmetoceras* are now placed in *P. (Gerthiceras)*.

Puchenquia (Gerthiceras) compressa
Westermann & Riccardi 1982
Pl. 8, figs. 9–11, Pl. 9, fig. 1

1982 *Puchenquia (Gerthiceras) compressa* Westermann & Riccardi, p. 35, pl. 6, figs. 2a–3.

Material – Portezuelo de Pedernales, section 16, 660710/9; Rio de la Sal, section 14, 720115/4; Quebrada El Asiento, section 3, 660707/7, ?/9, 10, 12, section 4, 670105/14, 15, and section 5, 670307/7; Quebrada El Hueso, section 1, 670306/9–11, and section 2, 670306/16; Quebrada La Chaucha, 661129/5; Quebrada El Patón, 680220/8; Quebrada El Bolito, bed 14, 670222/13; Manflas, locality 2, 661202/4, and locality 5, 720106/5; Portezuelo El Padre, locality 6, 680129/1.

Distribution – *P. malarguensis* Zone, *P. compressa* (and *P. mendozana*) Subzone.

Remarks – This is probably the most abundant hammatoceratid of northern Chile, being easily identifiable at larger size by its distant prominent primaries and dense, blunt secondaries with falcate flexure. There appears to be unusually high infraspecific variation, particularly in the septal suture which ranges from rather simple and straight (cf. Westermann & Riccardi 1972, pl. 5, figs. 2–6) to moderately complex with somewhat oblique and retracted umbilical lobes. Part of the reported simplicity, however, is due to the general corrosion of the Manflas specimens which probably also obscured some of the weak obliquity and retraction. Some small specimens could be microconchs. Apertures and clear indication of maturity, however, are usually missing in the small specimen.

Puchenquia (Gerthiceras) mendozana mendozana
Westermann & Riccardi 1982
Pl. 9, figs. 2–5

1973 *Sonninia (Euhoploceras)* sp. – Hillebrandt, tab. 1.
1982 *Puchenquia? (Gerthiceras?) mendozana* Westermann & Riccardi, p. 36, pl. 6, figs. 1a–d.

Measurements (mm)

	D	H	W	U
Holotype, phragmocone	90	36	28	28.5

Material – Single incomplete specimens from Quebrada El Asiento, section 3, bed 13, 660707/9, and section 4, bed 13, 670305/16; Quebrada El Bolito, bed 15, 670222/14; ? Quebrada Caballo Muerto, 670304/4; Manflas, bed 5 (McM. J1188).

Distribution – *P. malarguensis* Zone, *P. mendozana* Subzone.

Remarks – The bullae are extremely prominent and few, i. e. 5 to 6 per half-whorl. The new subspecies from the *P. compressa* Subzone, *P. (G.) mendozana spinosa*, is distinguished by the somewhat more numerous lateral spines, 8 or 9 per half-whorl.

Puchenquia (Gerthiceras) mendozana spinosa
Westermann n. ssp.
Pl. 9, figs. 6–7, Pl. 10, fig. 1

Holotype – The septate specimen B.St.M. 1983VI64 from bed 14 (670222/13) of Quebrada El Bolito, *P. compressa* Subzone.

Diagnosis – An early, somewhat more densely spinose chrono-subspecies (transient) of *P. mendozana* with 8 or 9 spines per half-whorl.

Derivatio nominis – Referring to the spines.

Other Material – Single incomplete cf.-specimens from Quebrada El Asiento, section 4, 670304/14; Quebrada El Hueso, between section 1 and 2, 670306/14, section 2, 670306/16; and Portezuelo El Padre, 670106/12.

Distribution – *P. malarguensis* Zone, *P. compressa* Subzone.

Remarks – This form is morphologically intermediate between *P. compressa* and *P. mendozana*, with compressed-ovate whorls and 8–9 primaries per half-whorl bearing prominent mid-lateral nodes at mid-flank; there are about 35 secondaries per half-whorl. There is, however, no morphological intergradation to either the associated *P. compressa* nor to the later *P. mendozana* s. s. In sample 670222/13, the associated *P. compressa* is clearly distinct by the finer ornamentation of the inner whorls. *P. mendozana* s. s., from the superjacent subzone, is even more "coronate", with only 5 or 6 lateral spines per half-whorl. This new subspecies also confirms that *P. mendozana* is an extreme *Puchenquia*, not a *Bredyia* (or *Pseudammatoceras*, cf. Westermann & Riccardi 1982, p. 37).

FAMILY ERYCITIDAE Spath 1928
SUBFAMILY PODAGROSICERATINAE Westermann & Riccardi 1972
Genus *Podagrosiceras* Maubeuge & Lambert 1955

The taxonomy of this subfamily and genus has recently been discussed at length (Westermann & Riccardi 1979). There is marked resemblance to *Abbasitoides* Geczy (? subgenus of *Abbasites* Buckman), which, however, differs in the septal suture, smaller size and in the absence of a smooth body chamber.

Podagrosiceras athleticum Maubeuge & Lambert 1955 ♂

1979 *Podagrosiceras athleticum* – Westermann & Riccardi, p. 116 (with earlier synonymy).

Material – Single specimens from Quebrada El Asiento, section 3, bed 10, 670305/23, and between sections 3 and 4,

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bed 10, 670306/2; Quebrada El Hueso, ? section 1, 670306/8, between sections 1 and 2, 670306/13; ? Quebrada El Bolito, bed 12, 670222/11.

Distribution – *Z. groeberi* Zone.

Remarks – These microconchs can easily be identified specifically since the holotype from Neuquén province, Argentina, is of the same morph.

Podagrosiceras aff. *athleticum*, ♀
Pl. 10, fig. 5

Material – Single large specimens with body chamber from Quebrada El Hueso, between sections 1 and 2, 670306/14; and Quebrada La Chaucha, 661129/5.

Distribution – *P. malarguensis* Zone, *P. compressa* Subzone.

Description – The macroconchs of approximately 120 mm complete diameter have evolute whorls with compressed elliptical, somewhat ovate whorl section; the umbilical slope is gentle. The distant blunt primaries are adorally concave, divide and fasciculate just below mid-flank into radial, terminally slightly projected secondaries, three per primary. The costae alternate mid-ventrally in the absence of any keel or carina, at least on the ultimate whorl (including body chamber). The septal suture is simple with radial envelope.

Comparison – *P. athleticum* ♂ is most similar in its inner whorls but become smooth on the body chamber.

Podagrosiceras maubeugei Westermann & Riccardi 1979, ♀
Pl. 10, figs. 2–4

1970 *Abbasites* sp. – Hillebrandt, p. 186.
1973 *Abbasites* sp. – Hillebrandt, p. 22.
1979 *Podagrosiceras maubeugei* – Westermann & Riccardi, p. 117, pl. 1, figs. 1–5.

Material – Mostly single specimens from Quebrada El Asiento, section 4, bed 15, 670305/16, and section 5, bed 15, 670305/3; Quebrada Caballo Muerto, 670304/3; Portezuelo El Padre, locality 7, 670106/11, 670306/12.

Distribution – *P. malarguensis* Zone, *P. maubeugei* zonule/horizon.

Remarks – The inner whorls are evolute with depressed ovate sections. The outer whorls become subcircular. The ornament consists of strongly prorsiradiate primaries and dense projected secondaries which are interrupted and alternate at mid-venter. The body chamber becomes smooth. The septal suture has the deep E and the subequal internal saddles of the bullate septum.

? SUBFAMILY PODAGROSICERATINAE OR FAMILY SONNINIIDAE

Genus *Zurcheria* Douvillé 1885

For the taxonomy of *Zurcheria* see Westermann & Riccardi (1972, p. 93; 1979, p. 115). The smooth ventral band and the small external lobe suggest its derivation from Erycitidae, rather than from Hammatoceratidae.

In the former case, *Zurcheria* should be classified in the Podagrosiceratinae (?), rather than in the Sonniniidae as generally assumed to be correct. The early age of the Andean representatives, i. e. *Z. groeberi* Zone of the Middle Aalenian, furthermore supports the first alternative.

Zurcheria groeberi Westermann & Riccardi 1972
Pl. 10, fig. 6

1972 *Zurcheria groeberi* Westermann & Riccardi, p. 94, pl. 31, figs. 1–5.

Material – Mostly single specimens from Quebrada El Asiento, section 3, bed 10, 660707/10, and between sections 3 and 4, bed 10, 670306/2; Quebrada El Hueso, between sections 1 and 2, 670306/13, and section 2, 670306/16.

Distribution – *Z. groeberi* Zone (+? *P. compressa* Subzone).

Remarks – The very involute immature whorls and the broader ventral smooth band permit easy distinction from *Podagrosiceras* which is sometimes associated with it.

Zurcheria sp. indet.

Material – Single poorly preserved specimens from Quebrada El Asiento, section 4, bed 10, 670305/14; Quebrada El Hueso, section 1, 670306/8; Manflas, locality 3, 670810/6, and ? locality 1, 670812/5.

Distribution – (?*B. manflasensis* Zone and) *Z. groeberi* Zone.

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PLATES

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Plate 1

Figs. 1–3: *Sphaerocoeloceras brochiiforme* JAWORSKI; all loc. 1 at Manflas (670812/5); nat size.

1: Complete internal mould; B. St. M. 1983VI1; lateral view.

2a, b: Almost complete internal mould; B. St. M. 1983VI2; a: lateral and b: ventral views.

3a, b: Almost complete internal mould; B. St. M. 1983VI3; a: lateral and b: ventral views.

Fig. 4: *Tmetoceras* cf. *flexicostatum* WESTERMANN; damaged internal mould; Quebrada El Asiento, section 4, bed 14 (670305/16); B. St. M. 1983VI4; lateral view, nat. size.

Fig. 5, 7: *Leioceras comptum chilense* WESTERMANN n. ssp.; nat. size.

5a, b: Holotype; septate internal mould with shell remains; loc. 4 at Manflas (720104/6); B. St. M. 1983VI5; a: lateral and b: ventral views.

7: *Leioceras comptum* cf. *chilense* WESTERMANN n. ssp.; internal mould of inner whorls; Arroyo Overas (790223/5); B. St. M. 1983VI8; lateral view.

Figs. 6a, b: Leioceratinae n. gen. et n. sp. A; fully septate internal mould; loc. 4 at Manflas (720104/6); B. St. M. 1983VI7; a: lateral and b: ventral views; nat. size.

Fig. 8: *Fontannesia* ? *austroamericana* JAWORSKI; almost complete internal mould; Quebrada El Asiento, section 8 (670307/11); B. St. M. 1983VI9; lateral view; nat. size.

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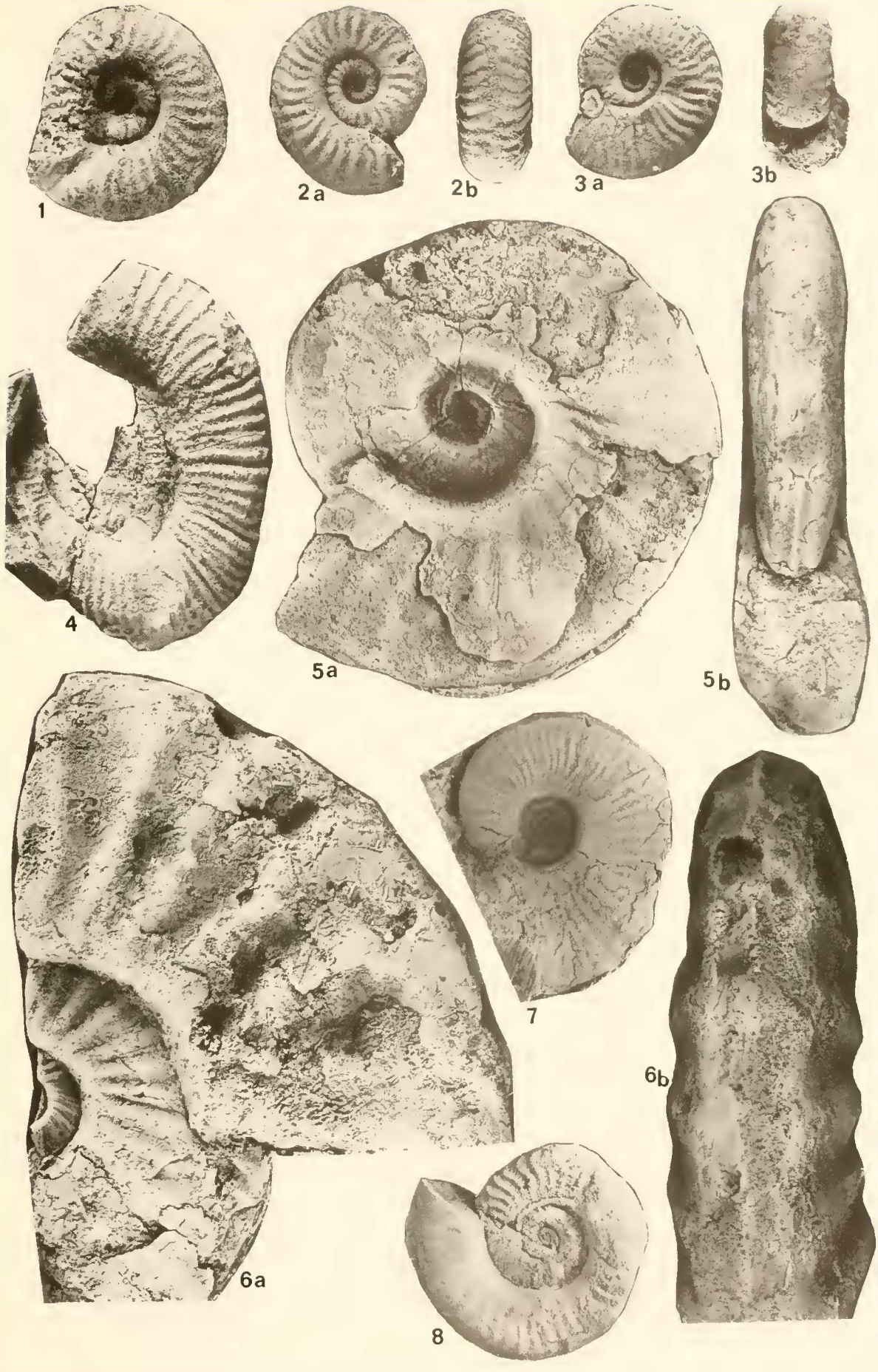

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Plate 2

Figs. 1a, b: ?Graphoceratidae, (?) n. gen. et n. sp. A [aff. *Ludwigia crassa* HORN]; septate internal mould; loc. 5 at Manflas (720106/5); B. St. M. 1983VI10; a: lateral and b: ventral views; nat. size.

Figs. 2–4: *Bredyia manflasensis* WESTERMANN n. sp.; all loc. 4 at Manflas (720104/6 + 6a); nat. size.

2a, b: Holotype, septate internal mould with shell remains; B. St. M. 1983VI11; a: lateral and b: ventral and sectional views.

3: Inner whorls; B. St. M. 1983VI12; nat. size.

4a, b: Inner whorls; B. St. M. 1983VI13; a: lateral and b: ventral views.

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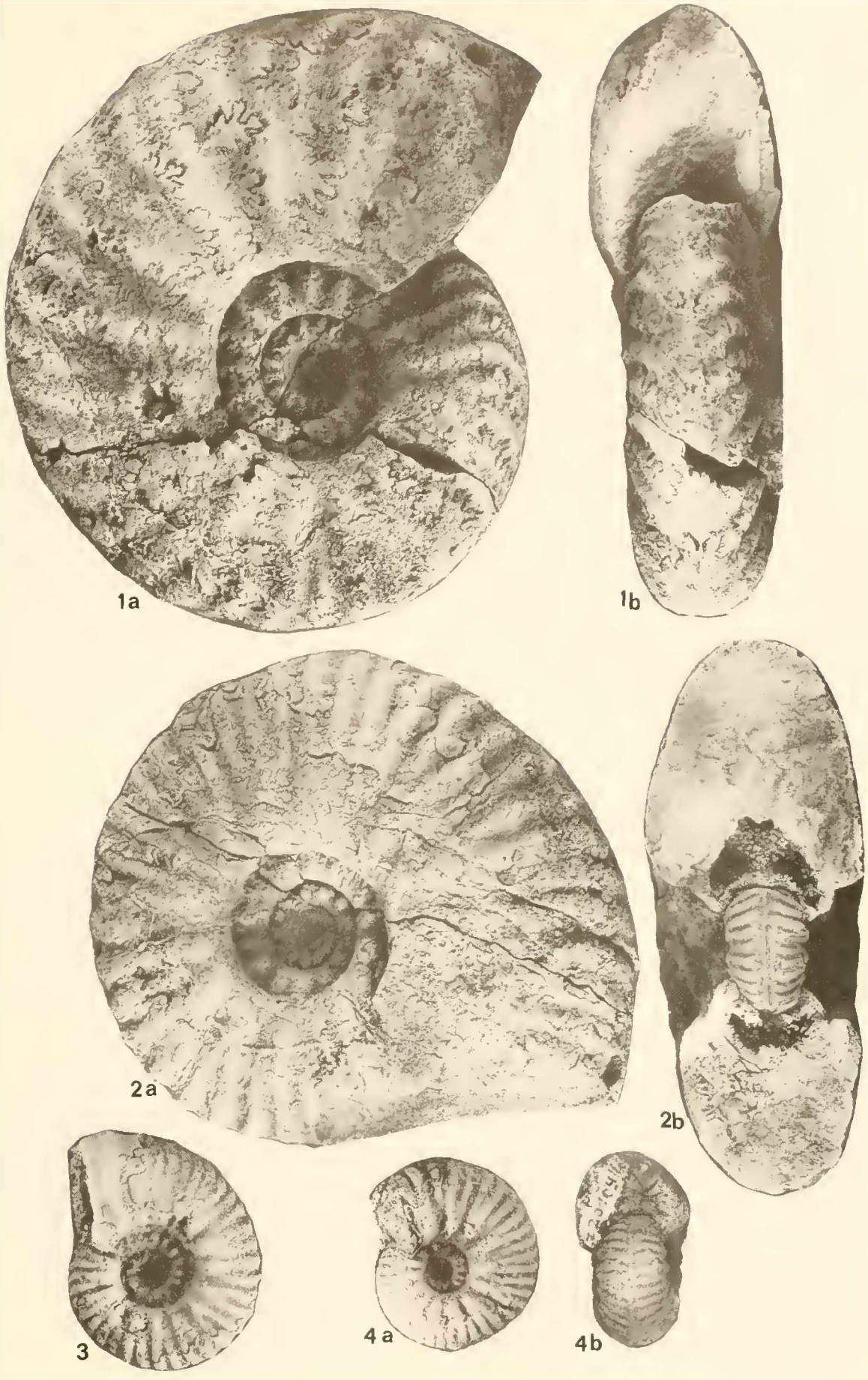

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Plate 3

Figs. 1–3: *Bredyia manflasensis* WESTERMANN n. sp. ♀; nat. size.

1a, b: Septate internal mould of involute variant; loc. 4 at Manflas (720104/6a); B. St. M. 1983VI14; a: lateral and b: ventral views.

2a, b: Internal mould of inner whorl; loc. 1 at Manflas (670812/5); B. St. M. 1983VI15; a: lateral and b: ventral views.

3a, b: Septate internal mould with shell remains of variant with rursiradiate ribs; loc. 1 at Manflas (670812/5); B. St. M. 1983VI16; a: lateral and b: ventral views.

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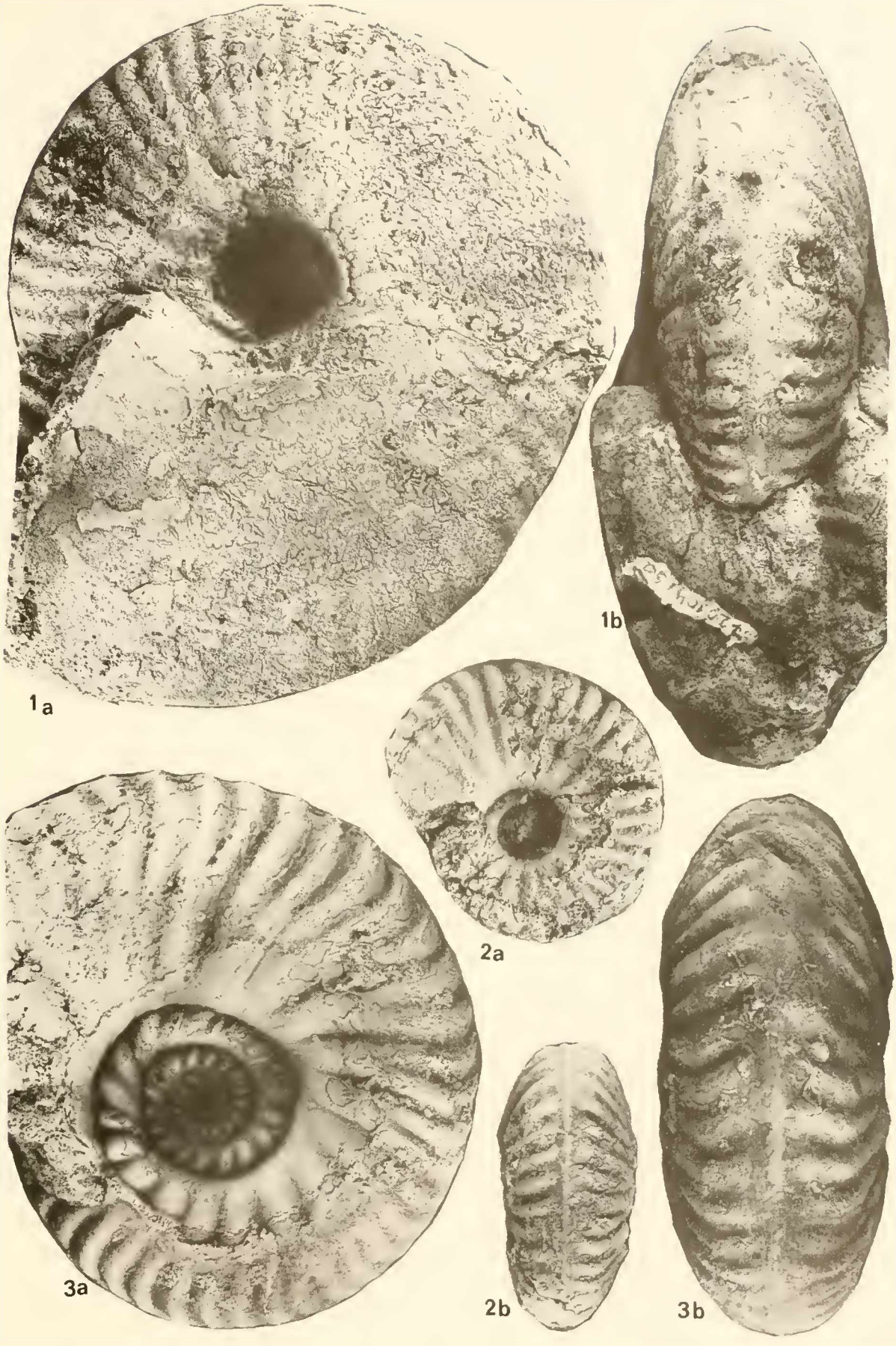

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Plate 4

Figs. 1–4: *Bredyia* cf. *manflasensis* n. sp., ♂ (? ♀ juv.); small specimens with incomplete body chambers; nat. size.

1: Largely with shell; Arroyo Overas (790223/5); B. St. M. 1983VI17; lateral view.

2: Internal mould with shell remains; Quebrada La Chaucha (661129/4); B. St. M. 1983VI18; lateral view.

3: Internal mould with shell remains; loc. 1 at Manflas (670812/5); B. St. M. 1983VI19; lateral view.

4: Internal mould; loc. 1 at Manflas (670812/5); B. St. M. 1983VI28; lateral view.

Fig. 5: *Bredyia manflasensis* WESTERMANN n. sp., ♀; fully septate internal mould; loc. 4 at Cerro Puchenque; no. McMaster J 1759; lateral view; ×0.9.

Fig. 6: *Bredyia manflasensis* WESTERMANN n. sp., ?♂; internal mould with shell remains, ¾ of last whorl body chamber; loc. 4 at Manflas (720104'6a); B. St. M. 1983VI25; lateral view; nat. size.

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Plate 5

Figs. 1–4: *Bredyia delicata* WESTERMANN n. sp.; nat. size.

1a, b: Holotype, septate internal mould with shell remains; loc. 1 at Manflas (670812/5); B. St. M. 1983VI29; a: lateral and b: ventral views.

2a, b: *B. delicata*?; internal mould of inner whorls; Quebrada La Chaucha (661129/4); B. St. M. 1983VI30; a: lateral and b: ventral views.

3: Evolute var. of *B. delicata*?; internal mould with shell remains; loc. 4 at Manflas (720104/6a); B. St. M. 1983VI31; lateral view.

4: Septate internal mould; loc. 1 at Manflas (670812/5); B. St. M. 1982VI32; a: lateral and b: ventral views.

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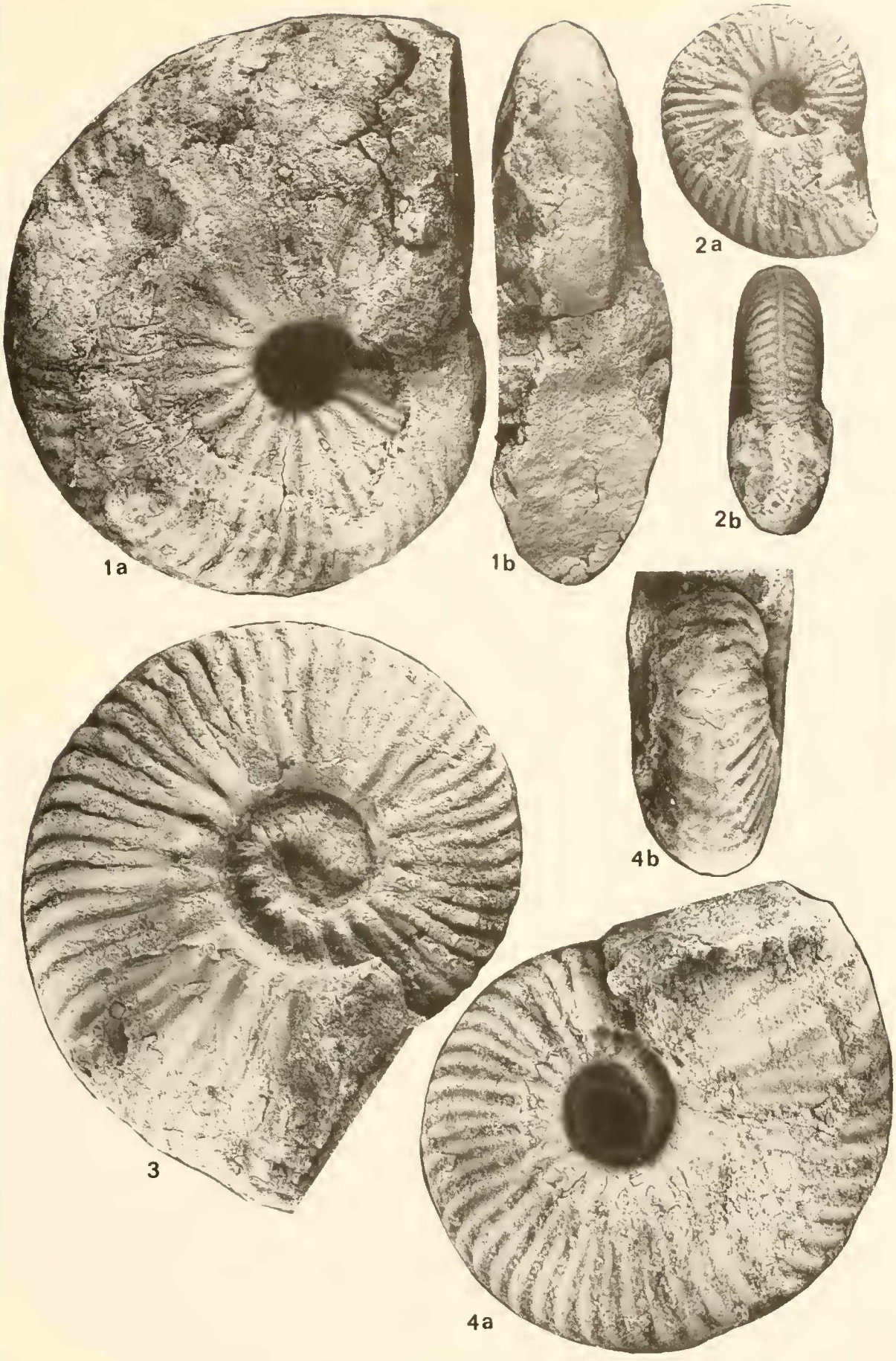

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Plate 6

Figs. 1a, b: ? *Bredyia delicata* WESTERMANN n. sp.; internal mould with shell remains of gigantic phragmocone; loc. 4 at Manflas (720104/6a); B. St. M. 1983V133; a: lateral and b: sectional views; ×0.5.

Figs. 2–4: *Planammatoceras (Pseudaptetoceras) klimakomphalum* (VACEK); lateral views of internal moulds; nat. size.

2: Septate whorls; Quebrada El Asiento, section 4, ? bed 13 (670305/14); B. St. M. 1983VI43; lateral view.

3: Septate whorls; Quebrada El Asiento, section 3, bed 12 or 13 (660707/10); B. St. M. 1983VI44; lateral view.

4: *P.* cf. *klimakomphalum;* complete, damaged specimen; Portezuelo de Pedernales, section 16 (670308/3); B. St. M. 1983V145; lateral view.

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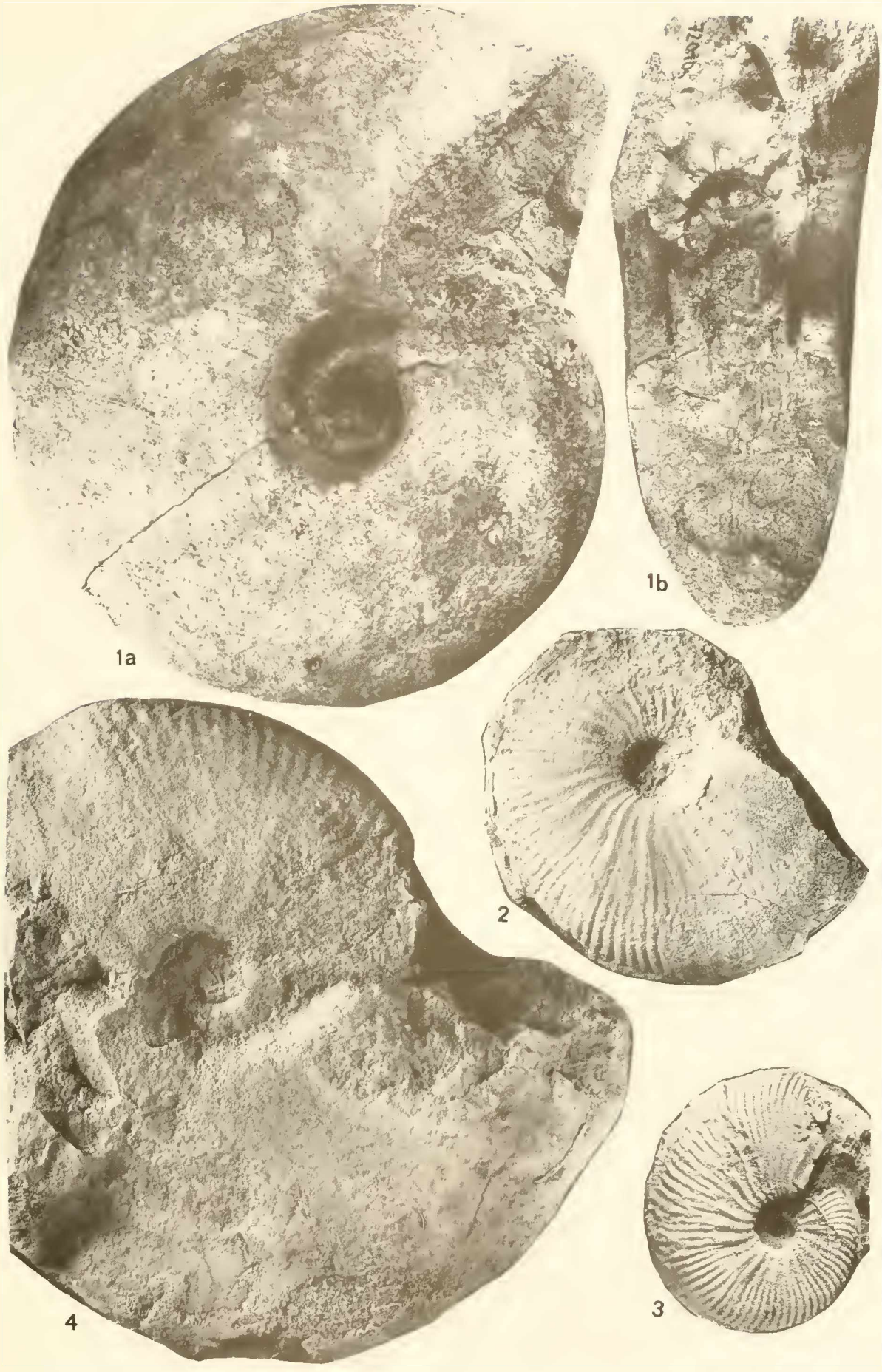

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Plate 7

Figs. 1–5: *Parammatoceras jensemi* WESTERMANN n. sp.; all internal moulds; nat. size.

1a, b: Holotype, phragmocone; Quebrada El Asiento; bed 10 (670305/14); B. St. M. 1983VI38; a: lateral and b: ventral views.

2: Septate whorls; Quebrada El Hueso, between sections 1 and 2, bed 10 (670306/13); B. St. M. 1983VI39; lateral view.

3a, b: Septate whorls; Quebrada El Asiento, section 3, bed 10 (670305/23); B. St. M. 1983VI41; a: lateral and b: ventral views.

4: Inner whorls; Quebrada El Hueso, between sections 1 and 2, bed 10 (670306/13); B. St. M. 1983VI40; lateral view.

5: Septate internal mould with part of body chamber; loc. 4 at Manflas (720104/7); B. St. M. 1983VI42; lateral view.

Figs. 6–7: *Planammatoceras (Pseudammatoceras) tricolore* WESTERMANN & RICCARDI; internal moulds; nat. size.

6: Septate whorls; loc. 1 at Manflas (670812/5a); B. St. M. 1983VI46; lateral view.

7: Septate whorls; Quebrada El Asiento, section 4, ? bed 13 (670305/14); B. St. M. 1983VI47; lateral view.

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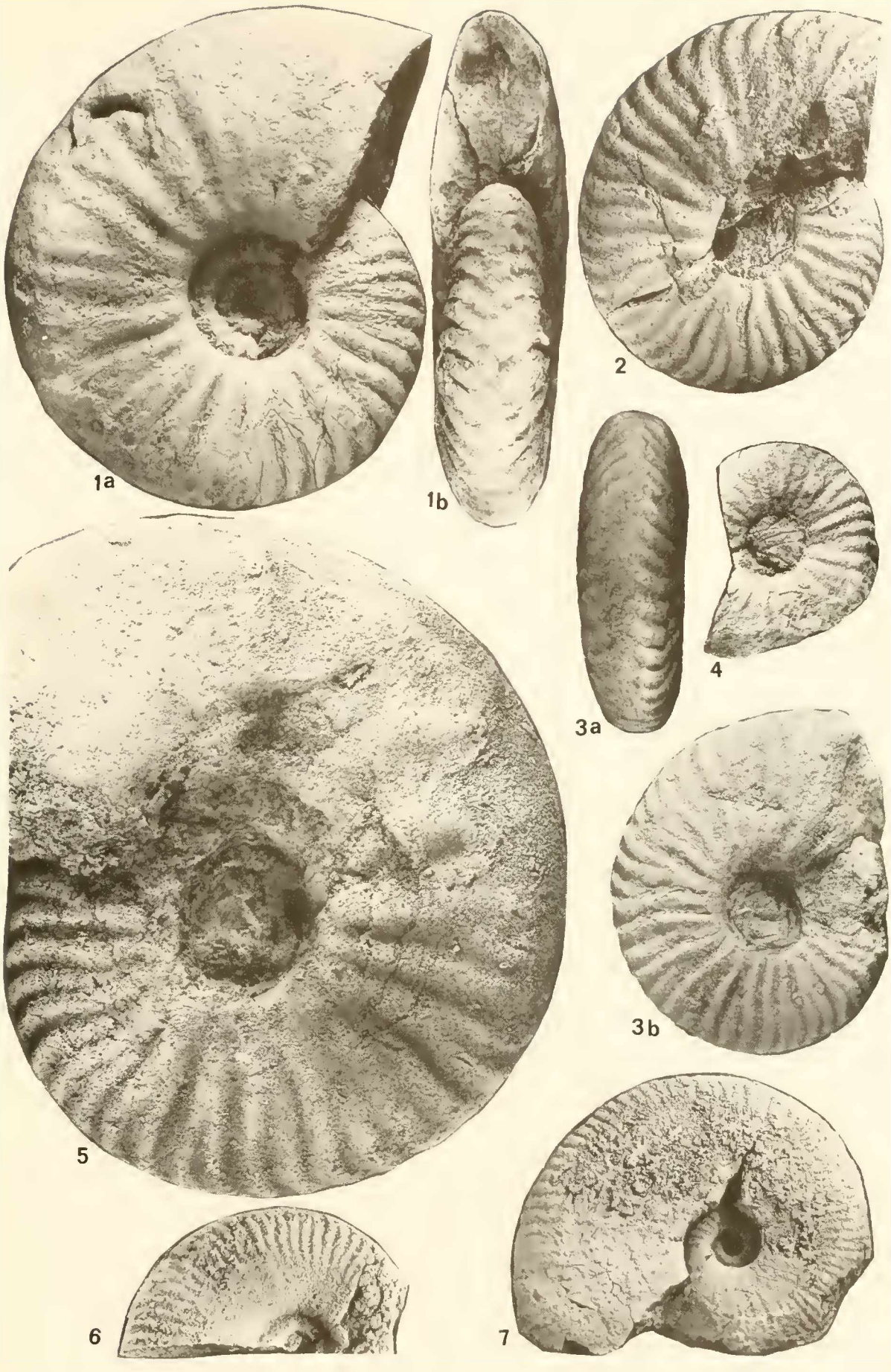

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Plate 8

Figs. 1–6: *Puchenquia malarguensis* (BURCKHARDT) ♀ (+ ♂).

1–5: Internal moulds; Quebrada El Bolito, bed 15 (670222/14); lateral views; nat. size.

1: Almost complete macroconch; B. St. M. 1983VI49.

2: Damaged almost complete macroconch; B. St. M. 1983VI50.

3: Damaged almost complete macroconch, coarsely ribbed variant; B. St. M. 1983VI51.

4: Almost complete microconch; B. St. M. 1983VI52.

5: Almost complete macroconch; B. St. M. 1983VI53.

6: Internal mould of microconch; Quebrada La Chaucha (661129/5); B. St. M. 1983VI54; lateral view; nat. size.

Fig. 7: *Puchenquia* sp.; septate internal mould; loc. 3 at Manflas (670810/6a); B. St. M. 1983VI55; lateral view; nat. size.

Fig. 8: *Eudmetoceras eudmetum jaworskii* WESTERMANN; fully septate internal mould; Quebrada El Bolito, bed 14 (670222/13); B. St. M. 1983VI48; lateral view; nat. size.

Figs. 9–11: *Puchenquia (Gerthiceras) compressa* WESTERMANN & RICCARDI; internal moulds; lateral views; nat. size.

9: Macroconch with $^1/_4$ whorl body chamber; Quebrada El Bolito, bed 14 (670222/13); B. St. M. 1983VI56.

10: Septate specimen with exposed inner whorls; loc. 5 at Manflas (720106/5); B. St. M. 1983VI57.

11: Septate whorls; loc. 5 at Manflas (720106/5); B. St. M. 1983VI58.

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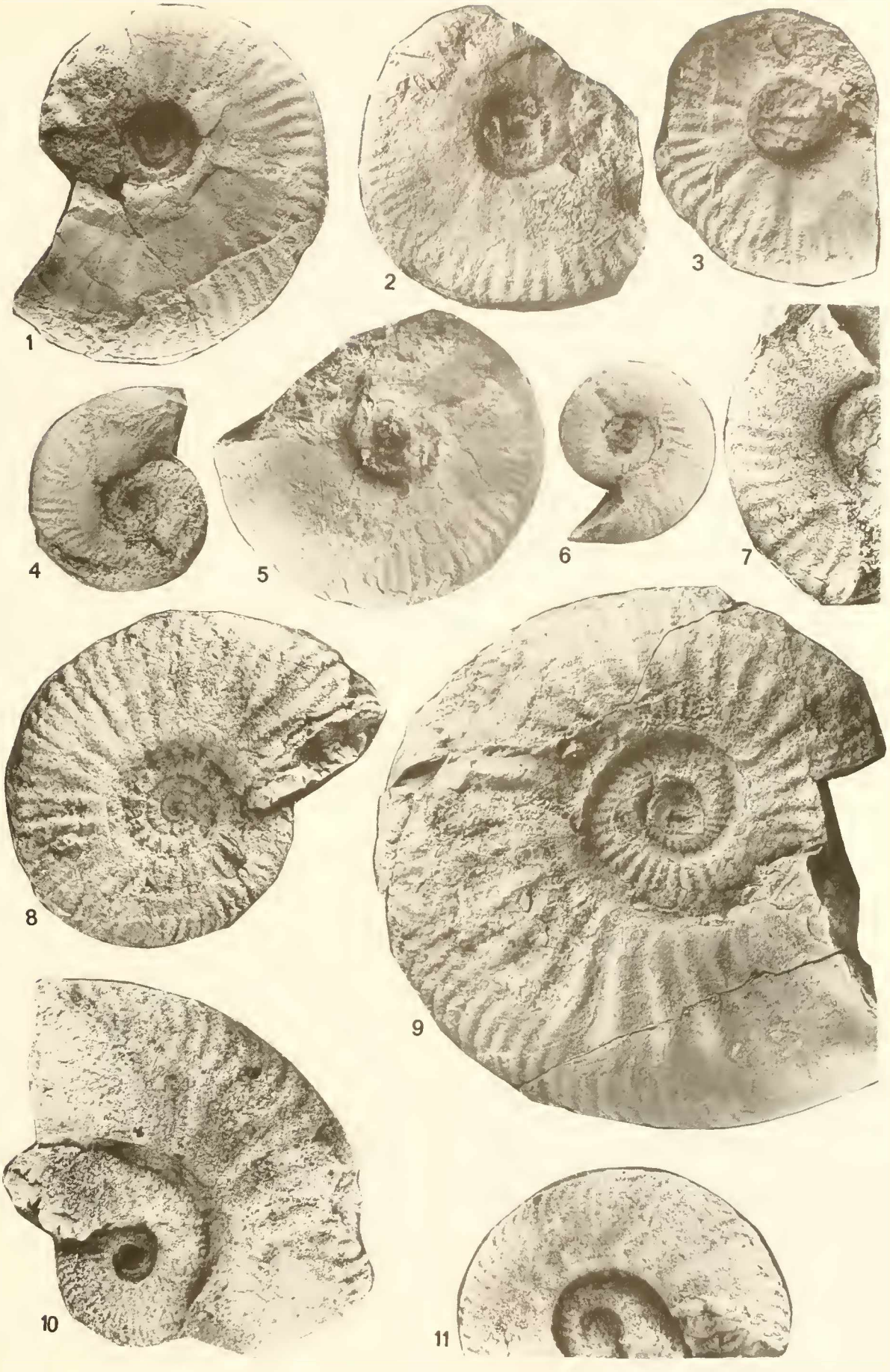

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Plate 9

Figs. 1a, b: *Puchenquia (Gerthiceras) compressa* WESTERMANN & RICCARDI, ♀; internal mould with almost complete body chamber; Quebrada El Asiento, section 5 (670307/7); B. St. M. 1983VI59; a: lateral and b: ventral views; nat. size.

Figs. 2–5: *Puchenquia (Gerthiceras) mendozana mendozana* WESTERMANN & RICCARDI; internal moulds; lateral views; nat. size.

2: Macroconch, part of body chamber; Quebrada El Asiento, section 3 (660707/9); B. St. M. 1983VI60.

3–4: *P. mendozana*?; septate fragments; Quebrada El Asiento, section 3 (660707/9); B. St. M. 1983VI61, 62.

5: Phragmocone of macroconch; Quebrada El Bolito, bed 15 (670222/14); B. St. M. 1983VI63.

Figs. 6–7: *Puchenquia (Gerthiceras) mendozana spinosa* WESTERMANN n. ssp., ♀; internal moulds; lateral views; nat. size.

6: Holotype, fully septate; Quebrada El Bolito, bed 14 (670222/13); B. St. M. 1983VI64.

7: Almost complete, damaged specimen; Quebrada El Hueso, section 2 (670306/16); B. St. M. 1983VI65.

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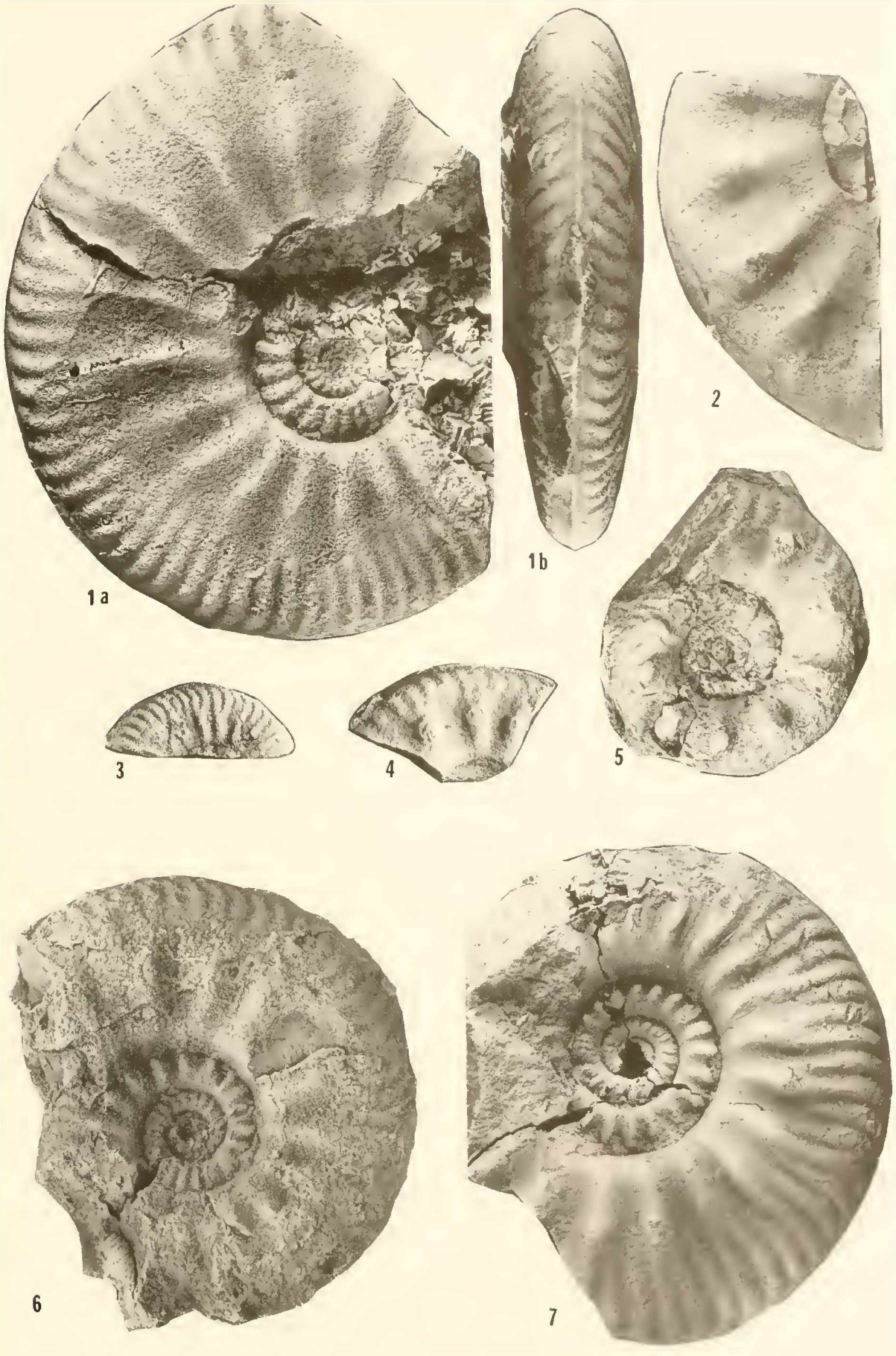

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Plate 10

Figs. 1a, b: *Puchenquia (Gerthiceras) mendozana spinosa* WESTERMANN n. ssp., ♀; almost complete, damaged internal mould; Quebrada El Hueso, between sections 1 and 2 (670306/14); B. St. M. 1983VI66; a: lateral and b: ventral views; nat. size.

Figs. 2–4: *Podagrosiceras maubeugei* WESTERMANN & RICCARDI, ♀; internal moulds; nat. size.

2a, b: Septate whorls; Quebrada Caballo Muerto (670304/3); B. St. M. 1983VI67; a: lateral and b: ventral views.

3a, b: Septate whorls; Quebrada El Asiento, section 4, bed 15 (670305/16); B. St. M. 1983VI68; a: lateral and b: ventral views.

4: Almost complete macroconch; Portezuelo El Padre, locality 7 (670106/12); B. St. M. 1983VI69.

Fig. 5: *Podagrosiceras* aff. *athleticum* MAUBEUGE & LAMBERT, ♀; almost complete internal mould; Quebrada El Hueso, between sections 1 and 2 (670306/14); B. St. M. 1983VI70; lateral view; nat. size.

Fig. 6: *Zurcheria groeberi* WESTERMANN & RICCARDI; probably complete internal mould; Quebrada El Hueso, section 2 (670306/16); B. St. M. 1983VI71; lateral view; nat. size.

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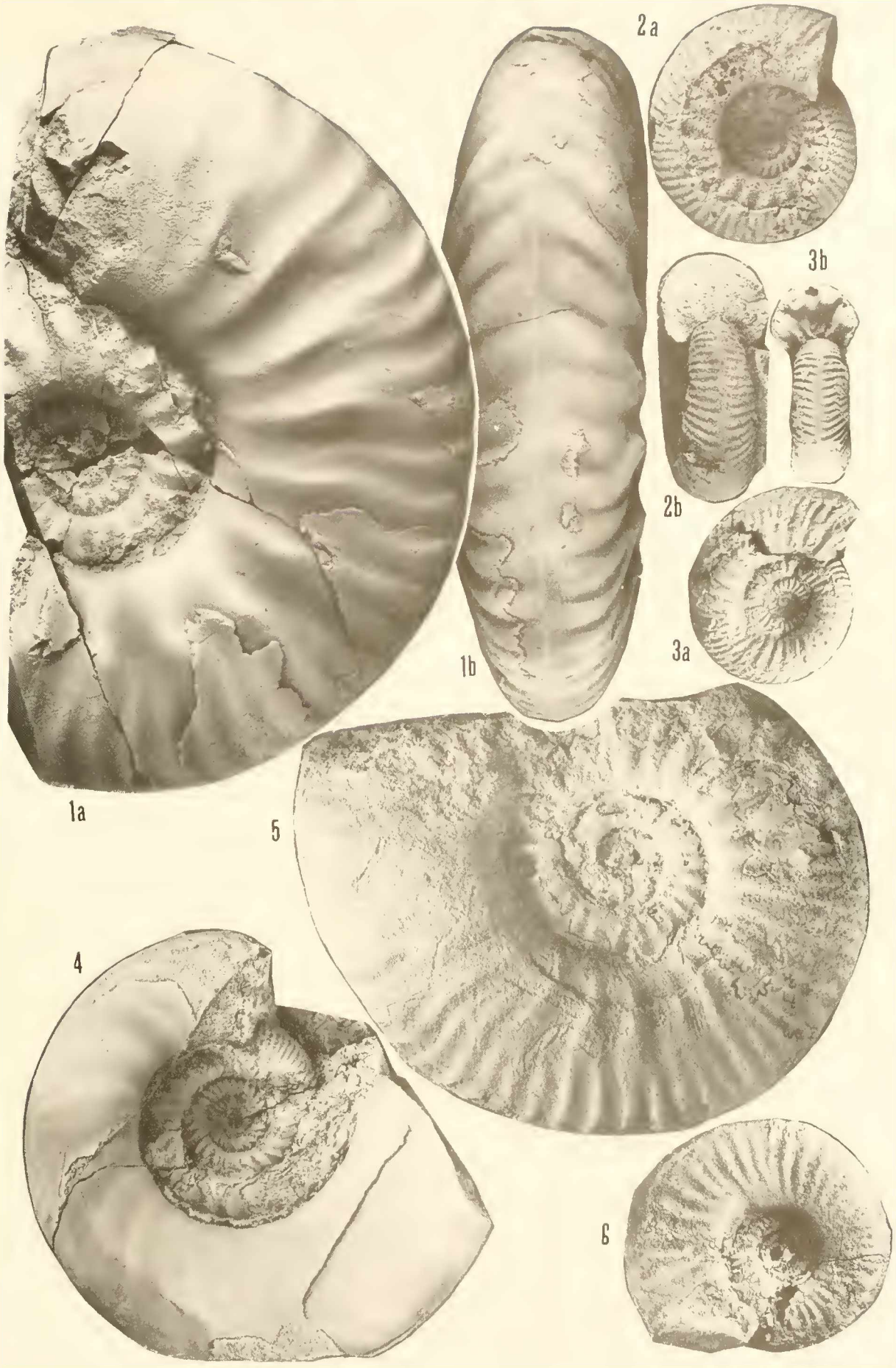

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