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OF THE ARGENTINE-CHILEAN ANDES. PART I: HILDOCERATAEAE.

DIE MITTELJURASSISCHE AMMONITEN-FAUNA UND BIOCHRONOLOGIE DER ARGENTINISCH-
CHILENISCHEN ANDEN. TEIL I: HILDOCERATAEAE.

FAUNA DE AMONITAS Y BIOCROLOGIA DEL JURASICO MEDIO DE LOS ANDES ARGENTINO-
CHILENOS. PARTE I: HILDOCERATAEAE.

(PAGE 1—116. WITH PLATES 1—31, ONE TABLE AND 40 TEXT-FIGURES.)



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(Fortsetzung siehe 3. Umschlagseite)

MIDDLE JURASSIC AMMONOID FAUNA AND BIOCHRONOLOGY OF THE ARGENTINE-CHILEAN ANDES PART I: HILDOCERATAEAE

DIE MITTELJURASSISCHE AMMONITEN-FAUNA UND BIOCHRONOLOGIE
DER ARGENTINISCH-CHILENISCHEN ANDEN
TEIL I: HILDOCERATAEAE

FAUNA DE AMONITAS Y BIOCROLOGIA DEL JURASICO MEDIO
DE LOS ANDES ARGENTINO-CHILENOS
PARTE I: HILDOCERATAEAE

BY

G. E. G. WESTERMANN¹⁾ and A. C. RICCARDI²⁾

With Plates 1—31, one Table and 40 Text-figures

Abstract

The early Middle Jurassic (Aalenian to Middle Bajocian) Hildocerataeae of the Argentine-Chilean Andes are revised taxonomically and chronologically, based on the reexamination of all available specimens and of most type localities in Neuquén, Mendoza, San Juan (Argentina) and Atacama (Chile) provinces. The type specimens of previously described species are reillustrated, but a number of them appears to be lost. While the Aalenian zones and their correlation remain unclear, the Lower and Middle Bajocian are divided into the (European) standard zones. Full faunal and biochronologic analyses will be given in Part II.

The Aalenian is mostly rather poorly fossiliferous, yielding locally the genera *Leioceras* (?), *Staufenia* (?), *Tmetoceras*, *Bredyia*, *Erycites*, *Planammatoceras* [including several unnamed new species]. Several diverse ammonoid assemblages occur at the approximate base of the Bajocian, with *Eudmetoceras* s. s., *E. (Euaptetoceras)*, *Fontannesia* (?), *Zurcheria* [*Z. groeberi* sp. nov.], *Sonninia* s. s., *S. (Euhoploceras)* [including *S. amosi* sp. nov.], *Puchenquia* gen. nov. [type-species *H. malarguense* BURCKH. of "*Harpoceras*" or "*Pleydellia* assemblage" auct.], an unnamed new genus of probable Hammatoceratidae intermediate to Sonniniidae [with spp. nov. A. & B], and *Tmetoceras*. Superjacent, *Sonninia (Fissiloboceras) zitteli* (GOTT.) [with 4 or 5 synonyms] and *Pseudotoites* [Part II] clearly indicate the Sowerbyi Zone in which *Sonninia (Papilliceras)* appears. The Sauzei Zone yields *S. (Papilliceras) espinazitensis* TORNO. [with 3 to 6 synonyms], early *Dorsetensia* [including *D. blancoensis* and *D. mendozai*, spp. nov.], Otoitidae and Stephanoceratidae [Part II]. The Humphriesianum Zone is established by *Dorsetensia romani* (OPPEL) and *D. liostraca* with *Stephanoceras* ex. gr. *humphriesianum* (SOW.) [Part II]. Oppeliidae, Lytoceratidae and Phylloceratidae are scarce [Part II].

Sexual dimorphism is indicated or suggested for most species described; this is illustrated in bivariate scatter diagrams. A number of early species names are drawn into synonymy, while several subgenera and species hitherto known only from Europe, are added; one genus and four species are new (see above).

Key words:

Ammonites — Middle Jurassic — South America — Hildocerataeae

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Zusammenfassung

Die Hildocerataceae des frühen Mittleren Jura (Aalenium bis Mittleren Bajocium) der Chilenisch-Argentinischen Anden werden taxonomisch und chronologisch revidiert, basiert auf Neuuntersuchungen aller zugänglichen Exemplare und der meisten Typlokalitäten in den Provinzen Neuquén, Mendoza, San Juan (Argentinien) und Atacama (Chile). Die Typen früher beschriebener Arten werden neu abgebildet, aber eine Anzahl scheint verloren gegangen zu sein. Während die Zonengliederung und Korrelierungen des Aalenium unklar bleiben, können Unteres und Mittleres Bajocium in (europäische) Standard-Zonen geteilt werden. Die ausführliche faunistische und biochronologische Analyse ist für Teil II vorbehalten.

Das Aalenium ist ziemlich fossilarm, lokal mit den Gattungen *Leioceras* (?), *Staufenia* (?), *Tmetoceras*, *Bredya*, *Erycites* und *Planammatoceras* [mit mehreren unbenannten neuen Arten]. Mehrere vielfältige Ammoniten-Assoziationen liegen nahe der Aalenium/Bajocium-Grenze, mit *Eudmetoceras* s. s., *E. (Euaptetoceras)*, *Fontannesia* (?), *Zurcheria* [*Z. groeberi* sp. nov.], *Sonninia* s. s., *S. (Euhoploceras)* [mit *S. amosi* sp. nov.], *Puchenquia* gen. nov. [Typ-Art *H. malarguense* BURCKH. der „*Harpoceras*-“ oder „*Pleydellia*-Gemeinschaft“ auct.], sowie eine unbenannte neue Gattung wahrscheinlicher Hammatoceratidae, nach Sonniniidae vermittelnd [mit spp. nov. A & B] und *Tmetoceras*. Direkt darüber ist die Sowerbyi Zone erwiesen durch *Sonninia (Fissiloboceras) zitteli* (GOTT.) [mit 4—5 Synonymen] und *Pseudotoites* [Teil II]; hier erscheint bereits *S. (Papilliceras)*. Die Sauzei Zone enthält *S. (Papilliceras) espinazitensis* TORNQ. [mit 3—6 Synonymen], frühe *Dorsetensia* [mit *D. blancoensis* und *D. mendozai* spp. nov.], Otoitidae und frühe Stephanoceratidae [Teil II]. Die Humphriesianum Zone ist nachgewiesen durch *Dorsetensia romani* (OPPEL), *D. liostraca* BUCK. und *Stephanoceras* ex. gr. *humphriesianum* (Sow.) [Teil II]. OPELLIIDAE, LYTCERATIDAE und PHYLLOCERATIDAE sind selten [Teil II].

Sexualdimorphismus ist für die meisten beschriebenen Arten mehr oder weniger gut erwiesen oder angedeutet; zur Illustrierung dienen bivariate Streu-Diagramme. Eine Anzahl älterer Artnamen werden als Synonyme eingezogen, während mehrere Untergattungen und Arten, die bisher nur vom europäischen Raum bekannt waren, hinzugefügt werden; eine Gattung und vier Arten sind neu (s. o.).

Schlüsselworte:

Ammoniten — Mittlerer Jura — Südamerika — Hildocerataceae

Resumen

Se revisa taxonómica y cronológicamente a los Hildocerataceae del Jurásico medio inferior (Aaleniano a Bayociano medio) de los Andes argentino-chilenos, sobre la base del estudio, de todos los ejemplares disponibles y de la mayoría de las localidades tipos de las provincias de Neuquén, Mendoza, San Juan (Argentina) y Atacama (Chile). Se reilustran los ejemplares tipos de las especies descritas previamente por otros autores, con excepción de algunos aparentemente extraviados. Las zonas del Aaleniano y sus correlaciones permanecen sin clarificar, mientras que el Bayociano inferior y medio se divide de acuerdo con la zonación standard europea. Un análisis completo, tanto faunístico como biocronológico será incluido en la Parte II.

El Aaleniano es poco fosilífero, y en él se hallan representados los géneros, *Leioceras* (?), *Staufenia* (?), *Tmetoceras*, *Bredya*, *Erycites*, y *Planammatoceras* [incluyendo algunas especies nuevas indenumeradas]. Aproximadamente en la base del Bayociano se hallan algunas asociaciones de amonitas con, *Eudmetoceras* s. s., *E. (Euaptetoceras)*, *Fontannesia* (?), *Zurcheria* [*Z. groeberi* sp. nov.], *Sonninia* s. s., *S. (Euhoploceras)* [incluyendo *S. amosi* sp. nov.], *Puchenquia* gen. nov. [especie tipo *H. malarguense*, de la asociación de “*Harpoceras*” o “*Pleydellia*” auct.], un género indenumerado probable Hammatoceratidae intermedio a Sonniniidae [con spp. nov. A y B], y *Tmetoceras*. En una posición estratigráfica superior, la presencia de *Sonninia (Fissiloboceras) zitteli* [con 4 ó 5 sinónimos] y *Pseudotoites* [Parte II] indica claramente la Zona de Sowerbyi, en la cual aparece *Sonninia (Papilliceras)*. La Zona de Sauzei contiene *S. (Papilliceras) espinazitensis* [con 3 a 6 sinónimos], representantes tempranos de *Dorsetensia* [incluyendo *D. blancoensis* y *D. mendozai* spp. nov.], Otoitidae y Stephanoceratidae [Parte II]. La Zona de Humphriesianum se ha establecido por la presencia de *Dorsetensia romani* y *D. liostraca* con *Stephanoceras* ex. gr. *humphriesianum* [Parte II]. OPELLIIDAE, LYTCERATIDAE y PHYLLOCERATIDAE son escasos [Parte II].

Para la mayoría de las especies descritas se indica o sugiere la presencia de dimorfismo sexual, lo cual se pone en evidencia en diagramas bivariados. Algunos nombres específicos anteriores son colocados en sinonimia, al tiempo que se describen algunos subgéneros y especies anteriormente sólo conocidos en Europa. Un género y 4 especies son nuevos (ver arriba).

Palabras llaves:

Amonitas — Jurásico Medio — America Meridional — Hildocerataceae

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Introduction

This monograph is an attempt to revise the rich and diverse ammonoid fauna known for nearly a century (since GOTTSCHKE, 1878) from the Argentine-Chilean Andes, and concerns its distribution, classification, biochronology and 'correlation'. The study is based on reexamination of the type specimens and of a number of type localities, on collections repositied in Museums, Institutes and Companies (cf. Acknowledgments), and on our own extensive collections from 'old' and 'new' localities in Mendoza, Neuquén and Atacama provinces of Argentina and Chile. The field work was carried out mainly during the first half of 1965 and the most important Argentine sections were reexamined in October, 1970. While we visited jointly all outcrops in Argentina, except for some exploratory work in the areas of Cerro Puchenque, Portezuelo Ancho and Arroyo Blanco by A. C. RICCARDI, the collecting trips in Chile were made by G. E. G. WESTERMANN with the able assistance of Mr. RAUL VICENCIO, then at the Escuela de Geología, Universidad Nacional de Chile, Santiago.

Part I (of 2) of this monograph deals with the superfamily Hildocerataceae (as of Treatise on Invertebrate Paleontology, Part L) of the Aalenian and early Bajocian and is mainly concerned with the most abundant, diverse and well preserved Sonniniidae. Almost all 'European' genera and subgenera are present with closely

related or identical species; significantly, a number of species names of the late nineteenth century from the Andes is now drawn into synonymy, while several 'European' forms have been added. The late Hammatoceratidae are less abundant and diverse, usually much more poorly preserved and largely endemic at the genus level. Relatively rare Hildoceratidae, with *Tmetoceras*, and probable Graphoceratidae, possibly only *Leioceras*, are also described. Part II will deal with the abundant superfamilies Stephanocerataceae (particularly Otoitidae, Stephanoceratidae and Macrocephalitidae) and Perisphinctaceae, as well as with the more scarce Haplocerataceae, Phylloceratina and Lytoceratina. The 'European' elements are indeed so well represented in the Bajocian (Sowerbyi to Subfurcatum Zones), that the standard zones are clearly indicated and therefore used. The zonation of the Aalenian, however, remains doubtful.

Part I includes a description and discussion of the previous literature of the reexamined lower Middle Jurassic sections or parts of sections with the listing of the assemblages. Part II will contain the entire Middle Jurassic parts of these sections or their completions, as well as the faunal analysis pertaining to taxonomic affinities, palaeobiogeography and biochronology.

Measurements

The measurements of the types and figured specimens as listed in the tables were all taken on the internal moulds (estimated if test present) in the conventional manner. D = diameter; H = whorl height at given D, from umbilical seam to venter in plane of coiling; W = whorl width at given D, perpendicular to plain of coiling; U = umbilical width at given D, 'inner' diameter at umbilical seam. Many specimens were measured at different diameters, representing morphogeny, at phragmocone (phrag.), body chamber (body ch.), and aperture as indicated. In the diagrams, such sets of measurements on single specimens are connected with thin lines, and plots for phragmocone measurements are distinct from those of body chambers. Relative growth rates, such as "W" (expansion rate) and "D" (distance from the coiling axis) of RAUP (1966), which require radial and angular measurements, have not been employed for reasons of consistency with data from literature and because of the frequently imperfect preservation.

Repositories

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

BMNH	British Museum (Natural History), Cromwell Road, London, S.W. 7, England.
DNGM	Dirección Nacional de Geología y Minería, Perú 562, Buenos Aires, Argentina.
GAUG	Geologisch-Paläontologisches Institut, Georg-August Universität, Berliner Str. 28, 34 Göttingen, West Germany.
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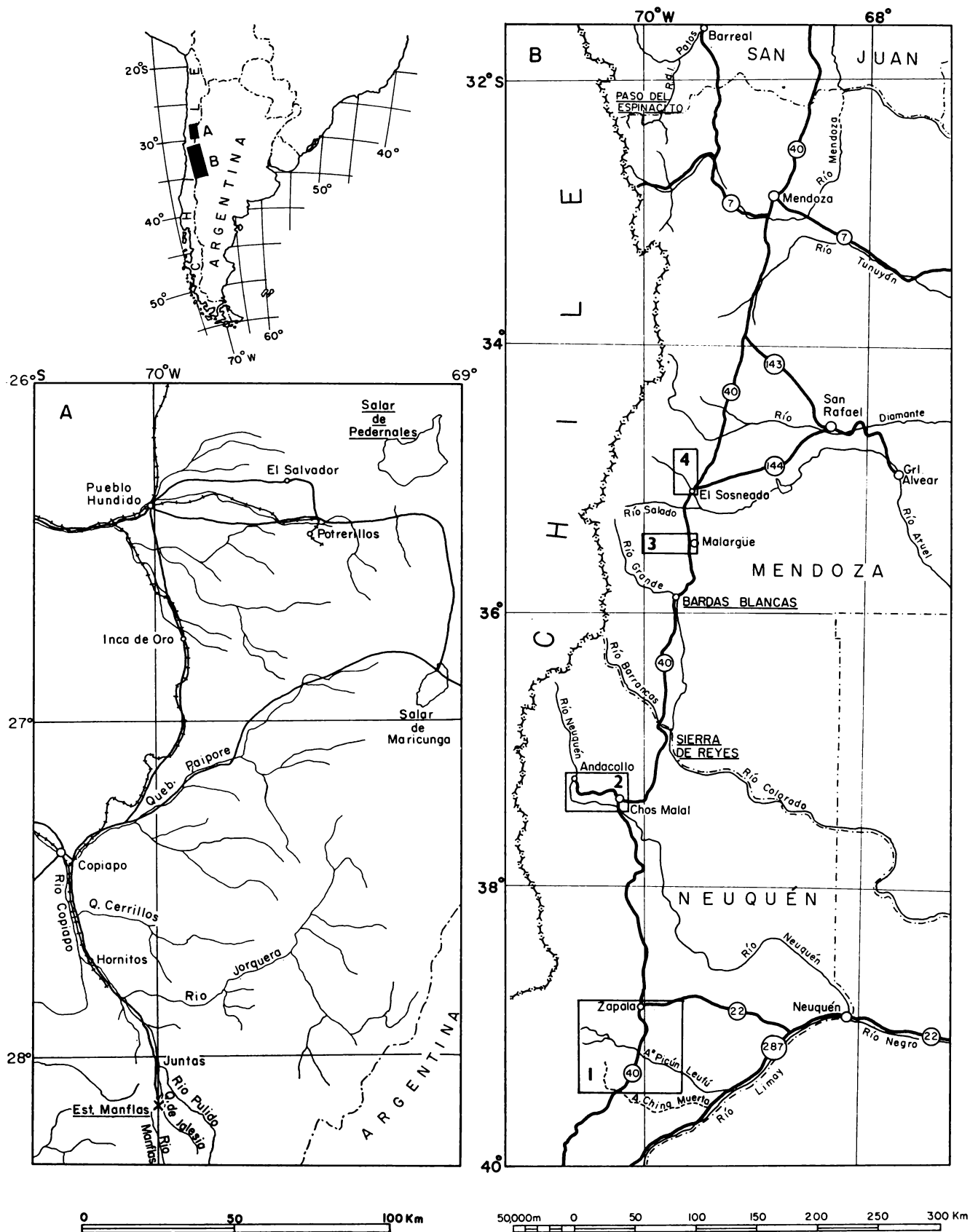
Fossil Localities

Formational names

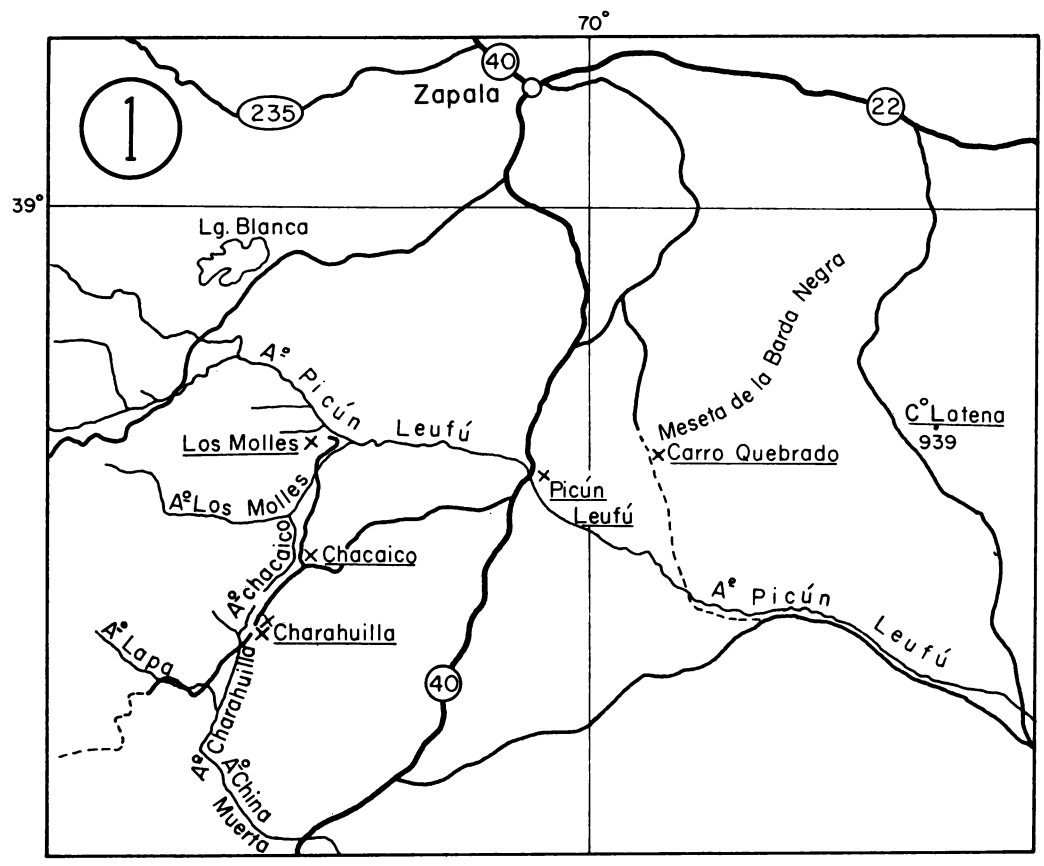
The definition and nomenclature of the Jurassic lithostratigraphic units of Neuquén and Mendoza are in a state of confusion. As pointed out by WEAVER (1931, p. 12) "there has been a tendency among the writers on the Mesozoic stratigraphy of Argentina to refer to the sedimentary formations in terms of European faunal zones". This was reinforced when GROEBER (1946) introduced such terms as "Cuyano" and "Chacayano" with chronostratigraphic meaning. GROEBER's ideas and terminology were accepted in the 1950's by virtually all Argentine geologists. Only in the 1960's did they begin to modify these names for lithostratigraphic use, although many geologists appeared to have difficulties to avoid the age implications.

The modification (emendation) of the chronostratigraphic terms used by GROEBER and his followers has only been possible or successful in cases of rather uniform lithology, but rarely throughout sedimentary basins. Some geologists have included different lithologies under "facies variation" within generalized formations; e. g., STIPANICIC (1966, p. 413) applied a single set of formations for Neuquén, Mendoza and San Juan provinces. Since such a system is inoperable, this author has subsequently introduced new formational names; e. g., STIPANICIC & BONETTI (1970, p. 65—66) now refer to the units below the lower gypsum of the Arroyo Blanco areas as China Muerta Formation and the Rio Atuel Group which in turn is divided into two formations. However, there is now no mention of the "Grupo Cuyano" used previously (STIPANICIC, 1966, p. 413). Furthermore, some of the named formations are poorly known regarding their areal distribution and facies variation.

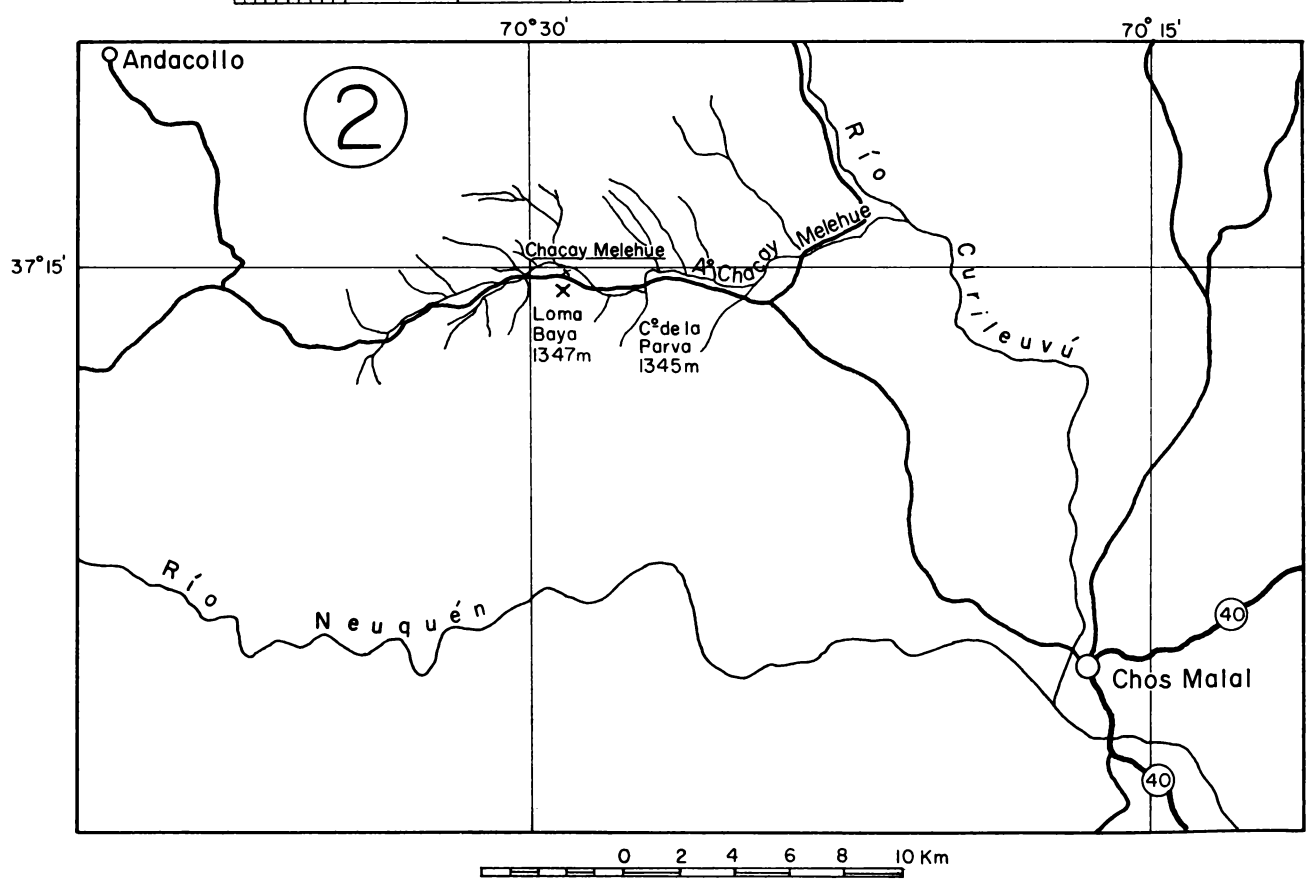
For the Arroyo Blanco section we will tentatively apply the formational names given by STIPANICIC (1966), STIPANICIC & BONETTI (1970) and VOLKHEIMER (1970); in southern Neuquén we may perhaps use Lajas Formation although this term was poorly defined apparently referring to all calcareous and argillaceous sandstones of the Los Molles area (WEAVER, 1931); at Chacay Melehue no formational names below the Auquilco Formation (upper gypsum) are available (cf. STIPANICIC, 1966, p. 447); at Cerro Puchenque, the lower part of the Middle Jurassic section has informally been called "Puchenque Formation" (unpublished geologic map prepared by the Geological Survey, DNGM); for the Bardas Blancas section no complete series of formational names has been worked out (cf. STIPANICIC, 1966, p. 429).



Text-fig. 1. Index maps for the regions of investigation in Chile (A) and Argentina (B): rectangles Nos. 1 to 4 indicate locality maps Text-figs. 2—3.



Text-fig. 2



In summary, the formational names for southern Neuquén and the Río Atuel area of Mendoza, are in part improperly defined; for Cerro Puchenque and Bardas Blancas we will partly refer to unpublished (ms.) names; and for Chacay Melehue we will tentatively and somewhat arbitrarily choose from names given to similar rocks in other areas. Our own knowledge in the field is inadequate for the naming of new formations. Our use of formational names in the stratigraphic descriptions is therefore tentative only, particularly where placed in parentheses; they are meant as a reference rather than formal application.

Neuquén Province, Argentina

In the Zapala area, the formational names are not clearly defined for the outcrops of Charahuilla, Chacaico, Los Molles, Picún Leufú, Paso del Carro Quebrado, and Cerro Lotena.

WEAVER (1931) introduced formational names for the different lithologic units, but they were not clearly defined, being listed merely in the Correlation Chart (pl. I). The “Los Molles Formation” is the “dark gray marine shales”, which according to the chart range in age from the Toarcian to the Opalinum Zone; “Above these beds are calcareous and argillaceous sandstones containing a marine fauna ranging in age from the zone of *murchisoni* to the zone of *sowerbyi*” (pl. I), which were not named; higher up, the next named lithologic unit in the area is the “Lajas Formation”, for “calcareous sandstones . . . interbedded with strictly continental sandstones”; above it, the continental sandstones of the “Lotena Formation” were recorded.

WEAVER (op. cit.) however also stated that the Lotena Formation “continues downward to the massive and bedded gray shales of the lower Dogger”, and that the “bluish gray and black marine shales” (Los Molles Formation) are overlaid by shallow water marine and continental sandstones and sandy shales which are in part middle Bajocian and in part Callovian (WEAVER, 1931, p. 25). Furthermore at Cerro Lotena “there is a continuous sequence of shallow water sandstones and sandy shales from the top of the massive shales of the zone of *opalinum* upwards to the base of the marine limestones of the lower Tithonian” (op. cit., p. 26).

Taking also into account the later restriction of the Lotena Formation (cf. GROEBER et al., 1953, p. 165), it seems therefore that Lajas Formation (as Las Lajas Formation in VOLKHEIMER, 1969, p. 134) could be used for the sandstones and shales underlying the Lotena Formation and overlying the Los Molles Formation.

1. Charahuilla-Chacaico (39° 20'—25' S, 70° 22' W)

Approximately 50—60 km southwest of Zapala, Neuquén province (Text-fig. 2); sections accessible by car.

The main outcrops are along the slopes of the broad anticlinal valley which in the South contains the Arroyo Charahuilla, running southward into the Arroyo China Muerta, and in the North the Arroyo Chacaico, running northward into the Arroyo Los Molles which, in turn, joins the Arroyo Picún Leufú.

The general stratigraphy of the area was studied by FERNÁNDEZ (1943) and summarized by GROEBER et al. (1953, p. 158) (cf. also STIPANICIC & RODRIGO, 1970, p. 359). However, the exact stratigraphic occurrences of the listed fossils were unknown. 235—340 m of clay, marlstone, and limestone bearing Sinemurian, Pliensbachian and Lower Toarcian ammonites, were said to be overlaid by 570—630 m of marly and limey shales with ammonites supposedly representing the European zones of *L. opalinum* (“*Harpoceras klimakomphalum*, *Harpoceras aalense*”), *L. murchisonae* (“*Harpoceras murchisonae*, *Tmetoceras gemmellaroi*”), and *O. sauzei* (“*Otoites sauzei*, *Sphaeroceras multifforme*, *Sonninia espinazitensis*, *S. mesacantha*, *S. propinquans*, *S. fascicostata*”).

The specimen of “*Cadomites* sp.” figured by LEANZA (1958) from Chacaico (fide STIPANICIC, 1969, p. 374, and label of the specimen at hand) which was regarded as the only evidence for the Humphriesianum Zone of Argentina, is a perfect *Stephanoceras* (*Skirroceras*) *macrum* (QUENSTEDT). The specimen resembles our own specimen from the Sauzei Zone of Chacaico and the species and subgenus are well known from the Sauzei Zone of Europe and Alaska (cf. IMLAY, 1964).

Text-fig. 2. Locality maps 1, Zapala area, and 2, Chos Malal area, in Neuquén Province (cf. Text-fig. 1 B).

1a) Bajocian section Charahuilla-1, at northeastern slope of Charahuilla valley, along a gully [Aalenian beds not exposed; Upper Toarcian with *Phymatoceras copiapense* (MOER.) exposed at opposite side of valley].

Formation (Lajas)	Age	Bed	Cat.-No.*	Thickness
				> 40 m sandstone and some shale.
	(? Humphriesianum Zone)	2	J 1341	30 m above base — <i>Isognomon</i> cf. <i>I. isognomonoides</i> (STAHL), <i>Ctenostreon</i> cf. <i>C. pectiniformis</i> (SCHLOTH.).
				13 m Sandstone, coarse, often crossbedded, forming the cliff — unfossiliferous.
	— ? —			22 m Arenaceous and silty shales grading downward into brownish shales — unfossiliferous.
	Sauzei Zone	1a ₁	J 1343	6 m Sandstone bed and grey marls — Marls with abundant <i>Oxytoma</i> , <i>Modiolus</i> , <i>Pleuromya</i> , pectinids, ostreids, also several serpulids, <i>Sonninia</i> (<i>Papilliceras</i>) sp. ♀, ? <i>Emileia</i> ♂ [<i>Otoites</i>].
		1a ₂	J 1311	7 m Marls — with rich ammonoid fauna: <i>Emileia</i> aff. <i>multiformis</i> (GOTT.) ♀ & ♂, also <i>E. multiformis</i> ♀, <i>E. cf. contracta</i> (SOW.) ♂, <i>S. (Papilliceras) espinazitensis</i> (TORNQ.) ♀, ? <i>Bradfordia</i> sp., <i>Chondroceras</i> cf. <i>giebeli</i> (GOTT.), (?) <i>C. ex gr. defontii</i> (MCLEARN), large <i>Lytoceras</i> sp.
				5 m Shale and marl — unfossiliferous.
				1.5 m Platy sandstone — some <i>S. (Papilliceras)</i> sp.
		1b	J 1310	2.5 m Shale and arenaceous marl — near base with abundant <i>Sonninia (Papilliceras) espinazitensis</i> ♀ & cf. ♂, single <i>S. (Fissiloboceras) cf. zitteli</i> (GOTT.), <i>Emileia</i> cf. <i>multiformis</i> ♂.
				15 m Shale and marl.
		1c ₁	J 1320	5 m Shale with concretions — abundant <i>Sonninia (Papilliceras) espinazitensis</i> ♀ & cf. ♂, single <i>S. (Sonninia) ovalis</i> (QU.) ♀, <i>S. (S. ?) alsatica</i> (HAUG) ♀, some pectinid and aviculid bivalves.
		1c ₂	J 1340	2 m Sandstone with concretions — abundant <i>Emileia</i> aff. <i>multiformis</i> ♀ & ♂ [<i>Otoites</i>], several <i>S. (Papilliceras)</i> sp.
	— ? —			50 m Dark micaceous shale — poorly fossiliferous.
	Sauzei/Sowerbyi Zone	1d	J 1342	At 30—35 m from top some badly preserved <i>S. (Papilliceras) cf. espinazitensis</i> ♀.

1b) Bajocian outcrop Chacaico, at southeastern slope of Chacaico valley.

(Lajas)	Sauzei Zone	1	J 1323	Scree from marls with concretions at approximately 20—30 m below base of cliff — <i>Emileia</i> sp. ♂, <i>Sonninia</i> (<i>S. ?</i>) cf. <i>alsatica</i> ♀ & ? ♂ (HAUG), <i>S. (Papilliceras) cf. espinazitensis</i> ♀, <i>Stephanoceras (Skirroceras) cf. macrum</i> (QU.).
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* “J” denotes the Geology Department, McMaster University, Hamilton, Ontario (MCM).

2. Los Molles (39° 12' S, 70° 17' W)

Approximately 50 km southwest of Zapala, Neuquén province (Text-fig. 2); section accessible by car.

The North-South oriented Charahuilla-Chacaico anticlinal valley turns easterly at the junction of Arroyo Los Molles with Arroyo Picún Leufú.

The outcrops of the southeastern limb of the broken anticline were examined by WEAVER (1931, p. 29 and plate I, section 16). He reported the following sequence (from below; cf. WESTERMANN, 1964 b, p. 175): (1) at least 300 m bedded shales with “*Posidonomya alpina*” [= *Bositra buchi*], near base with “*Dumortieria pusilla* JAW.” [? or a mistaken sonniniid or hammatoceratid microconch] and “*Hammatoceras insigne* SCHUEB.” [p. 407, said to have a ventral groove = ? *Erycites* or ? *Podagrosiceras*]. This entire interval could therefore belong in the Aalenian (? basal Bajocian). (2) 145 m shales and sandstone, with “*Posidonomya alpina*”. The holotype of *Podagrosiceras athleticum* MAUBEUGE & LAMBERT (1955; cf. WESTERMANN, 1964 b) came from either interval (1) or (2) which together comprise the Los Molles formation. (3) 28 m arenaceous shales with “*Sphaeroceras multiforme* GOTTSCHÉ” [p. 407, *Otoites gottschei* WEST. = *Emileia multiformis* ♂] and “*Hammatoceras lotharingicum* BEN.” [= ? *Sonninia*]. (4) 16 m sandstones and shales with “*Posidonomya alpina*” and, above, “*Sphaeroceras multiforme*”.

The section examined by us is at the northwestern limb of the anticline, south and west of the junction of Arroyo Los Molles and Arroyo Picún Leufú. The lower part of the section is as follows:

Formation	Age	Bed	Cat.-No.	Thickness
(Lajas)	(?? Humphriesianum Zone)			22 m Massive sandstone forming cliff.
	— ? —			95 m Shale, upper 10 m strongly arenaceous; remainder with thin sandstone interbeds; small concretions in middle part of sequence.
	Sauzei Zone	11a	J 1315a	20—30 m from top — <i>Sonninia (Papilliceras)</i> cf. <i>espinazitensis</i> (TORNQ.), <i>Gryphaea</i> sp., astartid and pleuromyid bivalves.
		11b	J 1315	35—50 m from top — <i>Emileia</i> aff. <i>polyschides</i> (WAAGEN) ♀, <i>E. multiformis</i> (GOTT.) ♀, <i>Sonninia alsatica</i> HAUG ♀ & ♂, <i>Dorsetensia</i> aff. <i>edoardiana</i> (ORB.), haploceratid indet., astartid bivalve.
		11c	J 1315b	55—60 m from top — <i>Emileia contracta</i> (Sow.) ♂ [<i>Otoites</i>], <i>E. sp.</i> ♀, <i>Sonninia</i> s. l. sp.
				90 m Massive sandstone, in 3 packets, and intermittent shales — unfossiliferous.
				90 m Shale with several massive sandstone beds (4 m at base) — unfossiliferous.
				60 m Shale with a few thin sandstone beds and concretions.
		9	J 1314	10 m above base — rare <i>Sonninia (Papilliceras)</i> sp. ♀, <i>S. sp.</i> ♂ and pteriid bivalve.
				22 m Basaltic sill with 3—5 m altered shale at base and top contact.
				100 m Fissile shale with a few sandstone beds and concretions above middle part.
		8	J 1316	10 m from top — <i>S. (Papilliceras) espinazitensis</i> ♀ & cf. ♂, <i>Bositra buchi</i> , belemnite indet., coniferous plant remains.
		7	J 1312	25—30 m from top — abundant <i>S. (Papilliceras) espinazitensis</i> ♀ & cf. ♂.
	— — —	6	J 1313, a	35—40 m from top — abundant <i>Pseudotoites</i> cf. <i>sphaeroceroides</i> (TORNQ.) ♀ and <i>P. cf. evolutum</i> (TORNQ.) ♂ [<i>P. (Latotoites)</i>], more scarcely <i>Sonninia (Papilliceras)</i> cf. <i>espinazitensis</i> ♀ & cf. ♂.
	(Sauzei-)Sowerbyi Zone			<i>Lytoceras</i> sp., <i>Bositra buchi</i> abundant in some concretions, <i>Inoceramus</i> sp., limid bivalve, plants.

<p>— — — — — (Los Molles)</p>	<p>— ? —</p>	<p>5 J 1328</p> <p>4 J 1317</p> <p>3 J 1330</p>	<p>85—87 m from top — <i>Sonninia</i> (<i>Euhoploceras</i> ?) sp. ind. ♀ & ♂, <i>Puchenquia</i> ? sp., <i>Bositra buchi</i>, <i>Plicatula</i> ?.</p> <p>20 m Sandstone, argillaceous sandstone and arenaceous shale — poorly fossiliferous, single partial impression of (?) <i>Sonniniidae</i> indet.</p> <p>12 m Foliated silty shale with interbedded thin siltstone beds.</p> <p>7—8 m from top — very abundant but completely crushed <i>Hildocerataceae</i> indet. (involute and evolute compressed keeled shells with somewhat sigmoid and usually divided or fasciculate ribbing, rarely tuberculate: possibly including <i>Grammoceratinae</i> and <i>Hammatoceratidae</i> [<i>Phymatoceras</i> ? or <i>Puchenquia</i> ?], or <i>Sonniniidae</i>), <i>Plicatula</i>, terebratulid brachiopods.</p>
<p>Up. Toarcian — basal Bajocian</p>			

2 a)

2—3 km downstream the Arroyo Picún Leufú from the Los Molles section described above, is the faulted and less complete exposure of the southeastern limb of the Charahuilla-Chacaico anticline which was studied by WEAVER (1931, p. 29). Shales 20—25 m below the massive sandstone forming the cliff (loc. 10, McM J1338) have furnished *Emileia* cf. *multiformis* (GOTTSCHÉ) ♀ & ? ♂, *Sonninia* cf. *alsatica* HAUG ♂, numerous shallow-water bivalves (pleuromyids, arcids, *Gryphaea*) and a gastropod. This assemblage resembles those from Los Molles, beds 11 a—b (above).

3. Paso del Carro Quebrado and Cerro Lotena (39° 11' S, 69° 40'—57' W)

Approximately 30 km southeast of Zapala (Text-fig. 2); accessible respectively by jeep and car.

The outcrops lie on the continuation of the above described anticlinal structure running South-North from Charahuilla-Chacaico to Los Molles where it turns eastward and is followed by the valley of Arroyo Picún Leufú.

At Cerro Lotena, the presence of fossiliferous beds placed in the Opalinum and Sauzei Zones was noted by KEIDEL (1925, pp. 13, 22, 23). WEAVER (1931, p. 25—27, and pl. I, section 17) reported from the Cerro Lotena area 600 m shales with occasional thin sandstone interbeds, bearing near the base "*Harpoceras puchensis* BURCK.", "*H. malarguensis* BURCK." [= ? *Puchenquia* spp.], *Bositra buchi*, and "*Hammatoceras insigne*" (cf. pl. I, section 17) [= ? *Eudmetoceras*]; the sequence becomes arenaceous above, with *Emileia* cf. *multiformis* and "*Sonninia* cf. *fascicostata* TORNQ." [= ? *S. espinazitensis* TORNQ.; but specimen from loc. 126 is a *Puchenquia* (?)]. The minute alleged "*Sphaeroceoloceras* cf. *brochiiiformis* JAW." (examined) reported from 100 m higher in the section are more closely affiliated with *Chondroceras* or *Erycites* (?). Furthermore, the described section (op. cit.) disagrees in lithology and thicknesses from the general section given in the text and from the columnal section; and most identifications are suspect (cf. WESTERMANN, 1964 a, p. 348).

The geology and general stratigraphy of Cerro Lotena and directly north of it was studied by SUERO (1951) who distinguished a lower [Aalenian] series of blue-gray clay and marls, sandstones, sandy limestones and conglomerates bearing "*L. opalinum* BURCK., *H.* cf. *planinsigne*, *Hildoceras* sp., *T. scissum*"; overlaid by 650 m brownish and reddish conglomerates, sandstones and clays, in the upper part with "*O. sauzei* and *H. gonionotum*" [Bajocian]; and above gray conglomerates and sandstones which were placed in the Callovian. From Paso del Carro Quebrado, approximately 25 km west of Cerro Lotena, SUERO (op. cit.) recorded brownish sandstone and brown sandy limestones with "*O. sauzei*, *E. multiformis*, *S. zitteli*, *S. espinazitensis*", and bivalves.

The Bajocian section of Cerro Lotena (SUERO, 1951), consisting of yellowish-gray marls with several coarse sandstone and conglomerate beds, dips steeply and is probably overturned, according to the age of two fossiliferous beds which have respectively yielded *Erycites* cf. *imlayi* WESTERMANN (Aalenian) and (?) *Stephanoceras* s. l. (Bajocian).

Paso del Carro Quebrado — The lower part of the section:

Formation	Age	Bed	Cat.-No.	Thickness	
(Lajas)	Sauzei Zone	6c	J 1319	20 m	Shales, grayish and yellow, at 10 m — <i>Sonninia (Papilliceras) espinazitensis</i> (TORNQ.) ♀.
		6b	J 1339	1.5 m	Calcareous sandstone — <i>Emileia</i> cf. <i>multiformis</i> (GOTT.) ♀ & ♂ [<i>E. (Otoites)</i> cf. <i>gottschei</i> WEST.], <i>Chondroceras</i> cf. <i>allani</i> (MCLEARN), <i>C.</i> cf. <i>giebeli</i> (GOTT.), ? <i>Pseudotoites</i> cf. <i>transatlanticus</i> (TORNQ.), <i>Trigonia</i> sp., <i>Pholadomya</i> sp., veneroid.
	— — —			15—20 m	Silty shales (poorly exposed).
		6a	J 1318	1 m	Calcareous Sandstone, yellow, partly conglomeratic — abundant <i>Pseudotoites</i> cf. <i>sphaerocerooides</i> (TORNQ.) ♀ & ♂ [<i>P. (Latotoites)</i> cf. <i>evolutum</i> (TORNQ.)], <i>P. singularis</i> (GOTTSCHE) ?, <i>S. (Papilliceras) espinazitensis</i> cf. ? subsp. <i>altecostata</i> (TORNQ.), <i>Pholadomya</i> sp., <i>Pleuromya</i> sp., <i>Goniomya</i> sp., veneroid.
	(Sauzei ?) Sowerbyi Zone			10—20 m	Sandstone and shale, yellowish.

4. Chacay Melehue (37° 15' S, 70° 30' W)

The Lomas Bayas at the right slope of the valley of Arroyo Chacay Melehue, approximately 25 km northwest of Chos Malal, Neuquén province (Text-fig. 2); at the road from Chos Malal to Andacollo.

No formational names are available for this section, unless those of the Zapala area would be used (Los Molles, Lajas?). The middle part of the Jurassic section bears a most prolific (Bathonian —) Callovian ammonite fauna (WESTERMANN, 1967 a, fig. 2), while the lower part includes rather poorly preserved ammonoids of Toarcian to Bajocian age (JAWORSKI, 1914; GROEBER, 1918; summary in GROEBER et al., 1953, p. 192). At the base are calcareous sandstones of Lower to Upper Toarcian age, overlying a supposedly Triassic to early Jurassic series of volcanic rocks. The Toarcian was said to be overlaid by approximately 150—200 m black limestones with "*Harpoceras klimakomphalum*, *H.* cf. *opalinum* and *Erycites fallax*", which were placed in the Opalinum and Murchisonae Zones. Although we have not found any ammonoids in these beds, the recorded fauna would suggest that this is the *Puchenquia* assemblage of late Aalenian to basal Bajocian age. The highest parts of this sequence were correctly identified as Sauzei Zone based on the occurrence of *Emileia multiformis* (GOTTSCHE).

Between the Sauzei Zone and the (Bathonian —) Callovian is a small but important new early Upper Bajocian assemblage (WESTERMANN, 1967 a) which was again collected in 1970 and will be described in the second volume of this monograph. The Macrocephalitidae need complete taxonomic and age revision.

The lower part of the section studied by us is as follows:

Formation	Age	Bed	Cat.-No.	Thickness	
(? Lajas)	Middle — Lower (Bathonian —) Callovian			550 m	Dark shales with concretions, several tuffaceous beds, and thin calcarenite beds near base and top — rich ammonoid fauna (cf. WESTERMANN, 1967a); first Macrocephalitidae at ? 6 m and 10 m above base.
	— — —			65 m	Shales with concretions and thin calcarenite beds.
		C	J 1210		Top 3—5 m — Leptosphinctinae spp., ? Parkinsoniidae [?? <i>Strenoceras</i> or <i>Parastrenoceras</i>], <i>Teloceras</i> cf. <i>multinodum</i> (QU.), 'Itinsaites' sp. ♂, cf. <i>Cadomites</i> sp. ♀ & ♂ [cf. 'C. cosmopolitum' MOER.], <i>Oppelia</i> s. l., <i>Bositra</i> sp.
	Upper Bajocian (Subfurcatum Zone)	18	J 1757		~ 15 m below top — poorly preserved Stephanoceratidae spp.:
	— ? —	B	J 1208		

Formation	Age	Bed	Cat.-No.	Thickness
	Subfurcatum or Humphriesianum Zone			? <i>Cadomites</i> sp. Lower 50 m — unfossiliferous.
	-----	A	J 1209	30 m Mudstone, arkose and conglomerate. Near base — <i>Sonninia</i> (<i>Papilliceras</i> ?) cf. <i>espinazitensis</i> (TORNQ.), <i>Emileia</i> sp.
— — —	Sauzei Zone			
(? Los Molles)	-----			100 m Bituminous black shales and argillites with some concretions — unfossiliferous.
	?			

Mendoza Province, Argentina

1. Sierra de Reyes (36° 53'—37° S, 69° 38'—46' W)

East of Río Colorado, slightly south of the confluence of Río Grande and Río Barrancas, southernmost Mendoza province (Text-fig. 1); in proximity of Highway 40.

From the western slope of the Sierra de Reyes, GROEBER (1918, 1933; GROEBER et al., 1953) and STIPANICIC (1966) reported Triassic overlaid by 10—12 m conglomerate; followed by arenaceous limestone with “*Hammatoceras tenuinsigne* VACEK” [= *Planammatoceras* cf. *planinsigne* (VACEK), here described]; approximately 100 m higher are sandstones and limestones with “*Sonninia espinazitensis*, *Sphaeroceras* [= *Emileia*] *multiforme* GOTTSCHKE, S. [= *Chondroceras*] *submicrostoma* TORNQ., and *Stephanoceras* [= *Pseudotoites*] *sphaeroceroides* TORNQ.”; 20 m above follows the Callovian. On the eastern side of the Sierra, these authors reported Jurassic beds with “*Sonninia alsatica* HAUG and S. cf. *romanoides* DOUV.” [= S. cf. *alsatica* and *Dorsetensia* sp.]; from higher up in the sequence came “*Sphaeroceras submicrostoma*”; followed by “*Stephanoceras humphriesianum* QUENST.”. 200—230 higher is the base of the Callovian. According to STIPANICIC (1966), this fauna indicates the Opalinum, Sowerbyi and Sauzei Zones. The supposed *S. humphriesianum* originally reported by GROEBER (1918, p. 11) was later omitted from the recordings (GROEBER et al., 1953).

Dorsetensia mendozai sp. nov. is described herein from an unknown stratigraphic level, Sierra de Reyes.

2. Bardas Blancas (35° 52' S, 69° 49' W)

Cliffs on both sides of the Río Grande at bridge of Highway No. 40, southern Mendoza province (Text-fig. 1).

The section has previously been studied by BURCKHARDT (1900, 1903), GROEBER (1918; et al. 1953), GERTH (1925) and STIPANICIC (1966). BURCKHARDT recorded “*Tmetoceras scissum*” (1900; referred to *T. gemmellaroi* in 1903) [= *T. cf. flexicostatum* WEST.] from the lower levels of limestones and marls, and “*Gryphaea calceola*” from white limestone higher in the section, placing the lower horizon in the Murchisonae and Sowerbyi Zones (and the upper in the Sowerbyi Zone and Sauzei Zone, cf. columnal section; recte Oxfordian).

GROEBER (1918, p. 19) reported a single loose block with “*Tmetoceras scissum*, *Erycites* nov. sp.” (= “*E. cf. gonionotum*” of GROEBER et al., 1953) and “*Zurcheria* nov. sp.” [= *Zurcheria groeberi* nov. sp.]. However, he placed this assemblage in the Murchisonae Zone although recognizing that *Zurcheria* was then known elsewhere only from the Sowerbyi Zone.

JAWORSKI (1926 a, p. 292) recorded a juvenile *Hammatoceras* ex gr. *H. insignis* Schübler from the basal beds [= horizon 21 of profile V of GERTH, 1925, pl. IV]; although the closest resemblance was believed to exist to species of the Opalinum Zone, the beds were correlated with the Murchisonae-Sowerbyi Zones of Paso del Espinacito. GROEBER et al. (1953, p. 210) reported *Hammatoceras* [= *Planammatoceras*] *tenuinsigne* VACEK from the base of the section which they therefore placed in the Opalinum Zone [recte Murchisonae Zone], and from higher in the section the assemblage already listed by GROEBER in 1918.

STIPANICIC (1966) identified a basal horizon with “*Hammatoceras* sp.” which he placed in the Opalinum Zone; 125 m above a level with “*Tmetoceras* and *Sonninia*”, referred to the Murchisonae or Sowerbyi Zone; and “*Gryphaea calceola*” bed with “*Perisphinctes* s. s.” in the overlying La Manga Formation dated as Oxfordian.

No formational name has been applied to the lower Middle Jurassic series described herein, except by DESSANTI (1966) in an unpublished geological map of the area who included it in the Puchenque Formation

(stratotype: Arroyo Calabozo near Cerro Puchenque). DESSANTI (op. cit.) described the La Manga Formation as "Calizas del Calabozo".

We found an association in a bivalve lumachelle bed of *Zurcheria groeberi* sp. nov., *Eudmetoceras* aff. *klimakomphalum* (VACEK), and *Tmetoceras* cf. *T. scissum* (BEN.) indicating latest Aalenian to earliest Bajocian age. The lithofacies suggests extremely shallow water to shoreline conditions so that this assemblage could be winnowed or condensed; the single incomplete *Tmetoceras* could also have derived from older sediments. However, the same ammonite assemblage occurs also in limestone concretions at Arroyo Blanco (below). We observed the following Middle Jurassic sequence:

Formation	Age	Bed	Cat.-No.	Thickness	
(La Manga)	Oxfordian			4—5 m	Gray limestone and some shale, andesitic sill at base — <i>Gryphaea calceola</i> sp.
"Puchenque" MS.	— ? —			~ 40 m	Conglomerate, coarse polymictic. Sandstone and yellowish marl — unfossiliferous.
	— — —	(1)	J 1325	~ 22 m	Sandstone, partly conglomeratic, and arenaceous lumachelle beds. From single lumachelle bed — rare <i>Tmetoceras</i> cf. <i>scissum</i> (BEN.), several <i>Eudmetoceras</i> (<i>Euaptetoceras</i>) sp. nov. aff. <i>klimakomphalum</i> (VACEK), <i>Zurcheria groeberi</i> nov. sp., minute ? <i>Sonniniidae</i> sp. ♂, and abundant <i>Trigonia</i> s. l. sp., ? <i>Corbula</i> sp., <i>Meleagrinnella</i> sp., <i>Entolium</i> sp., et al.
	Up. Aalenian/Bajocian Concava/lower Sowerbyi Zone			~ 40 m	Shales, metamorphosed at base — unfossiliferous.
	— ? —				Andesitic-keratophyric sill and thick red porphyrites.
(Remoredo ?)					

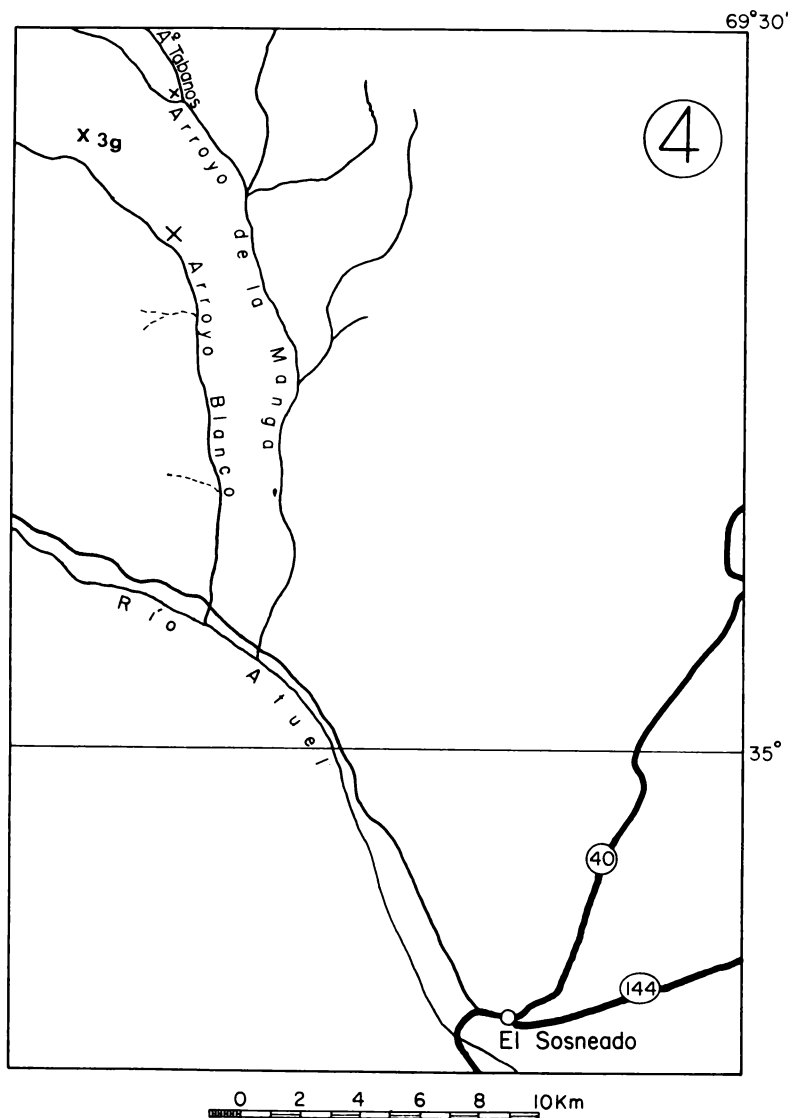
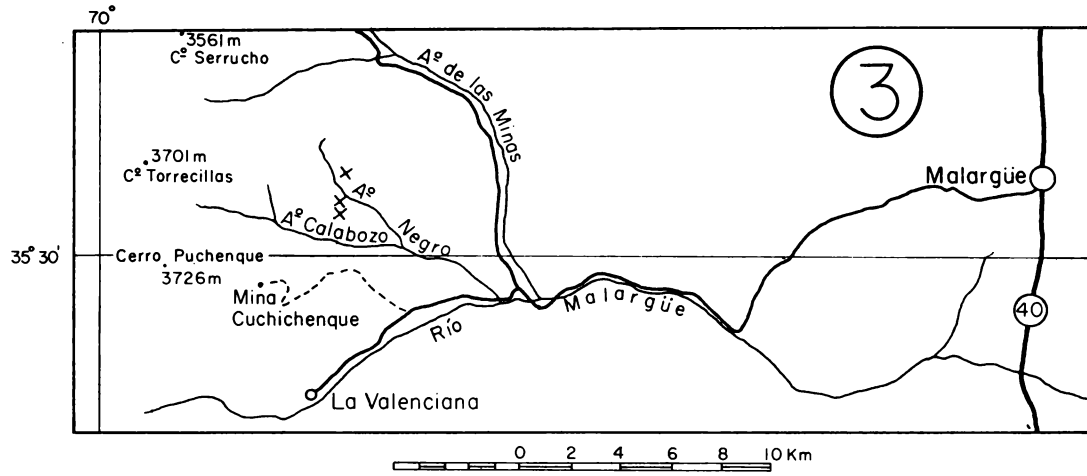
3. Cerro Puchenque (Cerro Puchén) (35° 30' S, 69° 58' W)

The Middle Jurassic Sections are on the valley slopes of the upper Arroyo Negro, directly northeast of Cerro Puchenque; approximately 36 km west of Malargüe, Mendoza province (Text-fig. 3). Car access to within approximately 4 km.

The section has previously been described by BURCKHARDT (1900, 1903), GERTH (1925) and JAWORSKI (1926a); a summary was given by GROEBER et al. (1953). The "black limestones" series was said to comprise approximately 200 m. The collection of HAUTHAL's locality No. 7 which was described by BURCKHARDT at first (1900) under "*Harpoceras klimakomphalum*, *H. aalense*, *H. cf. opalinoidea* and *H. aff. opalinum*", and later (1903) under "*H. malarguense*, *H. hauthali*, *H. puchense*, *H. klimakomphalum*, *H. striatulum*, and *Witchellia argentina*" [the "*Pleydellia* assemblage" auct., here placed in *Puchenquia* gen. nov.], came from the upper half of the section (cf. discussion of *Puchenquia*). In the lower part of the "black limestones", GROEBER et al. (1953, p. 213) distinguished four fossiliferous levels with (from top): (1) *Dumortieria pusilla* JAW., *Sphaerocoeloceras brocchiiforme* JAW.; (2) *Hammatoceras insigne* SCHÜBL., *Grammoceras* ? cf. *bassanii* FUC., *Fucinoceras meneghianum* HAAS; (3) *Hildoceras tenuicostatum* JAW., '*Witchellia*' *obscurcostata* JAW.; and (4) *Harpoceras subplanatum* (OPP.). Level (1) was correlated with the Upper Toarcian zone of "*Dumortieria pseudoradiata*" [recte *D. pseudoradiosa*] and levels (2) to (4) were placed in the "Middle Toarcian". The "black limestones" were said to be overlaid by Lower Callovian with "*Macrocephalites*".

The formational names "Puchenque Formation" and "Calabozo limestones", introduced for this section by DESSANTI (ms. 1966), are unpublished.

Since our brief field work just north and south of the upper Arroyo Negro in 1965 (cf. WESTERMANN, 1967a, p. 67), one of us (A. C. RICCARDI) has surveyed the entire Jurassic outcrop area surrounding the domal intrusive structure of Cerro Puchenque (1966), and we have reexamined and extended our earlier studies along the southern drainage slope of the Arroyo Negro (1971). The Toarcian to Bajocian section just south of the Arroyo Negro, dipping 50° E, is as follows.



Text-fig. 3. Locality maps 3, Malargüe area, and 4, El Sosneado area, in Mendoza Province (cf. Text-fig. 1 B).

Formation	Age	Bed	Cat.-No.	Thickness	
"Puchenque" MS.	? Callovian			~ 45 m	Massive sandstone and conglomerate, with interbedded shale and silty marlstone — unfossiliferous.
	— ? —			42 m	Shale, with lenticular sandstone interbedded increasingly towards the top, and large black limestone concretions particularly in the lower part — upper 31 m unfossiliferous.
	— ? —	11	J 1750		11 m above base, fossiliferous concretion — <i>Sonninia (Papilliceras) espinazitensis</i> cf. ? subsp. <i>altecostata</i> (TORNQ.).
	(? Sauzei) Sowerbyi Zone	12	J 1747		8 m above base, fossiliferous concretion — <i>Sonninia (Euhoploceras) amosi</i> sp. nov., <i>S. (Papilliceras) cf. peruana</i> JAW., <i>S. (S.) mirabilis</i> TORNQ., <i>Pseudotoites</i> cf. <i>singularis</i> (GOTT.), <i>Bradfordia</i> cf. <i>costidensa</i> Imlay, (?) <i>Calliphylloceras</i> sp., <i>Lytoceras</i> sp.
	Sowerbyi Zone	13	J 1754		4 m above base — <i>Sonninia</i> cf. <i>zitteli</i> (GOTT.).
		14	J 1753		1 m above base, layer of lenticular concretions, moderately fossiliferous — <i>Puchenquia malarguensis</i> (BURCKH.) ♀ & ♂, <i>P. cf. malarguensis</i> .
		15	J 1752	1.2—1.5 m	Several lenticular black limestone beds. Upper bed moderately fossiliferous — <i>Puchenquia</i> cf. <i>malarguensis</i> (BURCKH.) ♀, cf. <i>Sonninia (Euhoploceras ?)</i> sp. ind.
	(Concava ?) Sowerbyi Zone			50—80 m	Shale and silty shale, with some interbedded impure sandstone above; lower part poorly exposed.
		16	J 1748		1 m below top — abundant <i>Sonninia (Euhoploceras) amosi</i> sp. nov., more rarely <i>Puchenquia</i> cf. <i>malarguensis</i> (BURCKH.) ♀ & (?) ♂, <i>P. (?)</i> aff. <i>malarguensis</i> ♀.
		(~6)	J 1300		
		17	J 1755		~ 8 m below top — single fragment of (?) <i>Staufenia (Costileioceras)</i> sp. ind. [Same interval at north side of Arroyo Negro, 1—1.5 km N. of main section: ~ 25—37 m below top — poorly preserved rather abundant <i>Tmetoceras</i> sp. and undeterminable Hildocerataceae (also higher), single <i>Erycites ?</i> sp. ind.]
	(? Murchisonae Zone) Aalenian	5	J 1335		
		(5c)	J 1337		
		(5a)	J 1336		
				~ 70 m	Shale, with interbedded sandstone particularly in top 10 m and at ~ 25—40 m from base. Scree from upper half — <i>Hammatoceras (Hammatoceras) cf. insigne</i> (SCHÜBLER), <i>Sphaerocoeloceras brocchiiiforme</i> JAW.
	Upper Toarcian	4	J 1759		At 25—40 m from base — poorly preserved <i>Pblyseogrammoceras (?)</i> cf. <i>tenuicostatum</i> (JAW.).
		4a	J 1332		
		3	J 1331	~ 1 m	Calcareous sandstone, highly fossiliferous — <i>Harpoceras</i> cf. <i>exaratum</i> (Y. et B.), <i>Harpoceratinae</i> ind., <i>Dactylioceras</i> cf. <i>commune</i> (Sow.), <i>Peronoceras</i> sp. ind., <i>Frechhiella</i> cf. <i>subcarinata</i> (Y. et B.), pholadomyid, pleuromyid and trigoniid bivalves.
	Lower Toarcian			~ 20 m	Marls and calcareous sandstone — <i>Harpoceratinae</i> and bivalves.

4. Arroyo Blanco (34° 51' S, 69° 42' W)

Approximately 15 km upstream from its mouth with the Río Atuel, the Arroyo Blanco changes its course from an eastward toward a southward direction; a good Middle to Upper Jurassic section is here exposed along the left bank. Other sections and fossil localities are within a few kilometers north and northwest of this section. About 25 km northwest of El Sosneado (Text-fig. 3). The mouth of Arroyo Blanco can be reached by car.

The general stratigraphy of the area and the fauna of this section have previously been studied by GERTH (1925), JAWORSKI (1926 a), GROEBER (et al., 1953), STIPANICIC (1966), VOLKHEIMER (1970), and STIPANICIC & BONETTI (1970). They report a succession of approximately 400—600 m of Lower Jurassic sandstones and calcareous siltstones which are overlaid by approximately 250 m of shales with several fossiliferous limestone beds bearing “*Sonninia zitteli* (GOTTSCHÉ), *S. fascicostata* TORNQ. [= *S. espinazitensis* TORNQ.], *S. altcostata* TORNQ. [= *S. espinazitensis* subsp.], *S. mammilifera* JAW., *S. aff. argentinica* TORNQ. [= ? *S. zitteli*], *Emileia polyschides* WAAG., *E. aff. singularis* (GOTTSCHÉ) [= *Pseudotoites*], *Hammatoceras gerthi* JAW. [= ? *Eudmetoceras*], *H. lotharingicum* BEN. [= *Eudmetoceras eudmetum jaworskii* WEST.], and *Oppelia moerickei* JAW.” [= *Eudmetoceras (Euaptetoceras) klimakomphalum moerickei*]. JAWORSKI dated this fauna as Concava to Sauzei Zones. The Opalinum Zone is also indicated (GROEBER et al., 1953) and has recently been tentatively confirmed with tectonically disturbed flaggy siltstones yielding (?) *Leioceras opalinum* (REIN.) (described herein) approximately 6 km northwest of the Arroyo Blanco section near the watershed between the valleys of Arroyo Blanco and Arroyo La Manga (WESTERMANN, 1967 a). These shales are said to be overlaid by 45 m calcareous partly conglomeratic sandstone with interbedded shales; and 15 m shales and limestones, topped by a limestone bed with poorly preserved ammonites. Above follows 30 m gypsum, the “Yeso Inferior” which STIPANICIC (1966, p. 443) tentatively dated as Upper Bajocian or Bathonian; the overlying sandstones have yielded “*Reineckeia ex gr. anceps*” (GROEBER et al., 1953, p. 218). The “Yeso Inferior” may belong in the Middle Callovian (see section).

The formational sequence of the Arroyo Blanco area has recently been reviewed almost simultaneously by STIPANICIC & BONETTI (1970) and VOLKHEIMER (1970). Of the two formational names given to the same Middle Jurassic sequence by these authors, China Muerta (STIPANICIC & BONETTI, 1970) seems to have temporal priority over El Codo (VOLKHEIMER, 1970).

This “classical” Middle Jurassic section was examined by us in 1965 and again in 1970.

Formation	Age	Bed	Cat.-No.	Thickness
Tabanos				~ 30 m Gypsum, “Yeso Inferior” — unfossiliferous.
China Muerta/El Codo				1—3 m Dolomitic and gypsiferous limestone of varying thickness; marly bed at base — abundant
	Callovian (? Oxfordian)	3, A4	MLP 11531	generally poor preserved Perisphinctidae: Grossouvriinae ?. [cf. “ <i>Perisphinctes</i> ” <i>gleimi</i> STEINMANN].
				~ 5 m Soft fissile shales, poorly exposed.
	— ? —	4	J 1760	~ 3 m Sandstone, thick bedded and some interbedded shale with limestone concretions — <i>Macrocephalites</i> ? sp. indet., cf. <i>Indocephalites</i> sp., undeterminable fragments of Perisphinctidae.
				~ 25 m Sandstone, thick and thin bedded, partly conglomeratic, and interbedded shales with rare concretions. Scarce and poorly preserved fossils in sandstones — <i>Xenocephalites</i> sp., Macrocephalitidae ind., <i>Neuquenicerias</i> (?) sp., <i>Grossouvria</i> ? sp., <i>Bullatimorphites</i> .
	Callovian (?)	4c	J 1344	
	-----			1.5 m Flaggy siltstone, greenish-yellow weathering — loose from this bed, single <i>Macrocephalites (Macrocephalites) gr. formosus</i> (SOW.).
	? Macrocephalus Zone	5	J 1761	

Formation	Age	Bed	Cat.-No.	Thickness	
				~ 100(?) m	Shale with some beds of sandstone, conglomerate and siltstone, especially in upper part, several lenticular beds of dark limestone and calcareous fossiliferous concretions. The lower part is faulted.
	[Humphriesianum-Subfurcatum Zone]	A3	MLP 11532		[Loose from top — <i>Stephanoceras</i> sp. ♀, <i>Cadomites</i> ? cf. ' <i>C. cosmopolitum</i> ' (MOER.)]
		7	J 1764		
		4a	J 1345		[Loose from upper 40 m — <i>Stephanoceras</i> s. l. sp., <i>Chondroceras</i> sp.]
	— ? —				
	Sauzei-Humphriesianum Zone	10	J 1746		4 m below top — <i>Dorsetensia</i> aff. <i>edouardiana</i> (ORB.), <i>D. blancoensis</i> sp. nov., <i>D. mendozai</i> sp. nov., <i>Sonninia</i> cf. <i>alsatica</i> (HAUG).
		4b ₁	J 1324		[Loose concretion from upper 40 m — <i>Dorsetensia mendozai</i> sp. nov. ♀ & ? ♂, <i>D. blancoensis</i> sp. nov. ♀ & ♂, <i>Witchellia</i> sp. nov. indet. ♀, <i>Sonninia</i> (<i>Euhoplloceras</i> ?) sp. ♀, <i>Sonninia</i> (<i>Papilliceras</i>) sp. ♀ & ? ♂, <i>Stephanoceras</i> (<i>Stemmatoceras</i>) sp. ♀, <i>S. ex gr. nodosum</i> (QU.), <i>Holcophylloceras</i> sp., oysters and cf. <i>Plicatula</i> sp.]
	[Sauzei Zone]				
		6	J 1762		6 m below top — <i>Stephanoceras</i> (<i>Skirroceras</i>) cf. <i>macrum</i> (QU.)
		4a	J 1345		[Loose from same interval — <i>Emileia</i> cf. <i>multiformis</i> (GOTT.) ♀]
		4b	J 1321		16 m below top, fossiliferous concretions — abundant <i>Sonninia</i> (<i>Fissiloboceras</i>) <i>zitteli</i> (GOTT.) ♀ & cf. ♂, also <i>Pseudotoites</i> cf. <i>sphaeroceroides</i> (TORNQ.), <i>P. transatlanticus</i> (TORNQ.) ?, <i>Bradfordia</i> cf. <i>helenae</i> (RENZ), <i>Lytoceras</i> sp., bivalves and belemnite.
	Sowerby Zone	B11, A11	MLP 11359—11423		[Loose concretion from upper part — <i>Eudmetoceras</i> (<i>Euaptetoceras</i>) <i>klimakomphalum moerickei</i> (JAW.)]
		5b	J 1347		[Loose concretion from upper part — <i>Eudmetoceras</i> (<i>Euaptetoceras</i>) <i>klimakomphalum</i> (VACEK), <i>E. ?</i> sp., <i>Tmetoceras scissum</i> (BEN.), <i>T. cf. scissum</i> .]
		9	J 1751		[Loose — single <i>Tmetoceras</i> cf. <i>flexicostatum</i> WEST.]
	[Concava-Sowerby Zone]				
		5a	J 1346		[Loose — single <i>Tmetoceras</i> cf. <i>flexicostatum</i> WEST.]
	— (Fault) —				
	Upper Toarcian	5		> 50 m	Shell limestone, shale and sandstone. Upper part with abundant <i>Phlyseogrammoceras</i> (?) <i>tenuicostatum</i> (JAW.), <i>Phymatoceras</i> sp.

4 a.

5 km north along strike, the shale and sandstone series with the Bajocian-?Callovian boundary beds are again exposed at the left bank of the Arroyo la Manga, at the mouth of the Arroyo Los Tabanos.

Formation	Age	Bed	Cat.-No.	Thickness	
China Muerta/El Codo				12—15 m	(Igneous dyke) Silty shale with limestone concretion and interbedded sandstone, especially above. Concretion loose from this series — <i>Eurycephalites</i> sp., bivalves.
	Lower Callovian (? Bathonian)	2	J 1758		
	Sauzei (Humphriesianum ?) Zone	1	J 1749		Concretion at base — <i>Dorsetensia blancoensis</i> sp. nov., <i>Sonninia alsatica</i> HAUG.
	— — — (Toarcian-Bajocian)			> 100 m	Shale with several sandstone beds — unfossiliferous.

Atacama Province, Chile

1. Hacienda Manflas (28° 8' S, 69° 58' W), 95 km S.E. of Copiapó, at confluence of Río Manflas and Quebrada de la Iglesia forming Río Copiapó (Text-fig. 1 A, as "Est. Manflas").

This 'classical' Aalenian-Bajocian section was originally recorded by STEINMANN (1884) and described by MÖRICKE (1894) in inverted sequence and with partially mixed assemblages, probably due to the occurrence of two iron-oolites ("Eisenoolith") and the duplication by a low-angle overthrust. A preliminary revision has been published by the senior author (WESTERMANN, 1967a), and the entire area is currently being examined in detail by HILLEBRANDT (1970, pp. 184—188; preliminary report). Our Manflas ammonite fauna (collected in 1965 by WESTERMANN with the assistance of Mr. Raúl Vicencio, then at Inst. Geol., Univ. Nac. Chile), although restricted to a single section, clearly indicates to us slightly younger ages for the Aalenian assemblages than those given by HILLEBRANDT.

The highest beds examined were below the upper iron-oolite bearing Stephanoceratidae; they contained abundant but poorly preserved *Chondroceras* (?) cf. *submicrostoma* (GOTT.) (bed 7, J1191), almost certainly of the Humphriesianum Zone. Several decameters lower in the section, calcareous beds are intercalated in the thick shale and marl sequence clearly belonging to the Sauzei Zone; *Emileia* cf. *multiformis* (GOTT.) and *Sonninia* (*Papilliceras*) cf. *espinazitensis* (TÖRNQ.) appear to occur throughout (bed 6a, J1189), while the upper beds (bed 6b, J1190) also contain *Emileia* cf. *multifida* BUCKMAN and significantly, *Chondroceras* aff. *defontii* (MCLEARN) common in the North American Humphriesianum Zone. These beds are underlain by unfossiliferous reddish shales (including a liparitic sill).

Below the reddish shales lie several meters of grayish-whitish marls from which a moderately preserved but important ammonite fauna was collected (bed 5, MCM J1188). Most abundant is a genus with two species (unnamed) which unite attributes of late Hammatoceratinae [*Eudmetoceras*] with those of Sonniniidae; they were originally (WESTERMANN, 1967a, p. 67; cf. also HILLEBRANDT, 1970) identified with '*Hammatoceras* *gerthi* JAWORSKI and '*H. lotharingicum*' of JAWORSKI [= *Eudmetoceras eudmetum jaworskii* WEST.] and are here described under Hammatoceratidae ? gen. et spp. nov. This fauna also includes *Eudmetoceras* (?) cf. *kochi* (PRINZ), *E. (E.)* cf. *klimakomphalum* (VACEK), *Fontannesia* (?) *austroramericana* JAW. ♂, *Fontannesia* (?) sp. ♀, a single fragment of *Sonninia* (*Euhoploceras* ?) sp. (ex coll. BIESE), *Tmetoceras* cf. *scissum* (BEN.) and *T.* cf. *T. flexicostatum* WEST. Since the fauna was collected from the weathered head of the beds along a gentle slope, it is possible that two distinct assemblages were originally present as suggested by HILLEBRANDT (1970, p. 185). This fauna is dated as Concava Zone to early Sowerbyi Zone.

The underlying (lower) iron-oolite is fossiliferous in its upper part (~ 2 m) which has yielded *Bredyia* aff. *crassornata* (BUCK.), *Planammatoceras* sp. A (bed 4, McM. J1187); from this formation are also *Planammatoceras* ? sp. B. (ex coll. BIESE), and the *Erycites* cf. *gonionotus* (BEN.) described (from the "Humphriesianus-Schichten") by MÖRICKE (1894, pl. I, fig. 7). This fauna is dated by us as late Opalinum to Murchisonae Zone, with the Opalinum Zone questionable; if both zones are present, they would probably be condensed.

The (lower) iron-oolite is underlain by Upper Toarcian variegated shales with *Phymatoceras copiapense* (MÖRICKE).

2. Salar de Pedernales (approximately 26° 15' S, 69° 10' W)

Approximately 50 km N.N.E. of Potrerillos Mine, Atacama province (Text-fig. 1).

Two small ammonite assemblages, kindly made available to us (or briefly inspected and photographs furnished) clearly represent the Humphriesianum Zone, although the former may include the Sauzei Zone.

1. Collection of Mr. F. Garcia, E.N.A.P. (Inst. Geol., Univ. Nac., Santiago, GA-1035): *Stephanoceras* (*Stephanoceras*) aff. *humphriesianum* (SOW.) ♀, *S.* cf. *nodosum* (QU.) ♀, *S.* (*Epalxites*?) ♂ aff. *anceps* (QU.), *Dorsetensia* aff. *deltafalcata* (QU.).
2. Collection of Dr. A. v. Hillebrandt (Tech. Univ., Berlin, 660714/6, 670308/4): *Dorsetensia romani* (OPPEL), *D. liostraca* BUCKMAN forma tecta BUCK., said to be associated with *Stephanoceras* cf. *humphriesianum* (SOW.) (HILLEBRANDT, 1970, p. 189).

STANDARD ZONES		Westerman 1967 assemblages	
SUBFURCATUM		C. cf. palaeanthus	Leptosphinctinae, ?Parkinsoniidae Teloceras cf. multinodum Cadomites spp., C.? 'cosmopolitus/ pellicenthus
	HUMPHRIESIANUM	S. cf. humphriesianum	Stephanoceras ex gr. humphriesianum
SAUZEI		E. multiformis	S. (Stemmatoceras) ex gr. frechi
			S. (Skirroceras) cf. macrum
SOWERBYI		P. singularis	Bradfordia cf. heleneae B. cf. costidense
		(?) E. gerthi / 'p' puchensis [= p. malarquensis]	Fontannesia (?) austroamericana Eudmetoceras kimakomphalum moerickei E. gerthi, E. cf. kochi E. eudemetum jaworski Hammatoceratidae? gen. et spp. nov. A & B
CONCAVA			
MURCHISONAE			
OPALINUM		L. opalinum	Planmatoceras spp. Bredya aff. crassonata Erycites cf. gonianolus

ALENIAN			
B A U C I A N		Dorsentia liostroca D. romani D. aff. deltofolata	Chondroceras submicrostoma ? Sphaeroceras sp.
		D. aff. eduardiana D. biancaensis D. mendocini Sonninia elaeatica	Emileia multiformis incl. Oboites goitischei
S A U Z E I		Sonninia (Papilliceras) espinaztensis (?) incl. S. bodenbenderi	E. brocchii incl. O. contractus
		(?) S. e. alticostata	?
S O W E R B Y I		S. (Pisatibiceras) zitteli S. (F?) mammilifera S. (S) mirabilis S. (Papilliceras?) cf. peruana	Pseudorites sphaeroceroides P. singularis, incl. P. evolutus ? P. transatlanticus
		Tmetoceras scissum	Zurcheria groeberi Eudmetoceras cf. aff. kimakomphalum
C O N C A V A		S. (Euhoplaceras) amosi S. (E) cf. odicra	
		T. cf. flexicos-tatum	
M U R C H I S O N A E		? Erycites sp. ? Staufenia (Costlioceras) sp.	
		[(?) Leioceras opalinum]	[Planmatoceras aff. planinsigne]
O P A L I N U M			

Table 1. Chronologic distribution and correlation of early Middle Jurassic ammonites of Argentina and Chile. Boxes include related taxa of similar age. Species with poor stratigraphic information are placed in brackets, while light print indicates relative scarcity. Correlation with the "Northwest European" standard zones is approximate. (No indication of geographic distribution or faunal association is intended; third column: for "peruviana" read peruana).

Systematic Descriptions

Superfamily Hildocerataceae HYATT, 1867

Family Hildoceratidae HYATT, 1867

Subfamily Tmetoceratinae SPATH, 1936

Genus *Tmetoceras* BUCKMAN, 1892

Type-species — *Ammonites scissus* BENECKE, 1865, from the Aalenian of the southern Alps.

The genus has been discussed in some detail by WESTERMANN (1964 a, p. 426) on occasion of the description of a diverse *Tmetoceras* fauna from southern Alaska. Several new species, including lapped microconchs (♂; then distinguished as subgenus *Tmetoites* WEST.) occur throughout the late Aalenian Howelli Zone; rare *T. scissum* lies below this zone but probably also within it. Late Aalenian "*Tmetoceras regleyi* DUMORTIER" and *T. dhanarajatai* SATO, respectively matching *T. kirki* WEST. and *T. flexicostatum* WEST. from the Howelli Zone, have recently been described from Thailand (KOMALARJUN and SATO, 1964); "*T. regleyi*" was associated with supposed *Graphoceras concavum* (needing confirmation). The Japanese occurrences of *T. recticostatum* SATO (1954 a; synonymized with *T. scissum* by WESTERMANN, 1964 a, but possibly intermediate to *T. kirki*), however, appear to be of early to middle Aalenian age, because the upper *T. recticostatum* beds bear abundantly typical *Planammatoceras* while the associated "*Graphoceras* sp." seems to belong to *Pseudolioceras* (WESTERMANN, 1964 a, p. 435).

Clearly very late Aalenian to basal Bajocian *Tmetoceras* has been recorded from Oregon (LUPHER, 1941), together with *Praestrigites*; but the specimens are most scarce and no new findings have been made (WESTERMANN, 1964 a, p. 434; IMLAY, personal communication). There is, finally, also the "*Tmetoceras scissum*" from Espinacito Pass which according to BODENBENDER (in TORNQUIST, 1898, p. 6) was found in the same bed as "*Harpoceras concavum*" [= *Puchenquia* cf. *malarguensis* (BURCKH.) ♀]; a true *T. scissum* was figured from this area by GOTTSCHKE (1878, pl. 2, fig. 3).

The vertical range of the type-species *T. scissum* [syns.: *T. regleyi* DUM., *T. hollandae* BUCK., *T. circulare* BUCK.] in Europe is from the lower Opalinum Zone (or Jurens Zone ?) to the upper Murchisonae Zone, with the 'acme' or 'hemera' in the upper Opalinum Zone, Comptum Subzone [Scissum Zone auct.] (WESTERMANN, 1967 b, p. 152; SENIOR, PARSONS and TORRENS, 1969; MORTON, 1971).

Tmetoceras scissum (BENECKE, 1865)

(pl. 1, figs. 1—5)

(For synonymy see WESTERMANN, 1964a, p. 428)

Material

Arroyo Blanco, Mendoza province: 2 incomplete macroconchs and several fragments, internal mould with minor test remains, from concretion 9 (*Zurcheria-Eudmetoceras-Tmetoceras* assemblage) (MCM J1751) — Concava-lower Sowerbyi Zone.

Bardas Blancas, Mendoza province: (?) 1 small impression from block (*Zurcheria-Eudmetoceras* assemblage) of interval 1 (MCM J1325—12) — same age.

Cerro Puchenque, Mendoza province: (?) 7 impressions of *Tmetoceras* sp. ind. from bed 5a (MCM J1336); 1 large impression from bed 5 (MCM J1335) — (Lower ?) Aalenian.

Picún Leufú, Neuquén province: 2 large fragments, coll. I. SIMONATO (MLP 8149).

Hacienda Manflas, Atacama province, Chile: (?) 2 small fragments from bed 5 (MCM J1188: 17—20) — Concava-lower Sowerbyi Zone.

Description

The whorls are advolute with subquadrate section and broad venter bearing a wide groove throughout (6 to 50 mm D examined). The ornament consists of prominent stiff rectiradiate simple ribs which are born on the umbilical slope and end in high slightly oblique bullae beside the ventral groove. Constrictions are clearly present only on two large body chambers. The little incised septal suture agrees with that figured from *T. scissum* by WESTERMANN (1964 a, text-fig. 34).

One small specimen (pl. 1, fig. 3) associated with typical *T. scissum*, is somewhat more densely ribbed. However, the straight character of the ribs and the subquadrate section with wide ventral groove leave little doubt that this is a mere morphotype ('variety') of the same variable species. The presence or absence of constrictions is considered taxonomically insignificant (WESTERMANN, 1964 a, p. 429).

Measurements in mm

	D	H	W	U
MCM J 1751 : 17 body ch.	42	12.5	12.1	—
phrag.	(38) 26	7.7	7.8	11.8
: 18 body ch.	(~38) 35	10.5	11.6	16.5
phrag.	23	8.0	9.0	11
: 19 body ch.	28	8.5	8.4	12.1

Comparison

The specimens closely resemble the European and Alaskan representatives of *T. scissum*. While the larger Picún Leufú specimen (pl. 1, fig. 4) is a good match to the central European constricted morphotype (also present in S. Alaska), the Arroyo Blanco specimens resemble closely the rarely constricted Dorset specimens ("*T. circulare*" and "*T. regleyi*" of BUCKMAN, 1905; figured 1892, pl. XLVIII, figs. 1—3 and 8—10 respectively). *T. reticostatum* SATO from Japan is probably more compressed in the adult stage.

Tmetoceras cf. flexicostatum WESTERMANN, 1964

(pl. 1, fig. 6)

1900. *Tmetoceras scissum* BENECKE — BURCKHARDT, p. 31, pl. XXII, figs. 1, 2.

1903. *Tmetoceras aff. gemmellaroi* FUCINI — BURCKHARDT, p. 21, pl. II, figs. 4—5 (same specimen as BURCKHARDT, 1900).

(?) 1964. *Tmetoceras kirki flexicostatum* WESTERMANN, p. 440, pl. 72, figs. 8—10, text-fig. 37.

Material

Hacienda Manflas, Atacama province, Chile: 1 fragment with whorl segments from 3 whorls, overgrown by oyster, from bed 5 (MCM J 1188—29) — Concava-lower Sowerbyi Zone.

Arroyo Blanco, Mendoza province, Argentina: 1 incomplete large impression, loose from locality 5a (MCM J 1346).

Comments

The Manflas specimen bears dense and sharp slightly flexed ribbing on the three outer whorls (D = 35 mm), closely resembling the ribbing of the late Aalenian Alaskan species (WESTERMANN, 1964 a, p. 440, as subspecies of *T. kirki* WEST.; now regarded an independent species based on new collections made in 1964). The large specimen from Arroyo Blanco differs from *T. scissum* also in the more rounded section of the body chamber and the narrow shallow ventral 'groove' being restricted to rib interruption.

BURCKHARDT (1900, p. 31, pl. XXII, figs. 1, 2) has described a small (incomplete, juvenile or microconchiate) *T. cf. flexicostatum* from his locality 10 of the Bardas Blancas section under *T. scissum*, later (BURCKHARDT, 1903, p. 21, pl. II, figs. 4—5) referred to as "*T. aff. gemmellaroi* FUCINI". The dense slightly flexed ribbing with narrow ventral interruption clearly distinguishes this specimen from *T. scissum*; *T. gemmellaroi* [= *T. diffalense* GEMMELLARO] is more involute and compressed, with deeper ventral groove. It is probable that BURCKHARDT's locality 10 is the same as ours (interval 1, MCM J 1325), with a bivalve-*Zurcheria-Eudmetoceras* assemblage including a single small *T. cf. scissum*.

The occurrence, although scarce, of a species identical or closely affiliated with *T. flexicostatum* in the central Andean area is of biogeographic and chronologic significance, because of the age restriction of *T. flexicostatum* to the upper Howelli Zone of the uppermost Aalenian (above the *Eudmetoceras* zonule) in south Alaska, and the probably also upper Aalenian occurrence of the similar *T. dhanarajatai* SATO in Thailand (KOMALARJUN and SATO, 1964).

Family (?) Hildoceratidae HYATT, 1867
Subfamily (?) Grammocerotinae BUCKMAN, 1904

Genus *Fontannesia* BUCKMAN, 1902

Type-species — *Dumortieria grammocerooides* HAUG, 1887, from the Discites Subzone of the Inferior Oolite of Dorset, England.

The affinities and classification of *Fontannesia* have recently been discussed by WESTERMANN and GETTY (1970, p. 240), who tentatively assigned the genus to the Hildoceratidae, rather than to the Sonniniidae as previously classified (e. g. ARKELL et al., 1957, in 'Treatise', p. L270). *Fontannesia* is known from Europe, Asia Minor, western Australia, the East Indian archipelago, and the central Andes. Where its stratigraphic position is known, it marks the base of the Bajocian (WESTERMANN and GETTY, loc. cit.).

Fontannesia (?) *austroamericana* JAWORSKI, 1926 ♂

(pl. 1, figs. 7—8)

1926a. *Fontannesia austroamericana* JAWORSKI, p. 217, pl. 4, figs. 9a—c.

1926b. *Fontannesia austroamericana* JAWORSKI, p. 404, text-fig. 9, pl. XIII, figs. 9a, b (JAWORSKI, 1926a, refigured).

Material

Hacienda Manflas, Atacama province, Chile: 2 damaged complete internal moulds of which the smaller one has lappets, and 2 fragments (microconchs) from bed 5 (MCM J1188); ? 1 complete and several incomplete microconchs from "Schicht I" of Biese collection (MHNS SGO PI 10050) — Concava-lower Sowerbyi Zone.

Cerro Tricolor, Mendoza province, Argentina: the holotype (plastotype), almost complete internal mould with test remains and indication of lappets, from "locality 18, profile XII, horizon 2" (*Eudmetoceras gerthi* — *E. eudmetum jaworskii* assemblage) of Gerth collection (IPB 57) — (Concava?) lower Sowerbyi Zone.

Description

The small shell ($D \sim 40$ — 50 mm) is serpenticone and highly planulate, with flattish umbilicus; the last two whorls are almost adovolute and compressed elliptical in section. The flanks are slightly convex rounding shallowly into the umbilical seam. The venter is rather broad bearing on the phragmocone an obtuse fastigation³⁾ or very blunt barely separated keel; on the body chamber, the fastigation or blunt keel becomes obsolete. The nucleus of 6—10 mm diameter, however, is much more involute and more inflated.

The ornament of the last 3 whorls consists of rather strongly falcoid blunt ribbing with frequent to regular bifurcation to fasciculation. On the holotype (here refigured on pl. 1, fig. 8) and the largest specimen from Manflas (pl. 1, fig. 7), prorsiradiate primaries are developed which increase in prominence up to mid-flank; the projected secondaries are partly continuous with the primaries and in part more feeble and intercalated, all dying out just beyond the rounded shoulders. While the ribs of the body chamber of the holotype (and ? the smaller Manflas specimen) became laterally reduced, irregularly fasciculate and, more rarely, simple, the ribs of the slightly larger body chamber of the Manflas specimen remain divided into primaries becoming more prominent and very blunt secondaries.

The aperture of the holotype ($D = 44$ mm) has on one side the base of a lappet. A small, probably incomplete lappet is preserved at the smaller ($D = 39$ mm) of the two almost complete specimens from Manflas. The larger Manflas specimen is still incomplete at 50 mm diameter where it is also much more inflated; but adulthood cannot be determined in absence of the septal suture.

The holotype and the smaller Manflas specimens (including fragments) are undoubtedly microconchs (♂), while the larger Manflas specimen could possibly be a macroconch. Significantly, however, a much larger macroconchiate *Fontannesia* (?) occurs in the same assemblage (see below).

³⁾ The term "fastigate" (and "fastigation") are here spelled as in the "Treatise" (ARKELL, in ARKELL, KUMMEL & WRIGHT, 1957, p. L85) and as commonly used by palaeontologists; the authors are aware that the spelling is "fastigiate" and "fastigation" according to WEBSTER's Third New International Dictionary (1966) and The Random House Dictionary of the English Language (college ed., New York).

Measurements in mm

	D	H	W	U
Holotype (plastotype) ♂				
body ch.	44	10.5	8.1	24.0
phrag. ?	30	8.3	6.1	15.3

Affinities

F. (?) austroamericana ♂ was correctly compared by JAWORSKI (1926 a, p. 218) with the microconchiate *F. curvata* BUCKMAN rather than with the macroconchiate *F. grammoceroides* (HAUG) figured by BUCKMAN (1892, pls. XLVI—XLVII) from the same bed. (It is possible that the 4 macroconchiate and the 3 microconchiate "species" from a single bed of Bradford Abbas are all conspecific, i. e. *F. grammoceroides* ♀ & ♂). The English microconchs are all distinguished by the greater involution and the scarcity of biplicate ribs which are probably less strongly falcoïd. The Australian *F. clarkei* (CRICK) and associates (possibly all conspecific, cf. WESTERMANN & GETTY, 1970, p. 241), profusely illustrated by ARKELL and PLAYFORD (1954, pls. 27—30), as well as the related Indonesian forms described by WESTERMANN & GETTY (loc. cit.) do not seem to include microconchs. The inner whorls of the macroconchs, however, are more strongly keeled, probably more involute and bear less curved ribs with no or more rare biplication (although fasciculation is common).

Fontannesia (?) sp. indet. ♀
(pl. 2, fig. 1)

Material

Hacienda Manflas, Atacama province, Chile: 1 fragment, internal mould of phragmocone, from "Schicht I" of Biese Coll. (MHNS SGO PI 10051).

Remarks

The large phragmocone whorl (H = 41 mm, W = 25 mm) is moderately evolute and compressed ovate to trapezoidal in section, with steep umbilical wall, rounded umbilical margin and marked shoulders. The keel of this whorl and of the preceding one (impression) is solid and blunt. The prominent regular simple ribs are rarely fasciculate and project on the shoulder before dying out. The poorly preserved septal suture appears to be simple and straight.

This specimen was found together with several much smaller and at least in part microconchiate (♂) *Fontannesia* (?) *austroamericana* JAWORSKI, described above.

Family Graphoceratidae BUCKMAN, 1905
Subfamily Leioceratinae SPATH, 1936

Genus *Leioceras* HYATT, 1867

Type-species — *Nautilus opalinus* REINECKE, 1818.

The geographic distribution of *Leioceras* appeared hitherto to be restricted to the Tethyan and Boreal provinces (KALACHEVA & SEI, 1967; FREBOLD, 1958, 1960), since none of the Andean recordings by other authors has been confirmed (BURCKHARDT, 1900, p. 28, pl. XX, figs. 6, 7; 1903, p. 19; MÖRICKE, 1894, pp. 5, 20, 81; GROEBER, 1918, pp. 31, 42, 67, pl. V; GROEBER, STIPANICIC and MINGRAMM, 1953, pp. 228, 237, 239; STIPANICIC, 1966, p. 435). The probable *L. opalinum* from the Arroyo Blanco area, Mendoza province, described herein were only recently reported (WESTERMANN, 1967a, p. 66; STIPANICIC and BONETTI, 1970).

(?) *Leioceras opalinum* (REINECKE, 1818)
(pl. 1, figs. 10a—b)
(for incomplete synonymy see FREBOLD, 1958, p. 6)

Material

Upper north slope of the valley of Arroyo Blanco, approximately 18 km upstream, Mendoza province: numerous impressions, partially crushed, from bed 3g (MCM J 1756) (Text-fig. 3).

Comments

The involute strongly compressed whorls bear a sharp keel on an acute venter. The feeble ornament consists of flexed growth striae with irregular "hair ribs" which sometimes are bundled into faint plications on the inner flanks. In so far as the state of preservation permits comparison, there is close agreement with the illustrated European and Arctic Canadian representatives of the species (cf. FREBOLD, 1958 with references; HOFFMANN, 1913, pl. I).

In the assemblage of abundant (?) *L. opalinum* are a single minute *Tmetoceras* (?) sp. and a few small undeterminable costate ? Graphoceratidae which resemble the *Leioceras comptum* group of the European upper Opalinum Zone ["Scissum Zone"].

Genus *Staufenia* POMPECKJ, 1906

Subgenus *Costileioceras* MAUBEUGE, 1950

Type-species — *Ludwigia sinon* BAYLE, 1878, from the "Lias superieur" (recte lower Murchisonae Zone) of Württemberg.

Costileioceras has recently been placed as a subgenus in *Staufenia* POMPECKJ (RIEBER, 1963). The inner whorls of *Staufenia* s. s. are somewhat similar to *Costileioceras*, but the outer whorls are involute and smooth; "*Ludwigia*" *sehndensis* HOFFMANN is intermediate in those attributes; both subgenera have also the somewhat simplified septal suture in common. The genus *Staufenia* is distinguished from *Leioceras* in the more prominent ribbing without growth striae; and from the large majority of Graphoceratinae by the acute venter without marked shoulders and the falcoid rather than falcate ribbing. *Staufenia* s. s. and *S. (Costileioceras)* have previously apparently only been reported from Europe where they are restricted to the lower and middle Murchisonae Zone (including Sinon Zone/Subzone, cf. RIEBER, 1963, p. 10; WESTERMANN, 1967b, p. 82).

(?) *Staufenia (Costileioceras)* sp. indet.

(pl. 1, fig. 9)

Material

Cerro Pudenque, Mendoza province: 1 crushed fragment with umbilical impression, from bed 17 (MCM J1755) — Aalenian.

Comments

The whorls were originally moderately wide umbilicate and probably ogival in section, with acute venter bearing a poorly separated keel. The ornament consists of slightly flexed and strongly projected prominent ribbing with irregular plication, fasciculation and a few single ribs; some of the primaries are swollen into elongate bullae. However, the ribbing may be distorted due to the crushing.

There is good resemblance to *S. sinon* (BAYLE) as figured by HOFFMANN (1913, pl. III) from the lower Murchisonae Zone of Lower Saxony, in so far as the poor preservation of our specimen permits closer comparison.

Family Hammatoceratidae BUCKMAN, 1887

Subfamily Hammatoceratinae BUCKMAN, 1887

For full discussion of the genera and subgenera assigned to the Hammatoceratinae, the reader is referred to the recent review by the senior author (WESTERMANN, 1969, pp. 63—72) and references listed therein.

Genus *Planammatoceras* BUCKMAN, 1922

Type-species by original designation — *P. planiforme* BUCKMAN, 1922, from the (upper) Murchisonae Zone of Somerset, England [= *P. planinsigne* (VACEK)].

No further comments are added here to the recent discussions of this somewhat questionable genus by the senior author (WESTERMANN, 1964 a, pp. 411—412; 1969, pp. 65—66).

Planammatoceras cf. *planinsigne* (VACEK, 1886) subsp. nov. A ♀

(pl. 2, fig. 5)

(?) 1886. *Hammatoceras planinsigne* VACEK, p. (33) 89, pl. XIII, figs. 1 (lectotype des. ELMI, 1963), 2, (?) 3—4, 6.
1953. *Hammatoceras tenuinsigne* VACEK — GROEBER, STIPANICIC & MINGRAMM, p. 207.

Material

Sierra de Reyes, Mendoza: 1 somewhat damaged completely septate internal mould with test remains, coll. GROEBER, 1914 (original to GROEBER et al., 1953, p. 207), "stratum no. 10" of Quebrada de la Buitrera on the western slope of the Sierra; said to have come from a calcarenite approximately 100 m below beds with "*Sonninia espinazitensis* TORNQ., *Sphaeroceras multiforme* GOTTS., *Sph. submicrostoma* TORNQ., *Stephanoceras sphaeroceroideis* TORNQ. etc." of the Sowerbyi and Sauzei Zones, and overlying a transgression conglomerate. (DNGM 846 — coll. GROEBER) — Aalenian.

Description

The whorls are widely umbilicate throughout and compressed ogival in section bearing a prominent floored keel. The ornament of the inner whorls is rectiradiate and consists of short distinct primaries bifurcating at approximately one-third whorl height at fine round tubercles. On the outer whorl ($D \approx 140$ mm), the primaries extend to mid-flank with gentle curvature and are non-tuberculate; there are two to three times as many, increasingly projected secondaries reaching up to the keel. Finally, the ribbing is obsolescent at mid-flank. The poorly preserved septal suture is highly complex and contains strongly oblique umbilical elements.

Measurements in mm

	D	H	W	U	U/D
DNGM 846 phrag.	~ 140	58	35	51	(~ .36)
phrag.	~ 82	33	~ 25	31	(~ .38)
<i>P. planinsigne</i> , lectotype (plastotype)	(~140) 90	37	~ 25	28	(.31)
phrag.	68	28.5	22.3	20.5	(.33)

Comparison

The specimen closely resembles *P. planinsigne* (VACEK) from the Aalenian of Lake Garda in the Alps (plastotypes at hand), except for the somewhat more open coiling particularly of the inner whorls and possibly for the more strongly converging outer flanks. "*Hammatoceras*" *tenuinsigne* VACEK and *P. planiforme* BUCKMAN, both regarded as conspecific with *P. planinsigne* (WESTERMANN, 1964 a, 1969), are distinguished by the even more involute whorls and the non-tuberculate, more strongly curved or flexed ribbing. *H. hosourense* SATO (1954 b) from the Aalenian of northeast Japan is very close to the lectotype of *P. planinsigne* (VACEK, 1886, pl. 13, fig. 1) and also regarded synonymous. Other hammatoceratids with similar whorl shape have much more strongly ornate inner whorls.

Planammatoceras sp. A ♀

Material

Hacienda Manflas, Atacama province, Chile: fragments of a single poorly preserved internal mould, from the upper part of bed 4 (upper part of lower 'iron-oolite') (MCM J1187: 6); 1 half-whorl of large phragmocone, poorly preserved and distorted internal mould, from "Schicht II" (the lower 'iron-oolite') of BIESE collection (MHNS SGO PI 10052).

Remarks

The outer whorls (~ 130 and ~ 145 mm D) were (before distortion) rather widely umbilicate ($U \sim 35\%$ of D) and ogival in section, bearing a prominent "hollow-floored" keel. The ornament consists of blunt (? partly due to corrosion) non-tuberculate primaries reaching up to mid-flank, and somewhat projected blunt secondaries. The inner whorls and the septal suture are unknown.

These fragments closely resemble the specimen of *P. cf. planinsigne* (VACEK) subsp. nov. A ♀ described above, at comparative diameter.

Planammatoceras ? sp. B ♀

Material

Hacienda Manflas, Atacama province, Chile: the fragment of a large phragmocone with part of the penultimate whorl, undistorted internal mould, from "Schicht II" (the lower 'iron-oolite') of BIESE collection (MHNS SGO PI 10053).

Remarks

The penultimate ($D \approx 60$ mm) and ultimate ($D \approx 120$ mm) whorls are more involute than in the typical *Planammatoceras* described above ($U/D \approx 0.2$) and the whorl section is accordingly much higher, although similarly ogival with well rounded umbilical angle and prominent floored keel. The ornament of the penultimate whorl consists of non-tuberculate curved rather thin primaries and apparently somewhat fasciculate secondaries; the ultimate phragmocone whorl has blunt gently curved primaries reaching almost to mid-flank, and slightly projected blunt secondaries. The septal suture is not preserved.

While whorl shape and coiling of the ultimate whorl resemble those of the poorly known "*Parammatoceras obtectum*" BUCKMAN from the Murchisonae Zone of England as well as those of some species of *Eudmetoceras* (*Euaptetoceras*) from the Concava and Sowerbyi Zones (for full discussion of *Parammatoceras*, cf. WESTERMANN, 1969, p. 70), the ribbing is clearly that of *Planammatoceras planinsigne* (VACEK) (cf. "*P. planiforme*" BUCKMAN and "*H. tenuinsigne*" VACEK).

Genus *Bredyia* BUCKMAN, 1910

Type-species — *Burtonia crassornata* BUCKMAN, 1910, from the "Scissum Zone" of Dorset, England.

Bredyia aff. *crassornata* (BUCKMAN, 1910)

(pl. 2, figs. 2a—b)

? 1894. *Hammatoceras Alleoni* DUM. — MÖRICKE, p. 16, pl. IV, fig. 11.

Material

Manflas, Atacama province, Chile: several fragments of large shells (several very large ones were left at the outcrop) and incomplete juveniles or nuclei (or ♂ ?), more or less poorly preserved, corroded and distorted, from the upper part of bed 4 (upper part of lower 'iron-oolite') (MCM J 1187) — Upper Opalinum-Murchisonae Zone.

Description

The macroconch grows very large ($D \approx 400$ mm). The whorls are moderately involute and highly inflated with broadly ovate section. The high vertical umbilical wall rounds into the weakly curved converging flanks. The venter is broadly rounded and bears a low blunt keel. The ornament is very prominent consisting of short bullae-like primaries or fasciculations and rather strongly projected secondaries which swell ventrolaterally to greater height than the keel. The septal suture is not preserved.

Comparison

Although all specimens are more or less strongly deformed, the Andean species is almost certainly more inflated, particularly at maturity, than the English *B. crassornata* (cf. BUCKMAN, 1910, p. 98, pl. IX, fig. 1 and pl. X, fig. 1; 1925, "Type Amm.", pl. DLXXVII). *B. newtoni* (WRIGHT) ♂, also from southern England (and Switzerland, cf. MAUBEUGE, 1961, p. 61), is distinguished by the bisulcate venter. *B. ? alleoni* (DUMORTIER) from southeastern France which is placed in "*Parammatoceras*" by ELMI (1963), has more compressed and less ornate whorls. *B. ? feuguerollensis* (Brasil) from Normandie, placed in *Pseudammatoceras* by ELMI, has more evolute and compressed whorls.

Age

Bredyia crassornata appears to be known only from Dorset, where most specimens come from the single bed of the "Scissum Zone" [= Upper Opalinum Zone] of Burton Bradstock (the "*Bredyia*" recorded by WESTERMANN, 1964 a, p. 359, from the upper Murchisonae Zone near Beaminster, Dorset, has now been identified with *Ludwigia* ex gr. *crassa* HORN; this correction is based on the newly developed septal suture which is very simple and non-suspensive). The holotype of the very rare *B. newtoni* (♂, cf. WESTERMANN, 1964 a, p. 359) came from the Jurensis Zone or possibly from the Opalinum Zone (DONOVAN, 1958, fide GECZY, 1966, p. 31) while the Swiss specimen (MAUBEUGE, 1961) is undated. *B. ? feuguerollensis* was originally described from the Opalinum Zone, but confirmation seems to be missing (ELMI, 1963, p. 93). *B. ? alleoni* is dated as Opalinum Zone by GECZY (1966, p. 31) but probable Murchisonae Zone by ELMI (1963, pp. 55, 96).

GECZY (1966, p. 30) in his monograph on Hungarian Hammatoceratidae, has placed *Bredyia* (absent from Hungary) in the affinity of the “group of *H. brancoi* and *H. auerbachense*”. The poorly known “*H.*” [*Parammatoceras*?] *brancoi* PRINZ has been recorded from the Jurensis Zone to the “upper part of the lower Aalenian” (op. cit., p. 35), while “*H.*” [*Pseudammatoceras*] *auerbachense* (DORN) is only known from the Murchisonae Zone (DORN, 1935; ELMI, 1963).

The age of the poorly defined genus *Bredyia* may therefore range from the Jurensis to the Murchisonae Zone depending on which species are assigned to it. Furthermore, the local occurrence of *B. crassornata* in the bed of the “*Scissum* Zone” of Dorset cannot be construed as evidence for the worldwide restriction of this or related species to this ‘biochrone’ as is implicit in the Opalinum-Zone date given (“mit großer Sicherheit”) to the Chilean occurrence of “*Bredyia* spp.” by HILLEBRANDT (1970, p. 184). Significantly, *Tmetoceras scissum* has itself been the subject of much error of correlation because of its essential but not entire restriction to a single bed in southern England (see under *Tmetoceras*) but much longer ranges in other parts of the world, particularly around the Pacific (WESTERMANN, 1964 a, p. 344).

Genus *Eudmetoceras* BUCKMAN, 1920

Type-species by original designation — *E. eudmetum* BUCKMAN from the Discites Subzone of England; it is possible that the species ranges downward to the Murchisonae Zone. The genus has earlier been discussed at some length by the senior author (WESTERMANN, 1964a, p. 407; 1969, p. 66).

Subgenus *Eudmetoceras* BUCKMAN, 1920

Eudmetoceras (Eudmetoceras) eudmetum jaworskii WESTERMANN, 1964

(pl. 2, fig. 4)

? 1878. *Harpoceras* aff. *variabile* D'ORB. — GOTTSCHKE, p. 12, pl. 1, figs. 9a, b. (Spanish: Actas Acad. Nac. Cienc. Cordoba, vol. VIII, p. 243, pl. I, figs. 9a—b).

1926. *Hammatoceras lotharingicum* BENECKE — JAWORSKI, p. 221, text-figs. 7—8, pl. II, figs. 6a, b (holotype) and pl. IV, fig. 12.

1964a. *Eudmetoceras (Eudmetoceras) eudmetum jaworskii* WESTERMANN, p. 412.

? 1964a. *Eudmetoceras (Eudmetoceras) cf. eudmetum jaworskii* WESTERMANN, p. 413, pl. 67, figs. 1a b.

Only the plastotypes of JAWORSKI's figured two specimens of “*Hammatoceras lotharingicum* BENECKE” are available, of which the holotype of the subspecies *E. eudmetum jaworskii* is here refigured. This specimen came from the same bed as the holotype of *E. (Eudmetoceras) gerthi* JAW. and *Fontannesia (?) austroamericana* JAW. at Cerro Tricolor, Mendoza province. The age, therefore, approximates the Aalenian/Bajocian (Concava-lower Sowerbyi Zone) boundary and is probably lower Sowerbyi Zone. The other specimen of “*Hammatoceras lotharingicum*” (JAWORSKI, 1926 a, pl. IV, fig. 12) came from “horizon 9” of the Arroyo Blanco section which also yielded *Sonninia zitteli* (GOTT.) and *Eudmetoceras klimakomphalum moerickei* (JAW.) indicating Sowerbyi Zone. The fragment from the highest Aalenian of Wide Bay, Alaska (WESTERMANN, 1964 a, pl. 67, figs. 1 a, b), closely resembles this subspecies.

This subspecies was distinguished from *E. eudmetum* BUCKMAN by the more compressed whorl section and the coarser spinose ornament of the inner whorls. A small topotype of *E. eudmetum* from the Discites Subzone of Bradford Abbas, England (BMNH C4204) has similar shell shape but markedly denser ribbing with more projected secondaries. This subspecies is, however, not identical with the coarsely ribbed probable hammatoceratids from bed 5 of Manflas, Atacama Province, as proposed previously (WESTERMANN, 1967a, p. 67; HILLEBRANDT, 1970, p. 185); the Manflas form is here described under “*Hammatoceratidae?* gen. et sp. nov. B”. *E. eudmetum jaworskii* has a prominent keel and a strongly suspensive complex septal suture confirming its assignment to *Eudmetoceras* s. s.

Measurements in mm

	D	H	W	U
holotype phrag. (plaster cast)	~ 80	33.5	21.2	25.4
paratype phrag. (plaster cast)	60	23.8	24.8	19.2

Discussion

A single specimen referred to *Eudmetoceras* aff. *eudmetum* has recently been described from the lower Sowerbyi Zone of the Alaska Peninsula (WESTERMANN, 1969, p. 72, pl. 15, figs. a, b). That incomplete specimen clo-

sely resembles *E. eudmetum masticonnensis* ELMI from the Discites Subzone of southeastern France. The Andean subspecies differs mainly in the more compressed whorls.

Eudmetoceras (Eudmetoceras) gerthi (JAWORSKI, 1926)

(pl. 2, fig. 3; pl. 3, figs. 1a—b)

1926a. *Hammatoceras Gerthi* JAWORSKI, p. 219, pl. II, figs. 5a, b (lectotype), pl. IV, fig. 29, ? pl. III, fig. 11.

1926b. *Hammatoceras Gerthi* JAWORSKI, p. 405, text-figs. 10a—b, pl. XII, fig. 5, ? 6 (JAWORSKI, 1926a, pl. II, fig. 5a, and pl. III, fig. 11 refigured).

Only the plastotypes of "*Hammatoceras*" *gerthi* are available. The lectotype (here designated, refigured pl. 2, fig. 3) is from "horizon 2 of locality 18" (JAWORSKI, 1926a; marly shales with lenticular limestones) of Cerro Tricolor, Mendoza, and was associated with *Fontannesia* (?) *austroamericana* JAW., *Eudmetoceras eudmetum jaworskii* WEST., *E. klimakomphalum moerickei* (JAW.), and *Leptosphinctes (Praelptosphinctes) jaworskii* WEST. The incomplete paralectotype, from which the septal suture has previously been illustrated only (1926a, pl. IV, fig. 29), came from "horizon 7 of locality 6" (shales with limestone concretions) of Cerro China, Mendoza. This specimen, here figured on plate 3, figure 1, is more involute than the lectotype and has somewhat fasciculate ribs with reduced primaries. The listed fauna (JAWORSKI, 1926a, p. 273) includes *Sonninia zitteli* (GOTTSCHKE), *S. espinazitensis altecostata* TORNQUIST, *Pseudotoites* aff. *singularis* (GOTTSCHKE) and *Emileia* ? sp., of the Sowerbyi (-Sauzei ?) Zone. The second paralectotype from which JAWORSKI figured only the shell structure (1926a, pl. III, fig. 11; 1926b, pl. XII, fig. 6), however, stems from an involute shell bearing thin long primaries and strongly resembles the paralectotype of *E. klimakomphalum moerickei* (JAW.).

We were unable to reach the type locality, Cerro Tricolor, although several attempts were made in 1970, and no new material is available which is without doubt conspecific.

The prominent high keel which is well preserved on both paralectotypes, the septal suture (as figured by JAWORSKI, locs. cit.) with at least three oblique small (external) umbilical lobes along a sloping saddle envelope, the prominent primaries of the inner whorls, and the obsolete primaries of the outer whorls, all support the generic assignment to *Eudmetoceras*; the egression of the adult umbilical seam displayed by the lectotype and the more almost complete paralectotype are attributes of the subgenus *E. (Eudmetoceras)*. The dense relative strongly projected secondaries and the compressed whorl section indicate affinity to *E. ? insignoides* (QUENSTEDT), refigured by DORN (1935, text-fig. 1, figs. 5, 6 and pl. I, fig. 3, for septal suture see p. 21) from the late Aalenian or early Bajocian of the Swabian Jura, and to the *Eudmetoceras* sp. from the upper Howelli Zone (latest Aalenian) of South Alaska, originally described under *E. (E.) nucleospinosum* WEST. (1964a, pl. 66, fig. 5 only) but later excluded from this species (WESTERMANN, 1969, p. 82).

The recent statement by HILLEBRANDT (1970, p. 185) that "*E. gerthi* is closely related with *E. tenuiinsigne* (VACEK) and is difficult to distinguish from this species" (translated from German) is apparently due to his erroneous identification of an abundant hitherto undescribed form from the Manflas area, Chile (see under Hammatoceratidae ? gen. et spp. nov.; WESTERMANN, 1967a, p. 67).

Eudmetoceras (?) cf. *kochi* (PRINZ, 1904)

(pl. 3, figs. 2—3)

Material

Hacienda Manflas, Atacama province, Chile: 3 (+ 2?) fragments of large phragmocones, partially deformed and corroded internal moulds, from bed 5 (MCM J1188); 2 fragments of same preservation from "Schicht I" of Biese Collection (MHNS SGO PI 10054 a, b) — Concava-lower Sowerbyi Zone.

Description

The intermediate whorls of the large phragmocone are moderately involute and ogival in section, becoming more evolute and ovate with the outer whorl. The steep umbilical slope rounds into the slightly convex converging flanks. The venter is narrowly rounded to obtuse bearing a rather prominent sharp keel. The ornament consists of dense, blunt, projected secondaries on the outer $\frac{2}{5}$ — $\frac{1}{2}$ of the flanks, while primaries are missing or obsolete. The largest phragmocone fragments are almost smooth. The septal suture is highly complex with narrow

L and about three moderately suspensive umbilical lobes along a somewhat sloping saddle envelope. U_2 is only one-half as large as L and only slightly oblique to vertical; the following umbilical elements are, however, strongly oblique.

Discussion

The Hungarian holotype of *E. (?) kochi* has recently been redescribed and refigured by GECZY (1966, p. 76, pl. XVIII, fig. 1). However, the preservation of this almost entire large shell is poor because of corrosion. The smaller specimens tentatively referred to this species in the same monograph, however, show the dense projected ribbing and almost smooth inner flanks of our specimens. The septal suture is also identical. GECZY dated *E. (?) kochi* as probably "Upper Aalenian" (including the Discites Subzone; GECZY in litt. 1971).

Eudmetoceras ? sp. indet.

(pl. 4, fig. 2)

Material

Arroyo Blanco, Mendoza: 1 incomplete damaged phragmocone, internal mould with minor test remains, from concretion 9 (*Zurcheria-Tmetoceras-Eudmetoceras* assemblage; MCM J 1751 : 16) — Concava-lower Sowerbyi Zone.

Description

The whorls are inflated ogival ($H/W = 1.0 \rightarrow 1.2$) and moderately involute ($U/D = 0.23 \rightarrow 0.255$). The overhanging umbilical wall is separated from the subparallel inner flanks by a rounded slightly depressed umbilical margin. The outer one-half of the flank curves evenly to the somewhat obtusely arched venter which bears a prominent floored keel. The ornament consists of blunt rather prominent curved primaries dividing mid-flank into about twice as many rectiradiate secondaries. The septal suture is highly complex and quite strongly suspensive; U_2 is relatively large and somewhat oblique.

Measurements in mm

	D	H	W	U	H/W
MCM J 1751 : 16 phrag.	(~ 58) 43	18.6	15.5	10.5 (.244)	1.2
	25	10.1	10.0	5.8 (.23)	1.0

Discussion

This specimen closely resembles the *Eudmetoceras* (*Euaptetoceras*) aff. *klimakomphalum* (VACEK) from the same concretion (described below) except for the much stronger inflation (increased whorl width). This specimen could, however, alternatively be placed in *Planammatoceras* (cf. "*P. planiforme* BUCK.") and may indeed be intermediate to that poorly delimited genus (? or subgenus of *Eudmetoceras*; cf. WESTERMANN, 1964 a, 1969). The similarity to the (other) specimen of *Eudmetoceras* from the same assemblage, the high umbilical wall and the absence of lateral tubercles throughout, suggest to us that its best place is in *Eudmetoceras* s.l.

Subgenus *Euaptetoceras* BUCKMAN, 1922

[Syn.: *Pseudaptetoceras* GECZY, 1966]

Type-species by original designation — *E. euaptetum* BUCKMAN, 1922, from the Discites Subzone of Dorset; regarded as a junior subjective synonym of the Mediterranean *E. amaltheiforme* (VACEK); questionably distinct from *Parammatoceras obtectum* BUCKMAN, type-species of *Parammatoceras* (cf. WESTERMANN, 1964 a, p. 409; 1969, p. 70). The subgenus *Pseudaptetoceras* GECZY, 1966, with the type-species *E. klimakomphalum* (VACEK), is considered synonymous with *E. (Euaptetoceras)* (WESTERMANN, 1969, p. 68).

Eudmetoceras (*Euaptetoceras*) cf. *klimakomphalum klimakomphalum* (VACEK, 1886)

(pl. 3, figs. 4a—b)

(?) 1886. *Harpoceras klimakomphalum* VACEK, p. 81, pl. 8, figs. 16, 16a, 17, 17a [lectotype].

(For further listing cf. WESTERMANN, 1969, p. 74). The lectotype (VACEK, fig. 17, 17a) was designated by SAPUNOV (1964, p. 262).

Material

Hacienda Manflas, Atacama province, Chile: 2 internal moulds of phragmocone fragments of which one is corroded, from bed 5 (MCM J 1188) — Concava-lower Sowerbyi Zone.

Description

The shell is involute discoidal, with strongly compressed fastigate whorl section of the internal mould. The umbilical angle up to the maximal diameter of approximately 60 mm seems to be slightly rounded and not raised, resembling the immature lectotype. The ornament consists of rectiradiate rather prominent primaries and moderately dense somewhat projected secondaries of similar strength comprising a ventral angle of approximately 120°. The corroded specimen is somewhat more evolute than the figured specimen which it otherwise closely resembles.

Measurements in mm

	D	H	W	U
MCM J 1188 : 1 phrag.	55	30.5	16.0	6.8

Discussion

The figured specimen resembles the lectotype as far as can be made out from the incomplete preservation. The ribbing is much stronger than in *E. klimakomphalum moerickei* (JAWORSKI), and the primaries are not curved while the secondaries are more strongly projected.

Eudmetoceras (Euaptetoceras) klimakomphalum moerickei (JAWORSKI, 1926)

(pl. 4, figs. 3—7)

1894. *Harpoceras proximum* GOTTSCHKE — MÖRITZKE, p. 15, pl. VI, fig. 10.

1926a. *Oppelia Mörickei* JAWORSKI, p. 253, pl. III, figs. 12a—d (lectotype des. WESTERMANN, 1969, p. 80); fig. 13 (?).

1926b. *Oppelia Mörickei* JAWORSKI in JAWORSKI, KRANTZ and GERTH, p. 414, text-figs. 23a, b; pl. XI, fig. 9 (same specimen as JAWORSKI, 1926a, fig. 12).

Material

Arroyo Blanco, Mendoza province: 3 incomplete larger phragmocones, 3 fragments and 1 nucleus, from loose concretion 5b (MCM J 1347); the lectotype (plastotype) from "locality 7, profile VI, horizon 9" (JAWORSKI, 1926), (?) Sowerbyi Zone.

Cerro Tricolor, Mendoza province: (?) the paralectotype (plastotype) from "locality 18, profile 12, horizon 2" (Jaworski, 1926).

Description

The phragmocone is typically discoidal in shape, from approximately 20 mm to the adult diameter of 50 to 70 mm. The whorls are involute ($U/D = 0.10$ to 0.20) and strongly compressed subtriangular to ogival, with vertical to overhanging umbilical wall, a slightly rounded umbilical angle which is not raised, and a narrowly rounded acute venter with a sharp floored keel. The internal mould has a more rounded umbilical angle and a narrowly rounded, almost fastigate venter. The body chamber is poorly known.

The ornament consists of blunt dense, somewhat concave primaries on the inner one-third of the flank becoming obsolete toward the end of the phragmocone, and very dense radial secondaries which are most prominent on the outer one-third of the flank. The secondaries are only very slightly projected forming a highly obtuse angle on the venter (~ 150 — 160°).

The septal suture is highly complex, but only weakly suspensive as in other involute *E. (Euaptetoceras)* (cf. WESTERMANN, 1964 a, 1969; GECZY, 1966). L is slightly deeper than E, the L/U saddle is much smaller than the L/E saddle, U is about one-half as large as L and in vertical position, while the smaller umbilical elements are moderately oblique.

Measurements in mm

	D	H	W	U	H/W
Lectotype (plastotype)					
phrag.	66	37.5	19	6.9 (.105)	2.0
Paralectotype (plastotype)					
body ch.	~ 70	—	—	17 ($\sim .24$)	—
phrag.	~ 46	22	12.5	7.3 ($\sim .16$)	1.75
MCM J 1347 : 1 phrag.	(~ 50) 42	22	11.5	7.2 (.17)	1.9
: 2 phrag.	23.5	12.0	7.9	4.8 (.20)	1.5
: 3 phrag.	36.5	19.0	11.0	6.7 (.18)	1.7

Comparison

This subspecies is distinguished from the Tethyan *E. klimakomphalum* s. s. by the slightly rounded umbilical angle which is not raised, in the less projected to rectiradiate dense secondaries, and probably in the more fastigate whorl section. *E. klimakomphalum discoidale* WESTERMANN (1969, p. 75) from the Sowerbyi Zone of south Alaska, which this subspecies resembles most closely, has more prominent and more widely spaced secondaries and probably a larger diameter. *E. ? tyrrhenicum* (RENZ) from Sicily has subparallel flanks which converge only in the outer third, and shorter clearly projected secondaries, while the main part of the flank is entirely smooth.

Discussion

The single specimen from the "Unterer Dogger" (loose ?) of the Copiapó valley described by MÖRICKÉ (1894) under "*Harpoceras proximum* GOTTSCHÉ" is a perfect match to the lectotype from Mendoza. MÖRICKÉ's figure shows remnants of a prominent keel; the septal suture was said to differ from that of the true "*H. proximum* GOTTSCHÉ" [= *Sonninia zitteli* (GOTTSCHÉ)] and to resemble those found in "*Oppelia*". JAWORSKI (1926 a, b) described two new specimens which he believed to be conspecific with MÖRICKÉ's form, under the new name *Oppelia moerickei*, without assigning a holotype. JAWORSKI's specimen (1926 a, pl. III, fig. 12) from Arroyo Blanco, a phragmocone found together with or in proximity to *S. zitteli* (GOTTSCHÉ), closely matches MÖRICKÉ's specimen in the involute coiling and also in the (largely missing) prominent floored keel which is explicitly referred to in the Spanish edition of the paper. A remnant of the keel at the very beginning of the ultimate whorl can also be seen on the plastotype. This specimen was designated as the lectotype by WESTERMANN (1969, p. 80). The other syntype (figured only in the Spanish edition; 1926 a, pl. III, fig. 13) from Cerro Tricolor which was found together with *Fontannesia* (?) *austroamericana* JAWORSKI, *Eudmetoceras gerthi* JAWORSKI, and *E. eudmetum jaworskii* WESTERMANN, is an almost complete specimen with rather evolute body chamber and well preserved prominent keel. Compared with the lectotype, the phragmocone diameter is somewhat smaller, the umbilical angle is sharp (due to test preservation ?), and the phragmocone umbilicus is slightly larger. Notwithstanding these differences, JAWORSKI considered the two specimens as involute and evolute variants of the same species. Both specimens are here refigured (pl. 4, figs. 5, 6). Since no body chambers are preserved on our own material, we are unable to say with certainty if the Cerro Tricolor specimen (paralectotype ?) is conspecific with the Arroyo Blanco material.

ARELL's (1956, p. 585; cf. 1957, p. L 275) assignment of "*Oppelia morickei*" to *Bradfordia* is incorrect and was probably based on the German edition of JAWORSKI's paper (1926 b) only (with sections of internal moulds). Unfortunately, other authors followed ARELL's assignment without hesitation (e. g. BREMER, 1966, p. 163).

Our topotypes are slightly more evolute than the lectotype (cf. measurements), have a sharper umbilical angle and more persistent primaries; they therefore resemble the phragmocone of the paralectotype (?) even more strongly.

Age

Both syntypes of JAWORSKI apparently came from assemblages (see under Discussion) of the earliest Bajocian, indicating the (lower) Sowerbyi Zone with some certainty. However, our topotypes cannot be dated.

The age of the Mediterranean occurrences of *E. klimakomphalum* has recently been established outside of the classical "condensed" sequences of St. Vigilio at Lake Garda (type locality) and Sicily. In the Bakony Mountains of Hungary, the species appears to range from the upper Murchisonae Zone, Bradfordensis Subzone, through the Concava Zone into the lower Sowerbyi Zone, Discites Subzone, where it seems to be most common [GECZY, 1966, p. 78—83, fig. 122: "Concava Zone" sensu BUCKMAN ≈ Discites Subzone, cf. GECZY in litt. 1971; 1967a, p. 259, table I on p. 261: printing error wrongly indicating the limits of the "Biozone à *H. (P.) klimakomphalum*", cf. GECZY, in litt. 1971; 1967 b, p. 12].

The most complete sections are probably in the Basses-Alps of southeastern France where *E. klimakomphalum* was reported from the Discites Subzone (DUBAR et al., 1967, circular for 2nd Jurassic Colloquium, p. 9, 23). However, *Eudmetoceras* s. s. and *E. (Euaptetoceras)* sp. are there also recorded from the Concave Zone; but "*E. klimakomphalum renzi*" ELMI (1963) from the Rhone basin seems to be closer allied with *E. amaltheiforme* (VACEK) and *E. amplexens* (BUCKMAN) than with *E. klimakomphalum*.

At Wide bay, Alaska Peninsula, *E. klimakomphalum discoidale* WEST. is associated with species of *Sonninia* (*Euhoploceras*) and *Docidoceras* which are clear indicators of the early Sowerbyi Zone, Discites Subzone (WESTERMANN, 1969).

The "*Harpoceras klimakomphalum*" of BURCKHARDT (1900, pl. 20, figs. 12?, 13, 14; 1903, pl. 2, figs. 1—3) from Cerro Puchenque in Mendoza province, however, is not an *Eudmetoceras* because of the feeble keel and the simpler septal suture; this form is closely affiliated with "*Harpoceras hauthali*" and "*H.*" *malarguense*, BURCKHARDT spp., which were found in the same beds and are placed in the new genus *Puchenquia* (see below).

Eudmetoceras (*Euaptetoceras*) sp. nov. aff. *klimakomphalum* (VACEK)

(pl. 3, figs. 5—7; pl. 4, figs. 1a—b)

Material

Arroyo Blanco, Mendoza province: 2 well preserved phragmocones, 3 larger and 2 smaller mostly septate fragments from concretion 9 (*Zurcheria-Tmetoceras-Eudmetoceras* assemblage; MCM J1751) — Concava-lower Sowerbyi Zone.

Bardas Blancas, Neuquén province: 1 large and 3 small damaged and partly crushed incomplete phragmocones, from block (*Zurcheria-Tmetoceras-Eudmetoceras* assemblage) of interval 1 (MCM J1325) — Concava-lower Sowerbyi Zone.

Description

The phragmocone whorls at about 20—70 mm diameter are moderately involute ($U/D = 0.22$ to 0.27) with ogival section which is 1.5—1.8 times higher than wide. During this growth interval, the whorls tend to become slightly more evolute and compressed. The vertical umbilical slope is separated from the subparallel inner flanks by a slightly rounded non-elevated margin; the outer two-fifths to one-half of the flank rounds evenly to the acute or narrowly rounded venter which (on the shell) bears a prominent narrow floored keel. The nucleus below 20 mm diameter has ovate and less depressed whorls.

The ornament consists of blunt, rather widely spaced, somewhat sigmoid primaries reaching from the umbilical slope to almost mid-flank. The blunt dense secondaries and intercalatories are rectiradial on the flank and only very slightly projected on the outer flank comprising a highly obtuse ventral angle (intercostal angle $\approx 160^\circ$). The juvenile whorls ($D < 25$ mm), however, have somewhat more projected secondaries, while the primaries are extremely blunt and obsolete below 15 mm diameter.

The septal suture is highly complex with narrow L and a series of (at least) three small oblique umbilical lobes along an inclined saddle envelope.

Measurements in mm

		D	H	W	U	H/W
MCM J1751 : 9	phrag.	(72) 69	30.5	17.0	18.5 (.27)	1.8
	phrag.	37	15.7	10.5	~ 8.5 ($\sim .23$)	1.5
: 10	phrag.	35	16.6	9.0	8.1 (.23)	1.85
	phrag.	23	11.1	7.2	5.2 (.22)	1.55
: 11	phrag.	33	16.5	10.7	7.5 (.23)	1.55

Discussion

The phragmocone of this species, known only in a few incomplete specimens, resembles *E. klimakomphalum*, and in particular the subspecies *E. k. moerickei* (JAW.), except for the somewhat wider umbilicus, the slightly more inflated whorl section, and the more widely spaced primaries. In contrast to *E. klimakomphalum* s. s., but like the other involute eastern Pacific subspecies *E. k. moerickei* (JAW.) and *E. k. discoidale* WEST., the umbilical margin is slightly rounded, not raised, and the flanks meet the venter acutely at the keel. The more strongly suspensive septal suture of our form as compared with the more involute *E. klimakomphalum* s. l. is probably correlative with the smaller overlap of the whorls and not considered as taxonomically significant. The upper Aalenian and basal Bajocian *E. infernense* (ROMAN) has similar coiling, but differs in the more inflated whorls and the more prominent primaries. The specimen figured by BUCKMAN ("Type Amm.", IV, fig. 395—1) is subrectangular in section. *E. gerthi* (JAW.) differs in the more evolute, less fastigate whorls and in the sigmoid ribbing with strong primaries on the inner whorls.

The whorls of our species are probably more involute and compressed than in the middle Aalenian *Planammatoceras* of which *P. planinsigne* (VACEK) [cf. "*P. planiforme* BUCK." and "*P. tenuinsigne* (VACEK)"] shows resemblance in the ornament but differs also in the absence of a marked umbilical edge.

[Family Hammatoceratidae ? or Sonniniidae]

Hammatoceratidae ? gen. nov. (unnamed)

Discussion

The poorly preserved fauna from several meters of grey marlstone with limestone of locality 5 (MCM J1188) at Hacienda Manflas, Atacama province includes *Fontannesia* (?) *austramericana* JAW., *Sonninia* (*Euhoploceras* ?) sp. (rare), *Eudmetoceras* (*E.*) cf. *klimakomphalum* (VACEK), *E.* (?) cf. *kochi* (PRINZ), *Tmetoceras* spp. (rare), as well as an abundant previously undescribed taxon with 2 or 3 species combining attributes of late hammatoceratids with those of early sonniniids. The generally crushed and fragmentary state of preservation, however, does not permit the naming of new taxa.

HILLEBRANDT (1970, pp. 177, 185), perhaps following earlier preliminary identifications by one of us (WESTERMANN, 1967a, p. 67), may have recorded these new species under "*Eudmetoceras gerthi* (JAW.)", and (?) "*E. jaworskii* WEST."; however, the diagnostic septal sutures are not preserved on his specimens (personal communication and inspection of collection in Berlin by WESTERMANN). According to HILLEBRANDT (1970, p. 185; in litt. 1971), this grey calcareous sequence is estimated at approximately 7—9 m at Manflas, thickens northward to approximately 70 m in the Quebrada Asientos, and probably contains there two successive assemblages; i. e. the lower one including "*Eudmetoceras jaworskii*" and the upper "*E. gerthi*, *E. klimakomphalum*, *Sonninia* (?) sp., and *Tmetoceras* sp."

The whorls are moderately evolute and ogival in section, with steep but low umbilical slope, rounded umbilical margin, fastigate to narrowly rounded venter, and blunt keel. The ornament of the nucleus is weak, becoming increasingly prominent on the intermediate and outer whorls; prorsiradiate high primaries divide at mid-flank into markedly projected secondaries. The septal suture is relatively simple, with moderately broad trifold L and a graded series of 3—4 small straight to slightly oblique umbilical lobes aligned along a radial to somewhat suspensive saddle envelope.

The intermediate whorls resemble *Eudmetoceras gerthi* JAW. and *E. eudmetum* BUCKMAN in shape and ornament, but the nucleus misses the prominent, often tuberculate primaries. Moreover, the primaries do not become obsolete on the outer whorls as in all known *Eudmetoceras* species (including *E. gerthi* and *E. jaworskii*) but, on the contrary, highly ornate. The keel is blunt and solid to barely floored, never prominent and sharp as in *Eudmetoceras*. Ornament and keel resemble *Sonninia* (*Euhoploceras*) which, however, differs in the whorl section, the suture and in the ornament of the nucleus. The septal suture resembles that of *Eudmetoceras*, particularly *E. (Euaptetoceras)*, in the small size of U_2 and the presence of several additional small umbilical elements arranged in a graded series; but it differs in the greater simplicity (note, however, that most specimens are corroded) and little or no suspension. The suture is, therefore, also intermediate between those of *Eudmetoceras* and *Sonninia* s. l. Other, earlier, hammatoceratids, such as *Planammatoceras* which may show some resemblance in whorl shape and ornament, differ markedly in the strongly suspensive sutures with oblique large U_2 .

The new genus *Puchenquia*, described herein from beds of very similar if not identical age, agrees reasonably well in the ornament of the inner whorls, in the blunt keel and in the suture [cf. *P. malarguensis* (BURCKHARDT), 1900, pl. XX, fig. 10, 1903, pl. I, fig. 10], but differs by the obsolete primaries of the outer whorls (macroconch) and the strongly compressed whorl section. This indicates that the new unnamed genus (or subgenus?) is most closely allied to *Puchenquia* as was already stated earlier when it was erroneously identified with *Eudmetoceras gerthi* (WESTERMANN, 1967a, p. 67).

Hammatoceratidae ? gen. et sp. nov. A

(pl. 4, fig. 8; pl. 5, figs. 1—6)

Material

Hacienda Manflas, Atacama province, Chile: approximately 20 fragments of phragmocones and body chambers, more or less strongly corroded (with limonitic 'patina') and deformed (most are partly crushed) internal moulds, from bed 5 (MCM J1188); 3—4 fragments from "Schicht I" of Biese collection, same preservation (MHNS SGO PI 10055 a—c) — Concava-lower Sowerbyi Zone.

Description

The whorls are moderately evolute ($U/D = 0.25$ to 0.30) and ogival in section, the whorl height being approximately 1.3—1.5 times greater than the width. The low steep to vertical umbilical slope of the inner and

intermediate whorls is separated from the flank by a somewhat rounded, not raised, margin; the umbilical slope of the outer whorl and body chamber is probably less steep and the margin more rounded. The flanks converge to the fastigate or narrowly rounded venter which in test preservation (seen in polished sections) bears a low, blunt keel. A barely separate keel floor can be seen in some specimens, separated from the outer shell by a shallow space.

The ornament of the nucleus ($D \approx 15$ to 20 mm) consists only of low plications or blunt ribbing; the intermediate whorls bear rather prominent sigmoid ribbing with long prorsiradiate primaries dividing mid-flank into projected secondaries; on the outer whorl and body chamber, the primaries develop strongly, rising up to mid-flank where they divide into blunt secondaries which project and become prominent on the shoulder.

The septal suture is almost certainly only moderately complex (plate 5, figs. 2—6). This is evident from about ten fragments belonging to different shells with little variations in complexity (the limonitic 'patina' appears to be replacement of test). E is broad and usually somewhat shorter than L; L is also quite broad and trifid; U_2 is much smaller than L and vertical; 2 or 3 additional umbilical lobes (or parts of lobes) follow in a graded sequence, usually in slightly oblique position and with almost radial to somewhat suspensive saddle envelope. The internal suture is unknown.

Hammatoceratidae ? gen. nov. aff. sp. nov. A

(pl. 4, fig. 9)

Material

Hacienda Manflas, Atacama province, Chile: 1 almost complete internal mould, somewhat corroded and partly deformed and crushed, from bed 5 (MCM J1188 : 21) (together with spp. nov. A and B) — Concava-lower Sowerbyi Zone.

Remarks

This specimen resembles sp. nov. A but is distinguished in the more compressed and involute whorls bearing much finer ornamentation. The septal suture which is partially preserved on the outer and inner whorls, also resembles that of sp. nov. A. Present only in a single specimen, this form may either be a variety of sp. nov. A or a distinct species.

Hammatoceratidae ? gen. et sp. nov. B

(pl. 5, figs. 7—10)

Material

Hacienda Manflas, Atacama province, Chile: 6 fragments of medium to large phragmocones and body chambers, corroded and deformed (partly crushed), from bed 5 (MCM J1188 : 22—26) — Concava-lower Sowerbyi Zone.

Description

The intermediate and outer whorls are moderately evolute and inflated ogival to subtriangular in section, with the whorl height approximately equal to the whorl width. The keel appears to have been blunt and not prominent. The ornament is extremely prominent. The intermediate whorls have somewhat prorsiradiate primaries dividing at mid-flank into projected secondaries. On the outer whorls of the large shell, the primaries tend to develop into prominent distant bullae while the secondaries become blunt. The septal suture (pl. 5, figs. 7, 9) is only moderately complex, with quite broad L and a graded series of small umbilical lobes along a radial or slightly suspensive saddle envelope; the umbilical lobes are vertical to very slightly oblique.

Comparison

This species resembles sp. nov. A except for the much more inflated whorl section and the stronger ornament of at least the intermediate and outer whorls. However, style of ribbing, ventral fastigation with keel, and septal suture are the same.

Genus *Puchenquia*, gen. nov.

Type-species — *Harpoceras malarquense* BURCKHARDT, 1903.

Derivatio nominis — Referring to the locality Cerro Puchenque [Cerro Puchén auct.], type-locality of *P. malarquensis*, near Malarque, Mendoza province.

Age

(? uppermost Aalenian, Concava Zone-) basal Bajocian, (lower) Sowerbyi Zone.

Diagnosis

Shell compressed, keel minute becoming obsolete on body chamber; septal suture moderately complex and somewhat suspensive; microconch and inner whorls of macroconch widely umbilicate, with shallow umbilical slope and flexed, irregularly branching and fasciculate ribs; outer whorls of macroconch becoming involute with distinct steep umbilical slope, primaries obsolescent, secondaries dense and gently projected.

Discussion

History — In 1900 BURCKHARDT described a new ammonite fauna from Mendoza province, with "*Harpoceras aalense* ZIETEN", "*H. klimakomphalum* VACEK", "*H. cfr. opalinoides* CH. MAYER", and "*H. aff. opalinum* REINECKE". Affinity and age of this fauna which is probably a single assemblage have since been much discussed leading to largely unwarranted suppositions and accusations. According to BURCKHARDT (1900, p. 56) the collection was made by HAUTHAL from a black limestone of fossil "locality 7" at the "western slope of Cerro Puchén" [= Puchenque]. However, on his geological sketch map (pl. XXXII), locality 7 is indicated on the eastern to southeastern slope of Cerro Puchenque in a similar stratigraphic position as locality 8, i. e. within the "Lias and Lower Dogger". BURCKHARDT (p. 56) regarded this ammonite assemblage as age-equivalent to the European "Beds with *Harpoceras opalinum*"; he also tentatively correlated the beds of this locality with parts of levels 20/21 of his section which he placed in the "Zone of *Sphaeroceras Sauzei*". However, in his stratigraphic table (op. cit., pp. 66—67), level 21 was placed in the "Lias" and level 20 in the Bajocian, while the assemblage of Hauthal's locality 7 was listed from the "Zone of *Harpoceras opalinum*" of the "Dogger" below the Bajocian.

In 1903 BURCKHARDT redescribed this fauna, introducing new names: *H. malarguense* for the earlier (BURCKHARDT, 1900) supposed *Harpoceras cfr. opalinoides* and *H. aalense* (part.); *H. puchense* for *H. aalense* (part.); *H. hauthali* for *H. klimakomphalum* (part.); and *Witchellia argentina* for *H. aff. opalinum*. He also described a small specimen not previously figured under *H. striatulum* SOWERBY. "*H. malarguense* and "*H. puchense* were again regarded as closely affiliated to "*H. aalense*, i. e. *Pleydellia*, with reference to figures by DUMORTIER (1874) from La Verpillère, and by Meneghini (1867—81) from Assisi (the latter is now placed in *Brodieia* by PINNA, 1969); "*H. hauthali* was believed to be related to *Eudmetoceras klimakomphalum*, and "*Witchellia argentina* to *Dorsetensia romani* (OPPEL). BURCKHARDT (p. 100) therefore placed this fauna in the "Upper Lias" and "Lower Dogger". The type specimens are lost, possibly irretrievably, except for the original to "*Harpoceras cfr. opalinoides* CH. MAYER" (BURCKHARDT, 1900, pl. XX, fig. 16 only), i. e. the lectotype (here designated) of "*H. malarguense* BURCKHARDT, 1903.

GROEBER (1918, pp. 17—18) followed BURCKHARDT in regarding "*H. malarguense* and "*H. puchense* as close relatives of *Pleydellia aalensis*; however, he believed that "*H. striatulum* SOW." of BURCKHARDT (1903) is a mere variety of "*H. puchense* and that "*W. argentina* is not a *Witchellia* but an affiliated species of the same *P. aalensis* group. GROEBER (op. cit., pp. 18, 30) placed the base of the "black limestones bearing this assemblage" at Cerro Domuyo and Chacay Melehue, Neuquén province, in the "zone of *H. opalinum*", again mainly because of the supposed close faunal affinity with the classic exposures of San Vigilio in the southern Alps (VACEK, 1886) which he so dated; he (p. 30) disregarded JAWORSKI's (1914) record of a *Hildoceras boreale* together with *H. klimakomphalum* from Chacay Melehue suggesting that the specimen was allochthonous in the collection.

JAWORSKI (1926a) supported BURCKHARDT's original (1900) generic assignments of "*Witchellia argentina* and of the supposed *Grammoceras striatulum*, but (p. 291) pointed out that, while BURCKHARDT's dating of the assemblage (or fauna) from Cerro Puchenque may be correct, his own collections from other localities indicated also Toarcian.

The opinions of BURCKHARDT, GROEBER and JAWORSKI (ops. cit.) about the age of HAUTHAL's ammonite assemblage (or fauna) and of the "black limestone" of Cerro Puchenque, therefore, appear to differ only with respect to the regional exclusion or inclusion of part of the Upper Toarcian. GERTH (1925) essentially agreed with JAWORSKI in his biochronologic conclusions. Unfortunately, JAWORSKI had confused the reader by including the "Opalinum Zone" originally (1914, 1915) in the "Dogger" and later (1926a) in the "Lias". Furthermore, both authors usually omitted to clarify their reference to either the lithological unit of HAUTHAL's locality 7 containing

the ammonite assemblage (or fauna) or to the inferred age and range limit of the ammonite taxa identified. For these various reasons, there is much less factual disagreement between these authors than is apparent from their writings.

In 1953 GROEBER, STIPANICIC & MINGRAMM (p. 213) implicitly confirmed the occurrence of Upper Toarcian black limestones at Cerro Puchenque as earlier reported by JAWORSKI (1926 a), but stratigraphically distinct from the black limestone of HAUTHAL's locality 7.

WEAVER (1931, pp. 25—28 and correlation chart) recorded (not illustrated) "*Harpoceras malarguense*" and "*H. puchense*" from Río Picún Leufú and Cerro Lotena in Neuquén province, placing them in the "zone of *opalinum*". However, these identifications are in doubt (WESTERMANN, 1964 a, p. 348). Alleged *H. hauthali*, *H. malarguense*, *H. puchense*, and *Witchellia argentina* were also reported from Pampa de Agnia, Chubut province (PIATNITZKY, 1936, p. 101; cf. also FERUGLIO, 1949, pp. 107—108; STIPANICIC et al., 1968, pp. 85—86; STIPANICIC & BONETTI, 1970, pp. 74—78). One of us (RICCARDI) has examined the outcrops which have furnished only a Lower (-Middle) Toarcian fauna of dactyloceratids and harpoceratids.

ARKELL (1956, p. 586) tentatively confirmed BURCKHARDT's (1900, 1903) opinion of a close affinity of "*H.*" *malarguense* and "*H.*" *puchense* to *Pleydellia* (but referring only to GROEBER, 1918), and GROEBER's (1918) assignment of "*Witchellia*" *argentina* to the same genus and he also implicitly agreed with BURCKHARDT's identification of "*Harpoceras*" [*Eudmetoceras*] *klimakomphalum* from the same fauna.

WESTERMANN (1964 a, p. 348) suggested that BURCKHARDT's alleged *Harpoceras klimakomphalum* from Cerro Puchenque is closely affiliated with "*H.*" *hauthali* and "*H.*" *malarguense* constituting a closely knit series of macroconchs; that "*H.*" *puchense*, "*H. striatulum*" and "*Witchellia*" *argentina* may be the corresponding microconchs of this series; and that the entire figured ammonite fauna from Cerro Puchenque ("locality 7") may be assignable to two or three dimorphic species to be classified as a new genus or subgenus (unnamed) related to *Pleydellia*. After recollecting what was probably at or near HAUTHAL's locality 7 in 1965, the senior author (WESTERMANN, 1967 a, p. 67; 1969, p. 28) reported that the entire ammonite fauna from this locality as described by BURCKHARDT (1900, 1903) belongs to a single assemblage and suggested that all five species described under *Harpoceras* belong to one or two dimorphic species which are associated with abundant "(?) *Witchellia* sp. nov." and a single nucleus resembling *Sonninia (Euhoploceras) adicra* (WAAGEN) [both here placed in *Sonninia (Euhoploceras) amosi* sp. nov.]. The "*Harpoceras*" spp. [*Pleydellia* auct.] were considered to belong to a new genus (or subgenus) of either advanced Hammatoceratinae (aff. *Eudmetoceras*) or of very early Sonniniidae, because of the relatively simple and weakly suspensive septal suture, and the low keel (1969, p. 70); the whole fauna was dated as uppermost Aalenian to basal Bajocian.

On the other hand, GECZY (1966, 1967a) supported the specific identifications by BURCKHARDT (1900, pl. 20, figs. 9—11) of "*Harpoceras*" [*Pleydellia*] *aalense* and, tentatively, of "*Harpoceras*" [*Eudmetoceras*] *klimakomphalum* BURCKHARDT, 1900 (pl. 20, figs. 13—14).

Both of us restudied HAUTHAL's apparent locality 7 more extensively in 1970, now also including the better exposures on the south slope of a small tributary of the upper Arroyo Negro valley (beds 14—16), several hundred meters south of the hill top (bed 6, MCM J1300) visited in 1965 (cf. WESTERMANN, 1967 a, p. 67). The "*Harpoceras*" [*Pleydellia* auct.] assemblage occurs throughout a 3 m interval of concretionary shales and black limestones, and is associated with *Sonninia (Euhoploceras) amosi* sp. nov. at least in the lower 2 m. *S. amosi* is most abundant in the extremely fossiliferous limestone concretions at the base (bed 16, MCM J1748), while the "*Harpoceras*" assemblage is most frequent at the top of the 3 m interval (bed 14, MCM J1753).

Affinities

Although there is some superficial resemblance of the microconch (♂) with certain Hildoceratidae, such as *Pleydellia* as formerly suggested (see above), and of the macroconch (♀) with *Graphoceras* of the Graphoceratidae, the septal suture leaves little doubt of its affiliation with late Hammatoceratidae and/or early Sonniniidae. The adult suture of the macroconch is indeed close to that of involute *Eudmetoceras (Euaptetoceras)* ex gr. *klimakomphalum* (VACEK) as noted already by BURCKHARDT (1903, p. 17), although it is simpler and probably less suspensive in the juveniles. *Eudmetoceras* and other late Hammatoceratidae are, however, clearly distinguished in the prominent high keel. The nucleus of *Puchenquia* macroconchs and the entire phragmocone of the microconchs are, furthermore, much more compressed and evolute, and not very unlike those of the (?) sonniniids *Fontannesia*

(cf. WESTERMANN and GETTY, 1970, pp. 238—244) and *Dorsetensia* (δ), while similar sutures are also found in other early sonniniids such as the associated subgenus *Euhoploceras* which also may have slight suspension. *Puchenquia* therefore, appears to be an iterative synchronous offshoot to the sonniniids from late Hammatocera-tidae, probably *Eudmetoceras*, and could be placed in either family; the Hammatocera-tidae seem preferable to us. This classification appears to be supported by the presence of a more evolute rather deeply umbilicate macroconch, bearing relative straight and prominent ribs, in the *Euhoploceras* concretions (bed 16; pl. 8, fig. 1) which resembles “typical” *Eudmetoceras* in most attributes except for the faint keel.

The genus *Hosoureites* SATO (1958) from the Toarcian (?) and early Aalenian of northeast Japan is known only in poorly preserved specimens of *H. ikianum* (Yokoyama). The genus was tentatively placed in the Grapho-cerataidae (cf. SATO, 1964), but the septal suture is almost unknown. Although there is marked resemblance to *Puchenquia* in the ornament, the coiling of the inner whorls appears to be more involute, the umbilical edge is more strongly developed on the phragmocone, and the keel is probably more prominent.

Puchenquia malarguensis (BURCKHARDT, 1903) ♀ & ♂

(pls. 6—8; text-figs. 4—8)

P. malarguensis ♀:

- (?) 1898. *Harpoceras concavum* SOW. — TORNQUIST, p. 13, pl. I (XIV), fig. 2.
 1900. *Harpoceras* cfr. *opalinoides* CH. MAYER — BURCKHARDT, p. 28, pl. XX, fig. 16, pl. XXIX, fig. 4 [lectotype of “*H.*” *malarguense* here designated.]
 1900. *Harpoceras aalense* ZIETEN — BURCKHARDT, p. 27, pl. XX, fig. 10 only.
 (?) 1900. *Harpoceras Klimakomphalum* VACEK — BURCKHARDT, p. 27, pl. XX, figs. 12?, 13—14, and pl. XXIX, fig. 3?.
 (?) 1903. *Harpoceras Hauthali* BURCKHARDT, p. 16, pl. I, figs. 18—20 [= “*Harpoceras Klimakomphalum*” BURCKHARDT, 1900, pl. XX, fig. 12 and pl. XXIX, fig. 3, redrawn].
 1903. *Harpoceras Malarguense* BURCKHARDT, p. 12, pl. I, figs. 9—10 [BURCKHARDT, 1900, pl. XX, fig. 10, redrawn].
 (?) 1903. *Harpoceras klimakomphalum* VACEK — BURCKHARDT, p. 15, pl. II, figs. 1—3 [BURCKHARDT, 1900, pl. XX, figs. 13—14, redrawn].

P. malarguensis ♂:

1900. *Harpoceras aalense* ZIETEN — BURCKHARDT, p. 27, pl. XX, figs. 9, 11 only; pl. XXIX, figs. 1—2.
 1900. *Harpoceras* aff. *opalinum* REIN. — BURCKHARDT, p. 28, pl. XX, fig. 15.
 1903. *Harpoceras Puchense* BURCKHARDT, p. 13, pl. I, figs. 11—14.
 1903. *Harpoceras striatulum* SOW. — BURCKHARDT, p. 14, pl. I, figs. 21—23.
 1903. *Witchellia argentina* BURCKHARDT, p. 17, pl. I, figs. 15—17 [BURCKHARDT, 1900, pl. XX, fig. 15, redrawn].

Material

Quasi-topotypes from Cerro Puchenque [Cerro Puchén], Mendoza province: 4 incomplete macroconchs of which 2 are large body chamber fragments, and 2 adult microconchs of which 1 is almost complete and 1 fully septate, from bed 6 (MCM J1300); 9—12 macroconchs of which 5 have parts of the crushed body chamber, and 12—15 microconchs, mostly adult and partly with lappets, from bed 14 (MCM J1753); ?4 (+3?) mostly fragmentary large macroconchs from bed 16 (MCM J1748) [aff. *malarguensis*]; (?) 1 large septate macroconch from bed 15 (MCM J1752); the lectotype of “*H.*” *malarguense* (MLP 3387) and 2 almost complete microconchs, including the allotype, probably also from the Hauthal collection (labelled “*Harpoceras aalense*”; MLP 2956a,b); 1 almost complete macroconch (MLP 11576) — (*Concava* ?-) lower Sowerbyi Zone.

Paso del Espinacito, San Juan province: (?) 1 large septate macroconch [the type specimen of “*Harpoceras concavum* SOW.” of TORNQUIST, 1898, p. 13, pl. I (XIV), fig. 2], and 1 crushed large body chamber, also from the BODENBENDER ? collection bearing the same old label (DNGM 332) [cf. *malarguensis*].

Description

The first approximately two whorls (2—3 mm D) are depressed ovate and rather involute. At 4—6 mm diameter, the whorls become subcircular in section. The flanks may bear faint small tubercles but are generally smooth.

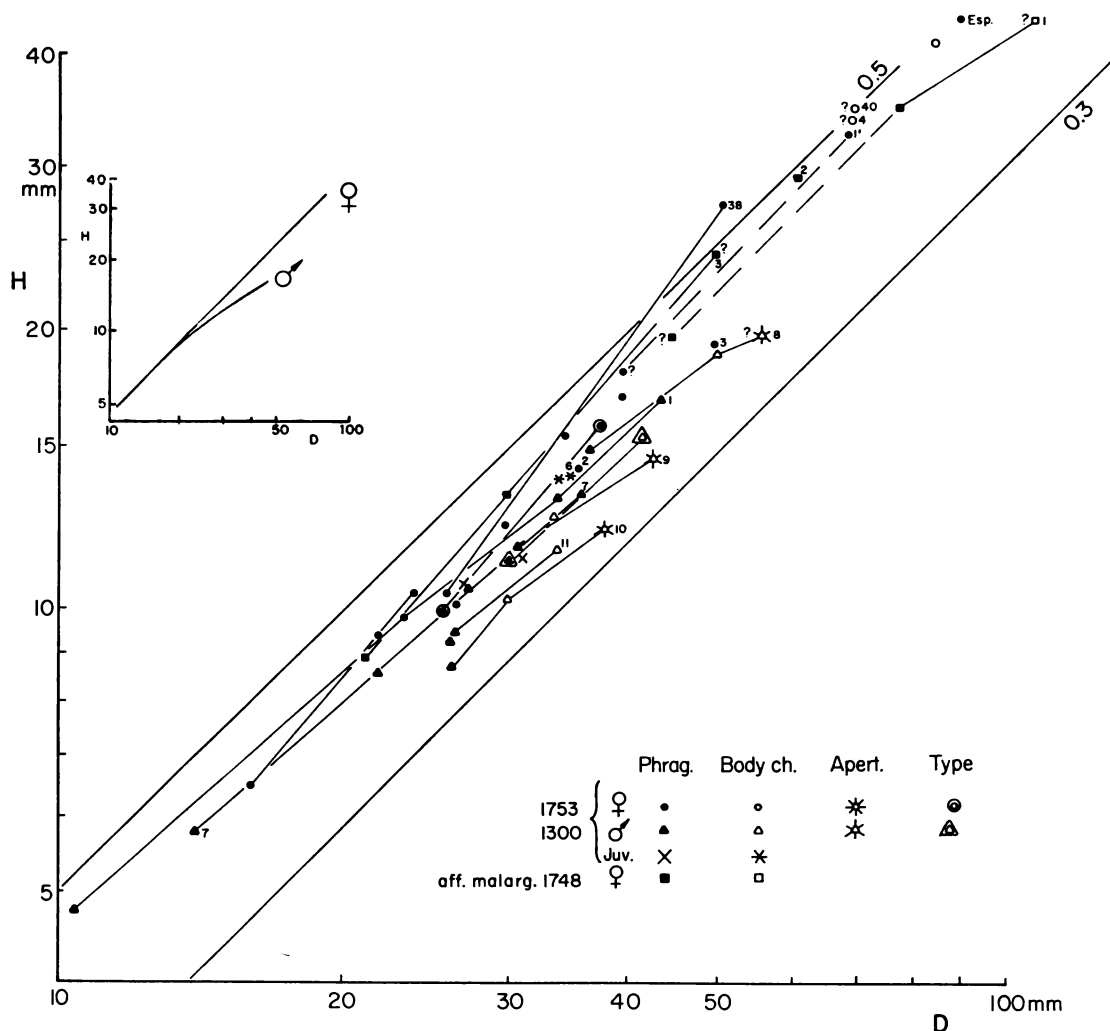
The subsequent whorls become rapidly more evolute and compressed; the whorl section is compressed elliptical, the flanks shallowly dipping to the umbilical seam, while the venter is acutely arched becoming weakly to markedly but bluntly keeled.

At about 10 to 25 mm diameter, i. e. the outer whorls of the microconch phragmocone, the whorls are moderately evolute (U/D = .30 to .35) with shallow subconical umbilicus, compressed subelliptical to slightly subrectangular in section, and bearing a blunt low usually solid keel on a curved venter (no sulci).

The ornament, commencing at several millimeters diameter, consists of weakly falcate to gently falcoid, blunt divided ribs, commonly with faint lateral tuberculation. Frequently, prorsiradiate blunt primaries or plications are borne at varying distance from the umbilical seam usually rising to form blunt bullae or blunt tubercles just below midflank; other specimens (particularly from bed 14) however, have irregularly fasciculate ribs which are more withdrawn from the seam leaving a smooth slope. The secondaries tend to commence radiately by bifurcation and intercalation forming a very obtuse angle with the primaries, unless curving gently to the fasciculations; they project moderately on the ventral shoulders and die out beside the keel leaving smooth keel bands.

The septal suture is moderately complex at this diameter, quite closely resembling that of *Sonninia* (*Euhoplloceras*) *amosi* sp. nov. (text-figs. 7, 15). The E/L saddle is about as broad as high, divided by a subcentral indentation, L is moderately broad and trifid, L/U₂ is approximately one-half the size of E/L, and U₂ one-half the size of L and tending to be slightly oblique; the saddle line then drops markedly along the somewhat suspensive and moderately oblique smaller umbilical elements consisting of two or three additional small lobe elements outside of the seam. The internal suture consists of a relative small I and I/U, saddle, and broadly subdivided umbilical elements, possibly including a divided U₁.

Macroconch (♀) — With increasing size, the shell becomes rapidly more compressed and more involute (text-figs. 4—6). At 30—40 mm diameter, a low but steep to vertical umbilical slope develops which is separated from the flattened flanks by a slightly rounded angle (not yet elevated); the whorl section becomes subrectangular

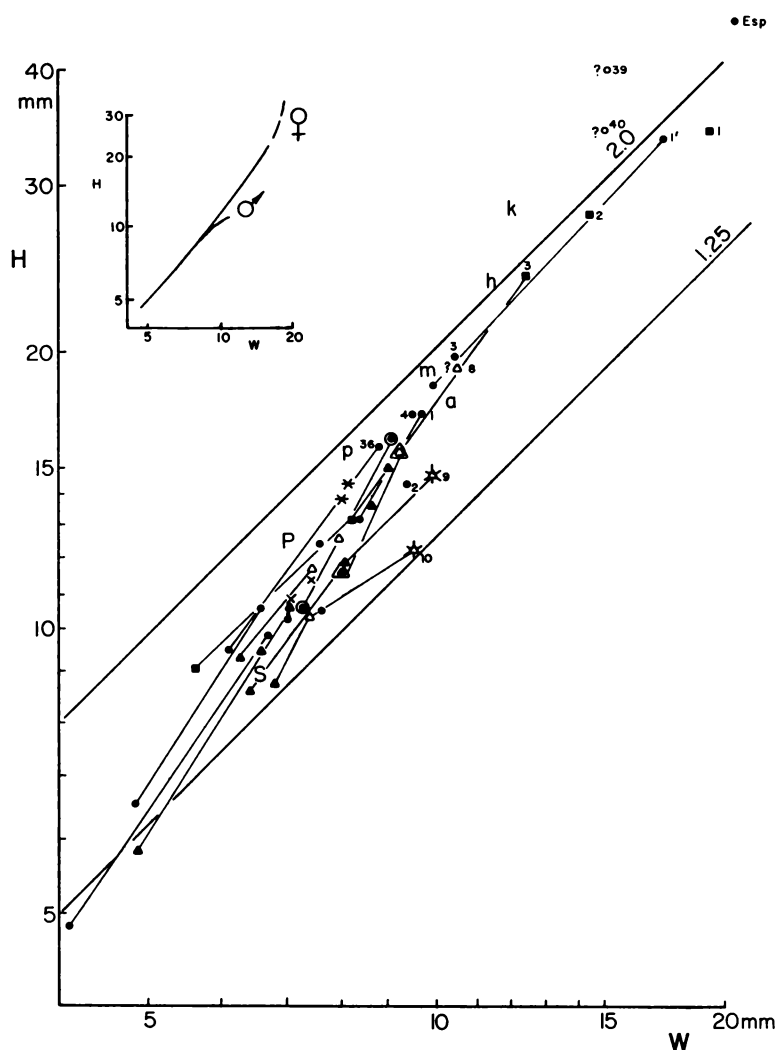


Text-fig. 4. Plot of whorl height (H) against shell diameter (D) for *Puchenquia malarguensis* (BURCKH.) ♀ & ♂, with type specimens, *P.* (?) aff. *malarguensis* and growth lines indicated. (Concava?) lower Sowerbyi Zone, Cerro Puchenque.

with rounded umbilical shoulders. The adult phragmocone, up to 80 mm in diameter, may have slightly concave inner flanks, while the venter becomes more acute. At first, the venter is narrowly rounded bearing a minute solid or barely floored keel, while the internal mould is faintly keeled to nearly fastigate. The largest phragmocone whorls have mostly fastigate internal moulds and faint to weak, apparently solid keels (test preservation).

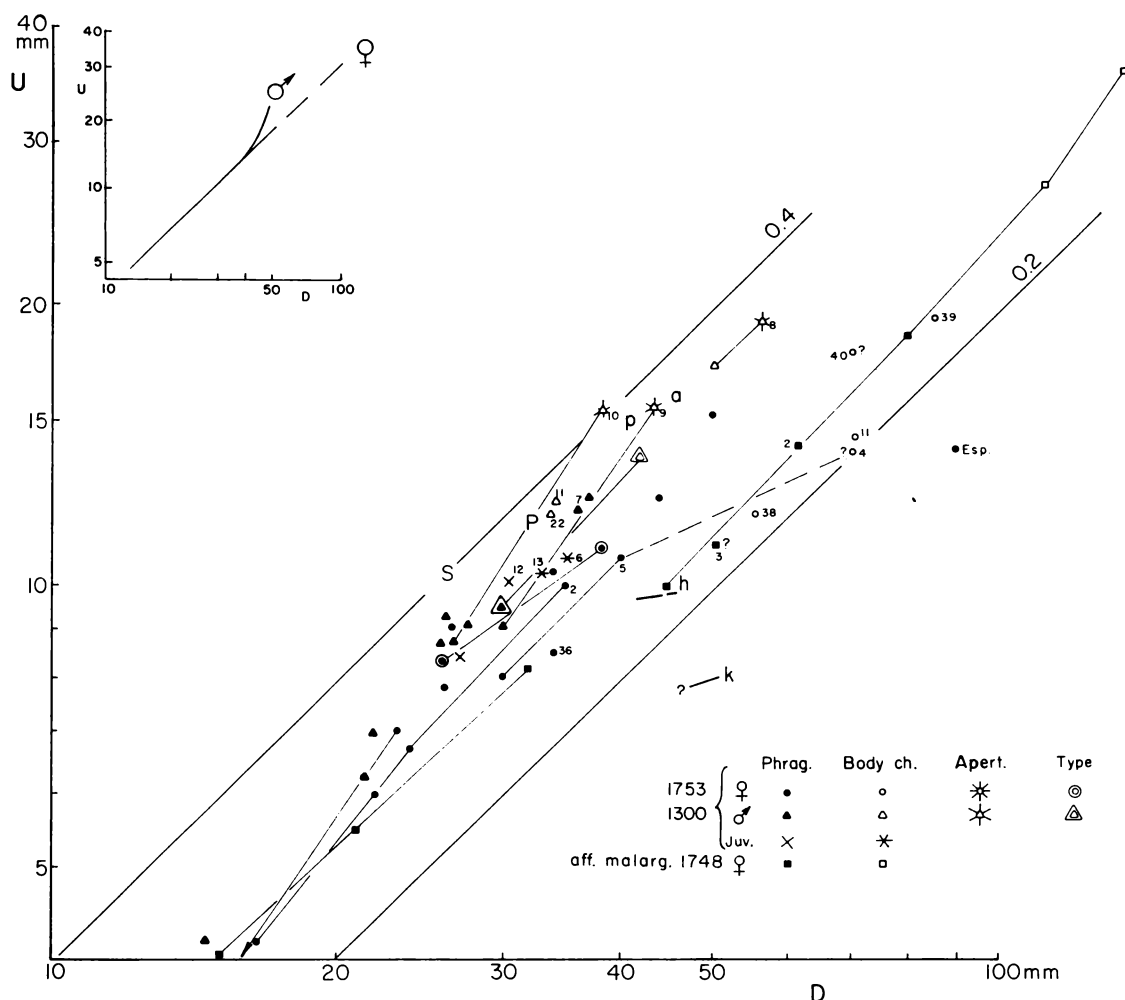
The ornament consists of more or less markedly flexed simple and fasciculate ribs becoming more and more obscure on the inner flank while remaining prominent on the outer flank, particularly on the shoulder. Only rarely are the primaries clearly distinct up to 40 mm diameter, combined with more pronounced mid-lateral bifurcation and falcation. Toward the end of the adult phragmocone, the ornament is usually restricted to widely spaced blunt weakly projected costae or plications on the outer flank.

The adult body chamber, approximately 70—125 mm in diameter, becomes progressively more involute and, probably, compressed. The inner flank tends to be somewhat concave adjacent to the slightly raised umbilical margin. The outer one-third of the flank rounds gently into the narrowly rounded to fastigate venter which bears a minute solid or barely floored keel. While the inner flank is smooth or has obsolescent very blunt and irregular



Text-fig. 5. Plot for whorl section, i. e. whorl height (H) against whorl width (W), for *Puchenquia malarguensis* (BURCKH.) ♀ & ♂, with type specimens of synonymous "species" and *P.* (?) aff. *malarguensis*. (Concava?) lower Sowerbyi Zone, Cerro Puchénque. Symbols as in Text-fig. 4.

Abbreviations for BURCKHARDT'S "species": a, "*Witchellia argentinica*"; h, "*Harpoceras hauthali*"; k, "*H. klimakomphalum* VACEK"; m, "*H. malarguense* (other than lectotype)"; p, "*H. puchense*"; s, "*H. striatulum* Sow.". Also Esp., *Puchenquia* cf. *P. malarguensis* from Paso del Espinacito.



Text-fig. 6. Plot of umbilical width (U) against shell diameter (D) for *Puchenquia malarguensis* (BURCKH.) ♀ & ♂, with type specimens of synonymous "species" and *P. (?)* aff. *malarguensis*. (Concava?) lower Sowerbyi Zone, Cerro Puchenque. Abbreviations as in Text-fig. 5.

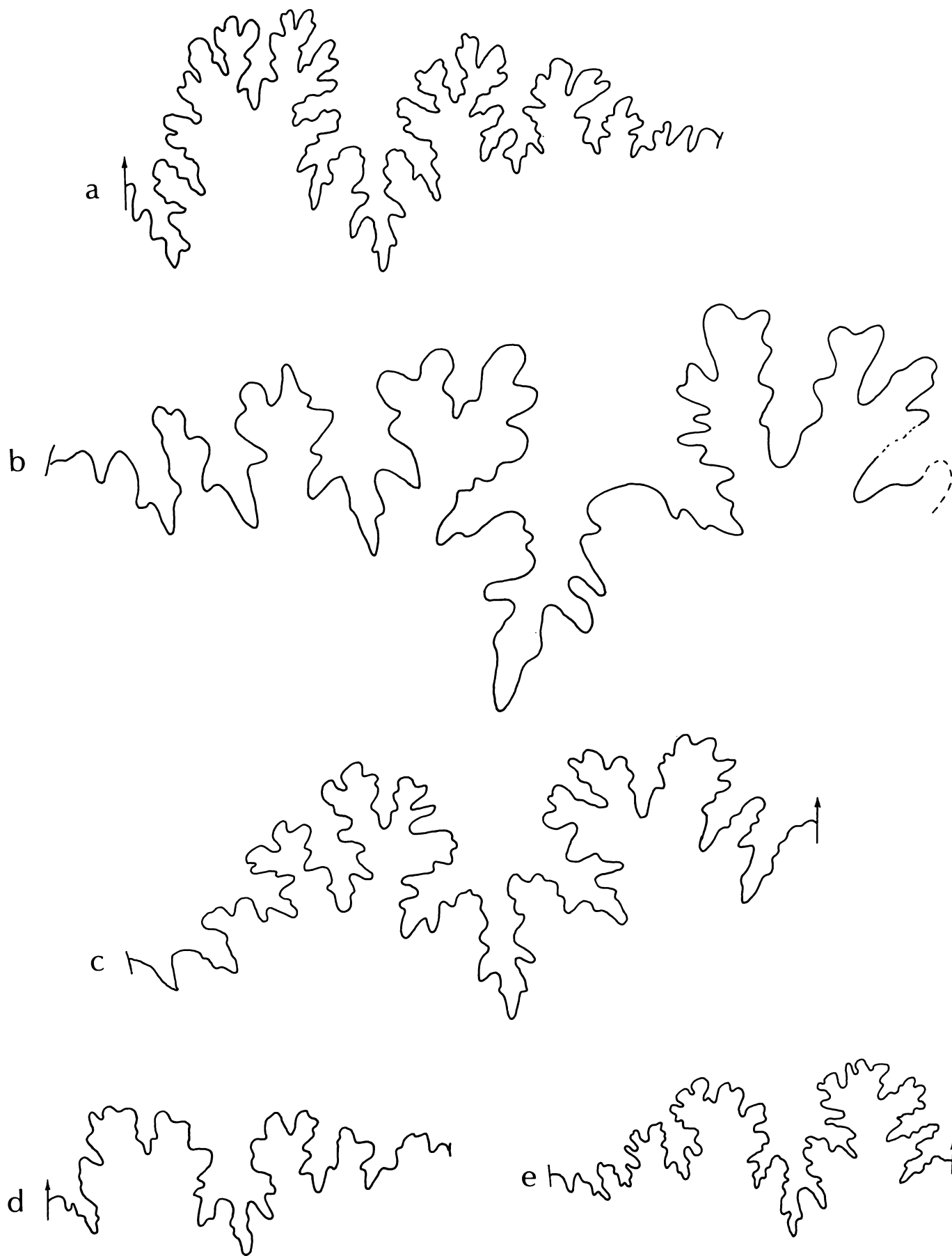
plications, the outer flank bears slightly projected to somewhat rursiradiate blunt ribs or plications which withdraw progressively from mid-flank and may finally become obsolescent. A faint striation is present on the two largest fragments. The aperture appears to be simple with sinuous outline.

The few specimens of *Puchenquia (?)* aff. *malarguensis* ♀ (pl. 8, fig. 1; text-fig. 4—6, 8) from the *Sonninia amosi* bed (16) of Cerro Puchenque are distinguished from modal *P. malarguensis* ♀ by the somewhat more evolute coiling and the more persistent blunt primaries. Although superficially resembling *Eudmetoceras* s. s., the small keel and the septal suture which is only weakly suspensive are attributes of *Puchenquia*. Additional material is required to decide whether this form which is associated with *P. cf. malarguensis* is merely a morphotype (forma), a subspecies, or a taxon distinct from *P. malarguensis*.

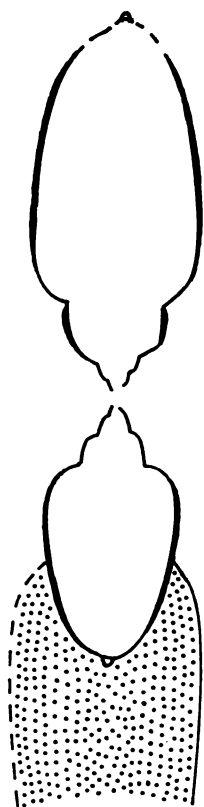
Microconch (♂) — The adult phragmocone ranges from about 20 to 37 mm in diameter, with a mode of approximately 30 mm, and closely matches the inner whorls of the macroconch (text-figs. 4—6).

The body chamber, about three-fifths whorls (~ 220°) in length, uncoils slightly and gradually. The section becomes at first somewhat more compressed, usually by flattening of the flanks resulting in a subrectangular cross

Text-fig. 7. Septal sutures of *Puchenquia malarguensis* (BURCKH.) ♀, (Concava?) lower Sowerbyi Zone, Cerro Puchenque. a, *P. cf. malarguensis* at H = 22 mm (MCM J 1752 : 1); b, the lectotype at H = 13 mm; c, topotype at H = 14 mm (MCM J 1753 : 3); d, at H = 9.4 mm (MCM J 1753 : 1); e, at H = 11 mm (MCM J 1753 : 5).



Text-fig. 7



Text-fig. 8. Cross section through the phragmocone with incomplete body chamber (shaded) of *Puchenquia* (?) aff. *malarguensis* (BURCKH.) ♀. (Concava?) lower Sowerbyi Zone, Cerro Puchenque (MCM J 1748 : 1).

section with ventral shoulders, and finally somewhat inflated at the aperture (text-fig. 5). The flanks continue to reach the umbilical seam with slight curvature without angulation. The umbilicus remains very shallow. The venter is obtusely flattened bearing a feeble keel, but may become somewhat fastigate, before rounding at the aperture, particularly on the internal mould. The complete shell diameter is usually 35—40 mm, but may reach 56 mm.

The ornament of the body chamber resembles that of the phragmocone, tending to become blunt toward the aperture, particularly on the inner flanks and venter. The increasing lateral projection of the growth line preceding the aperture usually also results in renewed lateral flexure of the ribs. The adult aperture bears a thickened margin, marked as a shallow constriction on the internal mould, and small tapering lateral lappets as well as a ventral lappet of apparently similar outline.

Measurements in mm

		D	H	W	U
Lectotype	♀ phrag.	38.0	16.0	9.0	11.0
	phrag.	26.0	10.5	7.2	8.3
Allotype	♂ body ch.	42.0.	15.5	9.2	14.8
	phrag.	30	11.5	7.9	9.6
MCM J 1753 : 1	♀ phrag.	44.0	17.0	9.6	12.5
	phrag.	34.0	13.2	8.3	10.4
	phrag.	23.5	9.9	6.7	7.0
	phrag.	10.5	4.8	4.0	2.2
: 2	♀ body ch.	51	—	—	—
	phrag.	35.0	14.2	9.4	10.0
	phrag.	24.0	10.5	6.5	6.7
: 3	♀ phrag.	16	6.5	4.8	4.0
	♀ phrag.	50.0	19.6	11.0	15.3
	phrag.	26.5	10.2	7.0	9.1

	D	H	W	U
: 4 ♀ body ch.	~ 70	~ 34	—	~ 14
phrag.	~ 41	—	—	~ 11
: 5 ♀ phrag.	40.0	17.0	9.6	10.8
phrag.	30.0	12.4	7.5	8.0
: 6 juv. body ch.	35.0	14.1	~ 8.0	10.8
phrag.	27.0	10.8	7.0	8.5
: 7 ♂ phrag.	36.0	13.5	8.7	12.1
phrag.	27.5	10.6	7.0	9.1
phrag.	14.4	5.8	4.8	4.2
: 8 ♂ body ch. (ap.)	56	~ 20	—	19.5
body ch.	50	19.5	~ 10.5	17.1
phrag.	37	15.0	~ 8.5	12.4
phrag.	22	8.7	6.5	7.0
: 9 ♂ body ch. (ap.)	43	14.8	9.9	15.4
phrag.	30	11.7	7.8	9.2
phrag.	21.5	8.5	6.3	6.3
: 10 ♂ body ch. (~ ap.)	38	12.1	9.5	15.5
body ch.	30	10.3	7.4	—
phrag.	26.5	8.8	6.8	8.8
: 11 ♂ body ch.	34.0	11.6	7.7	12.3
phrag.	26.1	9.5	6.5	9.3
: 12 juv. phrag.	30.2	11.5	7.3	10.1
: 13 juv. body ch.	33.9	14.0	7.8	10.2
MCM J 1752 : 1 ♀ phrag.	69.5	33.5	17.3	14.7
phrag.	~ 40	18.0	10.0	9.6
MCM J 1300 : 36 ♀ phrag.	34.5	15.5	8.7	8.5
phrag.	22	9.4	6.0	6.0
: 38 ♀ phrag.	55.5	27.6	(~ 13)	12.0
phrag.	26	10.5	7.5	7.9
: 39 ♀ body ch.	85	40.2	~ 15	19.6
: 40 ♀ body ch.	~ 70	34	~ 15	(~ 18)
: 22 ♂ body ch.	33.5	12.5	~ 7.8	12.0
phrag.	26.1	9.3	6.2	8.7
<i>aff. P. malarguensis</i>				
MCM J 1748 : 1 ♀ body ch. (ap.)	~ 130	—	—	37.5
body ch.	108	~ 44	—	27
phrag.	78	35.0	19.5	18.5
phrag.	~ 45	19.9	—	10.0
<i>cf. P. malarguensis</i>				
: 2 ♀ phrag.	61	29	14.5	14.2
: 3 ♀ phrag.	~ 50	24.4	12.5	11.1
phrag.	32	13.5	8.2	8.1
phrag.	21	9.0	5.7	5.5
phrag.	15	—	—	4
"Harpoceras concavum" of TORNQUIST, 1898				
GAUG 496—1 ♀ phrag.	~ 90	45.5	21.0	14.0

Discussion

The lectotype (pl. 6, fig. 1) — The fully septate macroconchiate (♀) cotype which was photographically illustrated by BURCKHARDT in 1900 (pl. XX, fig. 16) and which appears to be the only surviving type specimen of the entire "*Harpoceras*" assemblage, is here designated as the lectotype. Regrettably, all type specimens illustrated in drawings by BURCKHARDT in 1903 (pl. I, figs. 9—23 and pl. II, figs. 1—2) when he redescribed and named the species of this assemblage, cannot be found. Some of them were in the collections of the Bayrische Staatssammlung für Geologie und Paläontologie in Munich, Germany, and were destroyed (Dr. W. Barthel, in litt.). The lectotype, the only original specimen not refigured in 1903, has been preserved in the collections of the Museo in La Plata (MLP 3387) and is here refigured (pl. 6, figs. 1 a—b, text-fig. 7 b).

BURCKHARDT (1903, p. 12) described "*Harpoceras Malarguense* n. sp." without designation of a holotype, including in the synonymy "*Harpoceras aalense*" part. (fig. 10 only) as well as "*Harpoceras* cfr. *opalinoides*" of his 1900 work. While the first, slightly more evolute form (? based on a single specimen: 1900, fig. 10) served for most of the species description, the second was said to be present with several specimens and considered to be "... the same form or at least very close ..." [from German]. The supposed differences in the dimensions, however, can be substantiated only for the coiling of the last whorl ($U/D = 0.30$ vs. 0.27), while the whorl sections seem to be identical ($H/W \approx 1.85$). Furthermore, both syntypes (the first measured on the photographic illustration) have identical coiling ($U/D \approx 0.35$) of the inner whorls ($D \approx 34$ mm), and the "*H. aalense*" type specimen (1900, fig. 10) appears to be a rare evolute and prominently ribbed macroconchiate variant not represented in our collection from the type area.

The allotype (pl. 7, fig. 3) — The corresponding microconch (δ) to *P. malarguensis* ♀ is "*Harpoceras Puchense*" BURCKHARDT, 1903. After placing in the synonymy two microconchs figured in 1900 (plate XX, figs. 9, 11) under "*Harpoceras aalense*" (part.), BURCKHARDT now figured a third specimen, again without designating the holotype. All syntypes appear to be lost. A nearly complete topotype (MLP 2956b) from what appears to be the Hauthal collection has therefore been designated as the allotype of *P. malarguensis* ♂ (or the neotype of *P. puchensis* ♂).

Other "species" from Hauthal's locality 7 — As has been indicated above and is quite evident from our collections particularly from beds 6 and 14 of Cerro Puchenque, "*Harpoceras Puchense*" is the microconch (δ) of *P. malarguensis* ♀ as here defined.

"*Witchellia*" *argentina* BURCKHARDT, 1903, is almost certainly another, exceptionally large-sized microconchiate morphotype of *P. malarguensis*, characterized by mainly fasciculate ribbing; "*Harpoceras striatulum* SOW." of BURCKHARDT (1903) is a small microconchiate variant of the same species. Both forms are present in our collection from bed 14 (pl. 7, figs. 5, 7) and associated with modal *P. malarguensis* ♂ (+ ♀).

Somewhat dubious is the systematic position of "*Harpoceras*" *hauthali* and "*Harpoceras klimakomphalum* VACEK" of BURCKHARDT (1903) which were originally (BURCKHARDT, 1900) considered conspecific. "*H.*" *hauthali* was based on a single specimen, the holotype, which at first was photographically illustrated (1900, pl. XX, fig. 12) and then drawn (1903, pl. I, figs. 18, 20 and septal suture fig. 19) apparently after it was further developed from the matrix. This specimen also appears to be lost. The restricted "*H. klimakomphalum*" (BURCKHARDT, 1900, pl. XX, figs. 13—14; 1903, pl. II, figs. 1—3) has up to recently been regarded as correctly identified (p. 38). However, the irregular flexed ribbing and the minute keel of this specimen strongly indicate to us that it is a mere variant of the slightly more evolute and more prominently ribbed "*H.*" *hauthali*. The considerable discord between BURCKHARDT's measurements and figures of the holotype of "*H.*" *hauthali* is of some importance; the 1903 data accord more closely to the 1900 lateral photograph, while the 1903 drawing shows the umbilicus too small, particularly of the inner whorls. However, our own collections from the quasi-type locality include only a single specimen as involute as BURCKHARDT's "*H.*" *hauthali* and "*H.*" *klimakomphalum* and none as ornate as "*H.*" *hauthali*. It is therefore possible but not very probable that "*H.*" *hauthali* (including "*H. klimakomphalum*") is a distinct species or a chronological subspecies of *P. malarguensis*.

Comparison — There is good but superficial resemblance between the mature macroconchs of *Puchenquia* and the Eurasian *Graphoceras*, an approximate contemporary. Thus, the involute weakly ornate *Puchenquia* cf. *malarguensis* ♀ from Paso del Espinacito was identified with *Graphoceras concavum* (SOW.) by TORNQVIST (1898); from the illustration and description which excluded the septal suture, even ammonite authorities (ARKELL, 1956, p. 585; RIEBER, in litt.) have been unable to refute this identification. The specimen is here refigured (pl. 7, fig. 10) after development from the matrix and preparation of the complex suture which resembles that of involute *Eudmetoceras* (*Euaptetoceras*) ex gr. *klimakomphalum* (VACEK). *Eudmetoceras*, including *E. gertzi* (JAWORSKI), is distinguished in the prominent high keel and in the longer and much more prominent primaries. The somewhat complex and somewhat suspensive suture (besides other morphologic attributes) also clearly distinguishes the microconch from the Hildoceratidae, including *Pleydellia*.

Age of *Puchenquia* — At the quasi-type locality Cerro Puchenque, *P. malarguensis* and related forms described herein, lie together with and superjacent to the main occurrence of *Sonninia* (*Euhoploceras*) *amosi* sp. nov.; they underlie beds with *Sonninia* cf. *zitteli* and, slightly higher, *Pseudotoites* cf. *singularis* (GOTTSCHÉ),

Sonninia mirabilis TORNQUIST, *S. cf. peruana*, and *Bradfordia cf. costidensa* IMLAY. This clearly indicates the lower Sowerbyi Zone (~ Discites Subzone) for the *Puchenquia* assemblage; the position of the Aalenian/Bajocian boundary, i. e. the base of Discites Subzone, however, is difficult to define accurately in the absence of Graphoceratidae, since *S. (Euhoploceras)* in Europe may or may not range downward into the Concava Zone, largely as a consequence of the different definitions of the stage boundary. All other occurrences are stratigraphically and/or taxonomically poorly known, such as the recent record of "*Eudmetoceras puchense*" and "*E. malarguense*" from the supposed Murchisonae Zone of Paso del Espinacito (? and other localities) by HILLEBRANDT (1970, p. 187 and Table 2). Even if the identifications should be correct, the age assignment appears doubtful because of the recorded association with *Eudmetoceras eudmetum jaworskii* WESTERMANN.

Family Sonniniidae BUCKMAN, 1892

Genus *Sonninia* BAYLE, 1879

Type-species — *Waagenia propinquans* BAYLE, 1878.

Discussion

The nomenclatural and taxonomic confusion surrounding the type species and its improperly designated type specimen from four syntypes has recently been reviewed by HUF (1968, p. 26). HUF concluded that, although contradicting the Rules, the original to BAYLE's figure 1, not figures 3—4 as reproduced by ROMAN (1938, pl. XII, figs. 126, 126 a) and ARKELL et al. (1957, in Treatise, p. L 268, fig. 310), was the "preferred" type specimen. The fact that ROMAN (p. 139) designated BAYLE's figure 1 as the lectotype rather than BAYLE's figures 3—4 which he reproduced and called "type" in the plate explanation, is regarded by us as a typographical error. The specimen figured by ROMAN is therefore the lectotype. However all specimens appear to be lost and no decision in this matter should be taken without complete reinvestigation of the type material or topotypes. Since different syntypes were transferred to *S. sowerbyi* (MILLER) and *S. patella* (WAAGEN), related to the contradictory designations of type specimens (HUF, loc. cit.), all subsequent literature pertaining to *S. propinquans* is to be treated with the utmost care.

The taxonomic confusion is further enhanced by the poor knowledge of *S. sowerbyi* (MILLER, in SOWERBY, 1818; refigured by BUCKMAN, 1908, text-fig. to plate III) which is an inner whorl of an unknown macroconch, possibly belonging to the subgenus *Papilliceras* and probably coming from the Sauzei Zone. The only significant difference from the type specimen of *S. propinquans* appears to be the stronger compressed whorl section with highly arched venter; however, the subcircular whorl section of *S. propinquans* appears to be restricted to the inner whorls. Thus, there is a real possibility that the two forms are conspecific; they are certainly closely affiliated.

Subgenus *Sonninia* BAYLE, 1879

Sonninia (Sonninia) mirabilis TORNQUIST, 1898

(pl. 9, figs. 2—3)

1898. *Sonninia mirabilis* TORNQUIST, p. 23 (155), pl. IV (XVII), fig. 2.

Material

Cerro Puchenque, Mendoza province: 1 incomplete phragmocone, internal mould with test remains, from bed 12 (MCM J 1747: 12) — Sowerbyi Zone.

The holotype is from Paso del Espinacito.

Description

The phragmocone whorls are openly coiled throughout the preserved shells. The inner whorls are subcircular in section with evenly rounded venter bearing a narrow high floored keel; the ultimate phragmocone whorl, commencing at 25—35 mm diameter, becomes increasingly although only moderately compressed-elliptical with arching venter and keel. The ornament consists of widely spaced blunt primaries ending in prominent lateral tubercles or spines set slightly above mid-flank, and rather dense blunt, strongly projected secondaries. A few

weak ribs may be intercalated. The septal suture is moderately complex with straight radial saddle envelope, large vertical U_2 and very small high-set sutural elements ($U_3 + ?$).

Holotype — The species was based on a single specimen, the holotype (monotypy). The specimen is here refigured (pl. 9, figs. 2 a—b) from both sides after the right umbilicus has been developed from the matrix (permission of the curator). The completely septate internal mould with some test remains is partly crushed on the originally figured left side but apparently undistorted on the right. The correct measurements are given below, although the whorl width could be slightly reduced by crushing. Ventral sulci or tabulations are absent. TORNQUIST's description of "lateral furrows" refers to the lateral undercutting of the keel.

Measurements in mm

		D	H	W	U	H/W
Holotype	(♀) phrag.	77	28	17.2	30	1.63
	phrag.	40	14.5	11.8	15.2	1.23
MCM J 1747 : 12	phrag.	55	20.6	16.7	20.5	1.25
	phrag.	26.7	10.0	9.5	9.4	1.05

Discussion

Sonninia (Euhoploceras) "gibbera" BUCKMAN [= *S. (E.) adicra* (WAAGEN)] which TORNQUIST believed to be closely related to *S. mirabilis*, is distinguished in the subquadrate whorl section, the weakly projected costae and the blunt keel. *S. mirabilis* closely resembles *S. sowerbyi* (MILLER) as indicated by TORNQUIST (1898, p. 23), DORN (1935, p. 26), HILTERMANN (1939, p. 140), and ARKELL (in ARKELL & PLAYFORD, 1954, p. 591), and could indeed be conspecific as tentatively assumed by HILTERMANN (loc. cit.). The only difference appears to be in the coiling which is more evolute than in *S. sowerbyi* as usually understood.

The small specimen (D = 18 mm) described by GOTTSCHKE (1878, p. 11, pl. II, fig. 2) from Espinacito Pass under "*Harpoceras* aff. *Sowerbyi* MILL." seems indeed to be closely affiliated with *S. sowerbyi*, but is too small for specific identification. The examination of new photographs of what appears to be the original specimen (one of three specimens in the Stelzner collection), however, indicate that the illustration was strongly idealized (if the specimen is indeed the original).

"*Sonninia* aff. *sowerbyi*" of BURCKHARDT (1900, p. 30, pl. 22, fig. 8 and pl. 29, fig. 5; refigured under "*S. cfr. propinquans*" by BURCKHARDT, 1903, p. 28, pl. 2, figs. 12, 13) was based on a strongly crushed small whorl fragment from Villagra, near the border of central Chile with Mendoza, and cannot be identified generically.

Sonninia (Sonninia?) alsatica (HAUG, 1885) ♀ & ♂
(pl. 10, figs. 1—7; text-figs. 9—11)

1858. *Ammonites Tessonianus* D'ORBIGNY — QUENSTEDT, p. 294, pl. 53, fig. 9 [holotype, here refigured on text-fig. 9].

1885. *Harpoceras Alsaticum* HAUG, p. 677 [for above].

1886. *Ammonites Tessonianus falcatus* QUENSTEDT, p. 508, pl. 63, fig. 10 [same specimen as QUENSTEDT, 1858, pl. 53, fig. 9], ?11, non 9.

1893. *Sonninia alsatica* HAUG, p. 288, pl. X, fig. 1 [same specimen as HAUG, 1885, p. 677].

1925. *Sonnites alsaticus* HAUG — BUCKMAN, pl. DXXXVIII A.

Material

Paso del Espinacito, San Juan province: 1 rather poorly preserved incomplete internal mould from the Bodenbender collection (GAUG 22 [51]).

Charahuilla, Neuquén province: 1 well preserved septate macroconch with 1/4 whorl body chamber (MLP 7016); 1 septate macroconch from bed 1c (MCM J 1320 : 36).

Chacaico, Neuquén province: 1 small (juvenile? or microconch) good specimen with incomplete body chamber (MLP 8640); 3 to 5 moderately preserved incomplete macroconchs and ?1 microconch from bed 1 (MCM J 1323).

Los Molles and Arroyo Picún Leufú, Neuquén province: 1 good large septate macroconch, 1 incomplete juvenile? macroconch, 1 complete and 1 (+ ?) incomplete microconchs from bed 11b (MCM J 1315); (?) fragments from loc. 10 (MCM J 1338).

Sierra de Reyes, Mendoza province: 1 fragmentary macroconch (MBR 15014a).

Arroyo La Manga, Mendoza province: 1 incomplete damaged phragmocone from bed 1 (MCM J 1749 : 2).

Arroyo Blanco, Mendoza province: 1 (?) large macroconch [*S. cf. S. alsatica*] from bed 10 (MCM J 1746).

All dated specimens are from the (upper ?) Sauzei Zone (? to lower Humphriesianum Zone).

Description

The shell is planulate throughout, with loosely coiled almost serpenticonic whorls which vary in section from rounded subquadrate to moderately compressed rounded subrectangular. The umbilical wall is always steep,

sometimes vertical, and separated from the flanks by a slightly rounded edge. The broad venter bears a very prominent floored keel. The venter of the inner and intermediate whorls is usually tabulate and sometimes bisulcate on the internal mould. The ornament consists of prominent rectiradiate to weakly rursiradiate ribs which project on the shoulders and are most prominent at mid-flank. There is much variation from rather dense mostly single ribs to more distant extremely prominent ribs often fasciculating in pairs. The inner or intermediate whorls may bear lateral tubercles. As usual (WESTERMANN, 1966), the most highly ornate shells are also most strongly inflated.

The phragmocone of the macroconch (♀) reaches a diameter of 90 to 100 mm. Most macroconchs, however, are smaller, incomplete and probably not fully grown (no clear septal approximation). The septal suture is simple with a graded series of major elements along a straight saddle envelope, including a moderately broad lateral lobe (L), and two or three vertical to very weakly oblique umbilical lobes.

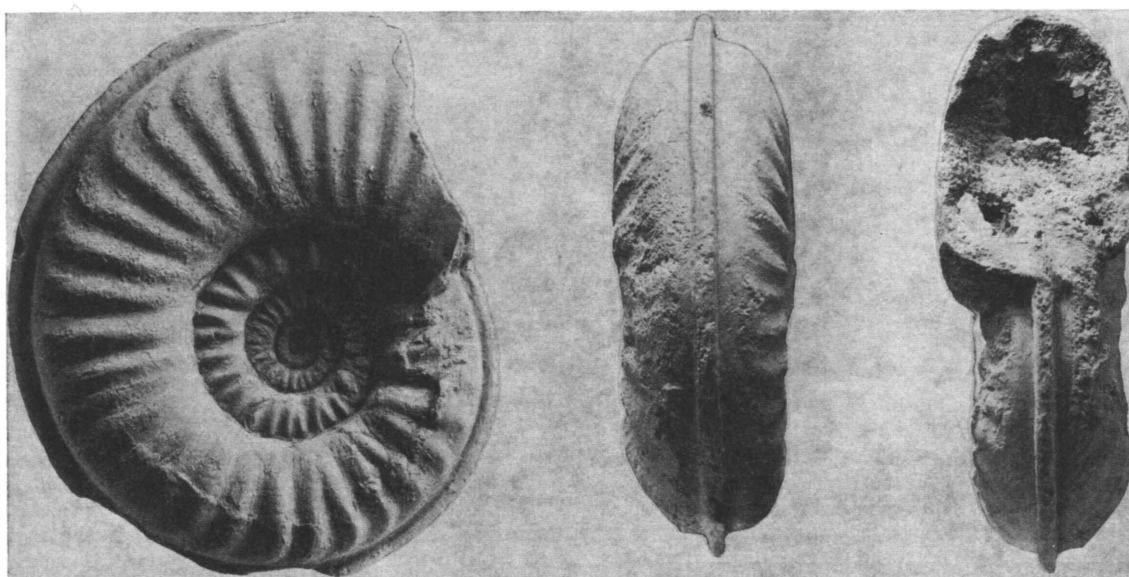
Among the several probable microconchs (♂) is one complete specimen of 35 mm diameter with 5/8 whorls body chamber bearing incomplete lateral lappets (pl. 10, fig. 3). It closely resembles the macroconchs in proportions and ornamentation. The illustrated incomplete specimen (pl. 10, fig. 2) may be a juvenile macroconch since the last septa are not approximated.

Measurements in mm

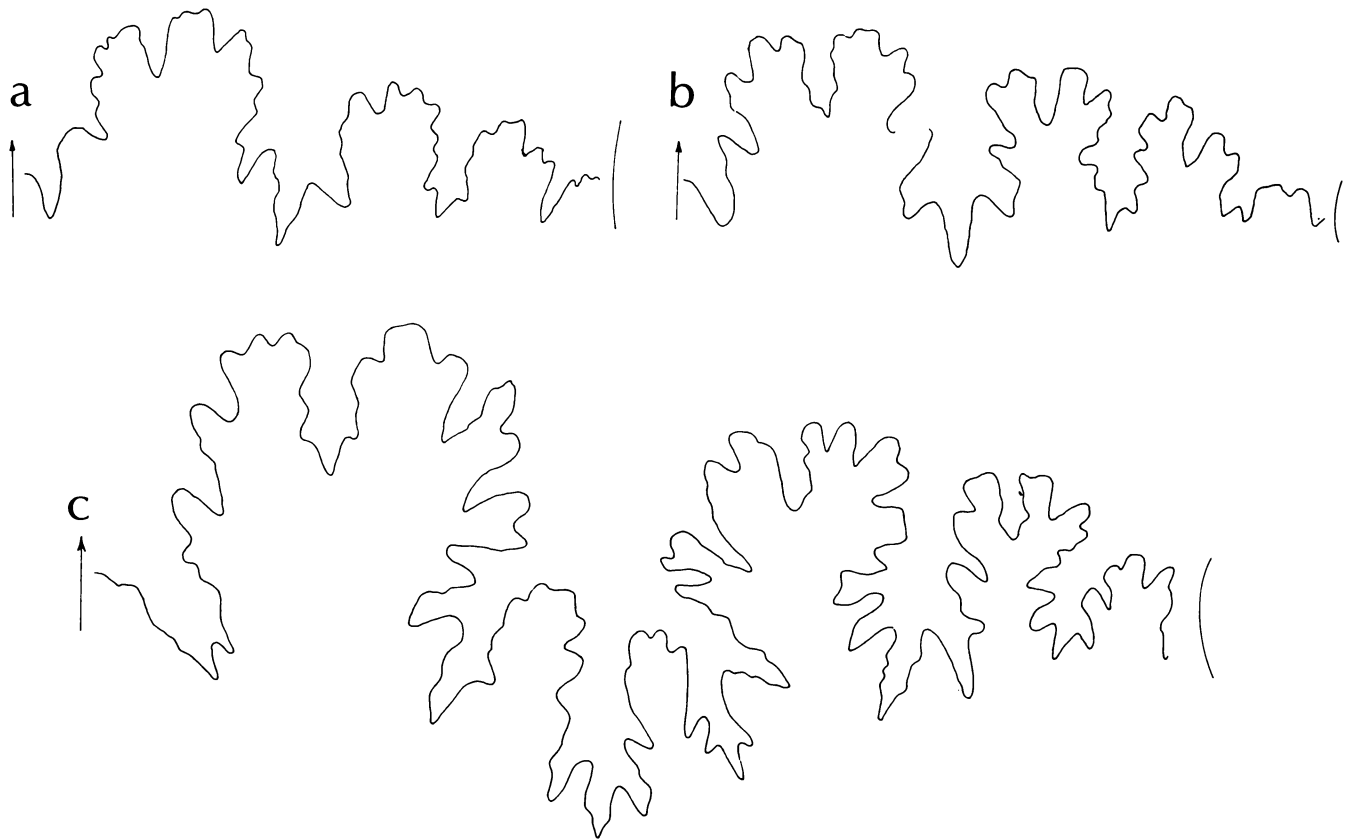
		D	H	W	U
MCM J 1315 : 3	♀ (end) phrag.	90	31.5	26	36
		63	22	19.5	24
MCM J 1315 : 4	body ch.	39	15.5	12.5	15
MCM J 1315 : 5	♂ aperture	35	11.5	8.5	14.6
	body ch.	26	9	6.8	10.2
MLP 7016	♀ phrag.	51	18.5	14.5	20
	phrag.	29	10.2	9.5	11.2
MLP 8640	(♂) body ch.	37	12	9.3	13.2
	phrag.	27	10.4	8.5	9
MCM J 1320 : 36	(♀) body ch.	51	17.5	14	21.5
	phrag.	38	12.5	11	16.2

Discussion

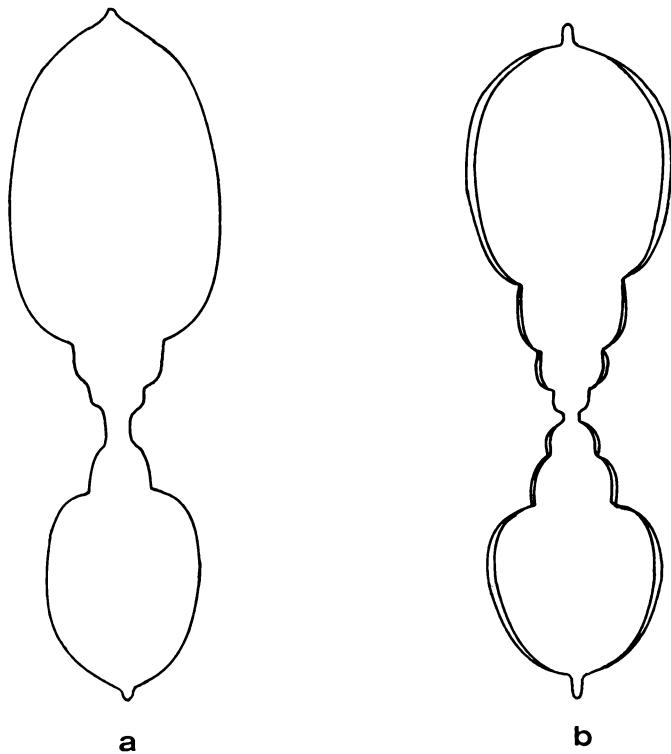
The holotype of *S. alsatica* (text-fig. 9) is clearly distinct from the lectotype of *S. propinquans* (see above) in the whorl section and ornament. The former has a steep separated umbilical slope and no lateral tubercles; the ribs are fasciculate on the nucleus becoming simple, prominent rectiradiate, and weakly projected on the outer



Text-fig. 9. Holotype of *Sonninia alsatica* (HAUG) from S. W. Germany, lateral and ventral views, X 1 (photographs by Wetzell, Tübingen).



Text-fig. 10. Septal sutures of *S. (S.?) alsatica* (HAUG); a, at D = 37.6 mm and H = 13 mm, Charahuilla (MCM J 1320 : 36); b, at D = 42.7 mm and H = 15.6 mm, Charahuilla (MLP 7016); c, at D = 66.1 and H = 29 mm, Los Molles (MCM J 1315 : 3). Sauzei Zone.



Text-fig. 11. Cross section through the phragmocone of a, *Sonninia (Sonninia) ovalis* (QUENST.), Charahuilla (MCM J 1320 : 27), and b, *S. (S.?) alsatica* (HAUG), Los Molles (MCM J 1315 : 3). Sauzei Zone, X 1.

whorls. The inclusion of *S. alsatica* in *S. propinquans*, as a subspecies (HILTERMANN, 1939, p. 160) or subjective synonym (OECHSLE, 1958, p. 113), resulted from the erroneous opinion regarding the lectotype designation of *S. propinquans*. The holotype of *S. alsatica*, here for the first time reproduced photographically (text-fig. 9), was said to come from the “Brauner Jura γ ” [= Sowerbyi — Sauzei Zones] of Spaichingen, Württemberg. Dr. Wiedmann informed us (in litt.) that the preservation indicates either the “Sowerbyi-Oolith” (Sowerbyi Zone) or the “unteres δ ” (lower Humphriesianum Zone).

HAUG’s specimen (1885, p. 677 and 1893, pl. X, fig. 1) was taken from the old Engelhardt collection of the Strasbourg Museum and labelled “*S. humphriesianum* zone de Mietesheim, Alsace”; this unit originally included the Sauzei Zone (WESTERMANN, 1967 b, p. 143). HAUG’s later statement (1893, p. 288) that the specimen originated in the “*Witchellia Romani* zone” is therefore conjectural. BUCKMAN’s specimen, which perfectly matches the holotype, came from the “Brown ironshot” of the Clatcombe quarry, near Sherborne, Dorset, “*alsaticus hemera*”. According to BUCKMAN’s earlier description (1893, p. 497—499) and RICHARDSON (1932, p. 77—78), the “iron-shot” comprises approximately 0.25 m Sauzei Zone and 0.55 m Humphriesianum Zone.

Sonninia (Sonninia) ovalis (QUENSTEDT, 1886) ♀

(pl. 8, fig. 3; pl. 9, fig. 1; text-figs. 11a, 12)

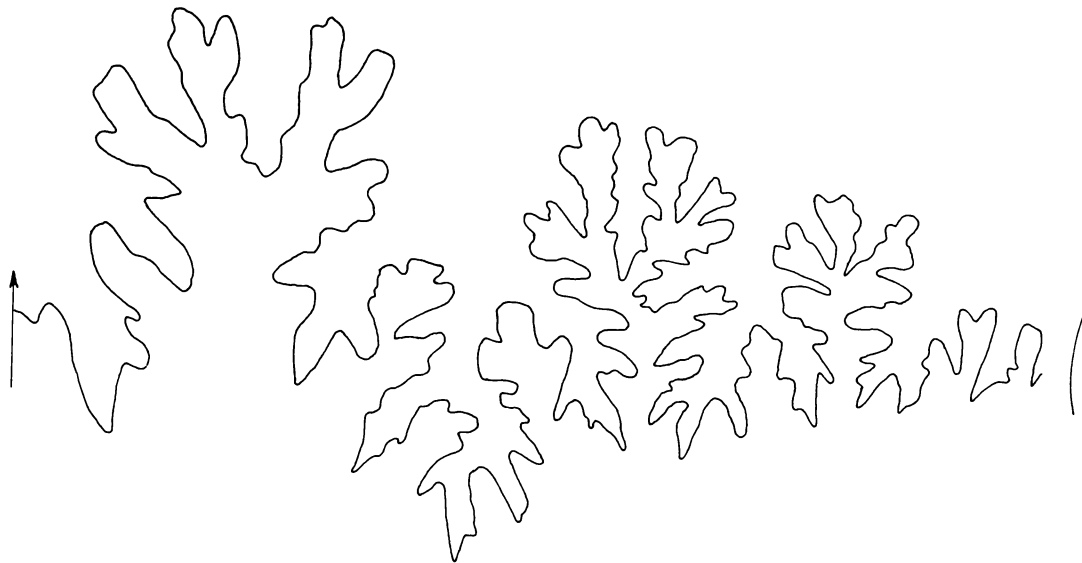
1886. *Ammonites Sowerbyi ovalis* QUENSTEDT, p. 496, pl. 62, fig. 1.

1958. *Sonninia ovalis* OECHSLE, p. 92, pl. 16, fig. 2; pl. 17, figs. 1, 2; pl. 19, fig. 1; pl. 20, fig. 14. [See list of synonyms therein.]

Material

Charahuilla, Neuquén province: 1 completely septate internal mould with test remains, from bed 1c₁ (MCM J1320:27) — Sauzei Zone.

Paso del Espinacito, San Juan province: 1 large septate internal mould (photograph), collected by A. v. HILLEBRANDT from the “Schicht mit *S. argentinica*”, subjacent to *P. singularis* beds (TUB) — Sowerbyi Zone.



Text-fig. 12. Septal suture of *Sonninia (Sonninia) ovalis* (QUENST.) at D = 60 mm and H = 28 mm, Sauzei Zone, Charahuilla (MCM J1320:27).

Description

The outer whorls are rather tightly coiled, overlapping three-fifths of the preceding whorls, and compressed elliptical in section, finally becoming ovate. The umbilicus of the inner and intermediate whorls is subconical with shallow umbilical slope; on the outer whorl the umbilical slope steepens and a faint angle develops. The venter is rounded on the internal mould and slightly acute on the test bearing a moderately prominent floored keel (with conellae).

The ornament of the small (D = 93 mm) phragmocone from Charahuilla, probably belonging to this species, consists of blunt somewhat flexed and projected fasciculate costae which become obsolete on the ultimate half-whorl. The large phragmocone (D = 150 mm) from Espinacito Pass bears prominent lateral tubercles on the inner whorls, irregular bullae or bullae-like fasciculations on the penultimate whorl and very blunt distant plications on the ultimate whorl.

The complicated septal suture closely resembles that of the *Sonninia* subgenus *Fissilobicerias* described below (text-figs. 22—24).

Measurements in mm

	D	H	W	U
MCM J1320:27 phrag.	93	45	28	22
phrag.	65	28.5	20.5	16.5
TUB phrag.	150	64.8	37	39

Discussion

The species was thoroughly reexamined by OECHSLE (1958) who concluded that *S. ovalis* appears to be almost entirely restricted to the Sowerbyi Zone of southern Germany. *S. ovalis* combines the shallow umbilical slope of the subgenus *Shirbuirnia* BUCKMAN with the complex septal suture of the subgenus *Fissilobicerias* BUCKMAN (but the single specimen of "*Fissilobicerias*" *gliberti* MAUBEUGE, 1951, from northeastern France which was included in *S. ovalis* by OECHSLE was said to have a "relatively simple" septal suture) and is therefore morphologically intermediate (see introduction to subgenus *Fissilobicerias*). However, it differs from both in the elliptical section of the inner whorls becoming ovate (with converging flanks) only with the outer whorls, i. e. an umbilical margin is absent and the venter is more broadly rounded.

Subgenus *Euhoploceras* BUCKMAN, 1913

Type-species by original designation — *Sonninia acanthodes* BUCKMAN, 1889 (mature stage first figured in 1892), from the (?Concava +) lower part of Sowerbyi Zone, England [= *S. adicra* (WAAGEN)].

Discussion

The subgenus was discussed extensively by WESTERMANN (1966) who placed all European species names attributed to this subgenus in the synonymy with *S. (E.) adicra* (WAAGEN) and merely distinguished several morphotypes as forma modesta, forma dominans, and forma or variety crassispinata. The species varies greatly, from compressed involute forms with obsolete ornament to inflated evolute and highly ornate forms. This mode of infraspecific variation is widely distributed giving rise to the (1st) BUCKMAN Law of Covariation (op. cit.). It was recently established also for *S. (E.) bifurcata* WESTERMANN (1969, p. 96), a close relative of *S. (E.) adicra* from the Sowerbyi Zone (? + Sauzei Zone) of south Alaska. Poorly preserved *S. (Euhoploceras)* were also described from Alberta under "*Schloenbachia gracilis*" WHITEAVES (1889), from California under "*Stiphromorphites schucherti*" CRICKMAY (1933), and are known from the basal Bajocian of Oregon (LUPHER, 1941). The only known occurrence from the western Pacific area is *S. (E.) playfordi* ARKELL (in ARKELL and PLAYFORD, 1954) which was based in three fragments from Western Australia where it was associated with the *Fontannesia-Pseudotoites* assemblage indicating the Sowerbyi Zone.

Sonninia (Euhoploceras) cf. adicra (WAAGEN, 1867), forma/var. crassispinata BUCKMAN, 1892
(pl. 11, figs. 1—2)

(For synonymy see WESTERMANN, 1966)

Material

Paso del Espinacito, San Juan province: 3 incomplete specimens of intermediate size and modest preservation (photographs), collected by A. v. HILLEBRANDT from "Schicht mit *S. argentinica*" (TUB 680106/13) — Sowerbyi Zone.

Description

All three shells have subcircular and widely umbilicate whorls with weakly convex venter and moderately strong blunt keel. The ornament up to 40—50 mm diameter consists of blunt ribs bearing very prominent lateral

tubercles; the smallest specimen (D = 40 mm) has rather dense, projected blunt secondaries gradually dying out beside the keel. The outer whorls of the two larger specimens bear simple rectiradiate costae which are irregular and rather dense on the medium-size specimen (D = 65 mm) and distant with bullae-like tubercles on the body chamber of the largest specimen (D = 86.8 mm).

Measurements in mm

	D	H	W	U
TUB 680106/2	40	14.8	13.7	14.5
TUB 680106/1	86.8	26	23	38.8

Sonninia (Euhoploceras) amosi sp. nov., ♀ & ♂

(pl. 11, figs. 3—9; pl. 12; text-figs. 13—16)

Holotype — The incomplete phragmocone of a macroconch (♀) figured on pl. 11, fig. 4 (MCM J1748:2). — **Allotype**, the complete microconch (♂) figured on pl. 12, fig. 1 (MCM J1300:41).

Locus typicus — Cerro Puchenque, Mendoza province.

Stratum typicum — Bed 16, highly fossiliferous layer of concretions 1 m below several black limestone beds; yielding *S. amosi* and rare *Puchenquia* ex gr. *malmarguensis* (BURCKHARDT), (late *Concava*?) early Sowerbyi Zone. — **Allotype** (♂) from bed 6 (≈ 16), same age.

Derivatio nominis — For Dr. Arturo J. Amos, Museo de Ciencias Naturales, La Plata, B.A., Argentina.

Diagnosis — A species of the subgenus *Euhoploceras* with compressed whorls, arched venter, keel obsolete on body chamber; spinose stage usually minute to obsolete, costae extending onto venter, blunt or obsolescent on body chamber.

Material

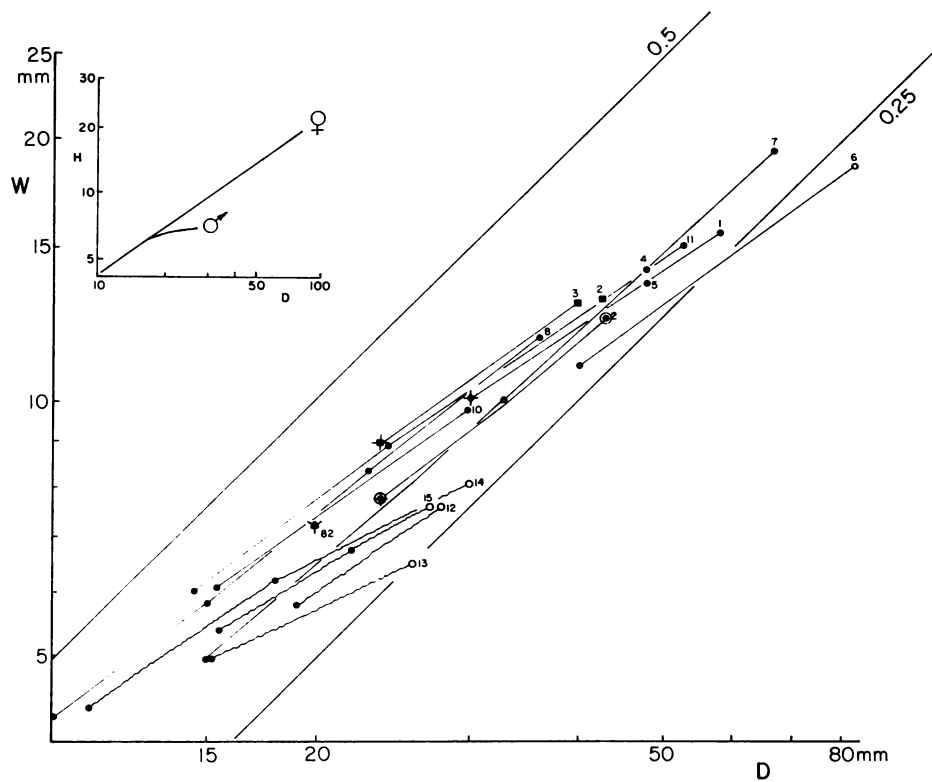
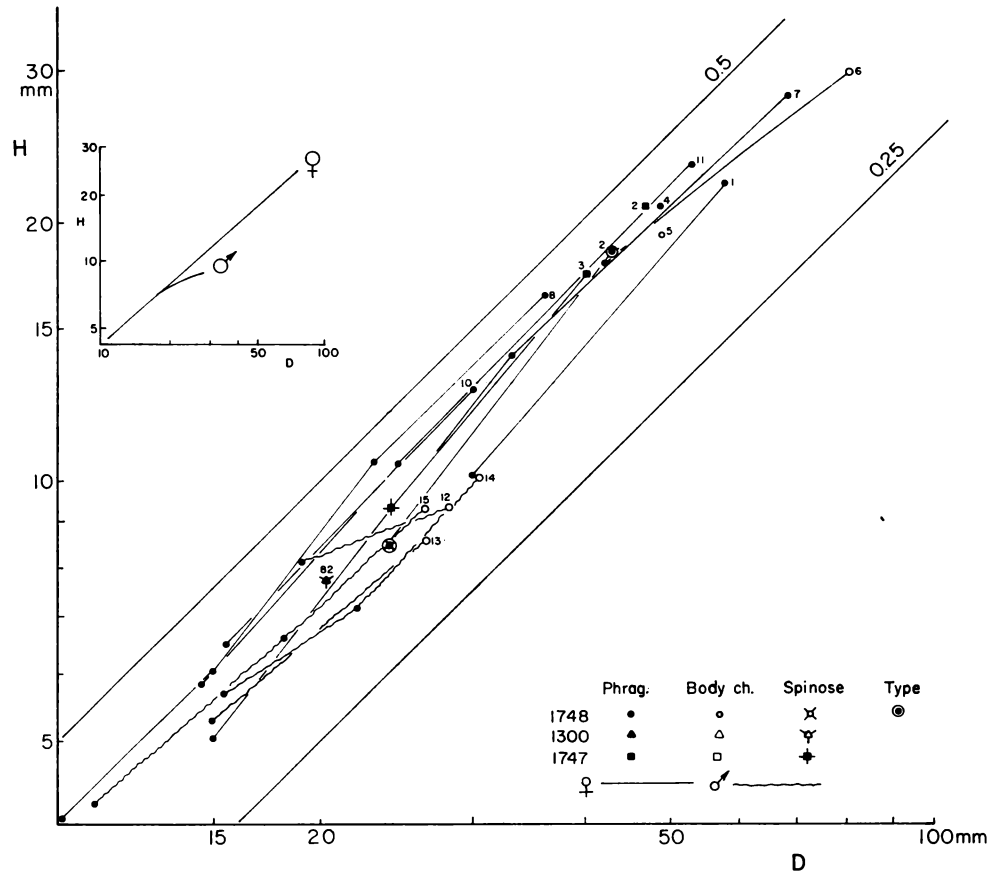
Cerro Puchenque, Mendoza province: 15 mature (including holotype) and approximately 15 immature macroconchs, mostly fragmentary or with incomplete body chambers, 20 mature microconchs with body chamber of which some are complete and several without body chambers, and 40—50 juveniles, from beds 6 and 16 (16 ≈ 6) (MCM J1300, J1748); about 8 fragmentary or incomplete specimens, mostly macroconchs, from bed 12 (MCM J1747).

Description

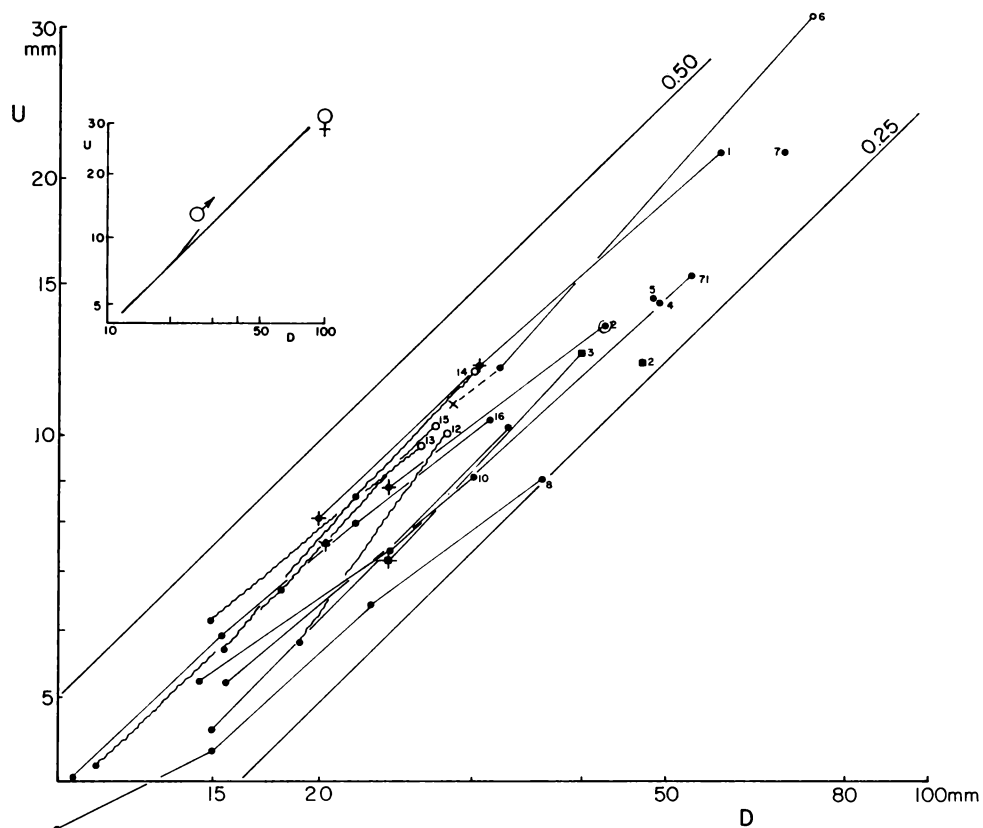
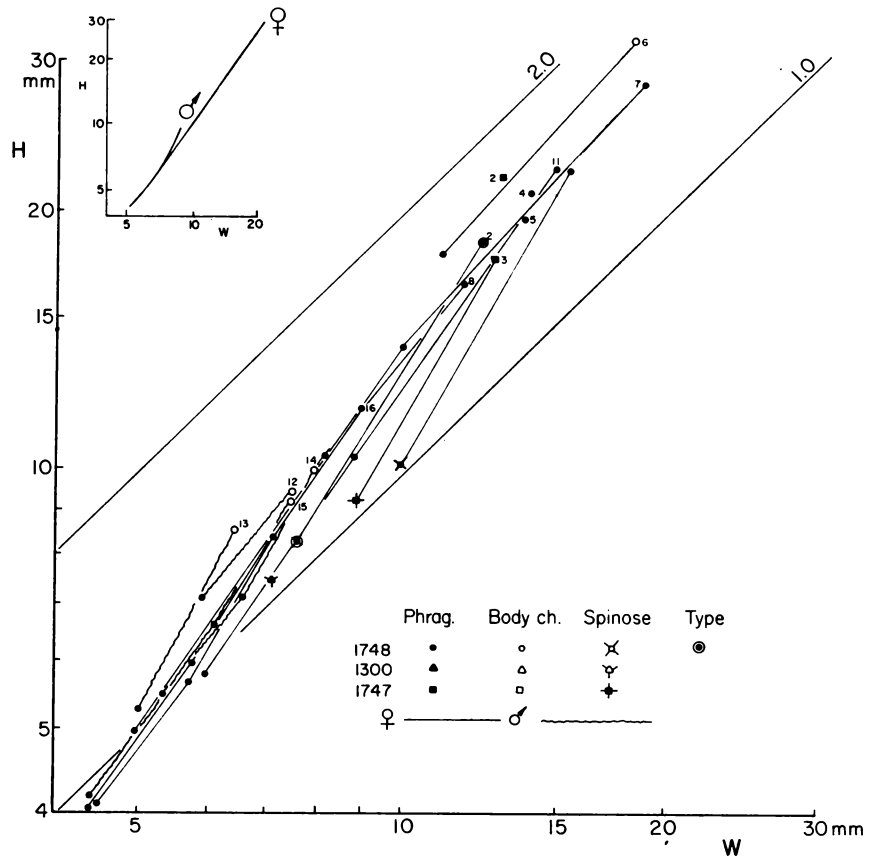
The juvenile whorls up to 20 mm diameter develop from depressed to subcircular and sometimes somewhat subquadrate in section and are moderately evolute (text-figs. 13, 14). Most commonly, the nucleus to 6—10 mm diameter is 'coronate' bearing more or less prominent lateral tubercles, blunt short primaries, blunt somewhat projected secondaries, and a small keel. Sometimes the tuberculate stage reaches 15 mm, rarely 20—25 mm (2 specimens, pl. 11, figs. 4, 9) and exceptionally 40 mm diameter (1 specimen, pl. 11, fig. 6). The secondaries of these highly coronate specimens remain prominent up to the immediate vicinity of the keel. The tuberculate stage is followed by increasingly compressed, densely to prominently costate whorls bearing almost rectiradiate to slightly flexed, frequently irregularly and weakly fasciculate ribs which project on the well rounded shoulder. The venter is slightly convex or sometimes tabulate (not sulcate) and bears a blunt low keel. As usual, the more strongly 'coronate' specimens tend to be more evolute and inflated than the less ornate forms (cf. WESTERMANN, 1966, 1969).

Macroconch (♀) — The phragmocone grows more compressed developing flattish subparallel flanks and a narrow steep umbilical slope with rounded to sharp umbilical angle. The adult diameter varies between 40 and 75 mm. The ribbing consists of blunt short primaries and quite dense blunt secondaries which are borne by irregular division, simple fasciculation and, more rarely, intercalation; they project moderately on the shoulder and die out on the narrowly rounded venter. The keel is narrow and not very high; when the outer shell breaks away, a blunt ridge is exposed consisting of secondary test material, i. e. the keel floor which is clearly separated from the primary wall only in specimens with relatively prominent keel thus becoming hollow (cf. WESTERMANN, 1971); the venter of the internal mould is narrowly rounded. At the end of the mature phragmocone, the primaries tend to become elongated and blunt while the secondaries are projected and often obsolescent.

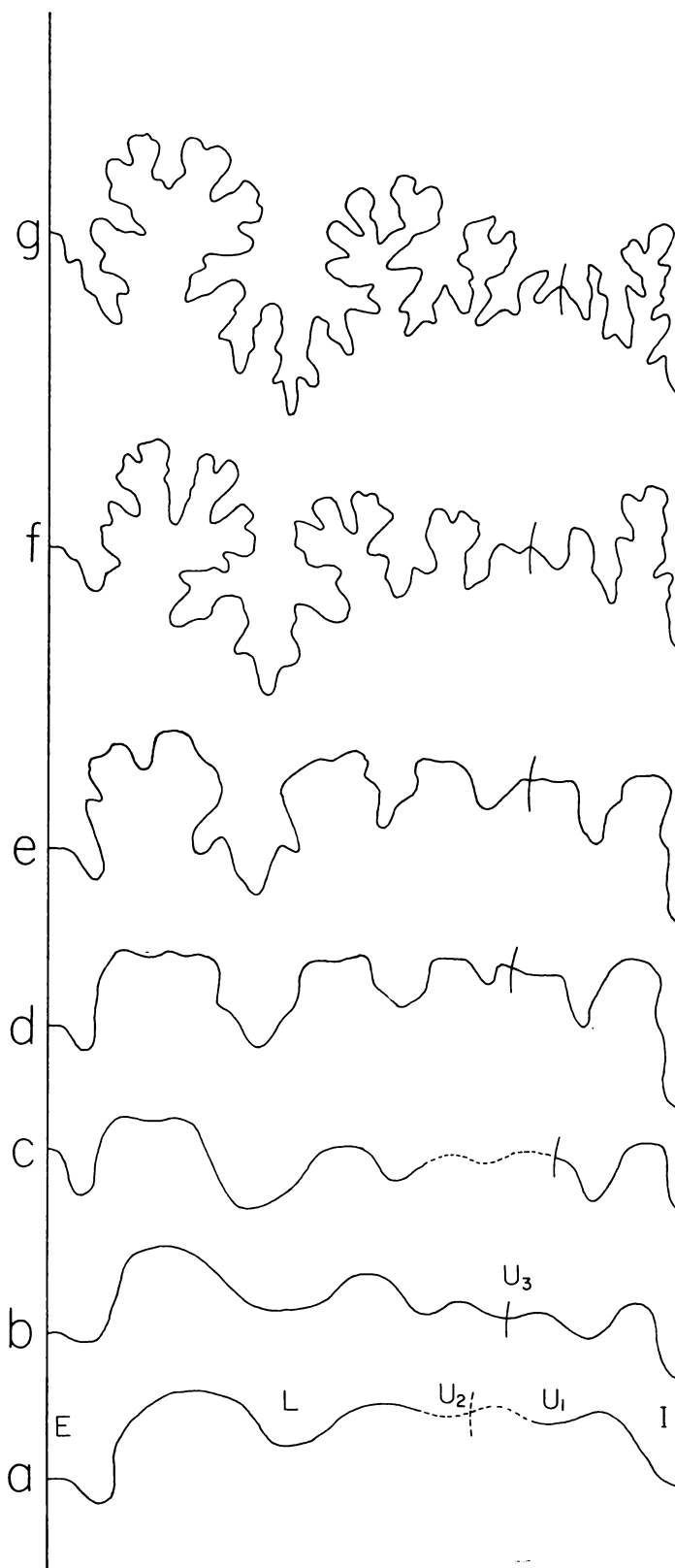
The mature body chamber egresses markedly. The keel is reduced to a weak carina and finally lost entirely, at least on the internal mould. The costation consists of blunt, irregular, mostly simple slightly flexed to rectiradiate plications with some intercalatories or secondaries; they project on the shoulder before dying on the



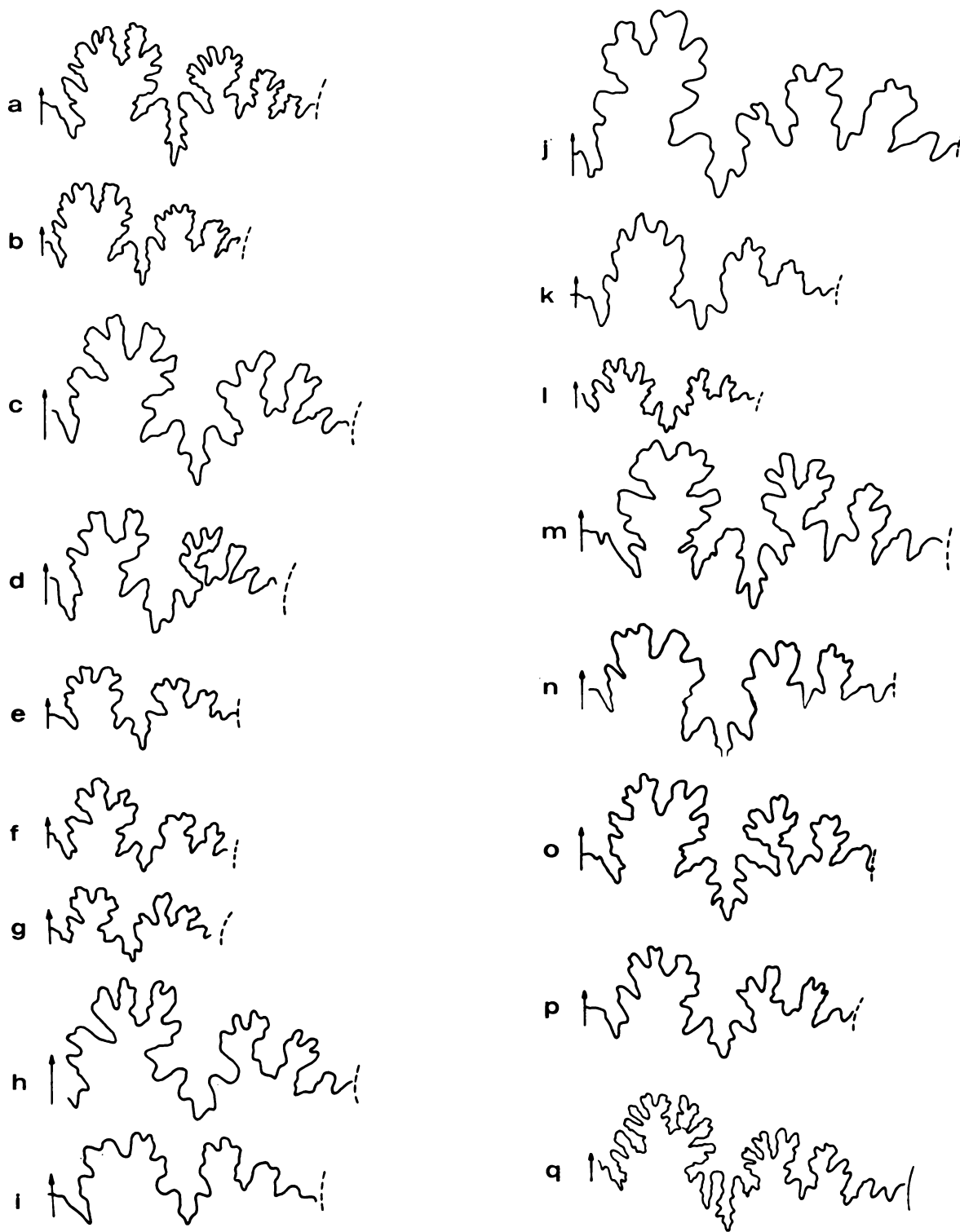
Text-fig. 13. Plots of whorl height (H) and whorl width (W) against shell diameter (D) of *Sonninia (Euhoplceras) amosi* sp. nov. ♀ & ♂, growth lines indicated. (Concava?) lower Sowerbyi Zone, Cerro Puchenque.



Text-fig. 14. Plots of whorl section, i. e. whorl height (H) against whorl width (W), and of umbilical width (U) against shell diameter (D) for *Sonninia (Euhoploceras) amosi* sp. nov., ♀ & ♂. (Concava?) lower Sowerbyi Zone, Cerro Puchenque.



Text-fig. 15. Ontogeny of the septal suture in *Sonninia* (*Euhoplloceras*) *amosi* sp. nov., at shell diameters (D) of, a, 0.70 mm; b, 1.9 mm; c, 3 mm; d, 5.2 mm; e, 8.7 mm; f, 17.3 mm; g, 26.2 mm (MCM J 1300:73). (Concava ?) lower Sowerbyi Zone, Cerro Puchenque.



Text-fig. 16. Septal sutures of *Sonninia (Euhoplloceras) amosi* sp. nov.; a, at D = 28.3 mm and H = 12.3 mm (MCM J 1300 : 50); b, at D ~ 18 mm and H = 7 mm (same specimen); c, at D = 21 mm and H = 9 mm (:51); d, at D = 18 and H = 7 mm (:52); e, at D = 19 mm and H = 8.3 mm (:53); f, at D = 20.7 and H = 9.2 mm (:54); g, at D = 17.6 mm and H = 7.4 mm (:55); h, at D = 21.7 mm and H = 8.6 mm (:56); i, at D = 18.4 mm and H = 8.4 mm (:59); j, at D = 15.3 and H = 7.4 mm (:61); k, at D = 18.7 mm and H = 7.4 mm (:62); l, at D = 19 mm and H = 7.8 mm (:64); m, at D = 22.2 mm and H = 9.2 mm (:68); n, at D = 21.6 and H = 7.4 mm (:81); o, at D = 19.2 mm and H = 7.2 mm (:82); p, at D = 17.5 mm and H = 7 mm (:79); q, at D ~ 30 mm and H ~ 13.4 mm (83). (Concava ?) lower Sowerbyi Zone, Cerro Puchenque.

venter. The costation becomes obsolete toward the end of the adult body chamber. The adult diameter is approximately 80—100 mm.

The septal suture (text-figs. 15, 16) is moderately complex with quite narrow trifold lobes and straight saddle envelope becoming slightly curved on the inner flank at maturity. The mature suture has five narrow umbilical lobes of which U_1 and U_4 are internal; U_2 is about one-half the size of L and may finally become very slightly oblique; U_3 , situated on the umbilical angle or upper umbilical slope, is much smaller, simple and markedly oblique at maturity; U_5 , adjacent to the seam, has the form of a simple indentation becoming oblique at maturity; internally (dorsally), the small U_4 may become slightly oblique, while U_1 is deep, narrow and straight.

Microconch (δ) — The phragmocone is fully grown at 20—25 mm diameter retaining the whorl section and ornament described above from the juvenile macroconchs. The cross section remains rounded to slightly compressed ovate or subquadrate, without defined umbilical wall. The feeble keel may be accompanied by narrow smooth ventral bands. The ornament is either entirely tuberculate with secondaries in twos and threes or, more often, becomes irregularly weakly fasciculate on the last whorl. The ribs project on the shoulders and die out closely adjacent to the keel.

The mature body chamber is $3/5$ to $3/4$ whorl long with a modal diameter of 30 mm. The whorl section is moderately compressed ovate to somewhat subrectangular, with flattened ventral bands accompanying the faint keel at least on the internal mould. The ornament consists of slightly to moderately falcoid and usually irregularly fasciculate ribs which withdraw increasingly from the umbilical slope and venter and finally become obsolete. The aperture has small spatulate lateral lappets and a short ventral lappet. The septal suture resembles that of the macroconch at similar size.

Measurements in mm

		D	H	W	U
Holotype	♀ phrag.	43	18.5	12.3	13.5
	phrag.	24	8.3	7.7	8.8
MCM J 1748 : 1a	♀ phrag.	58	22.5	15.5	21.7
	phrag.	30	10.2	10.0	12.1
	phrag.	~ 20	—	—	8.0
	♀ phrag.	49	21	14	14.3
: 6	♀ phrag.				
: 5	♀ body ch.	52/49	19.6	13.8	14.5
MCM J 1300 : 82	♀ phrag.	20.5	7.5	7.2	7.4
MCM J 1747 : 3	♀ phrag.	40	17.5	13.0	12.5
	phrag.	24	9.3	8.9	7.3
Allotype	♂ aperture	30.5	10.5	8	11.6
	phrag.	20	7.5	6.4	7
MCM J 1748 : 12a	♂ body ch.	28	9.4	7.5	10.2
	phrag.	19	7.1	5.9	5.8

Comparison

The holotype of *Sonninia* (*Papilliceras*?) *peruana* JAWORSKI (1925, p. 135, pl. IV, figs. 3 a—e; lectotype, plaster cast, refigured, pl. 27, fig. 1) from the “Capas con *Amm. Sauzei*” of Chunumayo, Peru, resembles *S. amosi* ♀, but differs by the presence of tubercles on the outer whorls.

S. amosi ♀ displays a similar high variation and covariation of shell dimensions with ornament as described from the northwest European *S. adicra* (WAAGEN) s. l. and the south Alaskan *S. bifurcata* WESTERMANN ranging from ‘coronate’ and inflated to densely costate and compressed shells (WESTERMANN, 1966, 1969). However, in the sample from Cerro Puchenque, highly ornate and inflated variants (or formas) are rare and the modal form is comparable to *S. adicra* forma modesta BUCKMAN. Our macroconchs are distinguished from those of *S. adicra* s. l. by the more narrowly arched venter, the keel becoming obsolete at maturity, the stronger secondaries on the phragmocone reaching almost up to the keel, the much weaker and more irregular ribbing of the outer whorl, and possibly also by the more strongly oblique umbilical elements of the septal suture and the smaller diameter. The microconch is distinguished similarly from the poorly known *S. adicra* microconch: the weaker keel and the more irregular somewhat falcoid ribbing of the last whorl, and probably the smaller diameter.

S. bifurcata WESTERMANN appears to resemble the Andean species more closely than does *S. adicra* because of the relatively prominent secondaries. However, the Alaskan species is distinguished by the heavier ornament,

particularly on the outer whorl, the frequent bifurcation on the inner whorls, the rounded umbilical angle, and the flatter venter.

The microconch is distinguished from *S. cf. espinazitensis* TORNQUIST ♂ [? *S. subdeltafalcata* TORNQUIST and *S. bodenbenderi* TORNQUIST] in the more evolute somewhat subrectangular whorls with smooth ventral bands and the denser ribbing at least on the body chamber where the primaries and often also the secondaries become obsolete.

Subgenus *Fissilobicerias* BUCKMAN, 1919

Type-species by original designation — *Ammonites fissilobatus* WAAGEN, 1867, from the Sowerbyi Zone of N.W. Europe.

Discussion

No significant discussion of the subgenus *Fissilobicerias* appears to exist and the name has only rarely been used in palaeontologic literature (e. g. MAUBEUGE, 1951). This is largely due to the scarcity of the type-species and the poor knowledge of the holotype which is a large involute phragmocone with consequently almost unknown inner whorls. Since more or less the same holds for *Shirbuirnia* BUCKMAN, an associate of *S. (Fissilobicerias)*, both taxa were distinguished in the Treatise (ARKELL et al., 1957, pp. L 268, 270) by the different complexity of the septal suture only, with the questionable inclusion of the latter as subgenus in *Shirbuirnia*.

Two specimens from southern England of each of the subgenera *S. (Fissilobicerias)*, *S. (F.) fissilobata* (WAAGEN), and of *S. (Shirbuirnia)*, *S. stephani* (BUCKMAN), are available (on loan from the British Museum, Natural History) which display the contrast in sutural complexity. Highly complex and interfingering (telescoping) sutures are present throughout the intermediate and outer whorls of *S. (F.) fissilobata* which closely resemble those of the Hammatoceratinae, e. g. the involute *Eudmetoceras (Euaptetoceras)*, except for the vertical and non-suspensive position of the umbilical elements (text-fig. 22). The *S. stephani* suture resembles that of typical *Sonninia* of the *S. propinquans — sowerbyi* group. There are other differences between *S. (Shirbuirnia)* and *S. (Fissilobicerias)* which cast doubt on close relationship between them. *S. (F.) fissilobata* is more strongly compressed throughout than the known species of *S. (Shirbuirnia)*, the intermediate and inner whorls having subparallel flanks while converging in *S. (Shirbuirnia)*; the inner whorls are never strongly nodose; the umbilical slope remains vertical to very steep and well separated from the flank in contrast to the rounded-ovate intermediate and outer whorls of *S. (Shirbuirnia)*; the keel does not seem to become obsolete on the body chamber as in the latter. *S. (F.) fissilobata*, in fact, is a good match to *Eudmetoceras (Euaptetoceras) amplexens* (BUCKMAN) which in Europe became extinct immediately below the occurrence of *S. (Fissilobicerias)*, differs apparently only in the suspensive septal suture, and might well have been the immediate ancestor. *S. (Shirbuirnia)*, on the other hand, resembles more closely *Sonninia* s. s., except for the outer one or two whorls.

However, at least one species intermediate in dimensions and ornament exists between *Sonninia (Fissilobicerias)* and *S. (Shirbuirnia)*, i. e. *Sonninia ovalis* (QUENSTEDT) (see OECHSLE, 1958, p. 92) having a rounded whorl section and nodes on the inner whorl but a complex septal suture. In consideration of the present confusion surrounding the classification of *Sonninia* s.l. and of the present sensible trend of taxonomic simplification, both *Shirbuirnia* and *Fissilobicerias* are here classified as subgenera under *Sonninia*. Both subgenera have previously been described only from the *S. sowerbyi* Zone of the British Isles and central Europe. In the Cotswolds, southern England (ARKELL, 1956, p. 32), and possibly on Skye, Scotland (MORTON, 1965), both taxa mark the middle part of the Sowerbyi Zone, the Trigonalis Subzone [with *S. (Shirbuirnia) trigonalis* BUCKMAN]. However, in the thick sections of the Weser Mountains in lower Saxony, northwest Germany (HILTERMANN, 1939), very similar *S. (Shirbuirnia)* species are partly associated with *S. (Euhoploceras) adicra* (WAAGEN) of the lower Sowerbyi Zone, suggesting that the stratigraphic restriction in the British Isles is due to ecological conditions (shallow water facies?).

Sonninia (Fissilobicerias) zitteli (GOTTSCHKE, 1878) ♀ & (?) ♂

(pls. 13—19, fig. 1; text-figs. 17—21, 23, 24)

1878. *Harpoceras Zitteli* GOTTSCHKE, p. 10, pl. I, figs. 4a—c.

1878. *Harpoceras Zitteli* var. α GOTTSCHKE, p. 10, pl. I, fig. 5.

1878. *Harpoceras proximum* GOTTSCHKE, p. 11, pl. I, fig. 7.

(?) 1878. *Harpoceras Stelzneri* GOTTSCHKE, p. 12, pl. I, figs. 6a—b only.

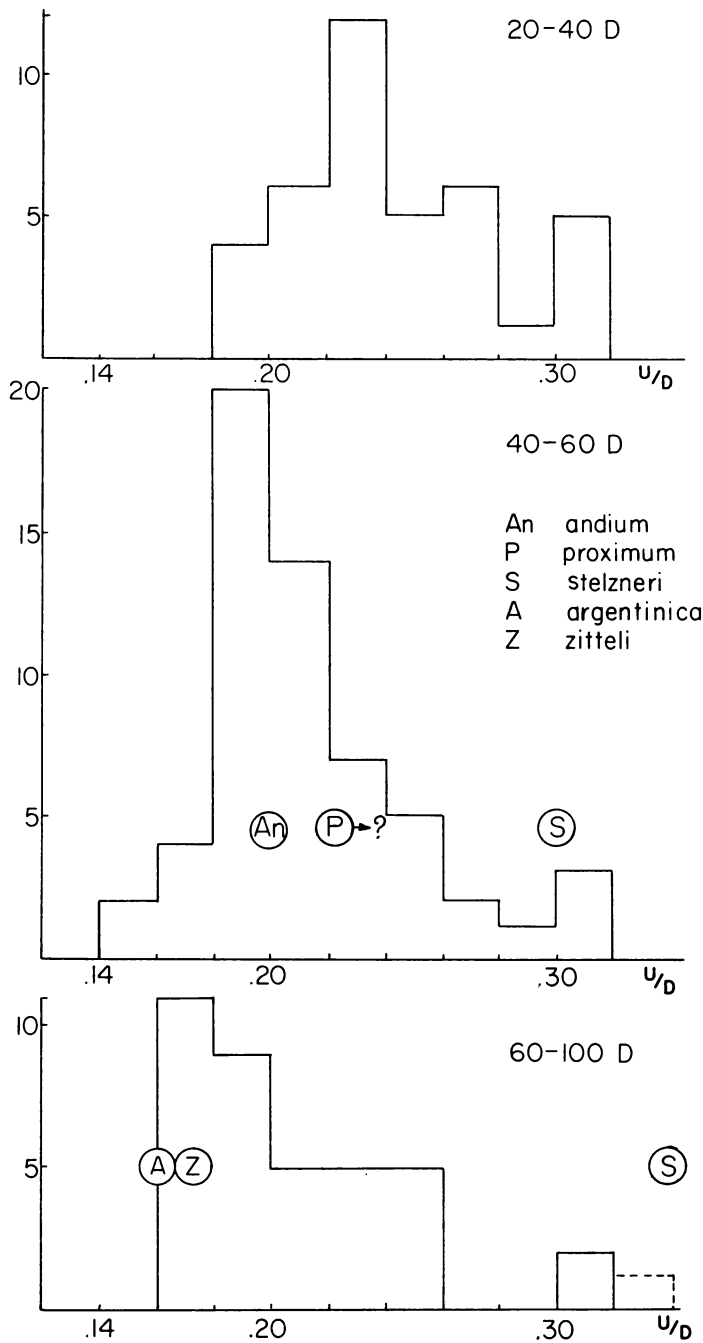
1878. *Harpoceras Andium* GOTTSCHE, p. 11, pl. I, figs. 8a—b, pl. II, figs 1a—b.
 1898. *Sonninia argentinica* TORNQUIST, p. 17 (149), pl. I (XIV), fig. 1 (lateral view; suture of different specimen). [? Subsp.]
 (?) 1898. *Sonninia Zitteli* GOTTSCHE — TORNQUIST, p. 17 (149), pl. II (XV), fig. 1 (lateral view).
 (?) 1898. *Sonninia intumescens* TORNQUIST, p. 18 (150), pl. II (XV), fig. 2 (lateral and ventral view).
 1926. *Sonninia Zitteli* GOTTSCHE — JAWORSKI, p. 226, pl. III, figs. 7a—c, pl. IV, fig. 18.

Material

Arroyo Blanco, Mendoza province: 116 (82 measured) well preserved phragmocones with test remains, a few with crushed beginning of body chamber, from bed 4b (= B 11, A 11) (MCM J 1321, MLP 11359—11423) — Sowerbyi Zone.

Cerro Puchenque, Mendoza province: (?) 2—3 incomplete specimens from bed 13 (MCM J 1754) — Sowerbyi Zone.

Charahuilla, Neuquén province: 1 large internal mould with one-half whorl incomplete body chamber (MCM J 1310—6) — Sauzei Zone.



Text-fig. 17. Frequency distributions for relative umbilical width (U/D) in the Arroyo Blanco sample of *Sonninia (Fissiloboceras) zitteli* (GOTTSCHE), for 3 intervals of diameter (D) of the phragmocone (D = 20 to 40 mm, D = 40 to 60 mm, and D = 60 to 100 mm). The U/D positions of the type specimens of synonymous "species" are indicated.

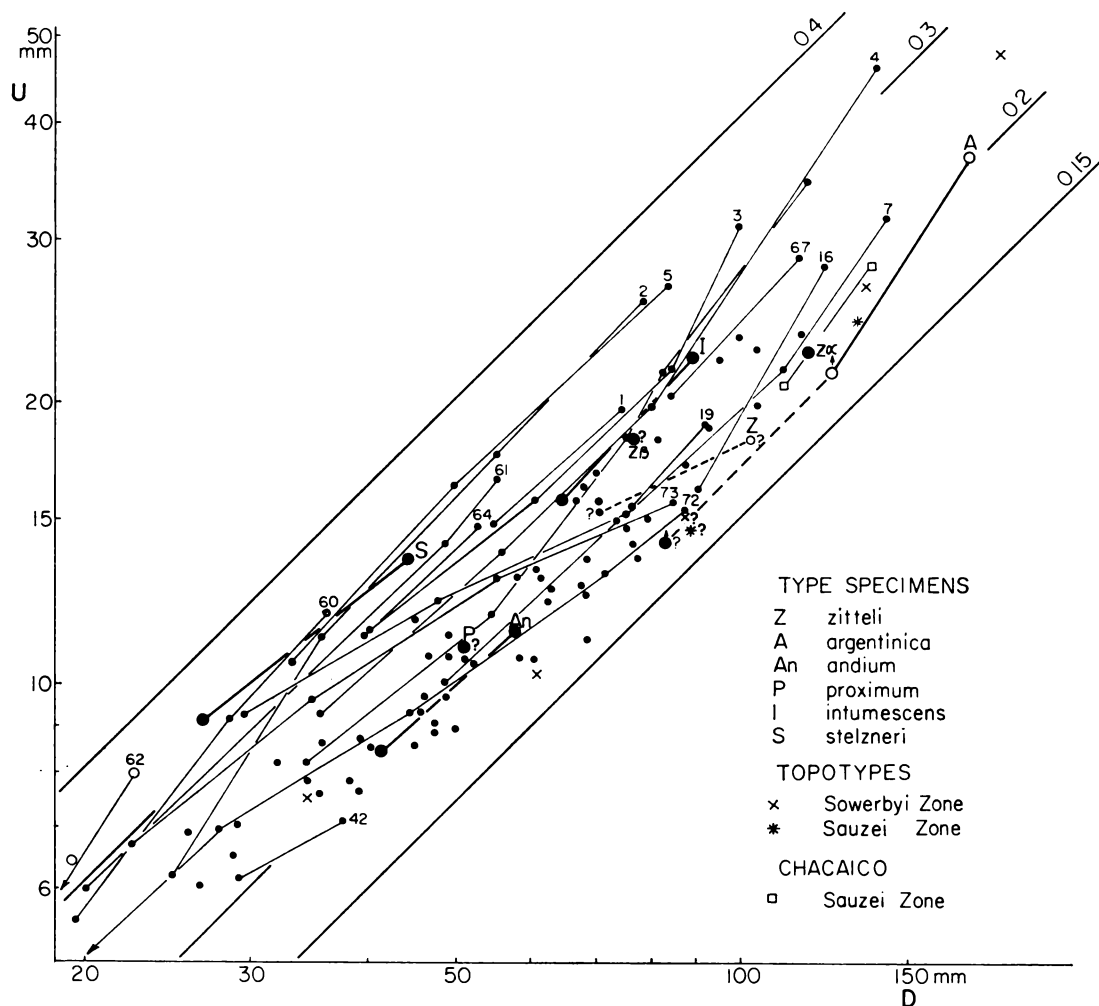
Paso del Espinacito, San Juan province: Bodenbender collection (Göttingen) described by TORNQUIST (1898) including type specimens of "*S. argentinica*" and "*S. intumescens*"; part of Stelzner collection (new photographs) (DNGM) described by GOTTSCHÉ (1878), including type specimens of "*H. Zitteli* var. α ", "*H. Stelzneri*", "*H. Andium*" and "*H. Proximum*"; ? Schiller collection (MLP 9608, 11577), 4 incomplete specimens; 1 damaged large specimen with incomplete body chamber (DNGM).

Description

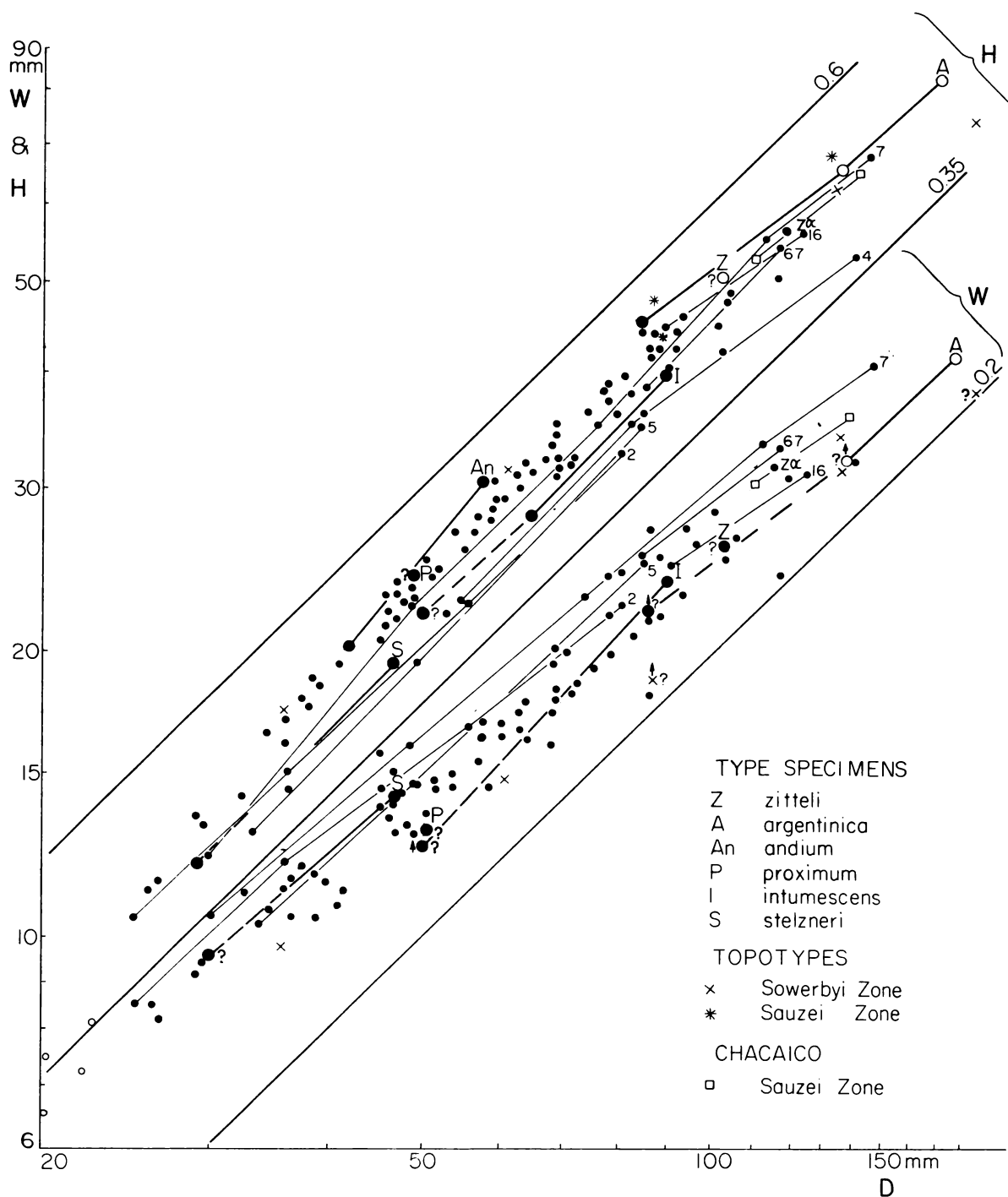
The Sample from Arroyo Blanco

The apparently randomly oriented densely packed large molluscan assemblage in the calcareous concretions of bed 4b (= B11, A11) is regarded as geologically instantaneous and as containing representative samples of a "paleo-population". Ammonites dominate belonging mainly to families Sonniniidae and Otoitidae, together with rare Oppeliidae and Lytoceratidae. At least the abundant Sonniniidae are monotypic belonging almost certainly to a single variable "paleospecies", i.e. *Sonninia (Fissilobicerus) zitteli*.

The sample of *Sonninia zitteli*, consisting mostly of macroconchs (♀), displays high variation in dimensions and ornament, with one of the more common morphotypes (or formas) closely resembling the (lost) holotype as figured by GOTTSCHÉ. Other intergrading morphotypes not only resemble "*H. Zitteli* var. α " and "var. β " but also the three other *Sonninia* species described by GOTTSCHÉ, i.e. "*Harpoceras Stelzneri*", "*H. Andium*", and "*H. proximum*"; all are therefore regarded as synonymous with *S. zitteli* (text-figs. 17—20).



Text-fig. 18. Plot of umbilical width (U) against shell diameter (D) for *Sonninia (Fissilobicerus) zitteli* (GOTTSCHÉ), with type specimens of synonymous "species"; many growth lines are indicated. Arroyo Blanco sample.

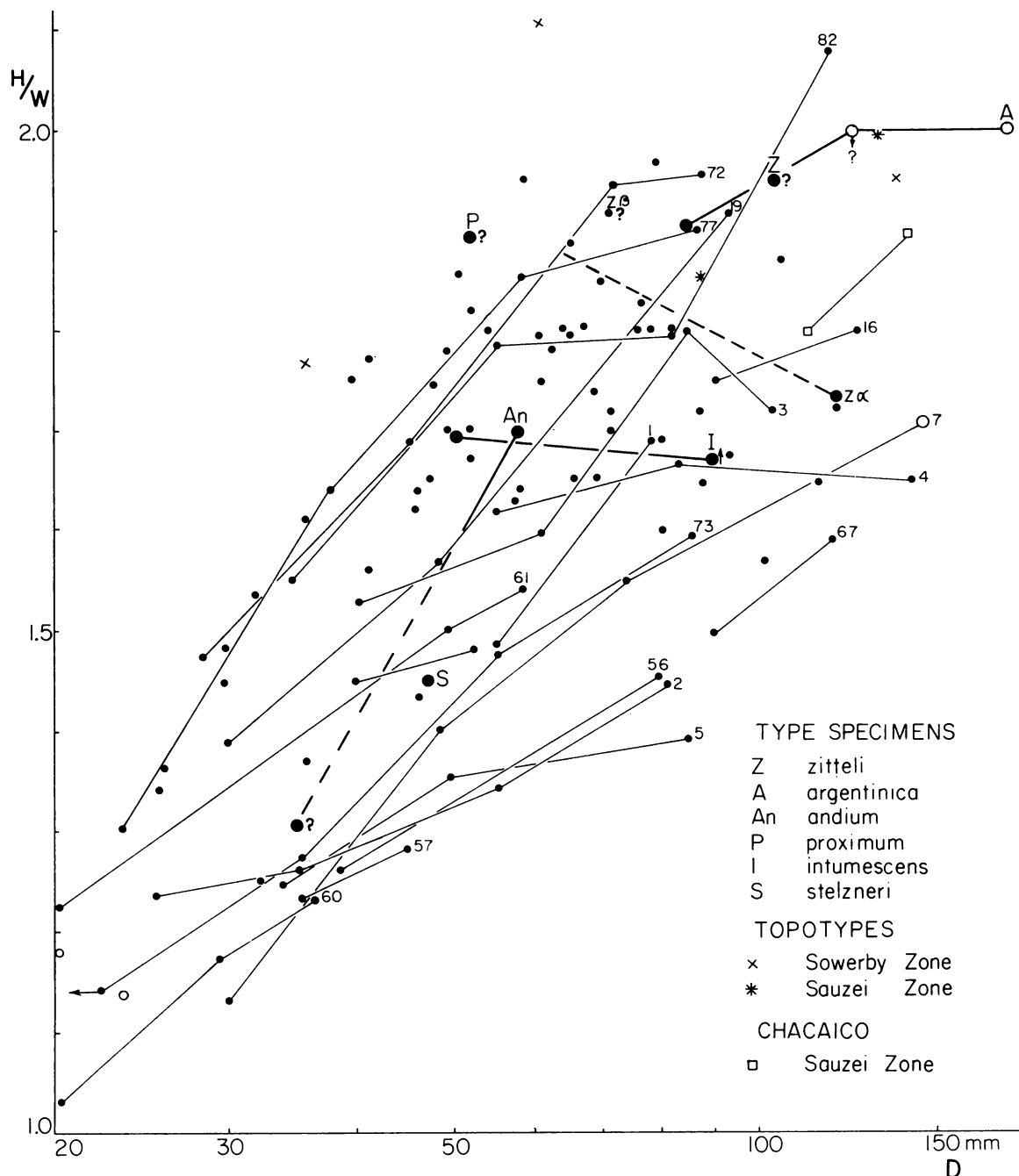


Text-fig. 19. Plots of whorl width (W) and whorl height (H) against shell diameter (D) for *Sonninia (Fissiloboceras) zitteli* (GOTTSCHE), with type specimens of synonymous "species"; several growth lines are indicated. Arroyo Blanco sample.

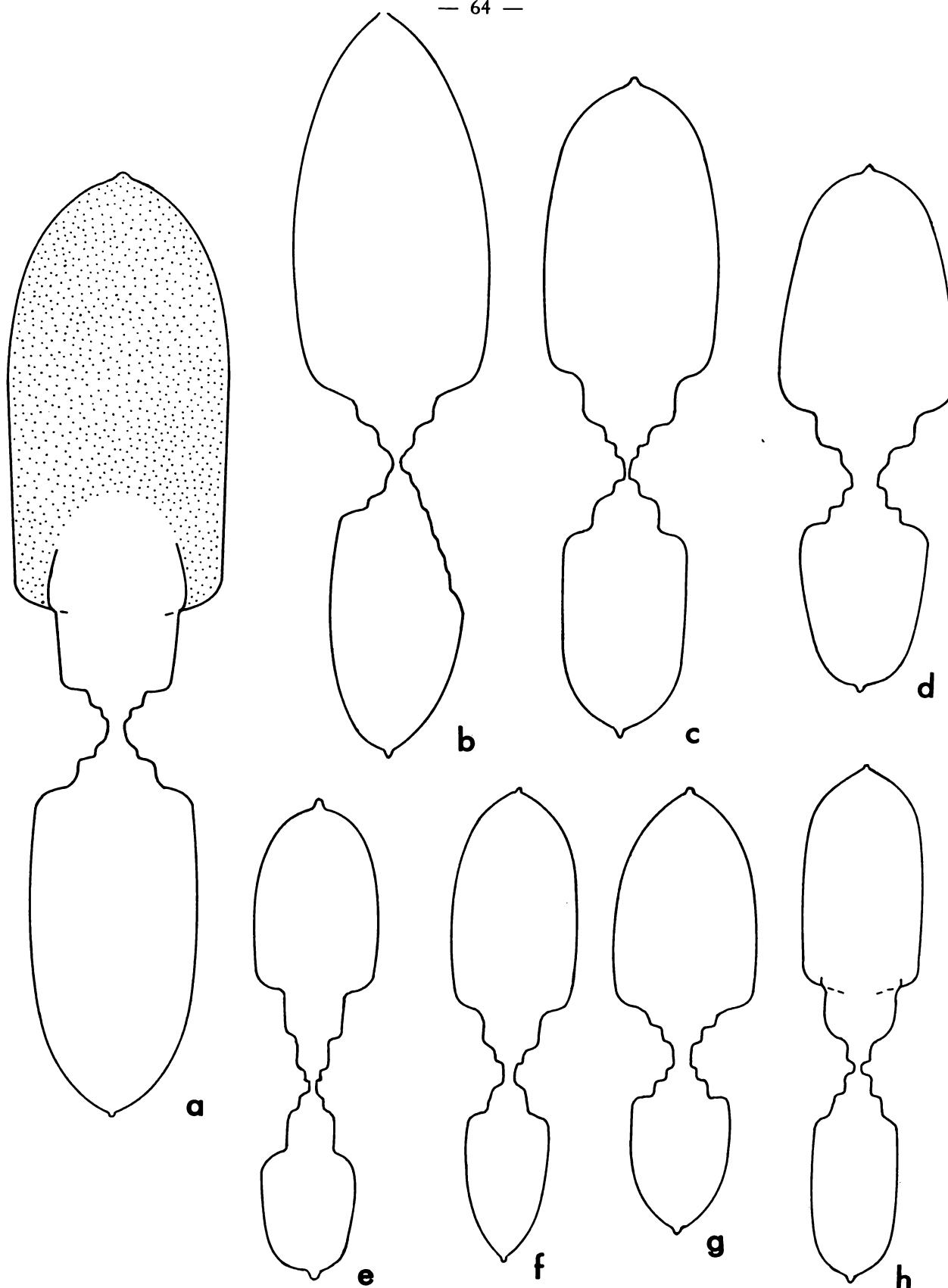
The innermost whorls are depressed elliptical, becoming subcircular and, between 6 and 10 mm diameter, compressed ovate in section, bearing a blunt keel. With the following whorl, a steep low umbilical slope with more or less rounded umbilical margin develops, the flanks tend to flatten, and the venter becomes obtuse to acute carrying a moderately high floored keel. The coiling varies resulting in an umbilical width ranging from about 25 to 35 percent of the diameter. At 5—6 mm diameter, blunt bullae-like swellings arise on the flanks which

at about 10 mm diameter have developed into blunt, broad, usually prorsiradiate, somewhat irregularly fasciculate costae. On the subsequent whorl, the costae strengthen, extend somewhat projected onto the venter, and become more strongly fasciculate with bundles of twos, rarely threes, and with single intercalatories. Blunt bullae-like swellings may continue irregularly, but tubercles are absent.

The intermediate whorls of the phragmocone become increasingly more compressed by positive allometry of height and negative allometry of width, at least up to about 50 mm diameter; further compression in the outer whorls may or may not be present, mainly owing to continued negative width allometry (text-figs. 19, 20). The whorl section varies from subrectangular to ovate to ogival (gothic arch), with low steep umbilical wall which is



Text-fig. 20. Plot of whorl section (H/W) against shell diameter (D) for *Sonninia (Fissilobicerus) zitteli* (GOTTSCHE), with type specimens of synonymous "species"; many growth lines are indicated. Arroyo Blanco sample.



Text-fig. 21. Cross sections through the phragmocone and body chamber (shaded) of *Sonninia (Fissiloboceras) zitteli* (GOTTSCHKE), X 1; a, lectotype of "*Sonninia argentinica*" TORNQUIST, Paso del Espinacito (GAUG 496—11); b, paralectotype of "*S. argentinica*" from same locality (GAUG 496—4); c—g, from the Sowerbyi Zone of Arroyo Blanco (MCM J1321—67, MLP 11363, 11413, 11362 and MCM J1321 :70); h, lectotype of "*Sonninia intumescens*" TORNQUIST (GAUG 496—17), Paso del Espinacito. Note slight crushing of a and h.

well separated from the flat flanks in the compressed forms but rounds into convex flanks in the thicker forms. The coiling usually becomes more involute corresponding to the increase in whorl height and overlap, except for the most evolute morphotype in which the umbilical width remains approximately constant or may even increase slightly. The range of variation in umbilical width is from 17 to 32 percent of the diameter ($D = 33$ to 50 mm). The keel is moderately prominent, sharp and well defined. The ornament consists of rectiradiate to weakly prorsiradiate costae which are more or less projected on the shoulders and irregularly fasciculate to about 20—25 mm diameter. However, the ribs usually remain somewhat irregular and vary highly in prominence and spacing between specimens; as usual, the more evolute and inflated whorls bear the stronger ornamentation, another example of the (1st) Buckman Law of Covariation between dimensions and ornament (WESTERMANN, 1966). Furthermore, the fine ornament of the involute compressed whorls becomes obsolescent at about 30—35 mm diameter while the strong costae may be retained to 40—50 mm diameter and, rarely, in blunt form up to the end of medium-sized phragmocones.

The outer one to two whorls of the adult macroconchiate (♀) phragmocone usually become more compressed reaching a height/width ratio of 2.0; but many specimens remain constant in whorl section, while depression is exceptional, resulting in a H/W range of 1.4 to 2.0 (text-fig. 20). Increased compression is owing to negative allometry of width growth, although height growth may also become slightly negative in the largest specimens (text-fig. 19). The coiling tends at first to become more involute up to about 70—100 mm diameter, varying between 17 and 32 percent of the diameter, until, at last the umbilical seam egresses weakly to moderately and gradually (last approximate one-half whorl) (text-figs. 17, 18). The complete phragmocone shell, in qualitative terms, varies from subdiscoidal shape with involute ogival or compressed subtriangular whorls, to planulate shape with evolute trapezoidal or ovate whorls; the umbilical slope is always essentially vertical becoming steep and well separated from the flattish subparallel to somewhat convex inner flank by a rounded margin which is never raised. The maximal width lies between one-third and three-sevenths of the whorl height, averaging at about two-fifths.

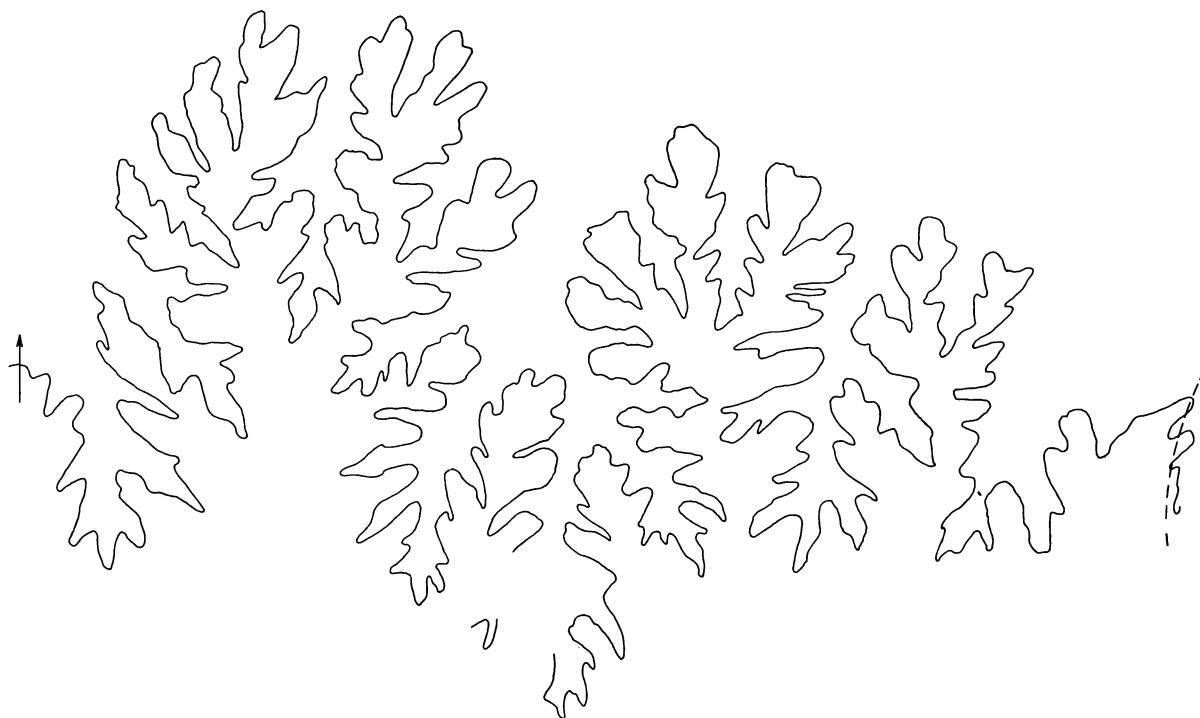
The outer whorls are usually smooth except for some faint irregular radial undulation. However, a few specimens of the modal morphotype show very blunt rather dense rectiradiate plications on the flanks, and the evolute morphotype has regular more widely spaced plications up to the end of the preserved shell. A single specimen (pl. 18, fig. 1; MCM J1321: 67) of modal whorl section and coiling differs in the retainment (or recurrence?) on the ultimate phragmocone whorl of costae fasciculation with bullae-like plications on the inner flank reminiscent of primaries. This specimen perfectly matches the lectotype of *Am. Sowerbyi rudis* QUENSTEDT as refigured by DORN (1935, pl. XXI, fig. 3).

Text-figure 18 illustrates that some of the most evolute ($U/D = 0.31$ to 0.33) adult specimens have modal inner and intermediate whorls (nos. 3, 4), while others are widely umbilicate with less compressed whorl section throughout (nos. 2, 5; ≥ 30 mm D). However, from the distribution of coiling (umbilical width) within the sample (text-fig. 17) it appears highly unlikely that they belong to a different species since their ornament and septal suture do not differ significantly from the lot.

Several small phragmocones ($D < 40$ mm) may or may not be adult; adult septal approximation is difficult to distinguish from the modal telescoping of the complex sutures. Two or three of them could be microconchs (below).

The septal suture is extremely complex, not only at maturity but already during adolescence at about 20—30 mm diameter (text-figs. 23, 24). There is close resemblance to the late Hammatoceratinae except for the absence of marked suspension and most sutures are a perfect match to those figured from European *S. fissilobata* (text-fig. 22 and DORN, 1935, text-fig. pl. V, fig. 9; BUCKMAN, 1920, pl. 181 B; Oechsle, 1958, pl. 11, fig. 11), including the telescoping of adolescent sutures. Nevertheless, variation in the shape of the lobes and saddles is appreciable, particularly in the width of the (“first”) lateral lobe L. The saddle envelope is straight to slightly convex; L is deeper than E, narrow to moderately wide, and irregularly trifid sometimes tending to be multifid, with reduced ventral branch; U_2 is narrow and about as deep as E; there follows another well developed saddle and, in larger specimens, also a small lobe which may be somewhat oblique. The suture on the umbilical slope and dorsal shell was not investigated.

(?) Microconch (♂) — Two or three specimens with incomplete body chamber at about 20 mm diameter appear to be adult and resemble the juvenile whorls of the numerous much larger specimens described above; they are



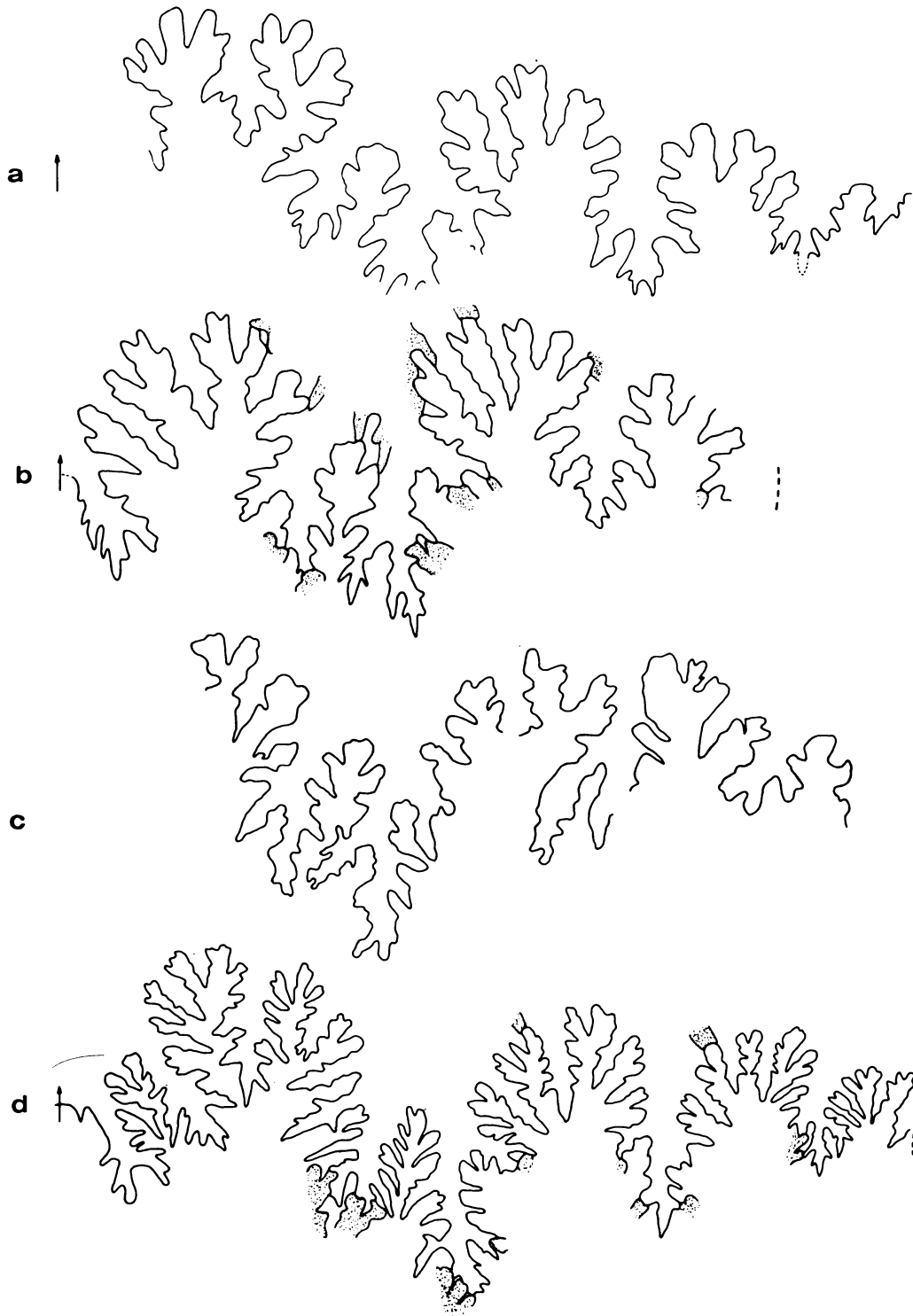
Text-fig. 22. Septal suture of *Sonninia (Fissiloboceras) fissilobata* (WAAGEN) ♀, at D = 50.8 mm and H = 25 mm. Sowerbyi Zone, England (BMNH C 9948).

therefore tentatively considered to be microconchs (♂) of *S. zitteli* (pl. 16, figs. 3—5). Several slightly larger specimens with partial body chamber may also be fully grown microconchs since all visible septa of the last whorl are tightly spaced. No aperture is preserved.

Type specimens and topotypes from Paso del Espinacito

“*Harpoceras Zitteli*” GOTTSCHÉ — The holotype (original designation and monotypy), a phragmocone with beginning of the body chamber (see original German text, mistranslated in Spanish text, 1925) of 103 mm diameter, is lost. After considering the disagreement between original description and illustrations in whorl section and ornamentation of the inner whorls, TORNUST (1898) supposed that the illustrations were correct. This opinion was based on new quasi-topotypes (different section?) but almost certainly not on inspection of the holotype; i. e., the maximal width of the whorl section is not near the umbilical seam but close to mid-flank and tubercles are absent. Illustrations and recorded measurements of the holotype agree in detail with the moderately involute morphotype of Arroyo Blanco, except for the alleged simplicity of the septal suture; GOTTSCHÉ’s drawing was probably based on a somewhat corroded specimen.

“*Harpoceras zitteli* var. α ” and “*H. zitteli* var. β ” GOTTSCHÉ were clearly regarded by the author as varieties (morphotypes or formas) of *S. zitteli*. Only the fragment of “var. α ” which originally was illustrated in the cross-sectional view only could be found and is here refigured in the lateral and ventral views (pl. 13, figs. 1 a, b). “Var. α ” was said to be distinguished from the “type” of *S. zitteli* “really only in the lesser height and the slower growth of the whorls” (our translation). GOTTSCHÉ’s measurements for the single specimen of “var. α ” are too small for the diameter (c. 120 vs. 130 mm) and, consequently, too large for the relative umbilical width ($U/D \approx 0.225$ vs. 0.17), relative whorl height ($H/D \approx 0.45$ vs. 0.44) and width ($W/D \approx 0.26$ vs. 0.23); the whorl section ($H/W = 1.75$) has been more closely approximated in the original illustration than in the table; the penultimate whorl has, however, a more acute venter than illustrated. “Var. α ” closely resembles “var. β ”, according to the original measurements of that specimen which was not illustrated. The latter was said to be distinguished from both *S. zitteli* “type” and “var. α ” in the larger umbilicus ($U/D \approx 0.23$).



Text-fig. 23. Septal sutures of *Somnia (Fissiloboceras) zitteli* (GOTTSCHÉ); a, lectotype of "*Somnia argentinica*" TORNQUIST (GAUG 496—11) at H = 58.9 mm; b, paralectotype of "*S. argentinica*" (GAUG 496—10) at H ~ 54 mm; c, holotype of "*Harpoceras Zitteli* var. α " GOTTSCHÉ at H = 66 mm (DNGM 7885); d, specimen from Arroyo Blanco at H = 54 mm (MCM J1321 : 67); a—c, from Paso del Espinacito.



Text-fig. 24. Septal sutures of *Sonminia (Fissilobiceras) zitteli* (GOTTSCHÉ); a, at H = 30 mm (MCM J1321:70); b, at H ~ 42 mm (MLP 11366); c, at H = 21.9 mm (MLP 11362); d, at H ~ 53 mm (MCM J1310:6); e, at H = 29.2 mm (MLP 11359); f, same specimen at H = 9.1 mm; g, at H = 15.6 mm (MLP 11415). Sowerbyi Zone, Arroyo Blanco, except d which is from the Sauzei Zone of Charahuilla.

Of particular interest is the relatively well preserved septal suture of the “*var. α*” specimen which is more complex than originally illustrated from the lost holotype and resembles that of the subgenus *Fissilobicerias*; L is rather broad as in some specimens of the Arroyo Blanco sample (text-fig. 23 c).

The topotypes, particularly those of the Bodenbender collection described by TORNQUIST (1898) vary in the coiling of the intermediate whorls ($U/D = 0.19$ to 0.24). The large septate specimen with body chamber fragment (TORNQUIST, 1898, pl. 2, fig. 1) is more involute than illustrated; the umbilicus has now been developed from the matrix ($U/D = 0.17$ at 90 mm D; ≈ 0.195 at 60 mm D). The inner flanks converge somewhat toward the umbilical margin which is more rounded than shown, and the umbilical slope is steep. The small, incomplete phragmocone (loc. cit., fig. 3) is strongly corroded on the illustrated side and the ribbing is visible only along one-third whorl of the other side.

“*Harpoceras proximum*” GOTTSCHÉ — The holotype (monotypy), figured only in the left lateral view, is lost; it is less than one whorl of a supposedly adolescent shell with 52 mm diameter. The alleged difference from *S. zitteli* is in the costation only, i. e. “the marked costae, in part single and in part bifurcating, of the juvenile shell” (our translation). As TORNQUIST (1898) has pointed out, the same ornament is found on the inner whorls of *S. zitteli*, and GOTTSCHÉ’s measurements differ from his illustration. The measurements are obviously in error with respect to relative whorl height and umbilical width at the largest diameter, adding up to 79%; according to the illustration $H/D = 0.47$ (vs. “0.54”) and $U/D = 0.22$ (vs. “0.25”). The illustration closely matches the modal form of the Arroyo Blanco assemblage, except for the septal suture which was probably worn. Following TORNQUIST, “*H. proximum*” is therefore placed in synonymy with *S. zitteli*.

“*Harpoceras Andium*” GOTTSCHÉ — The syntype, originally illustrated on plate 1, figures 8 a—b, is here refigured (pl. 13, figs. 2 a, b); the other syntype is lost. Slightly more than one-quarter whorl of phragmocone in moderate preservation had been broken away by GOTTSCHÉ before illustration and is now available. GOTTSCHÉ’s measurements and illustrations are inaccurate. The coiling at 42 mm diameter is more involute ($U/D = 0.20$) than illustrated and slightly more evolute than tabulated; the ribs are less curved than illustrated. (Note that the additional one-quarter whorl has some matrix attached to the umbilical margin and slope.) This specimen closely resembles the illustrations of the other (lost) syntype. Dimensions (text-figs. 18—20) and ornament of “*H. Andium*” are well matched by an abundant morphotype (slightly more involute than the mode) of the Arroyo Blanco sample of *S. zitteli*; “*H. Andium*” is consequently also placed in the synonymy of *S. zitteli*.

The “*Hammatoceras (Sonninia) andium* GOTTSCHÉ” of MÖRICKÉ (1894) from Manflas, Chile, was already correctly placed in synonymy with *S. (Papilliceras) espinazitensis altecostata* by TORNQUIST (1898).

“*Harpoceras Stelzneri*” GOTTSCHÉ — The two originally illustrated syntypes (here refigured; pl. 13, figs. 3, 4) are small, probably incomplete phragmocones. As in the other supposed species, GOTTSCHÉ’s measurements as well as his illustrations are partly inaccurate. The larger syntype (GOTTSCHÉ, pl. 1, figs. 6 a—b, here designated the lectotype) is somewhat smaller and more involute than illustrated ($U/D = 0.30$ vs. 0.32); the whorl height is lower than given in the table ($H/D = 0.41$ vs. 0.45); the costae are straighter on the ultimate whorl and less prominent on the ultimate half-whorl, becoming obsolete on the inner flank, than illustrated. The smaller syntype (GOTTSCHÉ, pl. 1, figs. 10 a—b) has a smaller diameter ($D = 34$ vs. 37 mm) and is more evolute ($U/D = 0.38$ vs. 0.35), with more slowly expanding and more rounded whorls, than illustrated; GOTTSCHÉ’s whorl height and width measurements are too high; the costation (according to photograph of side not illustrated by GOTTSCHÉ) differs strongly from the illustration consisting of blunt secondaries on the beginning of the outer whorl developing into rectiradiate blunt costae on the middle and outer flank.

The two syntypes differ so strongly in coiling, whorl section, and costation even if consideration is given to their different diameter, that they may belong to different species. The larger specimen (lectotype) closely resembles the evolute morphotype of the Arroyo Blanco sample which we tentatively include in *S. zitteli*. The smaller specimen probably cannot be confidently identified at the specific level, but may possibly belong in *S. (Euhoploceras)*. “*H. stelzneri*” is therefore probably another junior subjective synonym of *S. zitteli*.

In northwest Germany, HILTERMANN (1939, p. 156, text-fig. 30, pl. 11, fig. 2) questionably identified with *S. stelzneri* “a few forms” from the Sowerbyi Zone of Osnabrück, but the single illustrated specimen is too imperfect and the description too brief for confirmation. His supposition (HILTERMANN, pp. 157, 153) that “*Sonninia modesta*” BUCKMAN and a number of related forms [= *S. adicra* (WAAGEN); WESTERMANN, 1966] are conspecific with *S. stelzneri* is considered erroneous. “*S. modesta*” and the other European nonspinose forms of *Sonninia*

(*Euhoploceras*) *adicra* are distinguished by more compressed whorls with flatter flanks, more marked shoulders, and smooth bands or shallow grooves besides the keel; their ribs are generally not fasciculate and curved on the flanks.

"*Sonninia Argentina*" TORNQUIST — The large almost complete internal mould illustrated in side and ventral views is designated as the lectotype (refigured pl. 14, figs. 1 a, b and text-figs. 21 a, 23 a); the septal suture illustrated by TORNQUIST (pl. 1, fig. 1 part.) is from a small fragment of another specimen. The whorl section of the lectotype was grossly misrepresented in the illustration; only one side of the incomplete body chamber is preserved and a rock fragment attached to the internal mould was included as part of the whorl section (but not in the whorl width measurement) which then was symmetrically completed. On the outer whorl (with 180° body chamber) the umbilical slope is concave and the umbilical angle is sharp but not markedly raised. The slight concavity of the inner flank is probably largely owing to crushing; the last inner whorl has flat and parallel inner flanks, a sharp umbilical edge and vertical umbilical slope. The removal of the matrix from the umbilici has revealed that the flanks of the inner whorls have been broken along the umbilical seams and the inner flanks were somewhat crushed amounting to approximately 10 percent of the whorl width. The crushing effect is clearly seen on the smaller paralectotype (D = 93 mm); the steep umbilical slope resisted compression resulting in the elevation of the umbilical angle becoming an elevated edge. On the last phragmocone whorl, the newly developed left umbilicus of the lectotype is about 10 percent wider than the right. The septal suture is visible throughout the exposed right side of the phragmocone (text-fig. 23 a); it differs from the suture of *S. (Fissiloboceras)* in its simplicity and closely resembles the illustration of TORNQUIST from another specimen. However, this simplicity appears to be owing to partial dissolution of the internal mould.

The paralectotype from which TORNQUIST illustrated the septal suture is a fragment of an adult phragmocone with part of the body chamber; one side is broken off and there are obvious marks of wear. At similar diameter, it differs from the lectotype in the evenly convex flank and the rounded umbilical angle which, according to TORNQUIST, are criteria for *S. zitteli*. The illustrated last suture was reproduced incorrectly and appears also to be somewhat "senile". The penultimate suture of this specimen is here illustrated (text-fig. 23 b); it rides in part on the approximated adjoining sutures and is somewhat more complex than the last suture as shown in TORNQUIST's illustration.

On all three available paralectotypes of "*S. Argentina*", the innermost flank drops gently toward the somewhat rounded umbilical angle at 40—60 mm diameter. Parts of a quite complex septal suture with narrow lateral lobe can be seen in paralectotype no. 496—16.

There appears therefore no significant difference between "*S. Argentina*" and *S. zitteli* with regard to the septal suture and at least the adolescent phragmocone, as already stated by JAWORSKI (1926). Concerning the supposedly more involute inner whorls of "*S. Argentina*", the paralectotype no. 496—13 has a relative umbilical width (U/D) of 0.205 at 93 mm diameter (as correctly given by TORNQUIST) and of 0.21 at 64 mm. These values closely resemble those for the holotype of *S. zitteli* (cf. measurements and illustration of GOTTSCHÉ); they overlap with TORNQUIST's topotypes of *S. zitteli* (see above) which range in U/D from 0.17 to 0.24 (intermediate whorls); and they match the values for the modal form of the Arroyo Blanco sample. The only possibly significant difference of "*S. Argentina*", if not due to crushing, could be the adult development of a sharp umbilical angle or edge and of flat to slightly concave inner flanks on the outer whorl.

There is also the possibility that "*S. Argentina*" is slightly younger than *S. zitteli*, since BODENBENDER (in TORNQUIST, 1898) reported it in association with *Emileia multiformis* (GOTTSCHÉ) of the Sauzei Zone (but supposedly from the same beds as Stelzner's collection). Furthermore, the specimen of our own collection which most closely resembles the holotype of "*S. Argentina*" came from the Sauzei Zone of Charahuilla, Neuquén province. However, HILLEBRANDT (1970, p. 187) who recently reinvestigated the Espinacito Pass section, found "*Sonninia argentina* TORNQUIST (? = *S. zitteli* GOTTSCHÉ)" almost exclusively at a single level in the Sowerbyi Zone, in association with "*Sonninia* cf. *crassispinata* BUCKMAN" [= *S. (Euhoploceras)* cf. *adicra* (WAAGEN)] and *S. ovalis* (QUENSTEDT), and underlying beds with *Pseudotoites*.

"*S. Argentina*" is considered conspecific with *S. zitteli*, but with some reservation pending more and better preserved, stratigraphically collected material. There is, in particular, the possibility that "*S. Argentina*" is a chrono-subspecies of *S. zitteli*.

"*Sonninia intumescens*" TORNQUIST — The lectotype (TORNQUIST, pl. II, fig. 2, here designated), a com-

pletely septate internal mould with minor test remains, has been developed from the matrix and is here refigured (pl. 15, figs. 1 a, b; text-fig. 21 h). While TORNUST's illustration of the lateral view is accurate, the ventral view shows the flanks too flat and the shoulders too prominent. Furthermore, the high compression of the whorl section and the subparallel attitude of the flanks is partly owing to crushing, particularly along the umbilical seam. The original whorl section was probably somewhat ovate with the maximal width at one-third to two-fifths whorl height and with rounded umbilical margin.

Among the five available paralectotypes, only the largest specimen (no. 496—18, D = 100 mm) approximates TORNUST's description in the whorl section; however, this specimen has also been partly crushed in the umbilical area and probably resembled originally the more inflated form of the Arroyo Blanco sample. The other paralectotypes are inner and intermediate whorls of modal *S. zitteli* or of the more narrowly coiled "*S. Argentina*". The septal sutures, where visible and not corroded, appear to be complex as in *S. zitteli*.

"*Sonninia intumescens*" is therefore regarded as a junior synonym of *S. (F.) zitteli* (GOTTSCHÉ).

History

The original species description (GOTTSCHÉ, 1878, p. 10) was based on three specimens of the Stelzner collection from Espinacito Pass. The most complete specimen (phragmocone with beginning of body chamber) was designated as the type; the largest but fragmented phragmocone was distinguished as "var. α " because of "the smaller height and the slower growth of the whorls" (figured in section only); the smallest specimen was distinguished as "var. β " (not figured) because of the wider umbilicus. GOTTSCHÉ believed *S. zitteli* to be most closely related to *Sonninia patella* (WAAGEN). From the same collection, GOTTSCHÉ (op. cit.) described also other Sonniniidae under the names "*Harpoceras proximum* sp. n.", "*H. andium* sp. n.", "*H. Stelzneri* sp. n.", "*H. aff. Sowerbyi* MILL.", and a probable hammatoceratid under "*H. aff. variabile* D'ORB.". Unfortunately, the holotype of *S. zitteli* cannot be found; the type of "var. α " is refigured here. This and the majority of the other specimens of the collection are now kept in the Dirección Nacional de Geología y Minería, Buenos Aires.

Of the other "species" named by GOTTSCHÉ, "*H. proximum*" was based on a single small fragmentary specimen and said to be distinguished from *S. zitteli* by the presence of marked ribbing, simple and biplicate, of the immature shell. "*H. andium*", based on two incomplete small specimens without preserved septal suture, was said to differ from "*H. proximum*" by the smaller umbilicus and convex whorls (specimen to pl. II, fig. 1 is lost). "*H. Stelzneri*", based on three small incomplete specimens (two of them figured), was supposed to be distantly affiliated with *Dorsetensia deltafalcata* (QUENSTEDT); but the alleged presence of a broad "first lateral lobe" is contradicted by a new photograph of the specimen.

TORNUST (1898) based his reexamination of *S. zitteli* on eight topotypes collected by BODENBENDER, figuring two specimens. He noted that, in contrast to GOTTSCHÉ's statement, tubercles are missing (inner whorls) and that the maximum whorl width lies at mid-flank and not near the umbilical margin as shown in the original illustration of the holotype. TORNUST placed "*H. proximum*" GOTTSCHÉ in synonymy with *S. zitteli* recognizing its resemblance with the inner whorls of the larger *S. zitteli*; he also noted gross errors of GOTTSCHÉ's measurements for "*H. proximum*" (H/D = 0.47 vs. 0.54; U/D = 0.22 vs. 0.25). He named several new species of *Sonninia*, of which "*S. Argentina*" and "*S. intumescens*" closely resemble *S. zitteli*. The former, based on six specimens from Paso del Espinacito, was said to be distinguished by the more complex septal suture (in comparison with GOTTSCHÉ's figure), the flatter whorl sides and the different coiling (more involute inner whorls and more evolute body chamber), while the latter, based on 12 specimens also from Paso del Espinacito, supposedly differed in the more developed shoulders, the steeper umbilical slope, and the more inclined weaker ribbing.

The only description of *S. zitteli* from another locality is by JAWORSKI (1926 a); his small specimens came from Arroyo Blanco in Mendoza province (the same locality and, probably, bed from which our largest sample was taken) and from Cerro China, a few kilometers westward. JAWORSKI noted good resemblance in coiling with the evolute "var. β " GOTTSCHÉ and in whorl height with "var. α "; that the diameter of costae reduction varies as exemplified by GOTTSCHÉ's "*H. proximum*" and resembles TORNUST's figure 3 of *S. zitteli*; and he supposed that the septal suture closely resembles that of "*S. Argentina*". JAWORSKI believed that *S. zitteli* is closely affiliated to *S. patella* (WAAGEN), but that "*H. andium*" GOTTSCHÉ is not a sonniniid (JAWORSKI, 1915, p. 396; 1925, p. 131).

Finally, in monographic descriptions of central European Sonniniidae *S. zitteli* was regarded conspecific with *S. furticarinata* (QUENSTEDT) by HILTERMANN (1939, p. 186), and again compared with *S. patella* by DORN

(1935, p. 52). Finally, ARKELL (in ARKELL and PLAYFORD, 1954, p. 591) placed *S. zitteli* tentatively in *S. (Shirbuirnia)*, classified as a genus, and “*S. Argentinica*” in the affinity of *Witchellia (Sonninites) felix* (BUCKMAN), thus distinguishing the two species at the generic level as in the earlier work of GROEBER (1918).

Affinities

Sonninia (Fissilobicerias) zitteli closely resembles the northwest European *S. (F.) fissilobata* (WAAGEN, 1867) with which there could be some morphological overlap. *S. zitteli* is usually distinguished by the more acutely rounded venter without shoulders, at least of the inner and intermediate whorls; the absence of weak lateral plication on the outer whorls which OECHSLE (1958) believes to be characteristic for the European species; and possibly in the septal suture which may be somewhat simpler and sometimes have a broader lateral lobe, although *S. fissilobata* is poorly known in its variation. The resemblance to *S. fissilobata*, type species of the subgenus *Fissilobicerias*, is indeed so close that we have considered specific identity of the relatively rare European and the common Andean form. We have retained *S. zitteli* as a distinct species also because *S. fissilobata*, occurring in the Sowerbyi Zone only of the distant European area, is poorly known and the important Andean species is polytypic with a longer vertical range, possibly including several subspecies.

S. fissilobata (WAAGEN, 1867, p. 599, pl. XXVII, fig. 1) was reinvestigated by OECHSLE (1958, p. 96) who had at hand all known material and a few new specimens from southern Germany. Although defining *S. fissilobata* more broadly than previous authors, the species was said to be restricted to the Sowerbyi Zone of southern Germany. However, OECHSLE overlooked or ignored the record of a typical specimen from the “*Shirbuirnia hemera*” [Trigonalis Subzone, middle Sowerbyi Zone] of Sherborne in Dorset by BUCKMAN (1881, p. 603; 1920, pls. 181 A—B). The English and Scottish (MORTON, 1965) occurrences in the Trigonalis Subzone are probably of stratigraphic significance (see above) since the southern German “Sowerbyi-Bank” is a “condensed” deposit.

According to OECHSLE (1958, p. 96), the holotype of *S. fissilobata* (refigured by DORN, 1935, text-fig. pl. 5, figs. 8, 9 and pl. 13, fig. 1) is an extreme variant (involute compressed morphotype) while “*Ammonites Sowerbyi rudis*” QUENSTEDT (1886, p. 492, pl. 61, fig. 12; lectotype designated by DORN, 1935, and refigured text-fig. VI, figs. 2, 3; pl. XXI, fig. 3; not fig. 13 as designated by OECHSLE) represents the modal form of the highly variable species. The figures and measurements given by OECHSLE indicate that the Swabian *S. fissilobata* varies from very involute ($U/D = 0.14$), compressed ($H/W = 1.95$) and almost smooth forms to moderately evolute ($U/D \geq 0.26$), less compressed ($H/W \leq 1.67$) and somewhat ornate forms bearing primaries, secondaries and often tubercles up to the penultimate phragmocone whorl. If the evolute specimens from the Sowerbyi Zone of Swabia described by OECHSLE (1958, p. 119, pl. 14, fig. 1; pl. 15, fig. 5) under *S. pseudotrigonata* MAUBEUGE ($D = 54$ mm) are included in this species, the range of variation for umbilical width would extend to 0.31 and for whorl section to 1.31. The septal suture is always highly complex with narrow lateral lobe L.

Of interest in this connection is the evolute and ornate “*Fissilobicerias phlyctaenodes* BUCKMAN (1923, pl. 387) derived from an old collection and believed to be from the “Fossil Bed, lower part” of the Sandford Lane quarry in Dorset which was also the source of the typical *S. fissilobata* mentioned above. However, the brief study of the specimen has almost convinced us of its much closer affinities with the subgenus *Papilliceras*, particularly because of the minute lateral “papillae” on the ultimate whorl. From the same quarry and bed came also “*Prepapillites arenatus*, QUENSTEDT sp.” of BUCKMAN (1927, pl. 709) which is a typical *S. (Papilliceras)*.

Also regarded conspecific with *S. fissilobata* is “*S. frankonica*” DORN (1935, p. 59, pl. VIII, fig. 2; lectotype designated by OECHSLE, 1958) from the Swabian and Frankonian Jura which closely resembles the involute compressed morphotype of *S. fissilobata*. “*S. frankonica*” came from the Sowerbyi Zone of Swabia (OECHSLE, 1958, p. 119) and the “Mittel- γ ” of Frankonia. According to DORN (1935, p. 15) these beds contain “*Dorsetensia tecta*” and “*Witchellia pinguis*” which HUF (1968, pp. 37, 55, 107) identified respectively with *Sonninia (Shirbuirnia) stephani* BUCKMAN and *S. (Poecilomorphus) boweri* (BUCKMAN), both characteristic of the Sowerbyi Zone.

The ornament of the inner whorls of the involute compressed morphotype of *S. fissilobata*, as represented by the holotype, has remained unknown. The ornamental attributes observed in the evolute forms can certainly not be assumed to be the same for the whole species, as OECHSLE (1958, p. 97) has assumed; the closely affiliated *S. zitteli* varies according to the (1st) Buckman Law of Covariation (WESTERMANN, 1966), i. e. the involute compressed forms are much less ornate than the evolute inflated forms. The inner whorls of the involute compressed morphotype of *S. fissilobata* are probably very much like the much smaller “*S. frankonica*” DORN (see above).

Sonninia (Fissilobicerus ?) mammilifera JAWORSKI, 1926

(pl. 19, fig. 2)

1926a. *Sonninia mammilifera* JAWORSKI, p. 231, pl. III, fig. 1.

1926b. *Sonninia mammilifera* JAWORSKI, p. 408, pl. XII, figs. 3 a, b, text-fig. 12. (JAWORSKI, 1926 a, refigured).

Material

The holotype (plaster cast), a small incomplete, partly crushed (body chamber?) internal mould with test remains, from "locality 7, profile VI, horizon 9" of Arroyo Blanco, Mendoza province (IPB 41) — Sowerbyi Zone.

Remarks

The specimen almost certainly came from the *Sonninia zitteli* concretions of the Arroyo Blanco section. Despite our extensive recollecting in these beds yielding a large sample of *S. zitteli* and associate fauna, the holotype remains the only specimen of this poorly known species.

The whorls are quite strongly compressed ovate ($H/W = 1.6$) with narrowly rounded venter, becoming slightly tabulated at the end, and prominent keel. The ornament consists of prominent, long, slightly prorsiradiate and weakly flexed primaries which, on the outer half-whorl, divide on the outer flank into much finer projected secondaries; thin intercalatories are also present. On the preceding whorl, however, secondaries appear to be absent with the primaries or simple ribs extending onto the shoulder. The septal suture appears to be unknown.

JAWORSKI (1926 a, b) probably correctly placed this form in the affinity of *Sonninia (Fissilobicerus) zitteli* (GOTTSCHKE), from which it is clearly distinct by the more prominent distant ribbing and the more compressed whorl section.

Measurements in mm

	D	H	W	U
holotype (plaster cast)	49	21	13.5	12.6

Subgenus *Papilliceras* BUCKMAN, 1920

[Syn.: *Prepapillites* BUCKMAN, 1927]

Type-species by original designation — *P. papillatum* BUCKMAN, 1920, from the (Sowerby +) Sauzei Zone of England.

European Species

Like *S. (Fissilobicerus)*, the generic or subgeneric name *Papilliceras* has rarely been used in subsequent monographic studies; it was usually either ignored (DORN, 1935; OECHSLE, 1958) or regarded as synonymous with *Sonninia* s.s. (HILTERMANN, 1939) or, possibly, *Euhoploceras* (SPATH, 1936, p. 5). *Papilliceras* was retained at the generic level probably only by CRICKMAY (1933) and MAUBEUGE (1951), and as subgenus of *Sonninia* by ARKELL (ARKELL & PLAYFORD, 1954, p. 560; ARKELL et al., 1957, p. L268) although forms intermediate to *Sonninia* s.s. were admitted to exist. Apparently the only diagnosis was given by ARKELL et al. (loc. cit.): "with row of median lateral tubercles persisting over all septate whorls and in some also on body chamber, may be strigate". However (concentric) striation has never been observed by us and is recorded in the literature known to us only from the holotype of *S. strigocerooides* DORN.

The holotype of the first named species (not the type-species), *Sonninia mesacantha* (WAAGEN, 1867), was newly described and figured by DORN (1935, p. 43, pl. VIII, fig. 4). However, DORN's data of measurements were copied from WAAGEN; they are given correctly in the text-figures (measurements by Dr. W. BARTHEL). As HAUG (1885, p. 655) already noticed, the keel is hollow-floored as in *Sonninia sowerbyi* (MILLER), so that the only valid one of WAAGEN's supposed diagnostic attributes is the fine mid-lateral tuberculation of the outer whorl(s). HAUG (loc. cit.) and HILTERMANN (1939, p. 141) noted the identity of the inner whorls with *S. sowerbyi* and therefore classified *S. mesacantha* as a "mutation" or subspecies of *S. sowerbyi* only, with the supposed differences restricted to the outer whorls. JAWORSKI (1915, p. 399; 1925, p. 134) confirmed this identity of the inner whorls but suggested that the differences in the outer whorls warrant specific distinction. However, the holotype of *S. sowerbyi* (refigured by BUCKMAN, 1908, opposite pl. III) is only an incomplete phragmocone (from the ? Sauzei Zone of the Inferior Oolite of Dundry, Somerset) and the frequent statements about its supposed (HAUG, DORN, HILTERMANN, OECHSLE, locs. cit.) identity with "*Am. sowerbyi*" of D'ORBIGNY (1842, pl. 119, figs. 1—2) and

about the adult whorls of *S. sowerbyi* are therefore mere conjectures. The figured specimen of D'ORBIGNY is also a phragmocone (probably $D = 80$ mm) but differs from the holotype in the presence of prominent secondaries; it is not necessarily conspecific with the large specimen ($D = 230$ mm) recorded by the same author (loc. cit.) which was said to have an almost smooth outer whorl. One of us (WESTERMANN) who briefly studied the holotype in the Bristol Museum, believes that there is a good possibility that the holotype is the nucleus of a *S. (Papilliceras)*. Although the inner whorls of *S. mesacantha* tend to be more compressed than *S. sowerbyi*, the English *S. (P.) papillata* group has more inflated whorls resembling *S. (Euhoploceras) adicra* (text-fig. 28); thus *S. (P.) acanthera* BUCKMAN, a close relative of *S. papillata*, was regarded as synonymous with *S. adicra* by HILTERMANN (1939, p. 150).

The holotype of the type-species *S. (P.) papillata* is a large phragmocone with evolute ($U/D = 0.37 \rightarrow 0.41$) and moderately compressed ($H/W = 1.4 \rightarrow 1.45$) whorls; the inner whorls have distantly spaced lateral nodes with many intermittent simple ribs while the outer whorls bear widely spaced simple ribs with apparently regular small tubercles. Coiling and whorl section are similar to modal *S. (Euhoploceras) adicra* (WAAGEN) (WESTERMANN, 1966, text-fig. 8) but without grooves besides the keel. The prominence of the ornament (op. cit., text-fig. 9) resembles that of *S. adicra* forma dominans. In the bivariate plot of coiling (or whorl section) and ornament, the holotype of *S. papillata* has a marginal position in the *S. adicra* cloud (loc. cit.); only the convex venter and the "papillae" on the outer whorl of *S. papillata* appear to be clearly distinct.

It appears likely that *S. (P.) acanthera* (BUCKMAN), from the same quarry and bed as *S. (P.) papillata*, is merely a more strongly ornate variant of the type-species. It resembles *S. adicra* forma crassispinata in coiling and ornament but is much more compressed (WESTERMANN, 1966, text-fig. 9). Similarly, *S. (P.) micracantha* (BUCKMAN), from the Sauzei Zone of Dundry, Somerset, and "*Prepapillites arenatus*, QUENSTEDT sp." of BUCKMAN, supposedly from the Sowerbyi Zone of Sherborne, Dorset ("Fossil Bed, lower part", total thickness 0.5 m; fide ARKELL, 1933, p. 194; dated as "*Shirbuirnia*" hemera) may well be involute compressed and weakly ornate variants of *S. papillata*; they resemble *S. adicra* forma dominans in coiling and ornament but also differ in being more compressed with rounded venter and in bearing "papillae" on the outer whorls.

Prepapillites BUCKMAN (1927, pl. DCCIX, figs. 1—2) was based on "*Ammonites*" *arenatus* QUENSTEDT (1886) from the Sauzei Zone of the Swabian Jura Mountains. The only discussion known to us is by ARKELL (in ARKELL & PLAYFORD, 1954) who placed "*Prepapillites*" in synonymy with the subgenus *Papilliceras* (p. 560; also in Treatise, p. L268) and at the same time implicitly placed the type species "*Am.*" *arenatus* in *Sonninia* s. s. (1954, p. 591): "*S. espinazitensis* TORNQUIST is a *Sonninia* with outer whorls resembling the subgenus *Papilliceras* BUCKMAN, but with much smoother inner whorls, so that it is closely comparable with *Sonninia arenata* (QUENSTEDT) . . . though differing in its gentle umbilical slope". However, OECHSLE (1958) included "*Am.*" *arenatus*, together with several *Papilliceras* "species" of MAUBEUGE, as a subspecies in *Sonninia patella* (WAAGEN) thus considering the "papillae" as of only subspecific significance. SPATH (1936, p. 5) regarded "*Prepapillites*", together with "*Sherbornites*" BUCKMAN (1923), as intermediate between *Papilliceras* and *Euhoploceras* BUCKMAN (1913) thus implicitly discrediting both generic names.

The holotype of "*Ammonites*" *arenatus* QUENSTEDT (1886, p. 482, pl. 60, fig. 10) was refigured in the right lateral view by DORN (1935, pl. VII, fig. 1) and a complete section was drawn by OECHSLE (1958, pl. 12, fig. 10). The apparent disagreement between the measurements of DORN (p. 38) and OECHSLE (p. 104) is owing to the fact that DORN's measurements were taken at the end and OECHSLE's (first line) at the middle of the complete body chamber. Phragmocone and body chamber are extremely compressed ($H/W = 2.2 \rightarrow 2.4$). The nucleus bears strong blunt primaries with bullae-like swellings on the umbilical margin; the costae weaken progressively on the intermediate whorls becoming obsolete at 80—100 mm diameter; tubercles are missing on the phragmocone which ends at about 180 mm D. The body chamber, slightly more than a half-whorl long, has only weak short primaries with minute mid-lateral tubercles and, near the end, blunt projected dense secondaries. The aperture, at 161 mm diameter, is simple with sinuous peristome. The holotype and the few hypotypes from the German Jura Mountains are all from the "Blaukalk" of the Sauzei Zone (OECHSLE, 1958, p. 102). Already QUENSTEDT (1886, p. 482) assumed close affiliation of "*Am.*" *arenatus* with "*Am.*" *mesacanthus* WAAGEN; he and, later, DORN (1935, p. 39) distinguished these supposed species only by the respective absence or presence of prominent nodes on the inner whorls; QUENSTEDT appended "(cf. *mesacanthus*)" in the first mention of the new name (op. cit.). Resemblance is particularly strong with DORN's (1935, pl. VIII, fig. 1) hypotype of *Sonninia mesacantha* from Franconia (Sauzei

Zone; fide OECHSLE, 1958, p. 84) in which the tubercles are restricted to the inner whorls of approximately 55 mm diameter. This specimen is thus intermediate between the holotypes of "*Am.*" *arenatus* and "*Am.*" *mesacanthus*, and it is perfectly matched by BUCKMAN's (1925, pl. DLVII) "*Papilliceras*" *mesacanthum* from the Sauzei Zone of Bradford Abbas, Dorset. A specimen (MCM J1756) found by one of the authors (WESTERMANN) in the Berreraig Sandstone of Skye, Scotland, connects the Dorset form with the holotype of "*Am.*" *arenatus*, the inner nodose stage being restricted to the nucleus of 25 mm diameter. We consider OECHSLE's exclusion from *S. mesacantha* of DORN's specimens (and implicitly also of BUCKMAN's specimens whose work is ignored) as merely indicating a typological species concept. DORN (1935, pl. VII, fig. 2) also described a more evolute and more coarsely ribbed "*S. arenata* QU. variatio" which on the nucleus has "knotenförmige Gebilde" (node-like structures); the identity with "*Am.*" *arenatus* ("*S. patella arenata*") was confirmed even by OECHSLE (1958, p. 102 with correction of Sauzei Zone). Similar specimens were described from northeastern France (MAUBEUGE, 1951, p. 49—50, pl. III, fig. 2, pl. IX, fig. 6), one possibly with bullae on the nucleus. Another evolute, strongly costate form without tubercles (inner whorls) was named *Papilliceras pseudoarenatum* by MAUBEUGE (1951, p. 48, pl. XIII, fig. 3) and also placed in *Sonninia patella* by OECHSLE (1958, p. 103), based on Swabian specimens from the Sauzei Zone; it differs in the less strongly compressed whorl section ($H/W = 1.4$). Another intermediate form resembling "*Am.*" *arenatus* but close to "*Am.*" *mesacanthus* is *Sonninia strigoceroide*s DORN (1935, p. 57, pl. XXIII, fig. 2) which on the inner whorls bears bullae but not tubercles.

The English "*Papilliceras*" *papillatum* BUCKMAN, type-species, and "*P.*" *acanthum* BUCKMAN, on the other hand, have more rounded whorls than any of the *Papilliceras* species and specimens described above from the European continent with the exception of "*P.*" *pseudoarenatum*. Significantly, "*Prepapillites arenatus*" of BUCKMAN [= ? *S. (P.) pseudoarenata* (MAUBEUGE)], from the same quarry and bed as his other two species, differs similarly from the true south German and French "*Am.*" *arenatus*. Only BUCKMAN's "*P.*" *mesacanthum* from Bradford Abbas, also in Dorset, has the compressed whorl shape of the continental forms.

A morphological series from evolute, inflated and ornate forms to involute, compressed and almost smooth forms is known from the subgenus *S. (Euhoploceras)* which is regarded as the immediate ancestor of *S. (Papilliceras)* (WESTERMANN, 1966). The presence of two similar series is indicated for *S. (Papilliceras)*; one series includes the mainly central European "*Am.*" *mesacanthus*, *S. strigoceroide*s and "*Am.*" *arenatus*, and the other the mainly northwest European "*P.*" *papillatum*, "*P.*" *acanthum*, "*P.*" *micracanthicum*, "*P.*" *pseudoarenatum*, and "*Prepapillites arenatus*" BUCKMAN (non QUENSTEDT). The mainly central European species group or "superspecies" occurs also in the Hebrides (and ? northwest Africa) and is here referred to as the *S. mesacantha* group; the mainly northwest European species group or "superspecies" is also abundant in western North America and is referred to as the *S. papillata* group. Unfortunately, the poor knowledge of the European *S. (Papilliceras)* does not permit any radical changes of classification such as the strong reduction of specific names. However, we are on rather firm grounds to propose that the holotypes of "*Am.*" *mesacanthus* and "*Am.*" *arenatus* are merely extreme variants of a single species, whatever reasonable species definition one may choose. "*Prepapillites*" is therefore certainly synonymous with the subgenus *Papilliceras* since the type-species appear to be conspecific, thus confirming the opinion of the majority of authors (including those of the "Treatise").

Non-European Species

Northwest Africa — The subgenus is possibly present in the Atlas Mountains of Morocco with the *S. mesacantha* group, as suggested by some photographs kindly sent by Dr. DU DRESNEY several years ago.

North America — Species of this subgenus have been recorded from southeast Alaska (IMLAY, 1964), northern California (CRICKMAY, 1933) and east-central Oregon (LUPHER, 1941; no description or illustration). So far as is known, the subgenus is essentially restricted to the Sauzei Zone.

All North American specimens are fragmentary. The southeast Alaskan form which IMLAY (1964, p. B34) compared with "*Am.*" *arenatus* QUENSTEDT and of which 5 specimens (of 8) are available as plastercasts, has an unknown nucleus, finely costate intermediate whorls and almost smooth outer whorls except for a mid-lateral line of small tubercles; the whorls are moderately involute and compressed subrectangular in section ($H/W = 1.45$ to 1.65 , text-fig. 28). Because of the rather inflated whorl section, this form is much closer to the *S. papillata* group, such as "*Prepapillites arenatus*" of BUCKMAN (1927, pl. DCCIX), than to the *S. mesacantha* group.

Four fragments compared by IMLAY (1964, p. B34, not illustrated) with *S. espinazitensis* TORNQUIST but

said to differ in the stouter whorls, were kindly given on loan: (1) a large body chamber fragment has rather high-set lateral swellings, the dorsal impression of a sub-fastigate penultimate whorl and is tentatively assigned to *S. (Papilliceras)* ex gr. *papillata* (BUCKMAN); (2) a small septate fragment with compressed bisulcate-tricarinate whorl section is placed in *Witchellia* ex gr. *sutneri* (BRANCO) resembling weakly ornate variants of *W. sutneroides* WESTERMANN (1969) from the Sowerbyi Zone of Wide Bay; (3) two septate whorl fragments, possibly belonging to a single specimen, have compressed subrectangular sections with flattened venter and weak simple ribs. They are tentatively referred to compressed *S. (Euhoploceras)* resembling the European *S. (E.) adicra* forma *modesta* and some of the south Alaskan *S. (E.) bifurcata* WESTERMANN (1969); their age is probably Sowerbyi Zone although the subgenus may in Alaska range upward into the Sauzei Zone (op. cit.).

IMLAY (1964, p. B 33) tentatively placed three fragments in "*Sonninia projectifer* (BUCKMAN)", a form probably identical with *S. (Euhoploceras) adicra* (WAAGEN) of the Sowerbyi Zone (WESTERMANN, 1966, p. 298). However, as noticed by IMLAY, they differ from any known ornate *S. (Euhoploceras)* and closely resemble *S. (Papilliceras) acanthera* (BUCKMAN) of the *S. papillata* group.

"*Sonninia tuxedniensis*" IMLAY (1964, p. B 32) is morphologically intermediate between *S. (Euhoploceras)* and *S. (Papilliceras)*, combining the ornamentation of the former with the whorl section of the latter.

From the Mormon Formation of Mount Jura in northern California, CRICKMAY (1933) described and illustrated several poorly preserved fragments which were placed in 3 species of *Papilliceras*. (1) "*P. blackwelderi*" CRICKMAY was based on a single fragmentary specimen, of which at least the phragmocone seems to be crushed (cf. drawn whorl section). The last two whorls, including the body chamber, are strongly compressed (recorded as H/W = 2.3 to 2.9) and have obsolete ribs with mid-lateral 'papillae'. The fauna (op. cit., p. 898) of the "*blackwelderi* zone" (sic!) includes *Stephanoceras (Itinsaites) itinsae* (McLEARN) ♂ ["*Otoites reesidei*" CRICKMAY] and *Chondroceras russelli* CRICKMAY, both good indicators of the Humphriesianum Zone (WESTERMANN, 1956 a, p. 53—54); it was dated as "*Sonninia alsatica*" ('hemera?') [Sauzei/Humphriesianum Zone] by CRICKMAY (p. 899). (2) "*P. juramontanum*" CRICKMAY was possibly based on several specimens, but the holotype is a poorly preserved whorl fragment of an evolute shell bearing dense straight ribbing with mid-lateral tubercles; the recorded measurements indicate a weakly compressed whorl section (H/W = 1.27) and the specimen resembles *S. (Euhoploceras)*, as also stated by CRICKMAY. However, the "*juramontanum* zone" (sic!) is supposedly above the "*blackwelderi* zone". (3) "*P. stantoni*" CRICKMAY seems to be based only on a single fragmentary natural mould. The whorls are evolute, subcircular (H/W ≈ 1.0; according to measurements, photograph and drawn section), irregularly costate and tuberculate. This specimen differs from *S. (P.) acanthera* (BUCKMAN) with which it was compared, by the subcircular whorl section and closely resembles *S. (Euhoploceras) adicra* (WAAGEN) forma *crassispinata* from the lower Sowerbyi Zone of Europe (WESTERMANN, 1966). The "*stantoni* zone" of CRICKMAY (1933, p. 911) or "fauna (5)" (p. 899) which besides this ammonite contains only various brachiopods, was correlated with BUCKMAN's "*Labyrinthoceras hemera*" (loc. cit.) of the Sauzei Zone, probably because it overlies the "*schucherti* zone" containing "*Stiphromorphites schucherti*" CRICKMAY, another poorly known *S. (Euhoploceras)*. At least "*Papilliceras blackwelderi*" and "*P. juramontanum*" are nomina dubia being based on totally insufficient material permitting identification only at the subgenus level, and the status of "*P. stantoni*" is questionable. Unfortunately the type material was not available for reexamination (stored privately). Furthermore, the stratigraphic succession of the assemblages is open to doubt because of the extreme structural complication and poor exposures at Mount Jura (briefly visited by the senior author in 1959). Nevertheless, the listed assemblages, if indeed from single beds, are of interest because they would indicate an exceptionally late date for *S. (Papilliceras)*, i. e. Humphriesianum Zone of "fauna (7)". Similar excessive upward ranges, in comparison to Europe, are known from the Aalenian and early Bajocian of south Alaska (WESTERMANN, 1969).

South America — From Chunumayo, Peru, a single specimen of *S. (Papilliceras)* has been illustrated under *S. mesacantha* (WAAGEN) by JAWORSKI (1915, p. 399, pl. VIII, fig. 2, cross section only; same specimen as STEINMANN, 1929, p. 77, fig. 86, drawing or strongly retouched photograph) which according to STEINMANN (loc. cit.) came from the "Sauzei-Schichten". A photograph of the specimen was kindly sent by Professor H. K. ERBEN, Bonn. Because of the prominent costae on the intermediate whorls becoming weak on the outer whorl, and the highly compressed whorl section (H/W = 1.8), this specimen indeed resembles the European *S. mesacantha*. However, the nucleus is missing, so that its identification can only be tentative. JAWORSKI's (1915, p. 396) record of *S. arenata* (QUENSTEDT), of which a photograph is also available, indeed matches the central European species

in the lateral view, but the whorl section is more inflated ($H/W = 1.65$ at $D = 120$ mm, fide JAWORSKI) resembling that of "*P. arenata*" of BUCKMAN of the *S. papillata* group.

From Chile, the only previously figured specimens of *S. (Papilliceras)* are from the Manflas section in Atacama province described by MÖRICKÉ (1894, p. 18—19). The "*Hammatoceras (Sonninia) andium* GOTTSCHÉ" (pl. V, figs. 6 a, b) was correctly placed in *S. espinazitensis* subsp. ? *altecostata* TORNQUIST (TORNQUIST, 1898); the "*H. (S.) polyacanthum* WAAGEN" (pl. III, figs. 3 a, b) is a *S. espinazitensis* TORNQUIST. The locality (Hacienda Manflas) has been reexamined and a number of *S. espinazitensis* was collected from the Sauzei Zone.

The famous Espinacito Pass section, San Juan province, is the only occurrence in Argentina from where *S. (Papilliceras)* has been described and figured, with the exception of the two fragments from Portezuelo del Viento, Mendoza province, described by BURCKHARDT (1900, p. 30, pl. XXII, figs. 3, 4) under "*S. altecostata*". A similar fragment was described, but not illustrated (specimen at hand), from Canāda Colorada, also Mendoza province, by WEAVER (1931, p. 403). JAWORSKI's (1926 a, p. 227, pl. III, figs. 6, 8, 9) "*S. fascicostata* TORNQUIST" are of uncertain affinity and probably include at least one microconch (fig. 8).

The five alleged species of *S. (Papilliceras)* described and named by TORNQUIST (1898) under *Sonninia espinazitensis*, "*S. altecostata*", "*S. gracilis*", "*S. curviplez*", and "*S. fascicostata*" are all based on macroconchs (♀) and here regarded as belonging to a single species with probably two chronological subspecies. Since *S. espinazitensis* was based on the best material and served in naming the principal "Formenreihe", this name is here chosen for this polytypic species; *S. espinazitensis altecostata* is the only known probable subspecies other than the nominate subspecies, and is based on evidence partly of Dr. HILLEBRANDT's current work (1970 and in litt.). *S. bodenbenderi* and *S. subdeltafalcata*, TORNQUIST spp., probably represent the corresponding microconch form (♂). We are puzzled why GOTTSCHÉ's (1878) original work on the Espinacito Pass section excluded the description of this abundant species while the other molluscan fauna of the same assemblage was amply described and illustrated.

Sonninia (Papilliceras) espinazitensis TORNQUIST, 1898, ♀

(pls. 20—26; text-figs. 25—35)

1894. *Hammatoceras (Sonn.) polyacanthum* WAAG. — MÖRICKÉ, p. 19, pl. III, figs. 3 a (3 b ?) [♀].
 1894. *Hammatoceras (Sonninia) andium* GOTTSCHÉ — MÖRICKÉ, p. 18, pl. V, figs. 6 a, b [= ? subsp. *altecostata* ♀].
 1898. *Sonninia espinazitensis* TORNQUIST, p. 20 (152), pl. III (XVI), figs. 2 [holotype], 3; pl. IV (XVII), fig. 1 [♀].
 1898. *Sonninia fascicostata* TORNQUIST, p. 20 (152), pl. II (XV), fig. 5 [♀].
 1898. *Sonninia gracilis* TORNQUIST, p. 21 (153), pl. IV (XVII), fig. 4 [♀].
 1898. *Sonninia curviplez* TORNQUIST, p. 22 (154), pl. IV (XVII), fig. 3 [♀].
 1898. *Sonninia altecostata* TORNQUIST, p. 19 (151), pl. II (XV), fig. 4 [= ? *S. espinazitensis* s. str.], pl. III (XVI), fig. 1 [= ? subsp. *altecostata* ♀, lectotype, here designated].
 1900. *Sonninia altecostata* TORNQUIST — BURCKHARDT, p. 30, pl. XXII, figs. 3, 4 (non pl. 29, fig. 7) [= ? subsp. *altecostata* ♀].
 1931. *Sonninia altecostata* TORNQUIST — WEAVER, p. 403 [specimen studied] [♀].

Material

Paso del Espinacito, San Juan province, "Beds with *Sonninia* ex gr. *Sowerbyi* and *Sphaeroceras Sauzei*": 10 type specimens (TORNQUIST, 1898), 9 topotypes from Bodenbender collection (GAUG 496—29 to 37), and 1 type specimen from Güssfeldt collection (MNHUB); 1 large internal mould (DNGM 14281); 1 good specimen and 3 fragments (MLP 4240, 6660).

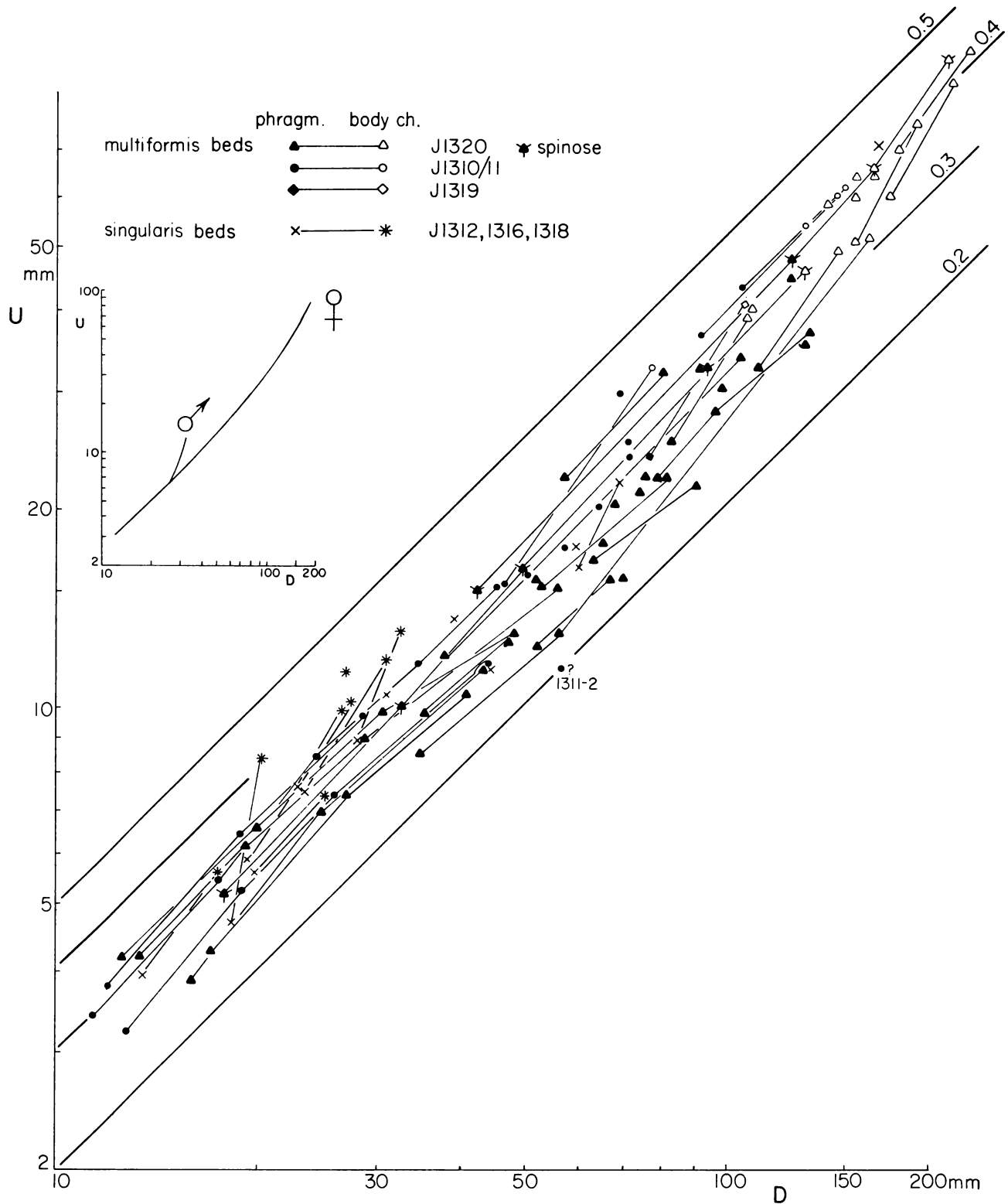
Zapala area, Neuquén province. Paso Carro Quebrado: 2 fragments (cf. ? subsp. *altecostata*) from bed 6 a (MCM J1318); 2 incomplete internal moulds and 3 fragments from bed 6 c (MCM J1319). Los Molles: several fragments from bed 6 (MCM J1313); 1 good specimen, several large and intermediate sized fragments and (?) 4 microconchs from bed 7 (MCM J1312); 4 good specimens, several fragments, ? several microconchs from bed 8 (MCM J1316). Charahuilla: 2 small good specimens and fragments from scree near bed 1a₂ (MCM J1311); 12 good (measured) and numerous fragments from bed 1 b (MCM J1310); 30 good (measured) and numerous fragments from bed 1c₁ (MCM J1320); (?) several poorly preserved specimens from bed 1 d (MCM J1342); 6 good specimens and 5 fragments (MLP 5985, 5990; MBR 4401, 5001, 5005, 5009, 5010, 5012, 5017, 5021, 5022). Chacaico: (?) several specimens from loc. 1 (MCM J1323); ? 2 good and 1 fragment (MLP 3696 a, 8607, 8752). Chacaico-Curi: 1 good (MBR 361). Catan-Lil: 1 good (MLP 1258) — Sauzei Zone, except for MCM J1318 and ? J1313 which are Sowerbyi Zone (*P. singularis* beds).

Sierra de Reyes, Mendoza province: 3 good specimens (MBR 15017, 15018, 15047c).

Cañada Colorada, Mendoza province: original to WEAVER (1931) (TBMWSM 314).

Cerro Puchenque, Mendoza province: several cf. ? subsp. *altecostata* from concretion 11 (MCM J1750) — (Sauzei ?) Sowerbyi Zone.

Manflas, Atacama province, Chile: 8 (+ 1 ?) incomplete macroconch and fragments from beds 6 a, b (MCM J1189—1190) — Sauzei Zone.



Text-fig. 25. Plot of umbilical width (U) against shell diameter (D) for *Sonminia (Papilliceras) espinazitensis* TORNQ., growth lines indicated. Sowerbyi Zone (*Pseudotoites singularis* beds) and Sauzei Zone (*Emileia* aff. *multiformis* beds), Neuquén Province. Note distribution of spinose forms.

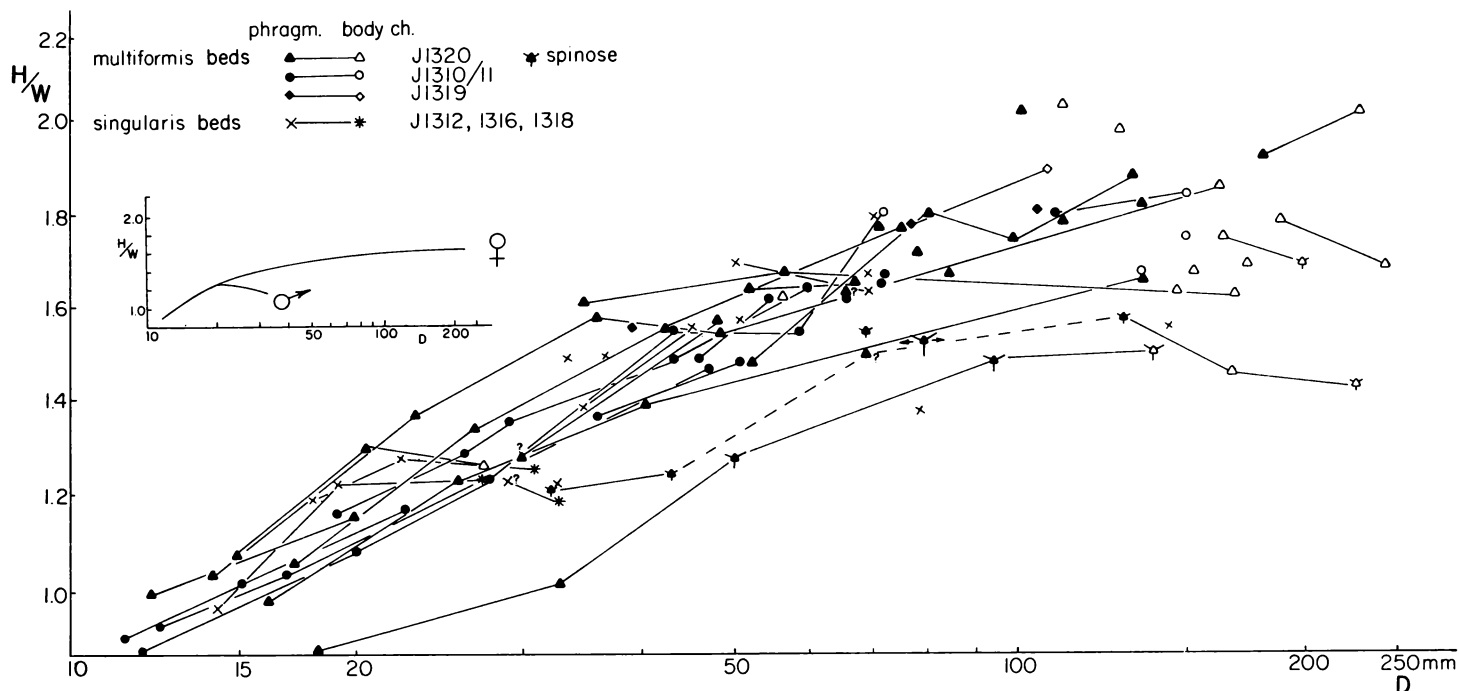
Description

Samples from the *Emileia* aff. *multiformis* beds (Sauzei Zone) of Charahuilla.

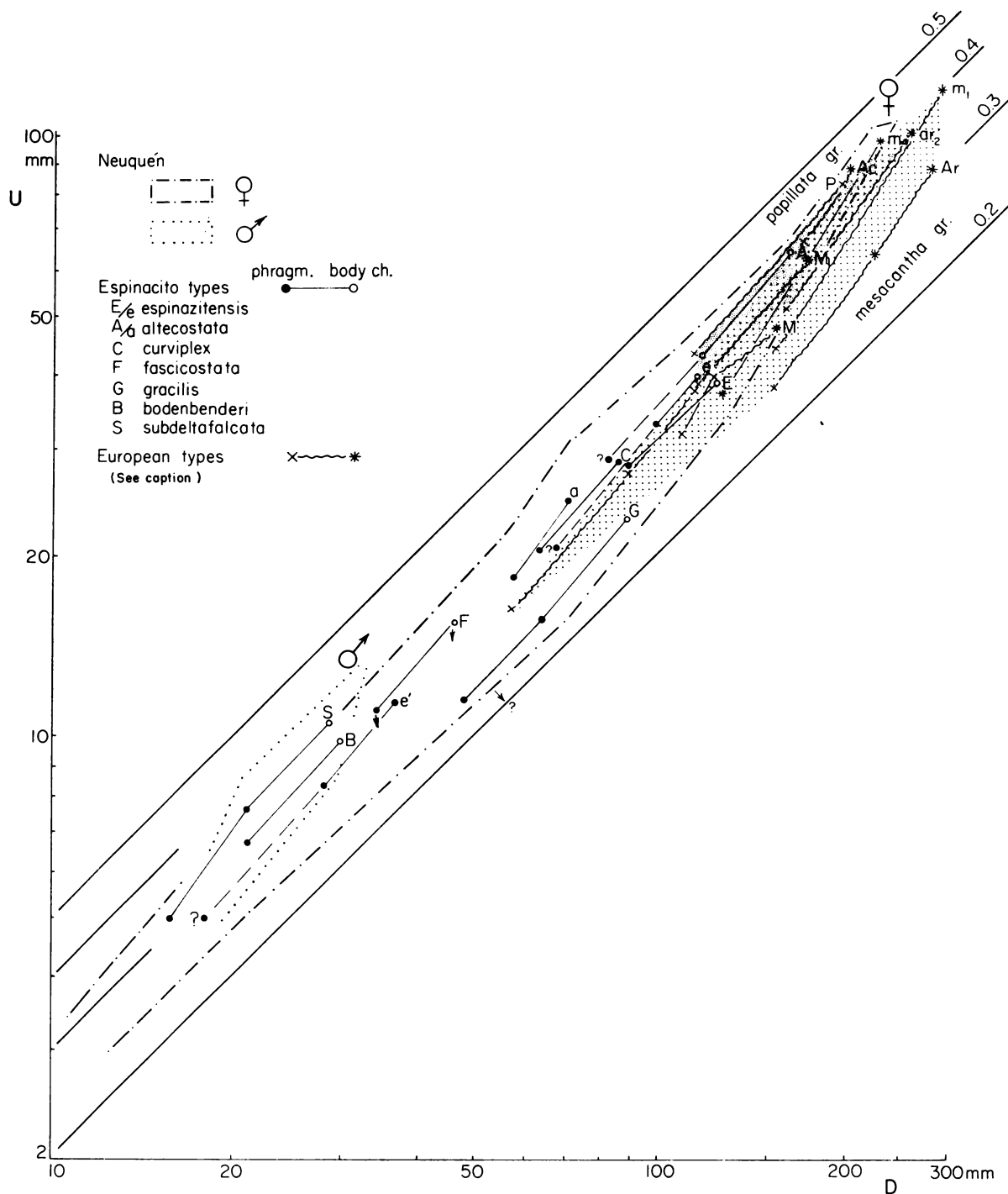
The two moderately large samples of well preserved macroconchs from a 30 m section of a thick sedimentary sequence, give evidence for a single polytypic series, with the possible exception of two or three highly spinose specimens (pl. 25). Both samples appear to include the morphotypes formerly named *S. espinazitensis* (s. s.), *S. fascicostata*, *S. gracilis*, *S. curviflex* and possibly *S. altecostata*, TORNQUIST spp. (text-figs. 25—32).

The adult macroconch is usually large ($D \approx 150$ to 300 mm), with compressed oval and moderately evolute whorls which egress considerably with the last whorl; there are fine dense and simple to somewhat fasciculate projected costae usually without tubercles on the inner whorls, and prominent distant simple rectiradiate costae with mid-lateral tubercles on the outer one to two whorls. However, some specimens have more strongly evolute and inflated whorls bearing more prominent ornament; their inner whorls bear fasciculate ribs with bullae-like swellings or irregular to regular nodes on the inner flanks and the body chamber is unusually also ornate. There are also more involute compressed specimens with obsolete or weak ornament throughout, except for the body chamber where mid-lateral fine tubercles are present and short blunt costae are developed towards the aperture (text-figs. 25, 26, 31, 32). Thus, variation of dimensions (H, W, U) and of prominence of ornament is interdependent according to the (1st) BUCKMAN Law of Covariation (WESTERMANN, 1966), the more evolute and inflated specimens being more highly ornate.

The whorl section develops from subcircular of the nucleus ($D = 10$ to 20 mm) to compressed oval, except for the spinose variants (rare morphotype) where whorl height exceeds width to 30—40 mm diameter (text-fig. 26). Compression increases progressively by negative allometry of whorl width resulting in a height-width ratio of 1.45—2.05 for the adult phragmocone at 100—150 mm diameter. The whorl section of the fully grown outer whorls including the body chamber is compressed ovate with shallow, more or less rounded umbilical slope and narrowly curved venter becoming obtusely to acutely arched beneath the hollow keel. The adult body chamber varies in length about a mode of three-quarters whorls and in diameter between approximately 200 and 300 mm. The coiling (text-fig. 25) of the inner whorls up to 60—80 mm diameter is moderately tight with the umbilical

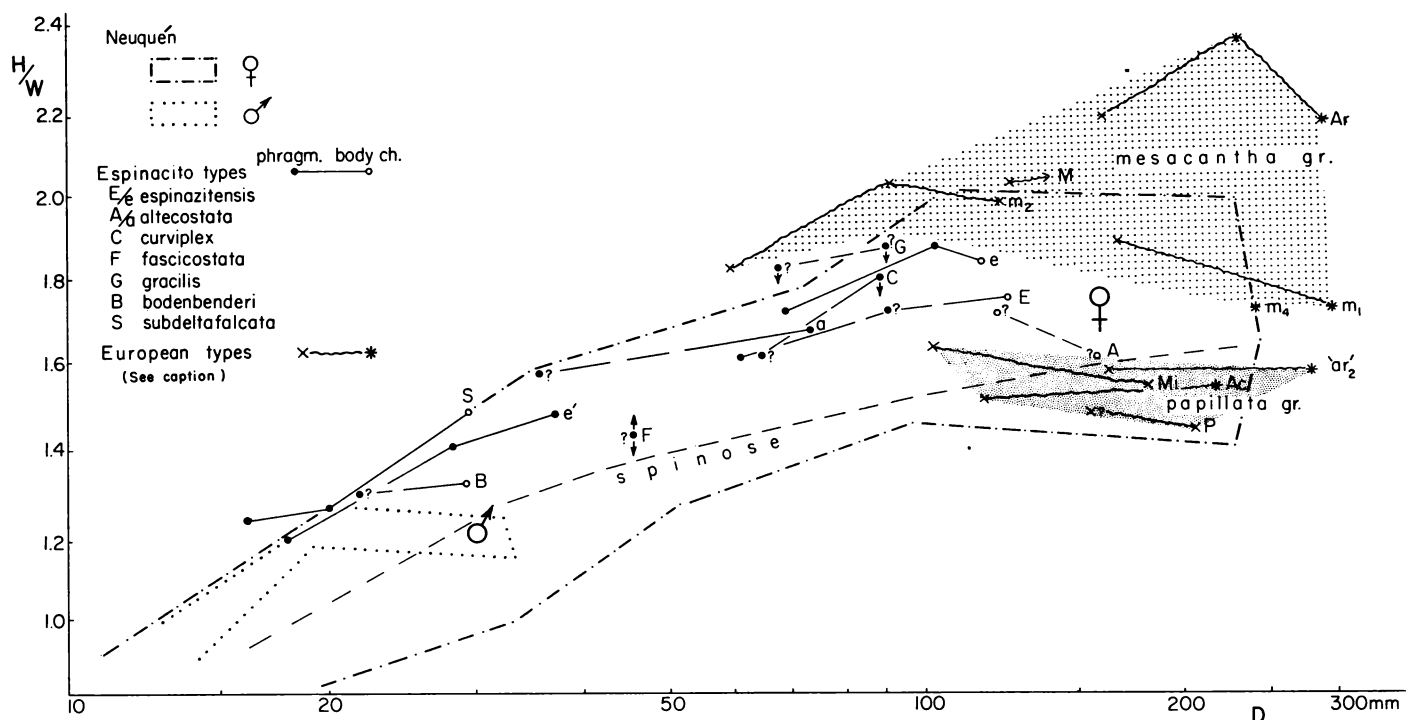


Text-fig. 26. Plot of whorl section (H/W) against shell diameter (D) for *Sonninia* (*Papilliceras*) *espinazitensis* TORNQ., growth lines indicated. Sowerbyi Zone (*Pseudotoites singularis* beds) and Sauzei Zone (*Emileia* aff. *multiformis* beds), Neuquén Province. Note distribution of spinose forms.



Text-fig. 27. Plot of umbilical width (U) against shell diameter (D) for the type specimens of *Sonninia (Papilliceras) espinazitensis* TORNQ. and synonymous "species" (see inset "Espinacito types"), as well as of the mostly European "species" here placed in the *S. papillata* and *S. mesacantha* groups (respectively in dark and light shading); polygons indicate the morphologic distributions of *S. espinazitensis* ♀ & ♂ from Neuquén Province (cf. Text-fig. 25). Measurements at end of phragmocone. Growth lines indicated.

Abbreviations — holotypes and lectotypes indicated by capital letters, paratypes, paralectotypes and hypotypes by lower case letters. *S. mesacantha* group: M, *S. mesacantha* (WAAGEN); m₁, "*P.*" *mesacanthum* of BUCKMAN; m₂, *S. mesacantha* from Skye, Scotland (MCM J 1756); r/A, "*Am.*" *arenatus* QUENST.; r/a, "*S. aff. arenata*" of MAUBEUGE; a₁, "*S. arenata* var." of DORN. — *S. papillata* group: P, *S. papillata* (BUCKMAN); Pa, *S. pseudoarenata* (MAUBEUGE); Mi, *S. micracantha* (BUCKMAN); Ac, *S. acantha* (BUCKMAN); a₂, "*P. arenata*" of BUCKMAN; a₃, "*S. cf. arenata*" of Imlay, S. Alaska.



Text-fig. 28. Plot of whorl section (H/W) against shell diameter (D) for the type specimens of *Sonninia (Papilliceras) espinazitensis* TORNQ. and synonymous "species" (see inset "Espinacito types"), as well as of the mostly European "species" here placed in the *S. papillata* and *S. mesacantha* groups (respectively in dark and light shading); polygons indicate the morphologic distributions of *S. espinazitensis* ♀ & ♂ from Neuquén Province (cf. Text-fig. 26). Same abbreviations as in Text-fig. 27. Note the distribution of spinose forms at low H/W (upper limit indicated).

width varying from 25 to 35 percent of the diameter; the last phragmocone whorl and the body chamber tend to egress progressively, with the umbilical width reaching up to 45 percent of the diameter.

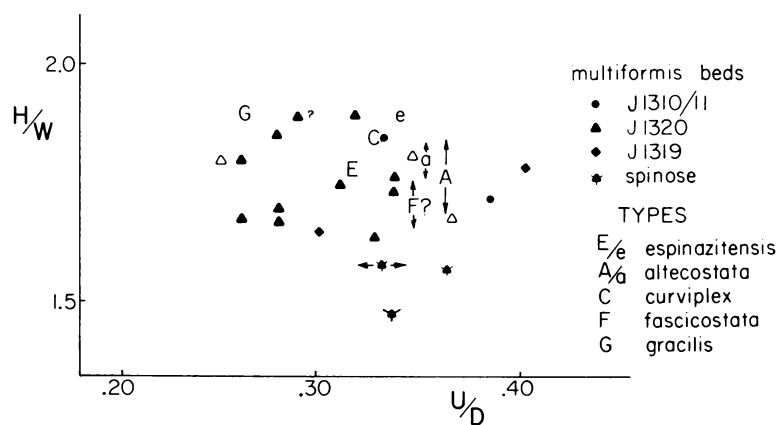
The ornament (text-fig. 31) of the inner whorls is highly variable, ranging in an apparently continuous series from obsolete ribbing to dense rectiradiate strongly projected simple ribbing, to irregular fasciculation, to ribs with irregular tubercles together with intercalatories, to distant bullae bearing prominent spines. Rib counts are difficult since they would be based on nonhomologous features, i. e. single ribs versus bullae borne by fasciculation. The samples were therefore subdivided into four arbitrary morphotypes (formas) based on ornament, i. e. 'obsolete', 'simple', 'fasciculate', and 'spinose', with intermediate morphotypes (text-figs. 31, 32). A close to normal distribution seems to be present in the largest sample (MCM J1320) in which the modal ornament is 'simple'.

Frequencies of morphotypes based on ornament:

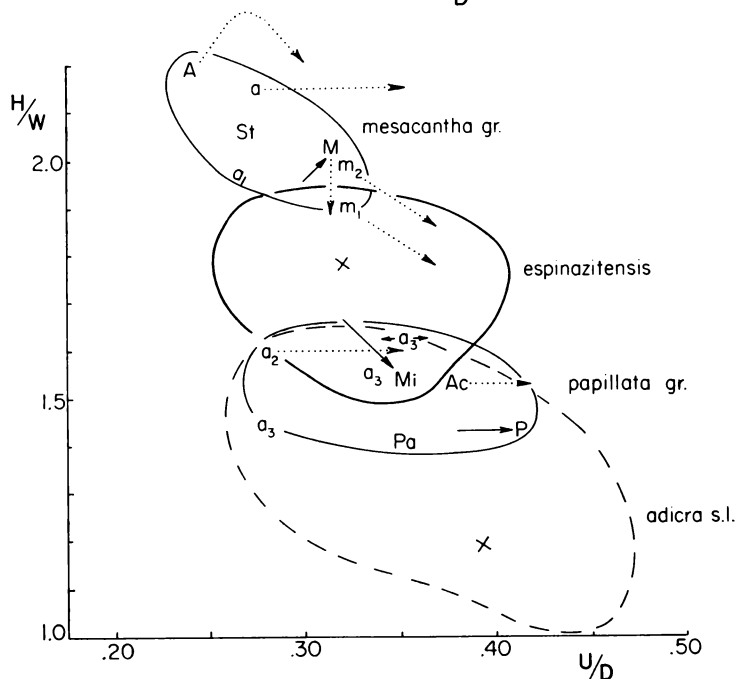
Sample No.	Obsolete	Simple	Fasciculate	Spinose
MCM J1320	5	10	7	3
MCM J1310/11	— (1?)	9 (+ 1?)	1	—

On the last whorl of the phragmocone ($D > 50-75$ mm), the ribbing of the flank usually becomes much more widely spaced and prominent (text-fig. 31). The ribs also retract from the umbilical slope and shoulder becoming rectiradiate plicae or elongate bullae which usually bear mid-lateral fine tubercles ('papillae') varying in number between 10 and 17 per half-whorl. On the adult body chamber, bullae and tubercles become consistently and markedly more prominent.

The keel is moderately prominent and floored on the phragmocone, becoming progressively reduced on the adult body chamber. No aperture is preserved.



Text-fig. 29. Plot of whorl section (H/W) against relative umbilical width (U/D) for large phragmocones of *Sonninia (Papilliceras) espinazitensis* TORNQ., with type specimens of synonymous "species" (capitals indicating holotypes and lectotypes). Neuquén Province. Note distribution of spinose specimens in area of low H/W and high U/D (inflated and evolute).

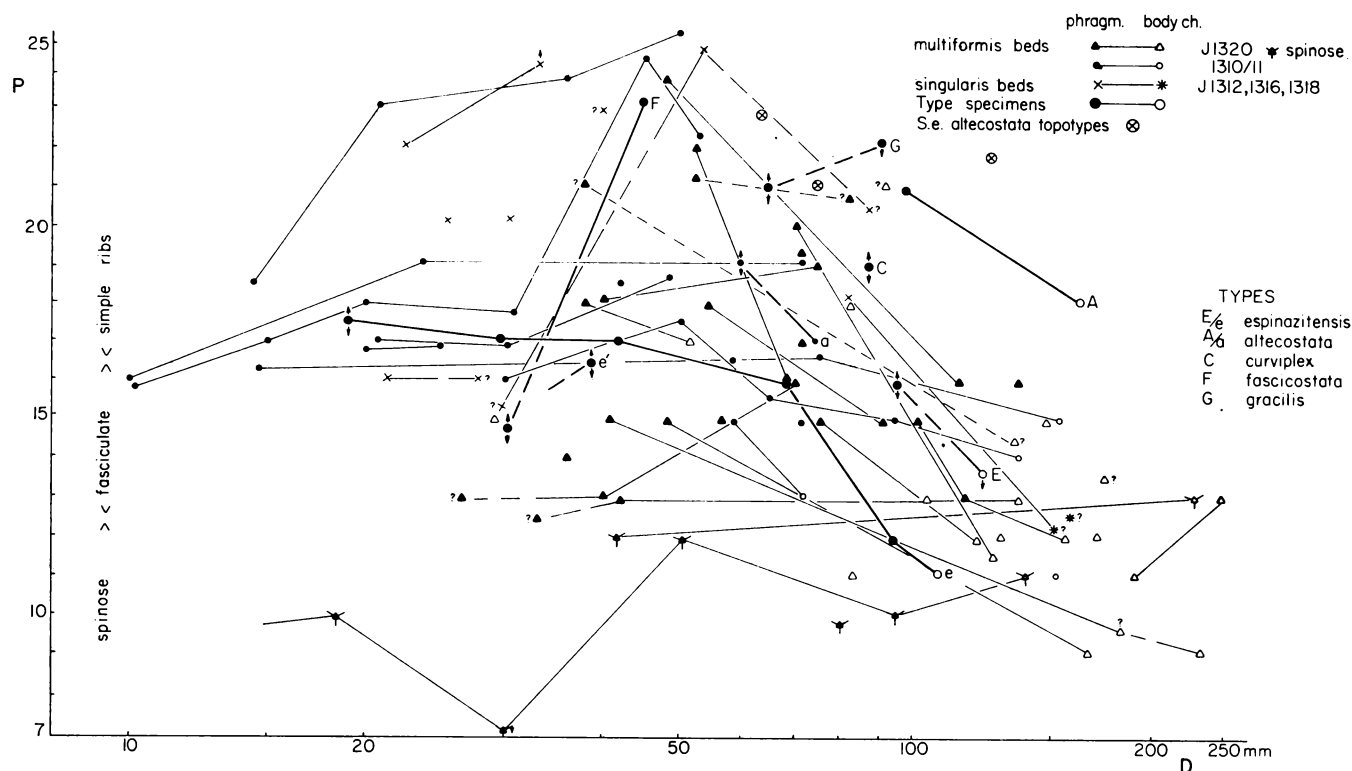


Text-fig. 30. Distributional areas of whorl section (H/W) against relative umbilical width (U/D), for large phragmocones of *Sonninia (Papilliceras) espinazitensis* TORNQ. from Neuquén Province (cf. Text-fig. 29), and of the *S. papillata* group and *S. mesacantha* group; the distribution of *S. (Euhoploceras) adicra* (WAAGEN) s.l. is indicated for comparison (from WESTERMANN, 1966). The positions of the type specimens of the *S. papillata* and *S. mesacantha* groups are indicated (see captions to Text-fig. 27). Dotted lines indicate growth of body chamber.

The septal suture (text-fig. 35) is quite simple, with rather narrow to moderately wide lateral lobe (L), straight saddle envelope, and vertical to somewhat oblique inner umbilical elements.

Discussion — The sample MCM J1320 from the lower part of the *Emileia* aff. *multiformis* beds consisting of 30 measured specimens includes all four ornament morphotypes, while in the smaller sample MCM J1310/11 of 10 or 11 specimens from a slightly higher level 'obsolete' and 'fasciculate' are rare and 'spinose' absent (see table above); 'simple' contributing 80—90% to the latter but only 40% to the former sample. Although collecting bias due to the small samples cannot alone account for these differences, no taxonomic conclusions are drawn on this single instance.

The extremely involute and compressed variant (pl. 23, fig. 2) is included in a single species together with the remainder of both samples because it is morphologically connected to what appears to be a continuous series by other specimens (pl. 23, fig. 6; pl. 24, fig. 1; and MCM J1320: 16). These specimens differ from the remainder of the sample also in the steeper umbilical slope which is more clearly separated from the flanks by an umbilical angle. Similarly, at the other end of the series, two highly spinose specimens (MCM J1320: 1 and pl. 25) are connected by intermediaries with the modal forms. Significantly, these rare spinose as well as the spinose-fasciculate intermediate morphotypes closely resemble the northwest European *S. papillata* group.



Text-fig. 31. Plot of number of primary ribs per whorl (P) against shell diameter (D) for *Sonninia (Papilliceras) espinazitensis* TORNQ. from Neuquén Province, with type specimens (large symbols) of synonymous "species", including the possible subspecies *S. e. altecostata* TORNQ.; growth lines indicated. Approximate distribution of ribbing morphotypes (spinose, fasciculate, simple) covarying with P, is indicated along the P axis. Also note marginal distribution of *S. e. ?* subsp. *altecostata*.

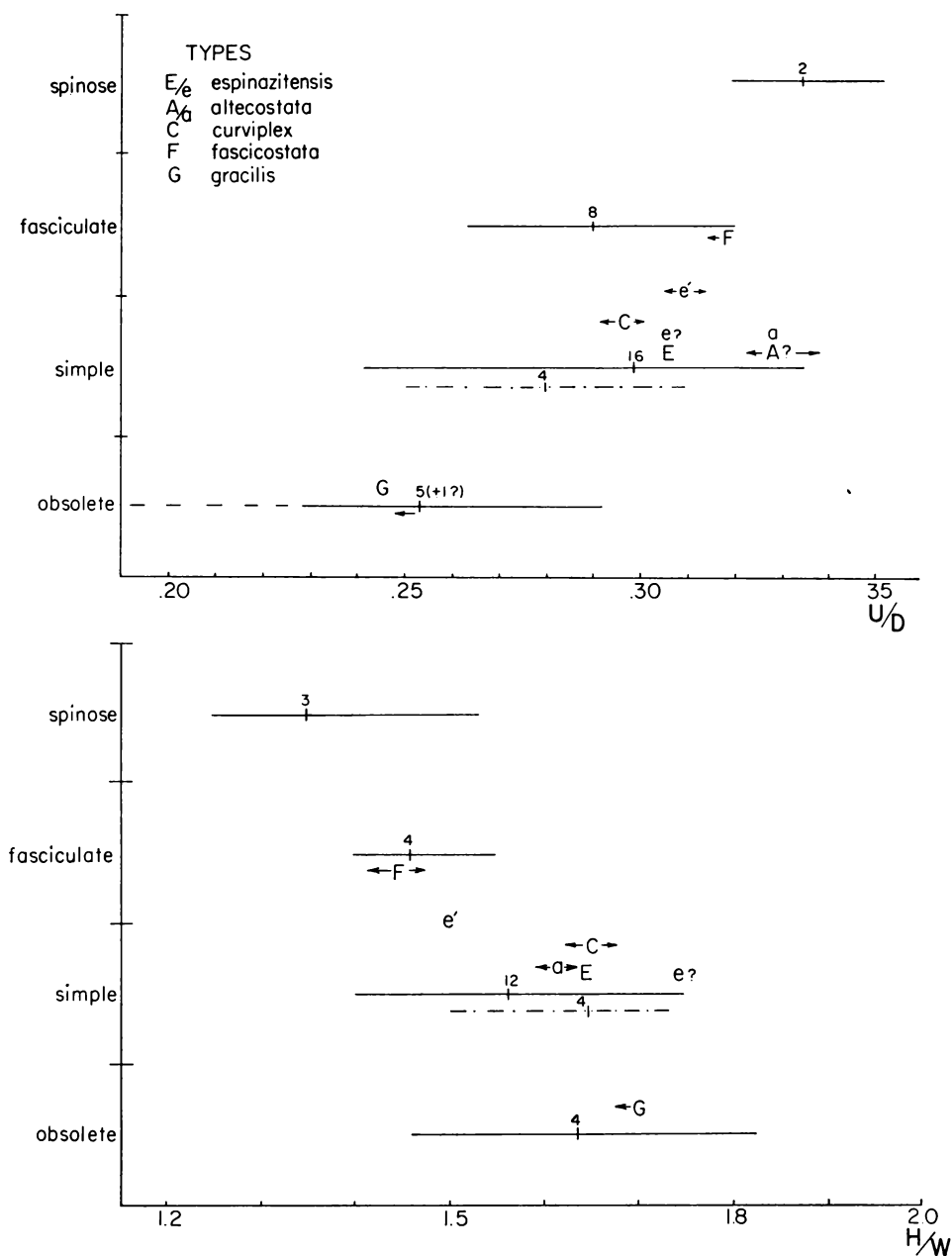
Samples from the *E. cf. multiformis* beds (Sauzei Zone) of Hacienda Manflas.

Besides six finely ornate and compressed, modal *S. espinazitensis*, sample MCM J1189 includes an irregularly spinose fragment with evolute inflated whorls. This specimen closely resembles MCM J1320: 2 (pl. 25) from Charahuilla, except for the somewhat more irregular costation of the inner whorls bearing more intercalatories, as in MCM J1320: 1. This Manflas specimen also matches the holotype of *S. papillata* so closely that it could have been identified with it; yet it still falls within the range of variation of *S. espinazitensis* as demonstrated by the Charahuilla samples. Significantly, the Manflas sample also contains several microconchs identical with *S. bodenbenderi* TORNQUIST ♂ (see below).

Samples from the *P. singularis* beds (Sowerbyi Zone) of the Zapala area.

The few well preserved but incomplete specimens and about 20 fragments from Paso del Carro Quebrado and Los Molles (MCM J1312, 1316, 1318) closely resemble the samples from the *E. aff. multiformis* beds described above. By strict comparison, however, the whorls tend to be slightly more compressed with flattened flanks and more marked shoulders and umbilical margin while the costation, at least of the inner and intermediate whorls, tends to be dense and regular. It is possible that all characters vary within the range of the samples from the *multiformis* beds; on the other hand, this early form (Sowerbyi Zone) may belong to a distinct chronologic subspecies, i. e. *S. espinazitensis altecostata* TORNQUIST (1898) which has recently been distinguished by HILLEBRANDT (1970) in Chile (text-fig. 31). Unfortunately, the material is unsatisfactory in number and preservation for statistical studies of comparison or discrimination.

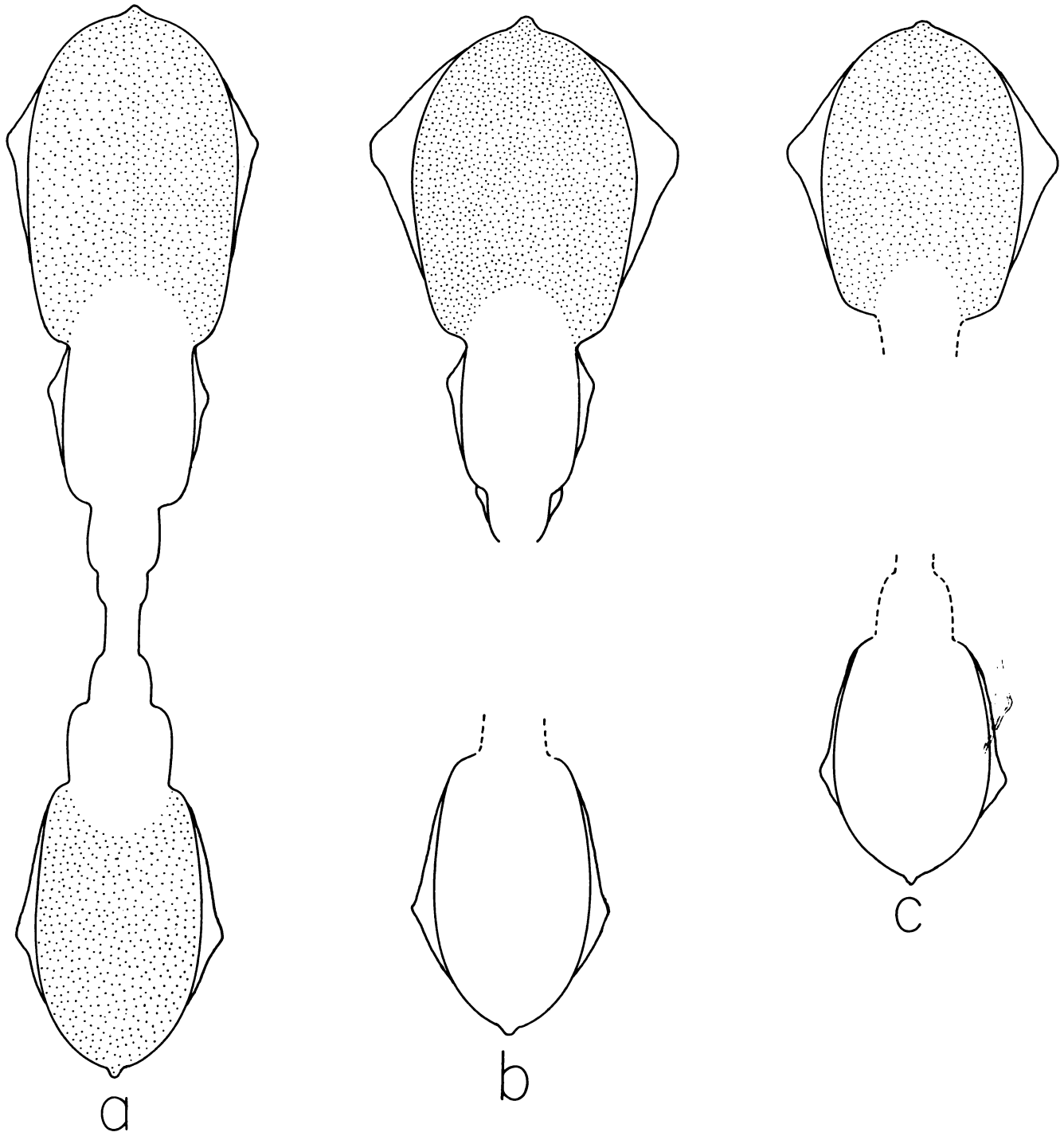
Additional collections made in 1970 support the distinction of the early chrono-subspecies *altecostata*.



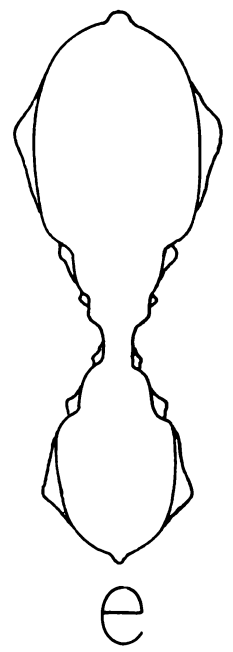
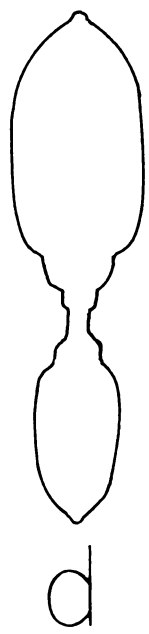
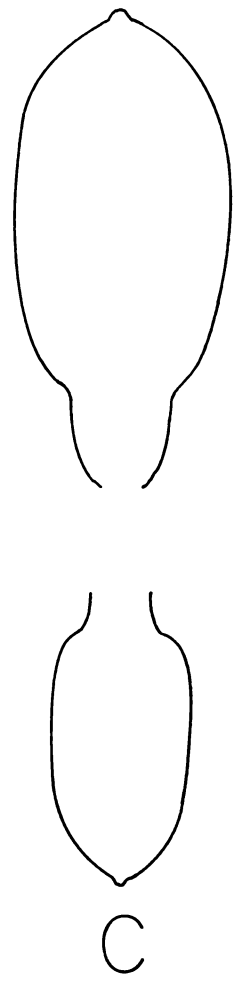
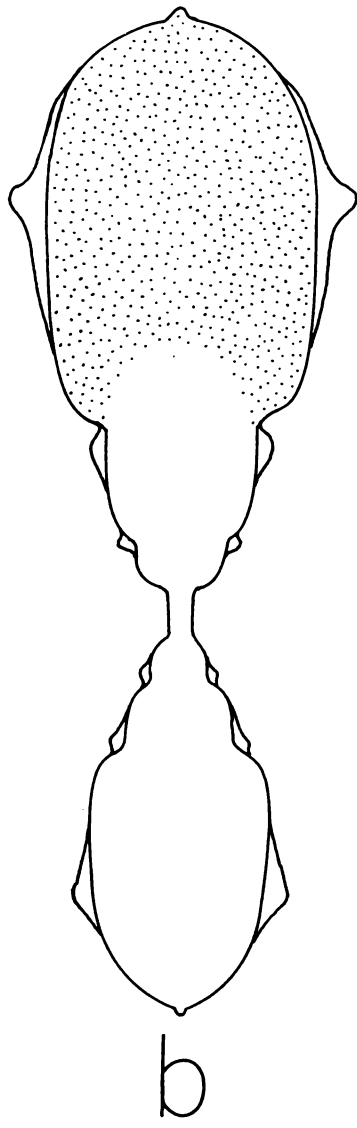
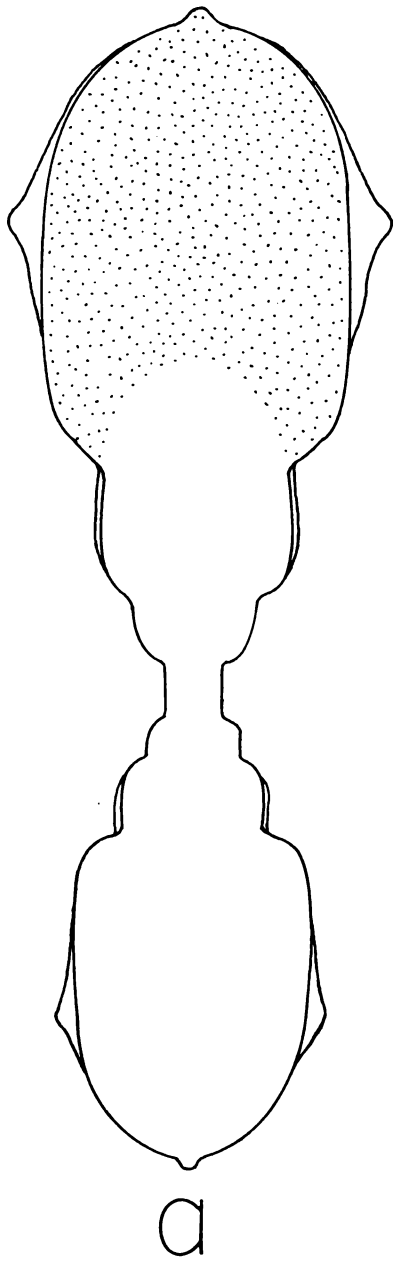
Text-fig. 32. Ranges and means, with sample sizes, of relative umbilical width (U/D) and of whorl section (H/W) for the different ribbing morphotypes of *Sonninia (Papilliceras) espinazitensis* TORNQ. from the Sauzei Zone of Neuquén Province, with type specimens of synonymous "species" indicated. Dash-dotted line representing small sample from the Sowerbyi Zone of Neuquén Province. All measurements from larger (mature) phragmocones. Note the trend from obsolete ribbing in involute and compressed shells to spinose ribbing in evolute and inflated shells.

Previous literature

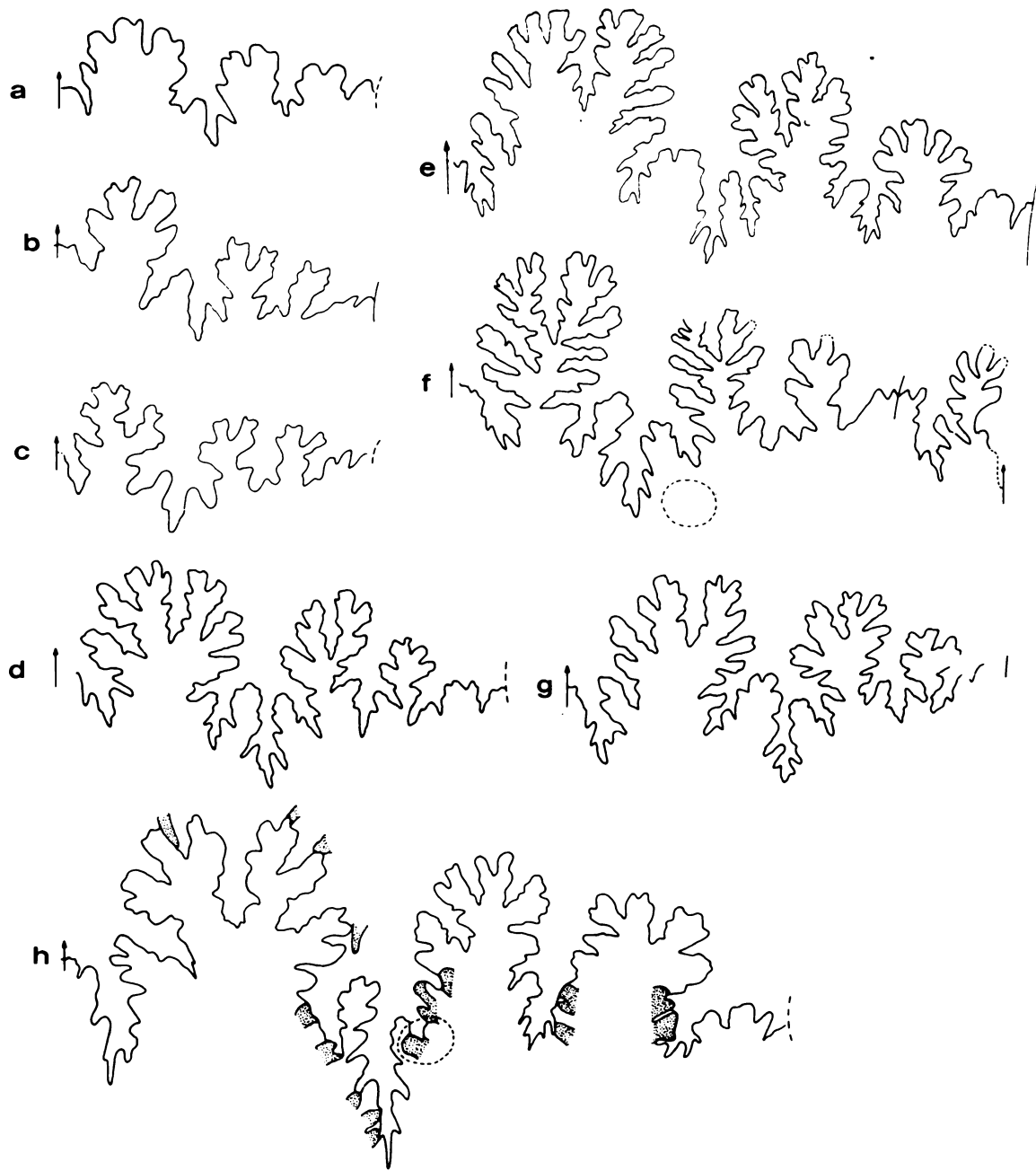
Previous descriptions of *S. espinazitensis*, as here understood in its broader limitation, have essentially been limited to the Espinacito Pass in northwest Argentina. The five "species" of TORNQUIST (1898), here regarded as conspecific (see above), were based on a total of only 6 almost fully grown macroconchs and 5 inner whorls (? or incomplete microconchs); all are moderately to poorly preserved and without useful stratigraphic information. The corresponding microconch (δ) was probably described under *S. bodenbenderi* TORNQUIST (and ? *S. subdelta-*



Text-fig. 33. Cross sections through phragmocone and body chamber (shaded) of adult *Sonninia (Papilliceras) espinazitensis* TORNO. ♀, X 0.75; (a, MCM J1320 : 35) b—c single specimen at different diameters (MCM J1320 : 1). Sauzei Zone, Charahuilla.



Text-fig. 34



Text-fig. 35. Septal sutures of *Sonninia (Papilliceras) espinazitensis* TORNQ. ♀; approximated neighboring sutures shaded; a, at D ~ 18.4 mm and H = 7.7 mm (MCM J 1320 : 22); b, at D = 18.7 mm and H = 7.8 mm (MCM J 1311 : 3); c, at D ~ 19.4 mm and H = 7.7 mm (MCM J 1313 : 2); d, at D ~ 38 mm and H = 17.5 mm (MCM J 1320 : 5); e, at H = 38.5 mm (Gütsfeldt coll., MNHUB); f, at D ~ 43.5 mm and H = 17.5 mm (MCM J 1320 : 2); g, same as e at H = 27.6 mm; h, at D ~ 98.7 mm and H = 44 mm (:4). Sowerbyi-Sauzei Zone, Neuquén Province, except e & g which are from Paso del Espinacito.

Text-fig. 34. Cross sections through phragmocone and body chamber (shaded) of *Sonninia (Papilliceras) espinazitensis* TORNQ. ♀, X 1; (a, MCM J 1320 : 4; b, 1320 : 2; c, 1320 : 19; d, 1320 : 5; e, 1320 : 2). Sauzei Zone, Charahuilla.

falcata TORNQUIST). All specimens are from the Bodenbender collection (Göttingen) except for the large paratype of *S. espinazitensis* which is from the Güssfeldt collection (Berlin).

S. espinazitensis was based on two large and one small incomplete specimens. Unfortunately, a poorly preserved specimen of the Bodenbender collection (TORNQUIST, 1898, pl. III, fig. 2) which is here refigured (pl. 20, fig. 3) was clearly designated as “Typus der Art” (p. 152), rather than the well preserved specimen with septal suture and one-third whorl body chamber of the Güssfeldt collection (pl. 4, fig. 1; here refigured, pl. 21, fig. 1). The holotype is a somewhat crushed phragmocone probably with the undistorted beginning of the body chamber and approximately 123 mm diameter. The left (figured) side is corroded and partly covered by a siliceous patina; the right side is less corroded but more strongly damaged. Although TORNQUIST’s illustration was somewhat stylized, the significant features are well displayed. The large paratype ($D \approx 115$ mm) is well preserved, largely with test; it was said to resemble the holotype in detail (“ins Allereinzeln”), but has slightly more evolute whorls with more distant ribs and tubercles. The small paratype ($D = 37$ mm) is a fully septate rather well preserved internal mould.

TORNQUIST placed his supposed species “*S. curviple*x” and “*S. gracilis*”, together with “*Harpoceras Stelzneri*” GOTTSCHKE [= *S. (Fissilobicer*as ?) aff. *S. zitteli* (GOTTSCHKE)] and “*Harpoceras andium*” GOTTSCHKE in the “Formenreihe” of *S. espinazitensis*; while including his supposed species “*S. altecostata*” and “*S. fascicostata*” in the “Formenreihe” of *S. zitteli*, together with the “*S. Argentinica*” and “*S. intumescens*” [= *S. zitteli*]. Thus, what is now considered to be the single paleo-species *S. espinazitensis* was in effect assigned to two different taxa which currently are classified at the subgenus level, i. e. *S. (Papilliceras)* and *S. (Fissilobicer*as).

Type specimens and synonymy

The holotypes and lectotypes (here designated) of *Sonninia espinazitensis*, “*S. gracilis*”, “*S. fascicostata*”, “*S. curviple*x”, and “*S. altecostata*”, all TORNQUIST 1898 spp. and from Paso del Espinacito, were partly developed from the matrix (with kind permission of Dr. S. Ritzkowski, curator); they are here refigured and their correct measurements listed.

*Sonninia espinazitensis*⁴⁾ TORNQUIST — The holotype (original designation; TORNQUIST, pl. III, fig. 2; here, pl. 20, fig. 3) matches the modal form of the Charahuilla samples in whorl section, coiling and ornament. Attention is drawn to the almost imperceptible but marked lateral crushing along the umbilical seam. Whorl width was therefore measured ventrad of the subsequent umbilical seam after developing the better preserved right umbilicus from the matrix. The large paratype (TORNQUIST, pl. IV, fig. 1) is distinguished only in the somewhat more compressed whorls becoming more evolute at maturity. The small paratype (TORNQUIST, pl. III, fig. 3), a nucleus, closely resembles the inner whorls of the former specimens as far as this can be observed, but the high compression of the whorls is close to the upper limit of variation of the Charahuilla samples.

“*Sonninia gracilis*” TORNQUIST — The holotype (monotypy; TORNQUIST, pl. IV, fig. 4; here, pl. 20, fig. 1) is completely septate, damaged, partially corroded, and moderately crushed throughout, resulting in slight asymmetry and missing nucleus without breakage along the umbilical seam. The involute compressed whorls and obsolete ribbing on the inner whorls match perfectly the ‘obsolete’ morphotype of the Charahuilla samples. The species name is therefore considered synonymous with *S. espinazitensis*.

“*Sonninia curviple*x” TORNQUIST — The only figured specimen and (potential) lectotype (TORNQUIST, pl. IV, fig. 3; here, pl. 20, fig. 2) is a corroded, irregularly crushed and damaged phragmocone, probably with the beginning of the body chamber. Coiling, whorl section, and ribbing (observed also on the inner flanks after the left umbilicus has been developed) seem to be very similar to the holotype of *S. espinazitensis*, except that the irregular ribs of the outer half-whorl are prorsiradiate rather than rectiradiate (at comparative diameters). On consideration of the variability of ribbing present in the Charahuilla samples, this difference is believed insignificant, if not due to deformation; “*S. curviple*x” is therefore another synonym. Two small specimens tentatively identified by TORNQUIST as inner whorls of “*S. curviple*x” are microconchs closely resembling *S. bodenbenderi* TORNQUIST ♂ (see below).

⁴⁾ The spelling of *espinazitensis* is based on the German transliteration of the Spanish name (Paso del Espinacito). Unfortunately, the Rules do not permit the emendation to the original and Latin spelling to “*espinacitensis*” (Dr. R. E. BLACKWELDER, in litt., Aug. 1971).

“*S. fascicostata*” TORNQUIST — The holotype (monotypy; TORNQUIST, pl. II, fig. 5; here, pl. 21, fig. 2) is a small, completely septate, irregularly crushed and otherwise distorted specimen. Coiling was apparently relatively evolute and the ribbing fasciculate only up to approximately 30 mm diameter, while most of the outer whorl bears simple irregular dense ribbing. The specimen matches the ‘fasciculate’ morphotype of the Charahuilla samples; “*S. fascicostata*” is therefore also synonymous with *S. espinazitensis*.

Sonninia (Papilliceras) espinazitensis (? subsp.) *altecostata* TORNQUIST

“*Sonninia altecostata*” TORNQUIST — The lectotype (here designated: TORNQUIST, pl. III, fig. 1; here, pl. 22, fig. 1) is a large internal mould consisting of the strongly crushed phragmocone and the partly distorted incomplete body chamber, slightly more than a half-whorl in length; the inner whorls up to approximately 50 mm diameter are almost completely destroyed and the last whorl of the phragmocone is strongly worn. The preserved outer whorls are more evolute than in the type specimens of *S. espinazitensis*, “*S. gracilis*” and “*S. curviple*”, approximating the upper range limit of the Charahuilla samples (text-fig. 27). The tuberculate ribbing of the outer whorl is denser than on any other specimen examined which bears costae of similar prominence and regularity at comparative diameter (text-fig. 31); the dense ribbing of “*S. gracilis*” and, possibly, of “*S. curviple*” is weaker, irregular and associated with more involute and compressed coiling. The apparently undeformed paralectotype (TORNQUIST, pl. II, fig. 4; here, pl. 22, fig. 2) is only half as large as the lectotype and completely septate. The developed right side is somewhat worn, the left side is damaged and not developed from the matrix. The costation on the outer half-whorl is more distant than on the lectotype at comparative diameter; in fact, ribbing and whorl shape resemble the modal ‘simple’ ribbed morphotype of the Charahuilla samples (text-fig. 31).

New material closely resembling the lectotype has recently been collected in situ at the type locality and at Hacienda Manflas, Chile, from the *Pseudotoites* assemblage, by Dr. A. Hillebrandt (cf. 1970). The senior author has seen the specimens and confirms the identification. The rib densities of three of Dr. Hillebrandt’s specimens have been plotted (text-fig. 31) from photographs which were kindly sent to us; they indicate possible morphological discrimination at least for larger specimens. Our own collections from the *P. singularis* beds of Los Molles, Neuquén province, (see above) and from the probable Sowerbyi Zone (bed 11, MCM J 1750) of Cerro Puchenque, Mendoza province, seem to support this slight difference in adult ribbing. The existence of the distinct chronological subspecies *S. espinazitensis altecostata* TORNQUIST in the Sowerbyi Zone of San Juan, Mendoza, and Neuquén provinces is therefore probable but not yet established.

Measurements of type specimens in mm

		D	H	W	U	H/W
<i>S. espinazitensis</i> ♀, holotype	body ch.	~ 123	48	27	39 (.32)	1.78
	phrag.	90	35	~ 20	28 (.31)	~ 1.75
	phrag.	60	24.5	15	18.5 (.31)	1.63
Tornquist, pl. IV, fig. 1	body ch.	~ 115	46	24.5	41 (.36)	1.87
	phrag.	100	39	20.5	34 (.34)	1.9
	phrag.	~ 69	28	16	21 (~.305)	1.75
Tornquist, pl. III, fig. 3	phrag.	37	14.5	9.7	11.6 (.31)	1.5
	phrag.	28	12.1	8.5	8.2 (.29)	1.42
	phrag.	~ 18	8.0	6.6	5 (~.28)	1.2
“ <i>S. fascicostata</i> ” ♀, holotype	phrag.	47	18	~ 12.5	14.5/15.5 (~.32)	~ 1.44
	phrag.	41	~ 16	~ 10+	—	~ 1.6—
“ <i>S. gracilis</i> ” ♀, holotype	phrag.	90	~ 38.5+	20	23/24 (~.26)	~ 1.9—
	phrag.	65	~ 28.5+	15.5	16 (.245)	~ 1.85—
	phrag.	~ 48	~ 21+	12.3	11.8 (.245)	~ 1.7—
“ <i>S. curviple</i> ” ♀, lectotype	? body ch.	88	34	~ 19	29 (.33)	~ 1.8
	phrag.	64	24.5	~ 15	21 (.33)	~ 1.63
	phrag.	~ 50	—	—	14.8 (~.295)	—
“ <i>S. altecostata</i> ” Tornquist ♀ lectotype (pl. III, fig. 1)	body ch.	165	53	~ 32	68 (.41)	~ 1.65
	body ch.	~ 120	44	~ 25	44 (.37)	~ 1.76
	phrag.	~ 83	—	—	29 (~.35+)	—
Tornquist, pl. II, fig. 4	phrag.	72	26	~ 15.5	25.5 (.355)	~ 1.7
	phrag.	58	23	—	18.8 (.325)	—
	phrag.	~ 43	16.5	~ 10.5	—	~ 1.6

Comparison

S. espinazitensis ♀ resembles both the European *S. mesacantha* group and the northwest European — North American *S. papillata* group, usually being slightly more inflated and evolute than the former and more compressed than the latter (text-figs. 27, 28). Although there is marked overlap with both groups if whorl shape is considered in isolation, the differences appear to become discrete when notice is taken also of ornament. The whorl shape overlap with the *S. mesacantha* group is occupied by the highly spinose *S. mesacantha* (WAAGEN) s.s. and the finely or 'obsolete' ribbed *S. espinazitensis*; the whorl shape overlap with the *S. papillata* group, on the other hand, includes the relatively weakly ornate "*Prepallites arenatus*" of BUCKMAN and *S. micracantha* (BUCKMAN) of the *S. papillata* group and the 'spinose' morphotype of *S. espinazitensis*. Coiling (text-fig. 27) is exactly as in the *S. papillata* group, at least for the outer whorls. Resemblance is therefore somewhat stronger to the *S. papillata* group than to the *S. mesacantha* group.

The principal difference from all other known species of the subgenus *Papilliceras*, however, is in the morphogeny of ornament. In *S. espinazitensis* prominence of ornament tends to increase throughout growth and particularly on the adult body chamber, while decreasing in the European and North American species. Thus the inner whorls are usually distinctly less ornate than in any other known species, except for the holotype of *Am. arenatus* QUENSTEDT which is tentatively regarded as the 'obsolete' ribbed end member of the proposed *S. mesacantha* group (morphologic series); the outer whorl resembles that of the *S. papillata* group in most aspects. Although the slight (5—10%) overlap with the *S. papillata* group causes (not quite unusual) difficulty in the identification of isolated spinose specimens, this should not prevent the application of a species concept recognizing morphologic variation.

The subgenus *Euhoploceras* which directly precedes in age the subgenus *Papilliceras*, is distinguished from the latter by the more inflated (less compressed) whorls and the absence of mid-lateral 'papillae' arising on the outer whorls. The nodes or spines of *S. (Euhoploceras)*, if present, are always accompanied by prominent ribs or bullae and morphogenetically continuous from the juvenile whorls. The bivariate distributions in whorl section and relative umbilical width of *S. (E.) adicra* (WAAGEN) and *S. (Papilliceras) espinazitensis* overlap within the 'obsolete' ribbed *S. adicra* forma modesta and the 'spinose' morphotype of *S. espinazitensis* (text-fig. 30). The *S. (P.) papillata* group is more closely allied to *S. (E.) adicra* than is *S. (P.) espinazitensis*; the first differs from *S. (E.) adicra* in the more rounded venter and the presence of adult 'papillae'.

S. (Euhoploceras) ranging from the (? Concava Zone) lower to middle Sowerbyi Zone (? Sauzei Zone) and occurring in Europe and along the eastern and southwestern Pacific margin (WESTERMANN, 1969, p. 93), is regarded as the direct ancestor of *S. (Papilliceras)* which occurs in the (upper ?) Sowerbyi and Sauzei Zones of the same areas (WESTERMANN, 1966, p. 311). Since the earliest known Pacific *Papilliceras*, i.e. *S. (P.) espinazitensis* ? subsp. *altecostata* TORNQ., is densely but prominently ribbed, a similar ancestral form within *S. (Euhoploceras)* is indicated for this 'province'; these ribbing attributes are present in the poorly known Australian *S. (E.) playfordi* ARKELL (in ARKELL and PLAYFORD, 1954, pl. 27, fig. 1).

Age and occurrence

The *P. singularis* beds (? subsp. *altecostata*) and, mainly, the *E. cf./aff. multiformis* beds of Argentina and Chile; Sowerbyi and Sauzei Zones, respectively.

Sonninia cf. espinazitensis TORNQ. ♂ [*S. bodenbenderi* TORNQ. 1898]

(pl. 21, figs. 4—6; pl. 22, figs. 3—5)

1898. *Sonninia Bodenbenderi* TORNQ. p. 24 (156), pl. V (XVIII), fig. 9.

? 1898. *Sonninia subdeltafalcata* TORNQ. p. 24 (156), pl. V (XVIII), fig. 7.

Material

Paso del Espinacito, San Juan province: the holotype of *S. bodenbenderi* and 2 topotypes (tentatively identified as inner whorls of "*S. curviplex*" by TORNQ. 1898, p. 22); ? the lectotype of *S. subdeltafalcata*.

Zapala area, Neuquén province. a) Charahuilla: 3 crushed microconchs with incomplete body chambers from bed 1b (MCM J1310); 1 good phragmocone with approximated septa and 1/2 whorl body chamber from bed 1c₁ (MCM J1320) — Sauzei Zone; b) Los Molles: 1 good specimen with approximated septa and 1/2 whorl body chamber from bed 6 (MCM J1313); 1 complete and 1 damaged specimen with apertures, 2 phragmocones with approximated septa and incomplete body chambers, from bed 7 (MCM J1312);

1 good impression with aperture and 1 crushed incomplete specimen from bed 8 (MCM J1316); ? single microconch from bed 9 (MCM J1314) — Sowerbyi to (early) Sauzei Zones.

Hacienda Manflas, Atacama province, Chile: at least 5 crushed incomplete specimens from bed 6 a (MCM J1189), associated with *S. espinazitensis* ♀ — Sauzei Zone.

Description

The phragmocone, attaining a diameter of about 20 mm, closely resembles the inner whorls of the most common morphotypes of *S. espinazitensis* ♀ (macroconch), described above, in coiling, whorl section and ornament (text-figs. 25, 26, 31). Several nuclei were prepared out of associated macroconchs for comparison. The whorls develop from depressed oval to subcircular at about 15 mm diameter and finally become slightly depressed with convex rather steep umbilical wall rounding into the flanks, and evenly rounded venter bearing a fine sharp keel. The internal mould may have faint tabulations beside the keel. The ornament which commences gradually at 5—7 mm diameter consists of blunt simple or somewhat fasciculate, rectiradiate to slightly flexed ribs which project on the shoulder dying out gradually on the venter. The septal suture perfectly matches that of the macroconch at comparative size.

The body chamber egresses markedly with the umbilical width approximately increasing from 30 to 40 percent of the diameter, and attains a length of one-half to three-quarters whorls and a diameter of approximately 30 mm. The aperture, partially preserved on specimen MCM J1312: 9, has lateral lappets of unknown shape. The ornament becomes much more prominent than on the phragmocone; the simple to somewhat fasciculate ribs grow progressively aperturad convex on the flanks and swell on the ventro-lateral shoulders.

One complete specimen (MCM J1312: 7; pl. 22, fig. 4) differs from the others from the same bed in the somewhat more inflated whorls and the presence of faint ventral grooves. This microconch is very tentatively referred to *S. espinazitensis*.

Type Specimens and Discussion

Sonninia bodenbenderi TORNQUIST ♂ — The holotype (monotypy; TORNQUIST, pl. V, fig. 9; here, pl. 22, fig. 3) is a small, partly distorted phragmocone with incomplete body chamber (1/3 whorl). The specimen agrees in detail with the microconchs described above, particularly specimen MCM J1320: 22 (pl. 21, fig. 5). Two topotypes tentatively identified by TORNQUIST (p. 22) as inner whorls of *S. curviflex* [= *S. espinazitensis*], are undoubtedly also microconchs and identical with the forms here described; specimen 496—36 is coarsely ribbed, while 496—37 resembles the more weakly ribbed Los Molles specimen MCM J1313—2.

Sonninia subdeltafalcata TORNQUIST ♂ — The only figured specimen (lectotype, here designated: TORNQUIST, pl. V, fig. 7; here, pl. 21, fig. 4) is a complete recrystallized test specimen with the aperture bearing an incomplete lappet. It is distinguished from *S. bodenbenderi* ♂ by the more evolute and compressed whorls with shallow umbilical slope, and in the costae which remain fasciculate well onto the body chamber where they are also denser, less prominent and less flexed. TORNQUIST's second satisfactorily preserved specimen of *S. subdeltafalcata* ♂ (496—45), however, closely resembles the holotype of *S. bodenbenderi* ♂ except for its smaller diameter.

Since no new material closely resembling *S. subdeltafalcata* ♂ is available and the exact stratigraphic level of the lectotype is unknown — except for the statement by TORNQUIST that it occurs with the other sonniniids [*P. singularis* or *E. multiformis* beds = Sowerbyi or Sauzei Zone] — the taxonomic status of this microconch is left undecided. DORN (1935, p. 113), HILTERMANN (1939, p. 170) and HUF (1968, pl. 9, fig. 6) regarded *S. subdeltafalcata* ♂ as a junior subjective synonym of *S. [Dorsetensia] deltafalcata* (QUENSTEDT, 1858) ♂ of the Humphriesianum Zone. HUF (loc. cit.), who poorly reillustrated the lectotype (but did not include it in his synonymy listing), also stated (p. 86) that there is complete intergradation between *Dorsetensia deltafalcata* ♂ and *D. romani* (OPPEL) which occur together; but he retained both as separate species. A comparison of *S. subdeltafalcata* ♂ with similarly ribbed *D. deltafalcata* ♂ and *D. romani* ♂, as abundantly illustrated by HUF, however, suggest to us that the former is more compressed with more acutely rounded to almost fastigate venter; on the other hand, the illustrated specimens of the *D. deltafalcata-romani* ♂ series with whorl sections resembling that of *S. subdeltafalcata* ♂ are more involute and bear weaker ornamentation.

The apparent identity of the inner whorls of these microconchs (♂) and their regular co-association with the macroconchs (♀) of *S. espinazitensis* make it most likely that *S. bodenbenderi* ♂ and possibly also *S. subdeltafalcata* ♂ are the males of *S. espinazitensis* ♀.

Measurements in mm

	D	H	W	U	H/W
<i>S. bodenbenderi</i> ♂, holotype					
body ch.	29	11	8.3	9.3 (0.32)	1.33
phrag.	21	8.6	~ 6.5	6.8 (0.32)	~ 1.32
<i>S. subdeltafalcata</i> ♂, lectotype					
body ch.	29	10.4	7.0	10.4 (.36)	1.5
? phrag.	21	8.0	6.3	7.5 (.36)	1.27
phrag.	~ 16	6.0	4.8	5.0 (~.31)	1.25

S. (Papilliceras) cf. (P. ?) peruana JAWORSKI, 1915 ♀
(pl. 27, figs. 2—3; Text-fig. 36)

(?) 1915. *Sonninia Peruana* JAWORSKI, p. 401, pl. VIII, figs. 3 a—e [lectotype here designated: figs. 3 a, c] (copy: JAWORSKI, 1925, Dir. Gen. Min. Geol. Hidrol., Sec. Geol., No. 4, p. 135, pl. IV, figs. 3 a—e).

Material

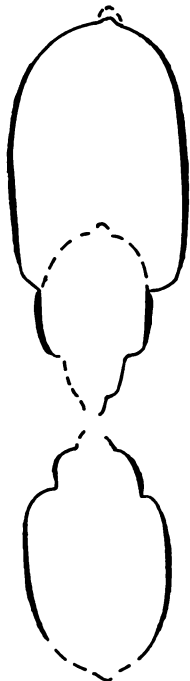
Cerro Puchenque, Mendoza province: 1 large damaged phragmocone, ? 1 large fragment and 6 small incomplete phragmocones, from bed 12 (MCM J1747) — Sowerbyi Zone.

Description

The whorls are moderately evolute and progressively more compressed in section; with narrow vertical umbilical wall, slightly rounded umbilical angle, parallel flanks, and narrowly rounded venter bearing a floored sharp keel. The umbilical wall develops between 10 and 20 mm diameter and remains vertical or almost vertical to about 80 mm diameter; the umbilical wall of the ultimate whorl of the largest phragmocone (~ 165 mm D) becomes somewhat less steeply inclined, while the whorl section becomes markedly ogival.

The ornament of the inner whorls consists of dense rectiradiate, simple to slightly fasciculate costae or costellae which project on the shoulders; tubercles are entirely absent in this juvenile stage. Beyond approximately 50 mm diameter, the ribbing becomes increasingly blunt, particularly on the innermost and outermost flanks, and finally obsolete; simultaneously, fine lateral tubercles develop which, together with faint radial plications, are the only ornament of the largest halfwhorl (~ 165 mm D).

The septal suture is poorly preserved.



Text-fig. 36. Cross section through the phragmocone of *Sonninia (Papilliceras?) peruana* JAW., holotype (plaster cast), X 1. Sauzei Zone (?), Chunumayo, Peru.

Measurements in mm

	D	H	W	U	H/W
<i>S. peruana</i> ♀, lectotype (plaster cast)					
? phrag.	88	36.5	23.5	27 (.305)	1.55
phrag.	~55	23	16	16 (~.29)	1.43
MCM J1747 : 2 ♀ phrag.	47	21.5	13.0	12.5 (.265)	1.55
: 5 ♀ phrag.	35	15.5	10.6	10.2 (.29)	1.47
: 7 ♀ phrag.	(~165) 150	62.2	—	46 (.39)	—
phrag.	83	38.0	23	25.5 (.305)	1.65

Comparison

The Cerro Puchenque specimens closely resemble *Sonninia peruana* JAWORSKI (1915) previously described only from the "Capas con *Amm. Sauzei*" [Sauzei Zone] of Chunumayo, Peru. The larger of the two (of a total of three) specimens figured in rough drawings by JAWORSKI is here designated as the lectotype (plaster cast figured here on pl. 27, fig. 1). The lectotype, which is the only known larger Peruvian specimen, is slightly more inflated at comparative diameters (cf. our measurements; JAWORSKI's measurements are erroneous) and more strongly ornate, with prominent tubercles present at a somewhat earlier growth stage.

Sonninia (Euhoploceras) amosi sp. nov. ♀, associated with *S. (P.) cf. peruana* of Cerro Puchenque, is distinguished by the tuberculate nucleus, the more inflated whorl section and the absence of tubercles ('papillae') on the outer whorls.

S. (Papilliceras) espinazitensis TORNQUIST ♀ is distinguished by the rounded and usually shallow umbilical slope, and the strong ribs of the outer whorls. All other species of this subgenus have tuberculate or bullate nuclei including *Am. arenatus* QUENSTEDT [= ? *S. (P.) mesacantha* (WAAGEN) forma/var. *arenata*] from the Sauzei Zone of Swabia. Significantly, *S. (Papilliceras)* spp. probably appear already in the (middle ?) Sowerbyi Zone of southern England (see discussion of subgenus).

Sonninia patella (WAAGEN), the lectotype of which comes from the Sowerbyi Zone of Swabia (cf. OECHSLE, 1958, p. 101), agrees in the compressed whorl section with vertical (or overhanging) umbilical wall, but is distinguished by the bullate rib fasciculations of the inner whorls and the absence of 'papillae' on the outer whorls.

Genus *Zurcheria* DOUVILLÉ, 1885

Type-species — *Zurcheria ubaldi* DOUVILLÉ, 1885, from the Sowerbyi Zone of the Toulon area, Provence.

Discussion

This genus, then restricted to *Z. ubaldi* DOUVILLÉ, was originally defined by the compressed open whorls with rounded venter (no keel), bearing slightly falcoid ribs which die out beside the venter and strongly projected fine growth lines which form chevrons on the venter; the septal suture is simple with straight saddle envelope.

BUCKMAN (1892, pp. 293—299) correctly placed the genus in the Sonniniidae (as Sonniniinae) including two species of VACEK (1886) from Cap San Vigilio, Lake Garda, and two newly named species from the Inferior Oolite; all are distinguished by the presence of tubercles, a minute keel, and, at least in part, by their hammatoceratid septal suture. "*Hammatoceras*" *pugnax* VACEK is an inflated microconch with prominent umbolateral and ventrolateral spines and a hammatoceratid suture; it was designated as the type-species of *Spinammatoceras* SCHINDEWOLF (1964, pp. 313—314). "*Hammatoceras*" *pertinax* VACEK, also a microconch, is much more compressed and finely ribbed bearing only minute tubercles; but the suture is also hammatoceratid resembling that of *Erycites* (VACEK, 1886, p. 96) and VACEK (1886) appears to have been correct in its close affinity to "*H.*" *pugnax*. The corresponding macroconchs were probably described under "*H.*" *tenax* and "*H.*" *sagax*, VACEK spp., which were believed to be affiliated with "*H. fallax*" BENECKE [= *Erycites fallifax* ARKELL]. This relationship is indeed manifested in the *Erycites*-like septal suture figured by VACEK (1886, pl. XV, figs. 13, 16 b, pl. XVI, figs. 1 a, 7) from the macro- and microconchs. This suggests that a subfamily Erycitiinae SPATH, 1928, (from Erycitiidae) would be useful. BUCKMAN (1892, pl. XLIX, figs. 21—22) figured a small specimen of *Spinammatoceras* (?) *pertinax* from the "Concavum-zone" [recte Discites Subzone (?)] of Bradford Abbas, Dorset. From the same beds, he also described and named "*Zurcheria*" *parvispinata* and "*Z.*" *inconstans* which probably belong to a single species characterized by rectiradiate primaries bearing ventrolateral spines; the septal suture has a narrow

lateral lobe and suspensive umbilical lobes. This suggests that these forms are more closely affiliated to the hammatoceratid *Spinammatocheras* than to the sonniniid *Zurcheria*. *Zurcheria* would then be restricted to nonspinose species with simple nonsuspensive suture. "*Z.*" *inconstans* has also been recorded from the Discites Subzone of Portugal (DUBAR et al., 1967, p. 17).

Zurcheria groeberi sp. nov.

(pl. 31, figs. 1—5, text-fig. 37)

Holotype — The specimen with incomplete body chamber figured on plate 31, figs. 1 a—c (DNGM 236); from the "Zone of *Harpocheras Murchisonae* . . . block no. 236 (GROEBER, 1918) of Bardas Blancas, Mendoza province.

Derivatio nominis — referring to P. GROEBER who collected the specimen in 1912 and correctly identified it with "*Zurcheria* sp."

Diagnosis — Whorls inflated bearing slightly flexed ribs which fasciculate in pairs on the inner whorls and partly branch on the outer whorl.

Material

Bardas Blancas, Mendoza province: the holotype, 1 body chamber fragment, and the partial impression of an inner whorl from a single block collected by GROEBER in 1912 (DNGM 236); 1 nucleus and 1 body chamber fragment from block with *Eudmetoceras* sp. nov. aff. *klimakomphalum*, *Tmetoceras* cf. *scissum*, and numerous bivalves, interval 1 (MCM J 1325 : 1, 2) — Concava-lower Sowerbyi Zone.

Arroyo Blanco, Mendoza province: several phragmocones, body chamber fragments and nuclei from concretion 9, together with *Tmetoceras scissum* and *Eudmetoceras* sp. nov. aff. *klimakomphalum* (MCM J 1751 : 1—7) — Concava-lower Sowerbyi Zone.

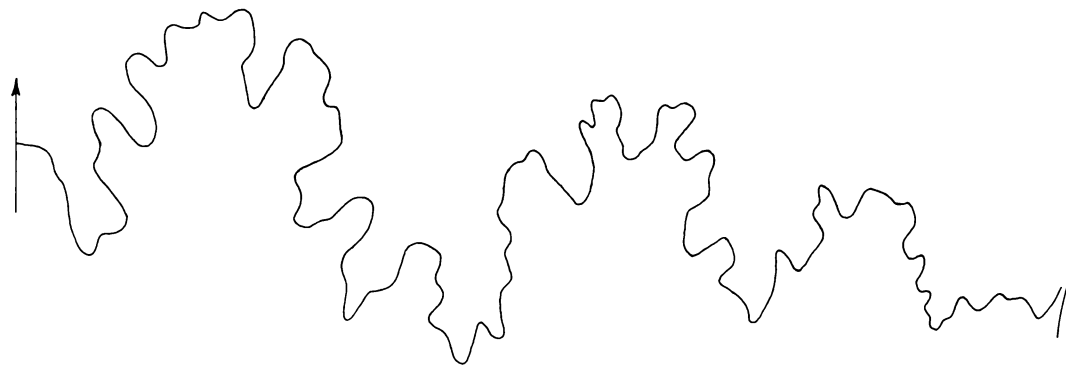
Las Yeseras, Mendoza province: 2 almost complete but partly crushed specimens and 1 nucleus; collected by Yacimientos Petrolíferos Fiscales (MLP 11556 a, b).

Description

The inner whorls at 10—20 mm diameter are subcircular in section, becoming slightly compressed rounded-ovate and finally somewhat subrectangular on the last phragmocone whorl. The flanks are gently convex curving into the rounded narrow umbilical slope and into the broadly rounded venter. The ornament consists of somewhat flexed, weakly falcoid, blunt ribs which fasciculate in twos on the umbilical margin of the nucleus. The more inflated variants bear stronger ribbing with distinct primaries of which some become bullae-like at mid-flank.

The last phragmocone whorl and the body chamber are rounded subrectangular in section bearing prominent ribs which are alternately single or biplicate on the outer flank. The blunt secondaries project and die out near mid-venter. The siphonal area is entirely smooth on shell and internal mould, at least up to the beginning of the body chamber; on the largest body chamber, (specimen from Las Yeseras), however, the ribs form blunt and obtuse chevrons on the venter. The body chamber of the holotype bears a very faint ventral fastigation. The complete diameter of the shell is approximately 40—60 mm. The aperture is unknown.

The septal suture (text-fig. 37) is simple with straight saddle envelope. All lobes are broad; E is exceptionally shallow; L is asymmetrically pseudo-bifid; U_2 is broad, vertical and trifid; another small umbilical lobe is present on the umbilical shoulder.



Text-fig. 37. Septal suture of *Zurcheria groeberi* sp. nov., at H = 12 mm (DNGM 236). Concava-Sowerbyi Zone, Bardas Blancas.

Measurements in mm

		D	H	W	U
Holotype	body ch.	42	15.2	11.5	15.1
	phrag.	32	12.5	11.0	11.5
	phrag.	24	9.5	8.3	6.9
MCM J1751:2	phrag.	21	8.5	9.3	6.2

Discussion

Zurcheria groeberi is distinguished from *Z. ubaldi* DOUVILLÉ by the more inflated whorls and in the ribbing which is denser and fasciculate on the inner whorls and partly biplicate on the outer whorl.

P. GROEBER (1918, p. 19, cf. 1953, p. 211) correctly assigned the specimen from the Bardas Blancas section, here designated as the holotype of *Z. groeberi*, to "*Zurcheria* nov. sp." [the label shows "*Zurcheria* aff. *Ubaldi* DOUVILLÉ"]. From the same block, GROEBER listed "*Tmetoceras scissum* BEN., *Erycites* nov. sp. (del grupo de *E. gonionotum*)" and several bivalve species of supposed *Trigonia*, *Pseudomonotis*, *Corbis*, *Modiola*, and *Cucullaea*, and dated the assemblage as Murchisonae Zone. The assemblage of our coquina block from interval 1 of the same locality (MCM J1325) includes *Zurcheria groeberi*, *Eudmetoceras* sp. nov. aff. *klimakomphalum* (VACEK), *Tmetoceras* cf. *scissum* (BEN.), and various shallow-water bivalves including *Meleagrinea* and *Trigonia* s. l.

Significantly, the same ammonite association including *E.* aff. *E. klimakomphalum* was also found in limestone concretion no. 9 from the lower shaly part of the Arroyo Blanco section (MCM J1751). The possibility of condensation and/or reworking may exist for the Bardas Blancas coquina bed, but not for the Arroyo Blanco concretion.

Genus *Witchellia* BUCKMAN, 1889

Type-species — *Ammonites laeviusculus* J. de C. Sowerby, 1824.

The genus and type-species have recently been reexamined and discussed at length (WESTERMANN, 1969, pp. 108—116). Eight named north-western European "species" appear to intergrade, from the involute compressed and weakly ornate *W. patefactor* BUCKMAN to the evolute planulate and strongly ornate *W. sutneri* (BRANCO); they were tentatively placed in the two species *W. laeviuscula* and *W. sutneri*. The venter varies in dependence on coiling and ornament, ranging from unicarinate-tabulate in the involute forms to tricarinate-bisulcate in the evolute forms. The venter of the lectotype of the type-species (refigured: op. cit., text-fig. 35) has, exceptionally, sloping tabulations (test), but it intergrades with forms bearing sulcae (cf. BUCKMAN, "Type Amm. VII", pl. DCCXLV). *Witchellia* (s. s.) was, therefore, restricted to include species usually bearing a bisulcate venter (at least on the internal mould) (op. cit.).

Witchellia sp. nov. indet. ♀
(pl. 31, fig. 6; text-fig. 38)

Material

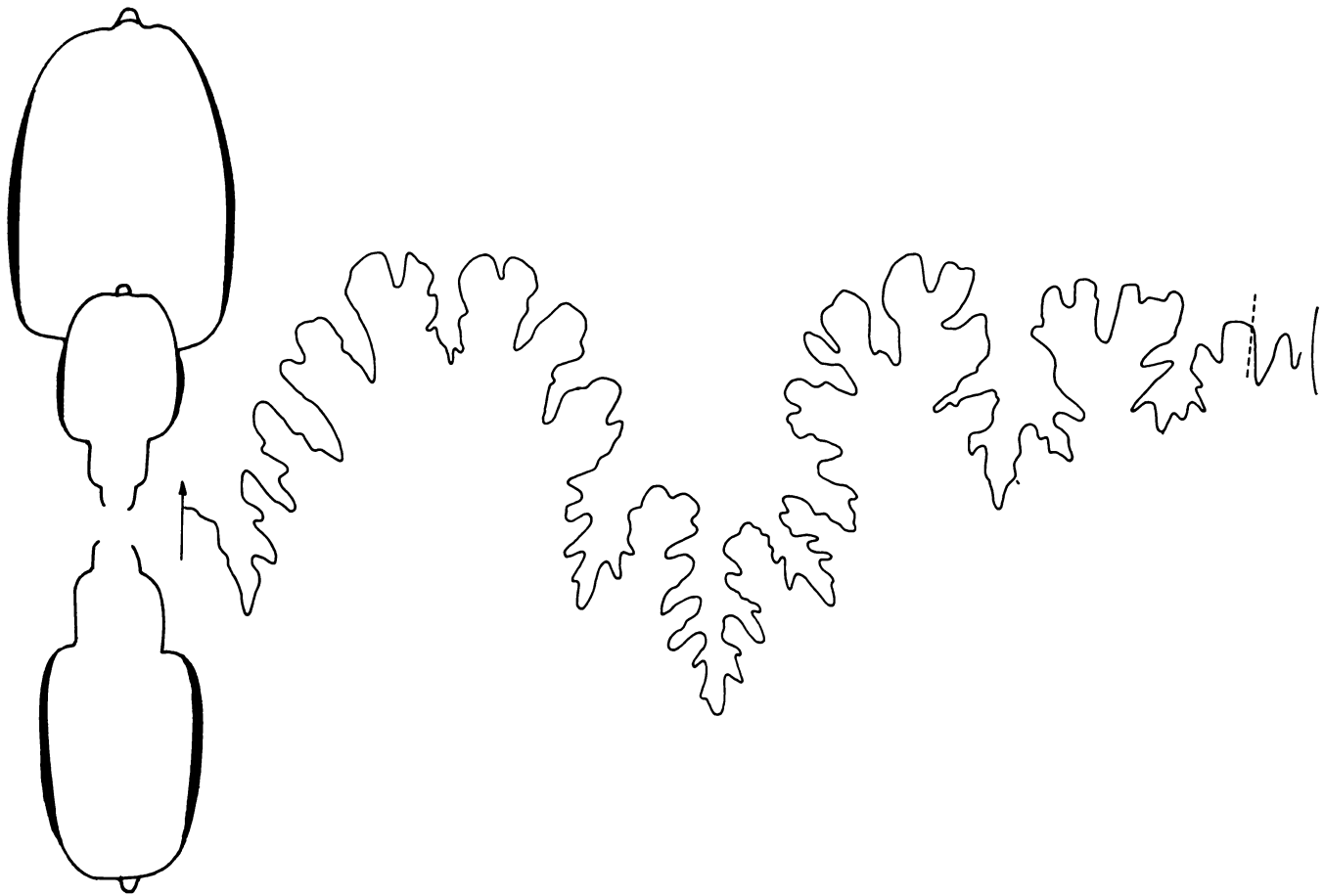
Arroyo Blanco, Mendoza province: 1 large completely septate internal mould with test remains from concretion 4b₁ (MCM J1324: 9) — Sauzei (? Humphriesianum) Zone.

Description

The whorls are widely umbilicate, with subrectangular section, slightly bisulcate venter, high floored keel, and blunt rectiradiate simple ribbing.

The nucleus has subcircular whorls, becoming subrectangular at about 10 mm diameter. The intermediate whorls have parallel to slightly converging flat flanks, bordering slightly rounded against the vertical umbilical slope and curving up to the blunt ventrolateral carinae which accompany shallow sulcae on the internal mould. The keel is blade-like prominent and floored. On the outer phragmocone half-whorl, the venter is tabulate, without sulci and carinae, bearing a prominent sharp keel with floor which leaves a blunt keel on the internal mould.

The ornament of the nucleus consists of faint, slightly fasciculate, dense radials. The penultimate whorl bears regular rectiradiate, quite distant plications which become obscure on the shoulders where they appear to project. On the outer half-whorl, the plications are similar but more blunt and retract from the umbilical mar-



Text-fig. 38. Cross section through the phragmocone (X 1) and septal suture (D = 80 mm and H = 30 mm) of *Witchellia* sp. nov. (MCM J1324 : 9). Sauzei Zone, Arroyo Blanco.

gin and outer flank. The septal suture is quite simple with broad trifid L and much smaller, narrow and vertical U₂ and (?) U₃.

Comparison

Our specimen is distinguished from all previously described species of *Witchellia* by the simple rectiradiate ribbing, following a faintly and densely ribbed nucleus; blunt ribbing is retained to at least the approximate end of the phragmocone at c. 150 mm diameter.

Measurements in mm

	D	H	W	U
MCM J1324 : 9 phrag.	150	52	33	54
phrag.	75	31	18	25.5
phrag.	33	13.5	8.5	10.5

Genus *Dorsetensia* BUCKMAN, 1892

Type-species by original designation — *Ammonites Edouardianus* D'ORBIGNY, 1845.

The genus has recently been extensively discussed and revised by HUF (1968, p. 72) who has given the following diagnosis (our translation from German): "Always flat-planulate ammonites with compressed ovate to triangular whorl section. Without sulci, perls, nodes or tubercles, but with ± falcid, low and only rarely sharp ribs or lirae which (except for the inner whorls) are always single. Widely and shallowly umbilicate relatively

small sharply ribbed extreme forms, usually with low solid keel, are morphologically continuously connected with compressed, deeply and narrowly umbilicate smooth often very large forms with marked hollow-floored keel. Septal suture simple and weakly incised, except for large forms.”

HUF (loc. cit.) points out that no single character suffices to distinguish *Dorsetensia* from *Sonninia*, and that this includes the simplified septal suture. He distinguishes the following species (synonyms placed in brackets): *D. edouardiana* (D'ORBIGNY, 1845) [*Witchellia regrediens* HAUG], *D. deltafalcata* (QUENSTEDT, 1858) [*Poecilomorphus moisyi* BRASIL, *Nannina evoluta* BUCKMAN, *N. undifera* BUCKMAN, *Witchellia hansenbodensis* MAUBEUGE], *D. romani* (OPPEL, 1857) [*Ludwigia romanoidea* DOUVILLÉ, *Am. deltafalcatus acutus* QUENSTEDT, *D. complanata* BUCKMAN, *D. pulchra* BUCKMAN; includes *D. romani parva* HUF], *D. liostraca* S. BUCKMAN, 1892 [includes *D. liostraca subtectata* BUCKMAN, *D. liostraca tecta* BUCKMAN]. However, HUF also points out that transitions exist between the contemporary *D. edouardiana* and *D. romani* (p. 78), particularly, between *D. romani* and *D. deltafalcata* (including small specimens) (p. 86); *D. liostraca* is said to differ from *D. romani* mainly in the keel which is floored only in the former. Thus, according to HUF's account, at least *D. romani* and *D. deltafalcata* may well belong to a single interbreeding species, although he keeps them separate. We follow this classification for the time being. The age of all species appears to be restricted to the Humphriesianum Zone except for scarce questionable *D. edouardiana* which, according to BUCKMAN's account (1892, p. 303, pl. 52, figs. 1—7; cf. HUF, 1968, pp. 76—77), are from the Sauzei Zone. The known lateral distribution of the genus ranges from northwestern Europe and the western Tethys to Tibet (ARKELL, 1952, 1953, 1956; ARKELL et al., 1957) and, probably, southward to Kenya and Madagascar (fide ARKELL et al., 1957); all occurrences are dated as Middle Bajocian (Sauzei to Humphriesianum Zone) (ops. cit.).

However, there has been much confusion about the type species *D. edouardiana* and related forms since HAUG (1893) attempted a taxonomic revision, owing to marked dimorphism (see below).

The type-species *D. edouardiana* (D'ORBIGNY, 1845)

The holotype (or syntypes if D'ORBIGNY's illustration is a synthesesogram) appears to be lost (HUF, 1968, p. 73). The specimen (or specimens) came from the Bajocian Oolithe Ferrugineuse of Bayeux in Calvados, France, where RIOULT (1964, p. 245) has recently reported *D. edouardiana* from an assemblage of the Humphriesianum Zone. D'ORBIGNY (1845) figured a specimen of 50 mm diameter (fide D'ORBIGNY) with steep or vertical umbilical wall on the outer 1 to 1½ whorls, and rectiradiate single ribs which project on the shoulders and become blunt on the outer ¼ whorl. The specimen may or may not have a part of the body chamber.

BUCKMAN (1892, pl. LII, figs. 8—24) figured 5 specimens under *D. edouardiana*, all supposedly from the Humphriesianum Zone of Dorset and Somerset; they were reillustrated by HUF (1968, pls. 7—8). Two specimens (BUCKMAN, pl. LII, figs. 18—20 and 21—23) have moderately evolute outer whorls with steep umbilical wall and weakening costae. One of them (figs. 18—20) was regarded by BUCKMAN and HUF as closely resembling the illustration of the holotype; BUCKMAN's other three specimens differ in the more evolute outer whorl without distinct umbilical wall and in the more prominent ribs, and one of them has the lateral lappets preserved.

HAUG (1893, p. 318) described the same pair of forms from the Oolithe Ferrugineuse of Bayeux and separated the evolute form without umbilical wall under *Witchellia regrediens*. However, he placed all of BUCKMAN's *D. edouardiana* in synonymy with *D. regrediens* (apparently not recognizing the presence of the two forms among BUCKMAN's specimens) and regarded the more compressed *D. pulchra* BUCKMAN (1892, p. 306, pl. LII, figs. 25—27) as a junior synonym of *D. edouardiana*. This classification was essentially followed by ARKELL (1952, 1953, 1956); significantly, a small collection from Tibet (ARKELL, 1953, pl. XIII, figs. 1, 2) also included both forms. The significant difference between the two forms was seen in the (“first”) lateral lobe (HAUG, 1893; ARKELL, 1953), which is allegedly trifold in *D. edouardiana* and bifid in *D. regrediens*; but this is obviously fallacious. The reproductions of HAUG (p. 306) show that L is irregularly bifid in both; this supposed difference is reversed according to BUCKMAN's figures (pl. LII), and the incision of L varies strongly within species of *Dorsetensia* (HUF, 1968).

HUF (1968, p. 72) again united the two forms figured by BUCKMAN (1892) under *D. edouardiana* into a single species, apparently believing that the differences in coiling and whorl section are insignificant and that the lappets preserved on a single complete aperture are characteristic for all specimens (both forms). However, HUF (op.

cit.) placed *D. pulchra* BUCKMAN in synonymy with *D. romani* (OPPEL), in spite of the prominent keel (see below).

It becomes immediately apparent that this is another case of the most common mode of shell dimorphism in Jurassic and Cretaceous Ammonitina. The larger form ($D \approx 45-55$ mm) with moderately involute outer whorls bearing a distinct umbilical wall is the macroconch or female shell (BUCKMAN, 1892, pl. LII, figs. 18—24); the somewhat smaller form ($D \approx 30-41$ mm) with a more evolute inflated outer whorl is the microconch or male shell (loc. cit., figs. 8—13, 15—17). *D. pulchra* BUCKMAN is based on a macroconch which differs from *D. edouardiana* in the more compressed whorl section ($H/W \approx 2.0$ vs. ≈ 1.6) with marked shoulders, i. e. attributes of *D. romani* (OPPEL), but agrees with the former species in the prominent keel and sharp umbilical margin.

Dorsetensia arabica ARKELL (1952, pl. 19, figs. 3—12) from a monotypic assemblage of the lowermost Dhurma Formation at Jebel Tuwaiq, Arabia, was said (p. 269) “to bear close comparison” to BUCKMAN’s (loc. cit.) macroconchs (here identified) and one of his probable microconchs (loc. cit., fig. 11) of *D. edouardiana*, particularly in the nuclei which they “closely resemble”; no differences were stated and ARKELL apparently held that comparatively large smooth outer whorls as in *D. arabica* were originally also present in BUCKMAN’s specimens. It was seemingly ARKELL’s belief that BUCKMAN’s specimens were not conspecific with the holotype (or illustration) of *D. edouardiana* which he, in turn, considered identical with *D. pulchra* (see above). ARKELL therefore distinguished the Arabian form as a new species. The large smooth outer whorls of *D. arabica* strongly resemble *D. liostraca* forma subsecta BUCKMAN (cf. HUF, 1968), although the keel appears to be solid in the former while it is floored in mature *D. liostraca*; the septal suture is simple with variable base of L. In conclusion, *D. arabica* is only tentatively retained as a separate species of the *D. liostraca* group.

ARKELL (1952, p. 269; 1956, p. 342) also noted the close agreement between *D. arabica* and the single fragments described earlier by SPATH and BESAIRIE respectively (fide ARKELL, locs. cit.) from Mombasa, Kenya, and northern Madagascar.

ARKELL (1953, p. 333, pl. XIII) furthermore described a single macroconch and two probable microconchs of *Dorsetensia* of the *D. edouardiana* group from the Bajocian of Tibet, tentatively referring the former to *D. romanoides* (H. DOUVILLÉ) and the latter to *D. regrediens* (HAUG). The macroconch was said to resemble *D. pulchra* BUCKMAN, except for the more inflated whorl section ($H/W \approx 1.65$, from illustration) which resembles that of *D. romanoides*. However, both *D. pulchra* and *D. romanoides* are strongly compressed and believed to be conspecific with *D. romani* (OPPEL) by HUF (1968, pp. 86, 87), although *D. pulchra* has the sharp umbilical margin and prominent keel of *D. edouardiana*. The Tibetan macroconch closely resembles *D. edouardiana* and, probably, *D. arabica* ARKELL, which were not compared by ARKELL (loc. cit.). The two probable microconchs from Tibet identified with *D. regrediens* were said to “agree well” with BUCKMAN’s figures of *D. edouardiana* [*“D. regrediens”* HAUG]. Consequently, the three Tibetan specimens described by ARKELL (loc. cit.) are here tentatively assigned to *D. edouardiana* ♀ and ♂.

Dorsetensia aff. *edouardiana* (D’ORBIGNY, 1845) ♀

(pl. 27, figs. 4, 5; text-figs. 39 a, 40 a)

Material

Los Molles, Neuquén province: 2 well preserved macroconchs with incomplete body chambers and most of the test, from bed 11 b (MCM J 1315 : 1, 2) — Sauzei Zone.

Arroyo Blanco, Mendoza province: 2 phragmocones with incomplete body chambers from concretion 10 (MCM J 1746 : 1, 2) — Sauzei-lower Humphriesianum Zone.

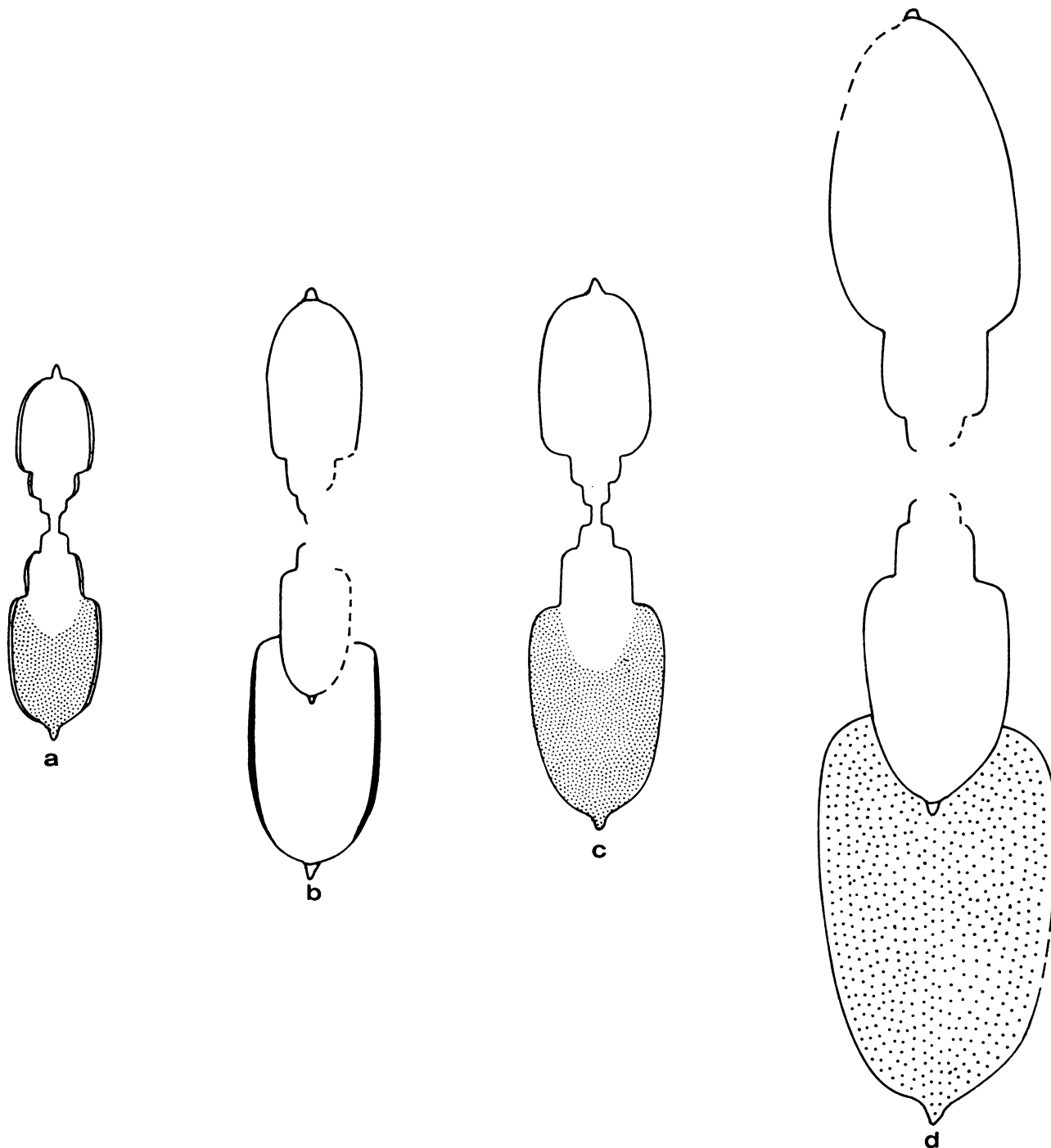
Paso del Espinacito, San Juan province: 1 large septate fragment from YPF loc. XE 12 (MLP 11557) — Sauzei Zone [reported together with *S. (Papilliceras)* cf. *S. espinazitensis* TORNØ. and *Otoites gottschei* WEST.; P. Stipanovic, in litt.].

Description

The whorls are rather widely umbilicate ($U/D = 0.33$ to 0.36) and moderately compressed ($H/W = 1.5$ to 1.6). The rounded to subrectangular section of the inner whorls soon becomes ovate; the narrow umbilical wall, developing at about 20 mm diameter, is vertical and separated from the flat flank by a slightly to moderately rounded margin; the venter is narrowly rounded tending to arch upwards on the outer one or two whorls. There is a prominent blade-like keel which is floored throughout the intermediate and outer whorls.

The ornament of the nucleus to approximately 20 mm diameter consists of rather fine, somewhat irregular,

partly fasciculate and more or less curved ribs. The intermediate and outer whorls, however, have prominent regularly spaced, rectiradiate simple ribs which project strongly on the shoulders where they weaken rapidly and soon become obsolete on the outer whorl; fasciculation in pairs occurs rarely. On the relatively small specimens ($D = 50$ to 70 mm) from Los Molles, the ribs become more widely spaced and blunt on the body chamber without being obsolescent; on the larger specimens the ribs become obsolete at approximately 100 mm diameter. The dense growth lines on the body chambers of the smaller specimens run parallel to the ribs.



Text-fig. 39. Cross sections of *Dorsetensia* spp., body chamber shaded if present, X 1; a, *D. aff. edouardiana* (D'ORB.), Sauzei Zone, Los Molles (MCM J1315 : 1); b, *D. blancoensis* sp. nov., holotype, Arroyo La Manga (MCM J1749 : 1); c, d, *D. mendozai* sp. nov., Sauzei (?Humphriesianum) Zone, Arroyo Blanco, c, holotype (MCM J1324 : 7; d, MCM J1746 : 20).

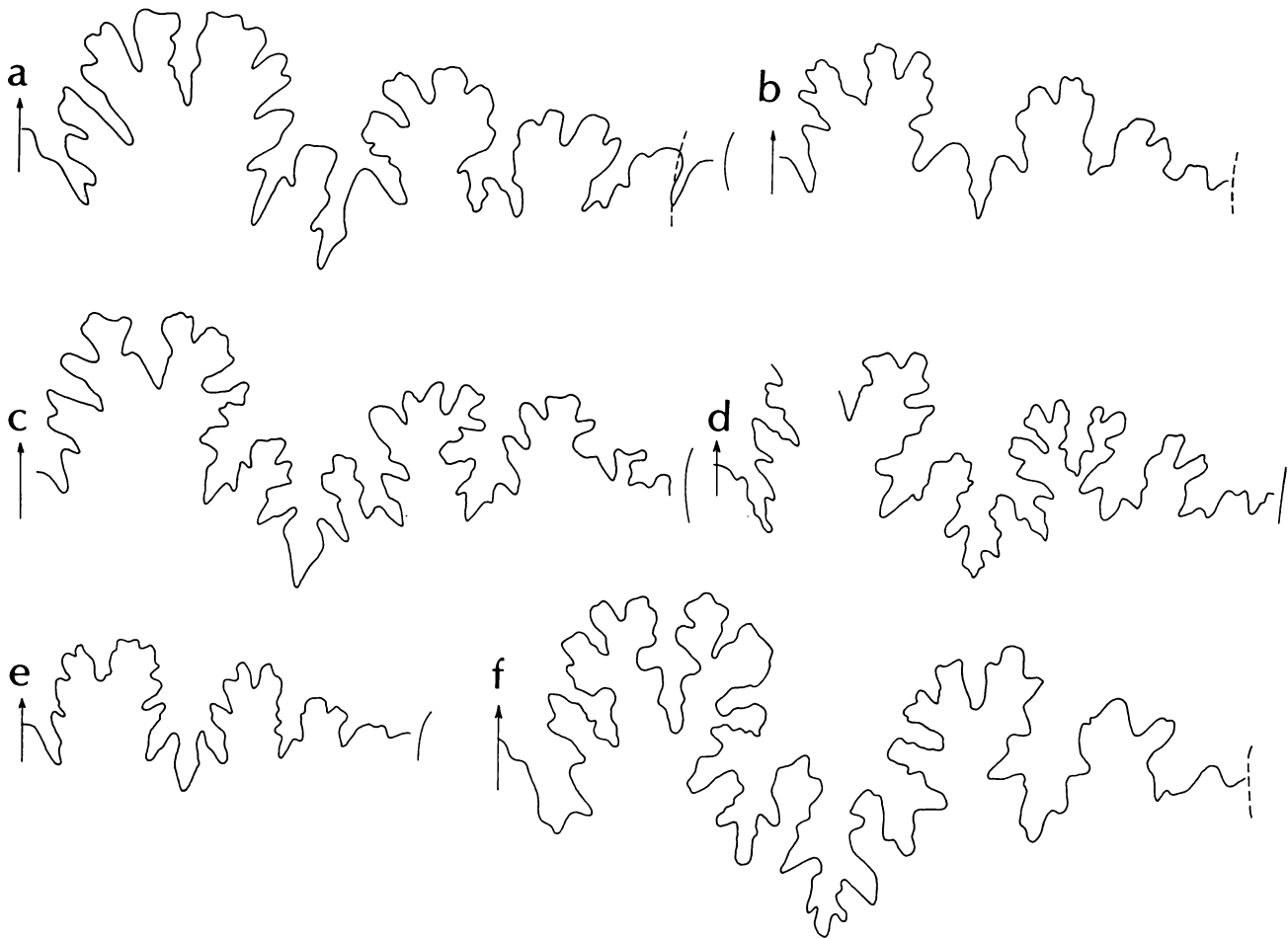
The septal suture (text-fig. 40 a) is simple with broad asymmetrically trifold L. The umbilical lobes and incisions of L are, however, more narrow and deep than in most figured sutures of *D. edouardiana*, and the suture is markedly more complicated than in the *D. liostraca* group.

Measurements in mm

	D	H	W	U	H/W
MCM J1315 : 1 body ch.	57	21 (0.37)	13.5 (0.24)	20 (0.35)	1.55
phrag.	45	17.3 (0.385)	11.5 (0.255)	15 (0.335)	1.50
: 2 body ch.	73	29 (0.40)	19 (0.26)	30 (0.41)	1.52
phrag.	42	17 (0.405)	11.3 (0.27)	14.5 (0.345)	1.50
phrag.	28	10.5 (0.37)	8.2 (0.29)	10.0 (0.36)	1.28

Comparison

The two almost complete smaller specimens closely resemble *D. edouardiana* (D'ORBIGNY), particularly the illustrations of the holotype (see above). Of the two figured English macroconchs (BUCKMAN, 1892, pl. LII, figs. 18—20, 21—23), the larger one (figs. 21—23; a phragmocone of 38 mm D) seems to have similar coiling but is



Text-fig. 40. Septal sutures of *Dorsetensia* spp.; a, *D. aff. edouardiana* (D'ORB.), at D = 49.4 mm and H = 19 mm, Sauzei Zone, Los Molles (MCM J1315 : 1); b, *D. blancoensis* sp. nov. at D = 33.1 mm and H = 14 mm, Sauzei (?Humphriesianum) Zone, Arroyo Blanco (MCM J1324 : 3); c—f, *D. mendozai* sp. nov., Sauzei (?Humphriesianum) Zone, Arroyo Blanco and (d, f only) Sierra de Reyes, c, macroconch (♀) at D = 43.5 mm and H = 19 mm (MCM J1324 : 6), d, macroconch (♀) at D ~ 49 mm and H = 13.5 mm (MBR 15047b), e, microconch (♂) at D ~ 26 mm and H = 10.6 mm (MCM J1324 : 8), f, macroconch (♀) at D ~ 75 mm and H = 33.2 mm (MBR 15047b).

more compressed while the other (figs. 18—20) is somewhat more evolute; however, HUF's measurements (1968, p. 77) of the first specimen do not agree with his photographic reproductions of the plastotypes; the photographs show somewhat more evolute coiling but similar whorl section as in the Andean form. The English macroconchs and the microconchs (phragmocones) are thus somewhat more evolute than our specimens. All figured specimens of *D. edouardiana*, including the holotype (illustration), also have more regular simple ribs on the nucleus, probably a somewhat simpler septal suture, and supposedly a solid keel.

D. arabica ARKELL (1952) differs in the early reduction of ribbing, the simpler septal suture and, probably, the solid keel. "*D. cf. romanoides* (DOUVILLÉ)" of ARKELL (1953) from Tibet differs similarly, as far as known. All other known species are even less prominently ribbed and differ considerably in whorl section and coiling.

Dorsetensia blancoensis, sp. nov. ♀ & ♂

(pl. 29, figs. 2—4; pl. 30, figs. 1—4; text-figs. 39 b, 40 b)

Holotype — The complete phragmocone, macroconch (♀), internal mould with test remains, on plate 29, figs. 2 a, b; from bed 1 of Arroyo La Manga at mouth of Arroyo Los Tabanos, Mendoza province; Bajocian (MCM J1749: 1). — **Allotype**: the damaged microconch (♂) with aperture on pl. 30, figs. 4 a, b; from concretion 4b₁ of Arroyo Blanco (MCM J1324: 5); Sauzei (?Humphriesianum) Zone.

Derivatio nominis — From Arroyo Blanco, a tributary of Rio Atuel, where the species is most abundant.

Diagnosis — Phragmocone whorls compressed with flattish flanks and moderately wide umbilicus; ribs fine and dense, slightly flexed, becoming obsolete on outer whorl; septal suture relatively complex. Macroconch (♀) with vertical to overhanging umbilical wall and sharp umbilical margin; microconch (♂) body chamber egressing, with compressed elliptical whorl section.

Material

Arroyo Blanco, Mendoza province: 3 (+ 1?) incomplete macroconchs of which 2 have part of the body chamber; 2 damaged microconchs with aperture and several juveniles and fragments from concretion 4b₁ (MCM J1324: 1) — Sauzei (?Humphriesianum) Zone; 2 fragmentary and almost complete macroconchs and 1 fragmentary microconch from concretion 10 (MCM J1746: 3—6) — Sauzei-Humphriesianum Zone.

Arroyo La Manga, Mendoza province: the holotype.

Charahuilla, Neuquén province: 2 fragmentary macroconchs with incomplete body chambers (MBR 5023, 5024).

Description

The nucleus at about 10 mm diameter has subcircular whorls with prorsiradiate medium to widely spaced blunt costae. The subsequent one or two whorls of the macroconch and the mature phragmocone of the microconch (20—25 mm diameter) are somewhat compressed elliptical to slightly subrectangular in section; the flanks curve gently to the umbilical seam and into the evenly curved venter which bears a moderately prominent keel. The ornament at this stage consists of dense simple, slightly flexed rectiradiate ribs arising near the umbilical seam and projecting before dying out beside the keel.

Macroconch (♀) — The whorls become more compressed ($H/W \approx 1.6$) subrectangular to somewhat ogival; the flattened flanks are separated from the vertical or overhanging umbilical wall by a sharp umbilical edge and converge in the outer one-third toward the narrow venter which is rounded on the internal mould. The outer whorl of the phragmocone and the body chamber may become slightly shouldered defining narrow obtusely inclined tabulations. The body chamber egresses moderately. The keel is prominent and floored.

The ornament consists of dense slightly flexed ribs which are usually simple but may fasciculate if very dense, such as in the Charahuilla specimens. The ribs die out beside the venter so that the projection is usually obscure. The ornament usually becomes obsolete on the last half-whorl of the phragmocone; but there is much variation, with specimen MCM J1324: 3 becoming smooth at approximately 35 mm diameter and both Charahuilla specimens retaining the dense ribbing well onto the body chamber. The extremely fine growth lines visible on the holotype follow the slightly flexed ribbing on the flanks and project strongly.

The diameter of the adult phragmocone varies between about 50 and 90 mm and the complete shell was approximately 65—110 mm. The aperture is unknown. The mature septal suture is moderately complex, i. e. markedly more complex than in the *D. romani* and *D. liostraca* groups, but not much more complex than in the illustrations of *D. edouardiana* ♀ by BUCKMAN (1892, pl. LII, fig. 23). The saddle envelope is straight; L is broad

and trifold with finger-like endings; the vertical U_2 is about one-half as large as L, quite narrow and indented; another umbilical lobe situated on the inner flank (U_3 or part thereof) is much smaller and somewhat oblique.

Microconch (δ) — The body chamber, three-fifths whorls in length in specimen MCM J1324: 4, egresses gradually without marked change in whorl section. The flanks are almost evenly convex curving gently into the umbilical seam and to the narrow venter which becomes slightly flattened by the development of faint shoulders and obtuse smooth tabulations. The keel becomes less prominent and finally blunt. The ornament consists of somewhat flexed simple radial ribs on the flanks which finally become obsolete. The adult aperture, respectively at 35 and 38 mm diameter at the two specimens, is marked by internally thickened test leaving a constriction on the internal mould, and simple small lateral lappets with converging margins. As usual, there is also a broad short ventral lappet.

Measurements in mm

		D	H	W	U
Holotype	♀ end phrag.	90.0	35.0	20.5	29.8
	phrag.	50.0	21.0	11.8	14.6
MCM J1324: 1	♀ phrag.	42.0	19.7	10.5	11.6
MCM J1324: 3	♀ phrag.	49.0	21.0	13.0	14.5
	phrag.	33.0	13.8	8.5	9.2
Allotype	♂ body ch.	34.0	12.2	9.0	10.6
	phrag.	22.0	9.6	8.0	~ 6.1

Comparison

D. blancoensis resembles *D. edouardiana* (D'ORBIGNY) most closely of all known species of *Dorsetensia*; it is distinguished by the somewhat tighter coiling (phragmocone $U/D \approx 0.30$ vs. 0.35 to 0.40), the denser and finer ribbing becoming obsolete on the body chamber also of the microconch, and probably by the somewhat more complex septal suture. *D. romani* (OPPEL) (with synonyms as discussed under the genus) is distinguished by the well defined shoulders, the low solid keel, the less developed umbilical slope, and in the very simple septal suture. *D. liostraca* forma subsecta BUCKMAN and *D. arabica* ARKELL differ in the more strongly converging flanks and in the much simpler septal suture.

There is a possibility that the two macroconchs from Neuquén described above under *Dorsetensia* aff. *edouardiana* are evolute and prominently ribbed variants of this species. Considering the septal suture which resembles that of many *Sonninia* species, it is interesting to speculate that the two *Dorsetensia* species here described from the Sauzei to (?) lower Humphriesianum Zone are closer to the ancestral stock than the previously known *Dorsetensia* species from the Humphriesianum Zone of Europe; only the latter have markedly simplified ("degenerate") sutures.

Dorsetensia mendozai, sp. nov. ♀ & ? ♂

(pl. 28, figs. 1—3; pl. 29, fig. 1; text-figs. 39c, d, 40c—f)

Holotype — The well preserved macroconch (♀) illustrated on pl. 29, figs. 1a—c; shell on left side partly exfoliated; from loose concretion 4b₁ of Arroyo Blanco near Malargue, Mendoza province: Sauzei (? Humphriesianum) Zone (MCM J1324:7).

Derivatio nominis — From Mendoza province.

Diagnosis — Macroconch (♀): whorl section inflated ogival with high vertical umbilical wall and prominent keel; umbilicus moderately wide and well stepped; septal suture relatively complex.

Material

Arroyo Blanco, Mendoza province: the holotype, 1 macroconch with incomplete body chambers, and ?1 complete microconch from loose concretion 4b₁ (MCM J1324: 6—8) — Sauzei (? Humphriesianum) Zone. One large complete macroconch from concretion 10 (MCM J1746: 20) — Sauzei-lower Humphriesianum Zone.

Sierra de Reyes, Mendoza province: 3 (+ 2?) macroconchs of which two have incomplete body chambers (MBR 15047 a, b, 15044 b, ?14979 a, b).

Description

Macroconch (♀) — The nucleus at about 10—15 mm diameter has subcircular whorls which subsequently become somewhat compressed. The flanks curve gently toward the umbilical seam and bear blunt, quite widely spaced simple to weakly fasciculate costae.

The intermediate whorls of the macroconch, from 15—20 mm diameter, become moderately compressed sub-ogival to somewhat subrectangular through the development of a vertical umbilical wall with slightly rounded edge and flattish flanks which converge more or less strongly beyond one-third to one-half whorl height. The blunt venter bears a moderately prominent floored keel. The weak ornament consists of blunt, somewhat irregular, rectiradiate to prorsiradiate, mostly simple ribs or plications which are quite widely spaced and become obsolete between 30 and 50 mm diameter. Feeble dense radial costellae are sometimes also present, but probably restricted to the shell surface (pl. 28, fig. 1).

The outer 1 to 1½ whorls, including the body chamber, become typically ogival to almost subtriangular in cross section by increased convergence of the flanks. The complete diameter varies between about 70 and 130 mm. The umbilical wall is vertical and separated by the slightly rounded edge. The venter is narrowly rounded to acute and bears a high keel, also on the body chamber. The umbilicus is moderately wide and well stepped. The flank is smooth or very obscurely plicate. The aperture is unknown.

The septal suture is relatively complex for *Dorsetensia*, approximating that of *Sonninia* s. s., with straight saddle envelope; L is broad and trifid, sometimes asymmetric; U₂ is barely one-half the size of L and vertical; the small U₃ (?) on the innermost flank is usually slightly oblique.

Dorsetensia (?) cf. *mendozai* sp. nov. ♂

Microconch (♂) — One of the microconchs (pl. 28, fig. 3) is a good, although not perfect, match to the nucleus of the much larger *D. mendozai* ♀ from the same assemblage and therefore tentatively identified with this genus and species. The phragmocone whorls are moderately compressed and elliptical to somewhat ovate in section; the venter is almost evenly and narrowly convex bearing a not very prominent keel. The ornament consists of moderately strong, somewhat blunt and slightly flexed ribs which are more often fasciculate in pairs than single.

The body chamber, three-fifths whorls long and 42.5 mm in diameter, egresses gradually, becomes somewhat more ovate with steep rounded umbilical wall, and bears simple lateral lappets. The weak ornament of the last three-quarter whorls consist of blunt, usually simple and mostly rectiradiate ribs or plications.

The septal suture is as described from the *Dorsetensia* macroconch at comparative diameter.

The ribbing of this microconch is somewhat more prominent than of *D. mendozai* ♀; it is also possible that fasciculation is more common although comparative data are incomplete for the nucleus of the macroconch.

Measurements in mm

		D	H	W	U
Holotype	♀ body ch.	94.0	36.0	23.0	27.0
	phrag.	68.0	30.0	20.0	20.5
	phrag.	45.0	18.0	13.5	13.5
	phrag.	30	13.0	10.0	8.5
	phrag.	20	8.5	7.5	6.0
MCM J 1324 : 6	♀ phrag.	65.0	27.5	17.0	20.5
	phrag.	46.0	19.0	12.5	13.0
MBR 15047 b	♀ body ch.	125.0	47.0	24.5	36.0
	phrag.	95.0	39.0	22.5	29.5
	phrag.	60.0	25.0	15.2	18.7
	phrag.	41.0	16.7	11.1	13.0
	phrag.	28.0	11.6	8.0	8.7
MCM J 1324 : 8	♂ body ch.	42.5	14.0	11.5	15.0
	phrag.	28.0	11.3	8.8	7.7

Comparison

This species has more strongly inflated whorls and more blunt ribs becoming obsolete than *D. aff. edouardiana* (D'ORB.) and *D. blancoensis* sp. nov. from the same assemblage. The previously known species of *Dorsetensia*, mostly from the Humphriesianum Zone of Europe, have simpler septal sutures and usually more compressed whorls. The closest of them appear to be *D. liostraca* BUCKMAN (cf. HUF, 1968) and *D. arabica* ARKELL (1952; a possible synonym); both are probably also distinguished by greater involution and the ribbing of the nucleus.

D. mendozai also shows some resemblance to the variable set of compressed ogival sonniniids bearing average ammonitic septal sutures from the Sauzei Zone of the Inferior Oolite of England. This apparently closely knit group was described by BUCKMAN (1923—1926) under the new generic names of *Sonninites*, *Anolkoleiites*, *Rubrileiites*, *Dundryites* and *Hyalinites*; they were rather arbitrarily placed in synonymy with either *Witchellia* or *Dorsetensia* by ARKELL et al. (1957, p. L 270) and tentatively united under the subgenus (or genus?) *Sonninites* [of *Dorsetensia*?] by WESTERMANN (1969, p. 114). This English assemblage needs to be thoroughly reexamined and can only be classified properly after the macroconch of *Dorsetensia edouardiana*, type-species, is better known. As usual, most of the supposed genera and species are only known in the macroconch or female shell.

The single here described microconch (MCM J1324: 8) resembling juvenile *D. mendozai* ♀ except for the body chamber, is quite close to some microconchs of *D. deltafalcata* (QUENSTEDT) figured by HUF (1968, pls. 9—13) from the Humphriesianum Zone of northwestern Germany. However, *D. deltafalcata* has a less prominent keel, often accompanied by ventral flattening of the body chamber of the microconch (cf. lectotype, op. cit. pl. 9, fig. 2) as well as of the macroconch (cf. op. cit., pl. 10, fig. 3).

Dorsetensia romani (OPPEL, 1857) 1862
(pl. 30, figs. 6—7)

1857. *Ammonites Romani*, OPPEL, p. 370.

1862. *Ammonites Romani* OPPEL, p. 145, pl. 46, figs. 2 a, b.

1968. *Dorsetensia romani romani* (OPPEL, 1857) — HUF, p. 86, pl. 13, figs. 6 a—e (holotype refigured), pls. 14—27, pl. 28, figs. 1—2. (Therein also complete synonymy.)

1970. *Dorsetensia cf. complanata* BUCKMAN — HILLEBRANDT, p. 189.

Material

Salar de Pedernales, Atacama province, Chile: 1 well preserved large phragmocone (♀; D = 93 mm) and several fragments from “fauna with *Stephanoceras cf. humphriesianum*”, HILLEBRANDT coll. (TUB 660714/6, 670308/4) — (Humphriesianum Zone).

Comments

This identification is based on a brief inspection of the specimen in Berlin by the senior author and on the photographs kindly made available to us by Dr. HILLEBRANDT.

The Chilean specimens closely resemble the European *D. romani* as recently profusely illustrated by HUF (1968). The compressed whorl section with steep umbilical wall and blunt umbilical margin, the well separated small keel, the costation of the nucleus, the feeble fasciculate ribbing becoming obsolete on the outer whorls, and the simple septal suture, are all in good agreement.

Besides the “*Stephanoceras cf. humphriesianum*” reported by HILLEBRANDT (1970, p. 189), this assemblage has also yielded *Dorsetensia liostraca* forma tecta BUCKMAN (see below) and *D. cf. deltafalcata* (QUENSTEDT) (the latter from photographs furnished by Dr. HILLEBRANDT).

Measurements in mm

	D	H	W	U
TUB 660714/6	93.0	34.5	31.0	33.6

Dorsetensia liostraca BUCKMAN, 1892, forma tecta BUCKMAN, 1892, ♀
(pl. 30, figs. 8—9)

1892. *Dorsetensia tecta* BUCKMAN, p. 311, pl. 56, figs. 2—5.

1968. *Dorsetensia liostraca tecta* BUCKMAN, 1892 — HUF, p. 107, pl. 47, figs. 2—4, p. 48 [Lectotype refigured], pls. 49—51. (Therein also complete synonymy.)

1970. *Dorsetensia tecta* BUCKMAN — HILLEBRANDT, p. 189.

Material

Salar de Pedernales, Atacama province, Chile: 1 large well preserved phragmocone (♀; D = 102 mm) and 1 septate fragment (♀), from “fauna with *Stephanoceras cf. humphriesianum*”, HILLEBRANDT coll. (TUB 660714/6 a, b) — (Humphriesianum Zone).

Comments

The confirmation of Dr. HILLEBRANDT's identification (1970, p. 189) is based on a brief inspection of the specimens in Berlin by the senior author and on the photographs made available by Dr. HILLEBRANDT.

The Chilean specimens closely resemble the northwest and central European *D. liostraca* forma *tecta*, recently revised by HUF (1968). The whorls are very involute and compressed ogival in section bearing a fine sharp keel. While the inner whorls are bluntly costate, the intermediate whorls have only low plications on the inner flanks and faint dense projected secondaries, becoming obsolete on the last phragmocone whorl where fine growth striae are present on the shell. The septal suture is simple with asymmetric trifid L.

Based on field experience of the senior author in northern Germany (cf. WESTERMANN, 1954) and from a study of the monographs by BUCKMAN (1887—1907) and HUF (1968), it is clearly apparent that the supposed species *D. subtectata*, *D. liostraca* and *D. tecta*, BUCKMAN 1892 spp., are mere formas of a single varying species, found together in the same beds. *D. liostraca* has been the most commonly used species name and is therefore retained.

The Pedernales specimens were associated with *D. romani* (OPPEL) and *D. cf. deltafalcata* (QUENSTEDT) (the latter from photographs furnished by Dr. HILLEBRANDT).

Measurements in mm

	D	H	W	U
TUB 660714/6 a	102	55.3	31.0	13.6

Dorsetensia aff. *deltafalcata* (QUENSTEDT, 1858)

(pl. 30, figs. 5 a—c)

1858. *Ammonites deltafalcata* QUENSTEDT, p. 394, pl. 53, figs. 7, 8 [lectotype des. RENZ, 1925: fig. 8; fide HUF, 1968].

1968. *Dorsetensia deltafalcata* (QUENSTEDT, 1886) — HUF, p. 78—86, pl. 9, figs. 2—7 [figs. 2 a—c, lectotype refigured]; pl. 10, figs. 2, 3; pls. 11, 12; pl. 13, figs. 1—5. (With complete synonymy on p. 78.)

Material

Salar de Pedernales, Atacama province, Chile: one well preserved fully grown phragmocone with beginning of body chamber, from beds with *Stephanoceras* spp. (MHNS GA—1035) — (Sauzei ? —) Humphriesianum Zone.

Description

The outer whorls are compressed ovate ($H/W = 1.3 \rightarrow 1.4$) with rounded umbilical slope reaching the seam vertically and narrowly rounded venter bearing a small keel, and quite narrowly coiled ($U/D = 0.26$). At the end of the phragmocone, the venter becomes broader and flatter with rounded shoulders and the umbilical seam begins to egress markedly.

The ornament of the outer two whorls consists of blunt distant rather strong and sinuous plications. They are fasciculate or simple and become obscure on the outer flanks dying out on the shoulder.

The septal suture is simple consisting of a gradually decreasing series of lobes and saddles along a rectiradial saddle envelope. The last two sutures are approximated.

Measurements in mm

	D	H	W	U
GA—1035 b end phrag.	50	20.4	14.3	14.4 (0.29)
phrag.	41	16.8	12.3	10.6 (0.26)
phrag.	~ 28	12.5	9.5	7.2 (~ 0.25)

Comparison

There is a good resemblance to some of the larger and more involute specimens of *D. deltafalcata* recently figured by HUF (1968, cf. pl. 10, figs. 2, 3). The only apparent difference is the slightly tighter coiling of our specimen; relative umbilical width (U/D) of the phragmocone falls just outside of the range of 0.31 to 0.40 given by HUF (1968, p. 84) for the European species. *D. romani* (OPPEL), which has also been recorded from the Humphriesianum Zone of Chile (HILLEBRANDT, 1970) and was described above, is distinguished by the much more compressed whorl section.

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Explanation of Plates

Plate 1

(All figures natural size)

- Figs. 1—5 b. *Tmetoceras scissum* (BENECKE)
1. Incomplete phragmocone and body chamber, with constriction, lateral view (MCM J1751:18). Concretion 9, Concava-Sowerbyi Zone, Arroyo Blanco.
- 2 a—b. Fragment of phragmocone and body chamber, lateral and ventral views (MCM J1751:17). Same location and age as Fig. 1.
- 3 a—b. Fragment of (?) immature specimen with beginning of body chamber, lateral and ventral views (MCM 1751:19). Same location and age as Fig. 1.
- 4 a—b. Fragment of phragmocone and body chamber with constriction, lateral and ventral views (MLP 8149:1). Picún Leufú.
- 5 a—b. Completely septate fragment, lateral and ventral views (MLP 8149:2). Picún Leufú.
- Fig. 6. *Tmetoceras* cf. *flexicostatum* WESTERMANN, latex cast of natural mould, lateral view (MCM J1346). Scree from lower shales, Arroyo Blanco.

- Figs. 7—8. *Fontannesia* (?) *austramericana* JAWORSKI ♂.
7. Almost complete probable microconch (♂), internal mould and latex cast, lateral view (MCM J1188 : 29 a). Bed 5, Concava-Sowerbyi Zone, Manflas.
8. Holotype (plaster cast), microconch (♂), complete with probable base of lappet, lateral and ventral views (IPB 57). Concava-Sowerbyi Zone, Cerro Tricolor.
Fig. 9. (?) *Staufenia* (*Costileioceras*) sp., crushed fragment, lateral view (MCM J1755). Bed 17, Aalenian, Cerro Puchenque.
Figs. 10 a—b. (?) *Leioceras opalinum* (REIN.), natural external moulds of crushed shells on bedding plane (MCM J1756 : 2). Locality 3 g near Arroyo Blanco.

Plate 2

(All figures natural size)

- Fig. 1. *Fontannesia* (?) sp. indet. ♀, fragment in lateral view (MHNS 10051). "Schicht I" (Concava-Sowerbyi Zone assemblage) of Biese coll., Hacienda Manflas.
Figs. 2 a—b. *Bredyia* aff. *crassornata* (BUCKMAN), poorly preserved internal mould, ventral and lateral views (MCM J1187 : 1). Bed 4, Opalium-Murchisonae Zone, Estancia Manflas.
Fig. 3. *Eudmetoceras* (*Eudmetoceras*) *gerthi* (JAWORSKI), lectotype (plaster cast), lateral view of phragmocone (IPB 58 a). (Concava ?) Sowerbyi Zone, Cerro Tricolor.
Fig. 4. *Eudmetoceras* (*Eudmetoceras*) *eudmetum jaworskii* WESTERMANN, holotype (plaster cast), phragmocone, lateral view (IPB 59 a). Same locality and age as Fig. 3.
Fig. 5. *Planammatoceras* cf. *planinsigne* (VACEK), subsp. nov. A ♀, incomplete phragmocone, lateral view (DNGM 846). Aalenian, Sierra de Reyes.

Plate 3

(All figures natural size)

- Figs. 1 a—b. *Eudmetoceras* (*Eudmetoceras*) *gerthi* (JAWORSKI), paralectotype (plaster cast), phragmocone, lateral view (IPB 58 b). (Concava ?) Sowerbyi Zone, Cerro China.
Figs. 2 a—3 b. *Eudmetoceras* (?) cf. *kochi* (PRINZ). Concava-Sowerbyi Zone, Hacienda Manflas.
2 a—b. Incomplete phragmocone; a, coated; b, uncoated detail showing septal suture (MHNS 10054a). "Schicht I" of Biese coll.
3 a—b. Large fragment of phragmocone; a, lateral view coated; b, uncoated detail showing septal suture (MCM J1188 : 28). Bed 5.
Figs. 4 a—b. *Eudmetoceras* (*Euaptetoceras*) cf. *klimakomphalum klimakomphalum* (VACEK), internal mould of incomplete phragmocone, lateral and ventral views (MCM J1188 : 1). Bed 5, Concava-Sowerbyi Zone, Hacienda Manflas.
Figs. 5—7 b. *Eudmetoceras* (*Euaptetoceras*) aff. *klimakomphalum* (VACEK).
5. Completely septate inner whorl or juvenile, lateral view (MCM J1325 : 9). Block 1, Concava-Sowerbyi Zone, Bardas Blancas.
6 a—b. Incomplete phragmocone, internal mould, lateral and ventral views (MCM J1751 : 10). Concretion 9, Concava-Sowerbyi Zone, Arroyo Blanco.
7 a—b. Slightly crushed phragmocone, lateral and ventral views (MCM J1325 : 8). Block 1, Concava-Sowerbyi Zone, Bardas Blancas.

Plate 4

(All figures approximately natural size)

- Figs. 1 a—b. *Eudmetoceras* (*Euaptetoceras*) aff. *klimakomphalum* (VACEK), damaged phragmocone, internal mould with test remains, lateral and ventral views (MCM J1751 : 9). Concretion 9, Concava-Sowerbyi Zone, Arroyo Blanco.
Fig. 2. *Eudmetoceras*? sp. indet., damaged phragmocone, lateral view (MCM J1751 : 16). Same locality and age as Fig. 1.
Figs. 3 a—7 b. *Eudmetoceras* (*Euaptetoceras*) *klimakomphalum moerickei* (JAWORSKI).
3 a—b. Septate nucleus or juvenile, internal mould with test remains, floored keel partly preserved, lateral and ventral views (MCM J1347 : 2). Concretion 5 b, Arroyo Blanco.
4. Fragment of phragmocone, largely with test, floored keel partly preserved, lateral view (MCM J1347 : 4). Same locality and level as fig. 3.
5 a—b. Lectotype (plaster cast), internal mould of phragmocone, lateral and ventral views (IPB 70 a). (?) Sowerbyi Zone, Arroyo Blanco.
6. Paralectotype (?) (plaster cast), damaged phragmocone with test and preserved keel, lateral view (IPB 70 b). Cerro Tricolor, Mendoza.
7 a—b. Septate nucleus or juvenile with test and part of keel, lateral and ventral views (MCM J1347 : 3). Concretion 5 b, Arroyo Blanco.

- Figs. 8—9. Hammatoceratidae? gen. et sp. nov. A and aff. A. Bed. 5, Concava-Sowerbyi Zone, Hacienda Manflas.
8. Modestly preserved fragment with part of body chamber, lateral view (MCM J1188 : 6).
9. Aff. sp. nov. A, modestly preserved, somewhat crushed and distorted, but almost complete specimen, lateral view (MCM J1188 : 21).

Plate 5

(Figures natural size if not otherwise indicated)

- Figs. 1—6. Hammatoceratidae? gen. et sp. nov. A, modestly preserved internal moulds. Concava-Sowerbyi Zone, Hacienda Manflas.
1. Somewhat crushed phragmocone, lateral view (MCM J1188 : 1 a). Bed 5.
2 a—b. Damaged end of phragmocone with beginning of body chamber; a, lateral view coated; b, uncoated detail (MHNS 10055a). "Schicht I" of Biese coll.
3. Fragment of phragmocone, lateral view (MCM J1188 : 3). Bed 5.
4 a—b. Fragment of phragmocone; a, lateral view coated; b, detail uncoated, X 1.5 (MHNS 10055b). "Schicht I" of Biese coll.
5. Partly crushed fragment of phragmocone and beginning of body chamber, lateral view (MCM J1188 : 2). Bed 5.
6. Fragment of end of phragmocone, lateral view (MCM J1188 : 5). Bed 5.
Figs. 7—10. Hammatoceratidae? gen. et sp. nov. B, modestly preserved internal moulds. Concava-Sowerbyi Zone, Hacienda Manflas.
7. Somewhat crushed fragment of ? juvenile, lateral view (MCM J1188 : 23). Bed 5.
8. Beginning of body chamber, somewhat crushed, lateral view (MCM J1188 : 22). Bed 5.
9. Damaged fragment of phragmocone, lateral view (MCM J1188 : 22 a). Bed 5.
10 a—b. Damaged fragment of phragmocone, lateral and ventral views (MCM J1188 : 25). Bed 5.

Plate 6

(All figures natural size)

- Figs. 1 a—9 b. *Puchenquia malarguensis* (BURCKHARDT) ♀, internal moulds with test remains. (Concava ?)-Sowerbyi Zone, Cerro Puchenque.
1 a—b. Lectotype, internal mould of phragmocone, lateral and ventral views (MLP 3387).
2 a—b. Entire phragmocone with crushed and incomplete (umbilical margin missing) fragment of body chamber, lateral and ventral views (MCM J1753 : 3). Bed 14.
3. Phragmocone with crushed incomplete body chamber, lateral view (MCM J1753 : 2). Bed 14.
4. Approximately complete crushed specimen, lateral view (MCM J1753 : 4). Bed 14.
5. Almost complete body chamber, lateral view (MCM J1300 : 39). Bed 6.
6. Almost complete, with crushed body chamber incomplete at umbilicus, lateral view (MCM J1753 : 1). Bed 14.
7 a—c. Phragmocone, last halfwhorl slightly crushed, lateral and ventral views (MCM J1300 : 38). Bed 6.
8 a—c. Almost complete, with crushed body chamber, lateral and ventral views (MLP 11576).
9 a—b. Phragmocone with beginning of crushed body chamber, lateral and ventral views (MCM J1300 : 36). Bed 6.

Plate 7

(All figures natural size)

- Figs. 1—2. *Puchenquia malarguensis* (BURCKHARDT). Bed 14, (Concava ?) Sowerbyi Zone, Cerro Puchenque.
1. Juvenile with one-quarter whorl somewhat crushed body chamber, lateral view (MCM J1753 : 6).
2. Phragmocone, juvenile or (adult) microconch, lateral view (MCM J1753 : 7).
Figs. 3—8 b. *Puchenquia malarguensis* (BURCKHARDT) ♂ [= *H. puchense* (BURCKHARDT)]. (Concava ?) Sowerbyi Zone, Cerro Puchenque.
3 a—b. Allotype [= *H. puchense*, neotype], complete with damaged aperture, lateral and ventral views (MLP 2956 b).
4. Damaged specimen with base of lappet, lateral view (MCM J1753 : 9). Bed 14.
5 a—b. Complete exceptionally large specimen with slightly damaged aperture, lateral and ventral views (MCM J1753 : 8). Bed 14.
6 a—b. Almost complete specimen, lateral and ventral views (MCM J1753 : 10). Bed 14.
7. Damaged phragmocone with beginning of body chamber, lateral view (MCM J1753 : 11). Bed 14.
8 a—b. Phragmocone with one-half whorl of body chamber, lateral and ventral views (MCM J1300 : 22). Bed 6.
Figs. 9—10. *Puchenquia* cf. *malarguensis* (BURCKHARDT) ♀.
9. Large phragmocone, lateral and ventral views (MCM J1752 : 1). Bed 15, Sowerbyi Zone, Cerro Puchenque.
10. "*Harpoceras concavum* Sow." of TORNQUIST (1898, pl. I, fig. 2), lateral and ventral view (GAUG 496-1). Paso del Espinacito.

Plate 8

(All figures natural size)

- Figs. 1 a—b. *Puchenquia* (?) aff. *malarguensis* (BURCKHARDT) ♀, almost complete specimen with crushed body chamber, lateral views; b, outer whorl omitted (MCM J 1748 : 1). Bed 16, (Concava?) Sowerbyi Zone, Cerro Puchenque.
- Fig. 2. *Puchenquia* cf. *malarguensis* (BURCKHARDT) ♀, damaged phragmocone, lateral view (MCM J 1748 : 2). Same locality and bed as Fig. 1.
- Fig. 3. *Sonninia* (*Sonninia*) *ovalis* (QUENSTEDT) ♀, lateral view (TUB). Sowerbyi Zone, Paso del Espinacito (coll. et fotogr. A. v. Hillebrandt).

Plate 9

(All figures natural size)

- Figs. 1 a—b. *Sonninia* (*Sonninia*) cf. *ovalis* (QUENSTEDT) ♀, phragmocone, lateral and ventral views (MCM J 1320 : 27). Bed 1c₁, Sauzei Zone, Charahuilla.
- Figs. 2 a—3 b. *Sonninia* (*Sonninia*) *mirabilis* TORNQUIST.
- 2 a—b. Holotype (plaster cast), phragmocone, lateral and ventral views (GAUG 496-60). Paso del Espinacito.
- 3 a—b. Phragmocone, lateral and ventral views (MCM J 1747 : 12). Bed 12, Sowerbyi Zone, Cerro Puchenque.

Plate 10

(All figures natural size)

- Figs. 1—7. *Sonninia* (*Sonninia*?) *alsatica* (HAUG) ♀ & ♂. Sauzei Zone, Neuquén, except fig. 6.
- 1 a—b. Macroconch (♀), lateral and ventral views (MCM J 1315 : 3). Bed 11 b, Los Molles.
- 2 a—c. Juvenile or microconch (♂) with incomplete body chamber, lateral and ventral views (MLP 8640). Chacaico.
- 3 a—b. Complete microconch (♂), lateral and ventral views (MCM J 1315 : 5). Bed 11 b, Los Molles.
- 4 a—c. Macroconch (♀), phragmocone, lateral and ventral views (MCM J 1320 : 36). Bed 1c₁, Charahuilla.
- 5 a—b. Macroconch (♀), phragmocone with beginning of body chamber, lateral and ventral views (MLP 7016). Charahuilla.
- 6 a—c. Incomplete internal mould, mainly body chamber, lateral and ventral views (Bodenbender coll., GAUG 22-51). Paso del Espinacito.
- 7 a—b. Incomplete juvenile probable macroconch (♀?), lateral and ventral views (MCM J 1315 : 4). Bed 11 b, Los Molles.

Plate 11

(All figures natural size)

- Figs. 1—2 b. *Sonninia* (*Euhoploceras*) cf. *adicra* (WAAGEN). "Schicht mit *S. argentinica*, Sowerbyi Zone", Paso del Espinacito (coll. et fotogr. A. v. HILLEBRANDT).
1. Incomplete specimen, lateral view (TUB 680106-1).
- 2 a—b. Incomplete specimen, lateral and ventral views (TUB 680106-2).
- Figs. 3—9 c. *Sonninia* (*Euhoploceras*) *amosi*, sp. nov. ♀ & ♂. (Concava?) lower Sowerbyi Zone, Cerro Puchenque.
3. Probably complete adult phragmocone of microconch (♂), last two sutures approximated, lateral view (MCM J 1748 : 4). Bed 16.
- 4 a—c. Holotype, incomplete phragmocone of macroconch (♀), modal form (MCM J 1748 : 2 a). Bed 16.
- 5 a—b. Macroconch (♀), probably adult, phragmocone with beginning of body chamber, compressed and weakly ornate form, lateral and ventral view (MCM J 1748 : 16). Bed 16.
- 6 a—b. Macroconch (♀), incomplete phragmocone, inflated and spinose form, lateral and ventral view (MCM J 1748 : 1 a). Bed 16.
7. Macroconch (♀), fragment of phragmocone and body chamber, lateral view (MCM J 1300 : 89). Bed 6.
- 8 a—b. Macroconch (♀), fragment of phragmocone and body chamber, lateral and ventral views (MCM J 1300 : 87). Bed 6.
- 9 a—c. Incomplete juvenile phragmocone, inflated and spinose form, lateral and ventral views (MCM J 1300 : 82). Bed 6.

Plate 12

(Magnifications as indicated)

- Figs. 1—10. *Sonninia* (*Euhoploceras*) *amosi* sp. nov. ♂. (Concava?) lower Sowerbyi Zone, Cerro Puchenque.
- 1 a—f. Allotype, microconch (♂), complete with lappets; a—d, lateral and ventral views X 1; e—f, lateral and ventral views (a, c) X 2 (MCM J 1300 : 41). Bed 6.
- 2 a—b. Complete microconch (♂) with apparently complete lappet, internal mould, lateral view; a, X 1; b, X 2 (MCM J 1748 : 12 a). Bed 16.

- 3 a—d. Complete microconch (♂) with incomplete lappet and attached (?) *Placunopsis* sp., lateral and ventral views, X 1 (MCM J1748 : 12 b). Bed 16.
- 4 a—c. Adult phragmocone of microconch (♂), inflated and spinose form, lateral and ventral views; a; X 1; b—c, X 2 (MCM J1300 : 80). Bed 6.
- 5 a—e. Complete microconch (♂) with incomplete lappet, lateral and ventral views; a—c, X 1; d—e, X 2 (MCM J1300 : 1). Bed 6.
- 6 a—c. Complete microconch (♂) with apparently complete lappet, lateral and ventral views; a—b, X 1; c, X 2 (MCM J1300 : 42). Bed 6.
- 7 a—c. Probably adult and almost complete phragmocone of microconch (♂), inflated and spinose form, lateral and ventral views, X 1 (MCM J1300 : 81). Bed 6.
8. Probably adult complete phragmocone with beginning of body chamber of microconch (♂), lateral view, X 1 (MCM J1300 : 50). Bed 6.
9. Almost complete adult microconch (♂) with one-half whorl body chamber, lateral view, X 1 (MCM J1748 : 13). Bed 16.
10. Complete microconch (♂) with damaged aperture, lateral view, X 1 (MCM J1748 : 14). Bed 16.

Plate 13

(Figures natural size if not otherwise indicated)

- Figs. 1 a—4 b. *Sonninia (Fissilobiceras) zitteli* (GOTTSCHKE). Paso del Espinacito.
- 1 a, b. Type specimen of “*Harpoceras Zitteli* var. α ” GOTTSCHKE (1878), fragment of phragmocone, lateral and ventral views, X 1.2 (DNGM 7885).
- 2 a, b. Syntype of “*Harpoceras Andium*” GOTTSCHKE (1878), phragmocone; lateral view and ventral (X 1.2) view (DNGM 9436).
- 3 a, b. Syntype of “*Harpoceras Stelzneri*” GOTTSCHKE (1878), ? incomplete phragmocone, lateral (X 1.8) and ventral (X 1.9) views (DNGM 9435 a).
- 4 a, b. Syntype (lectotype) of “*Harpoceras Stelzneri*” GOTTSCHKE (1878), ? incomplete phragmocone, lateral and ventral views (DNGM 9435 b).

Plate 14

(All figures natural size)

- Figs. 1 a—4 b. *Sonninia (Fissilobiceras) zitteli* (GOTTSCHKE).
- 1 a, b. Lectotype of “*Sonninia Argentinica*” TORNQUIST (1898, pl. 1, fig. 1), macroconch (♀), phragmocone with incomplete body chamber, lateral and ventral views (GAUG 496—11). Paso del Espinacito.
- 2 a, b. Macroconch (♀), incomplete phragmocone, lateral and ventral views (MLP 11417). Sowerbyi Zone, Arroyo Blanco.
- 3 a, b. Incomplete phragmocone, lateral and ventral views (MLP 11415). Sowerbyi Zone, Arroyo Blanco.
- 4 a, b. Incomplete phragmocone of macroconch (♀), lateral and ventral views (MLP 11396). Sowerbyi Zone, Arroyo Blanco.

Plate 15

(All figures natural size)

- Figs. 1 a—3 c. *Sonninia (Fissilobiceras) zitteli* (GOTTSCHKE) ♀. Sowerbyi Zone of Arroyo Blanco, except fig. 1.
- 1 a, b. Lectotype of “*Sonninia intumescens*” TORNQUIST (1898, pl. II, fig. 2), phragmocone of macroconch (♀), lateral and ventral views (GAUG 496—17). Paso del Espinacito.
- 2 a, b. Incomplete phragmocone of macroconch (♀), lateral and ventral views (MLP 11414).
- 3 a—c. Phragmocone of macroconch (♀), lateral view, ventral view and polished cross section (MCM J1321 : 73). Bed B 11.

Plate 16

(All figures natural size)

- Figs. 1—6. *Sonninia (Fissilobiceras) zitteli* (GOTTSCHKE) ♀ & ♂. Concretion A 11 (= B 11), Sowerbyi Zone, Arroyo Blanco.
- 1 a—e. Macroconch (♀), incomplete phragmocone of evolute form, lateral and ventral views; c—e, parts of the outer whorl removed (MLP 11360).
- 2 a, b. Macroconch (♀), incomplete phragmocone of involute form, lateral and ventral views (MLP 11375).
- 3 a, b. (?) Microconch (♂), phragmocone with incomplete body chamber, lateral and ventral views (MLP 11421).
4. (?) Microconch (♂), phragmocone with incomplete body chamber, lateral view (MLP 11423).
- 5 a, b. (?) Microconch (♂), phragmocone with incomplete body chamber, lateral and ventral views (MLP 11420).
- 6 a, b. Incomplete phragmocone of macroconch (♀), lateral and ventral views (MLP 11373).

Plate 17

(All figures natural size)

- Figs. 1—4. *Sonninia (Fissilobicerias) zitteli* (GOTTSCHÉ) ♀. Concretion 4 b (= A 11, B 11), Sowerbyi Zone, Arroyo Blanco.
1. Incomplete phragmocone, modal form, lateral view (MCM J1321 : 82).
 - 2 a, b. Incomplete phragmocone, modal form, lateral and ventral views (MLP 11422).
 - 3 a—c. Incomplete phragmocone, evolute form; a—b, outer phragmocone fragment removed, lateral and ventral views (MLP 11361).
 - 4 a, b. Incomplete phragmocone, involute form, lateral and ventral views (MCM J1321 : 70).

Plate 18

(All figures natural size)

- Figs. 1 a—4 b. *Sonninia (Fissilobicerias) zitteli* (GOTTSCHÉ). Concretion 4 b (= A 11, B 11), Sowerbyi Zone, Arroyo Blanco.
- 1 a, b. Macroconch (♀), incomplete phragmocone, ornate variant, lateral and ventral views (MCM J1321 : 67).
 - 2 a, b. Macroconch (♀), incomplete phragmocone, involute form, ventral and lateral views (MLP 11367).
 - 3 a, b. Probably juvenile macroconch (♀ ?), phragmocone with beginning of body chamber, lateral and ventral views (MLP 11416).
 - 4 a, b. Probably juvenile macroconch (♀ ?), phragmocone with beginning of body chamber (MLP 11418).

Plate 19

(All figures natural size)

- Figs. 1 a, b. *Sonninia (Fissilobicerias) zitteli* (GOTTSCHÉ) ♀, complete (?) phragmocone, evolute form, lateral and ventral views (MLP 11362). Concretion B 11, Sowerbyi Zone, Arroyo Blanco
- Figs. 2 a—c. *Sonninia (Fissilobicerias ?) mammilifera* JAWORSKI, holotype (plaster cast, imperfect). (?) Sowerbyi Zone, Arroyo Blanco.

Plate 20

(All figures natural size)

- Figs. 1 a—3 b. *Sonninia (Papilliceras) espinazitensis* TORNQUIST ♀. Paso del Espinacito.
- 1 a, b. “*Sonninia gracilis*” TORNQUIST (1898), holotype, phragmocone, lateral and ventral views (GAUG 496—34).
 2. “*Sonninia curviflex*” TORNQUIST (1898), syntype, phragmocone probably with beginning of body chamber, lateral view (GAUG 496—35).
- 3 a, b. Holotype of *S. espinazitensis*, phragmocone probably with beginning of body chamber, both lateral views (GAUG 496—32).

Plate 21

(All figures natural size)

- Figs. 1 a—3 b. *Sonninia (Papilliceras) espinazitensis* TORNQUIST ♀.
- 1 a—c. Paratype (TORNQUIST, 1898, pl. 4, fig. 1), phragmocone of macroconch with beginning of body chamber, both lateral views and ventral view (coll. Güssfeldt, MNHUB). “Ramada Abhang”, Paso del Espinacito.
 2. Holotype of “*Sonninia fascicostata*” TORNQUIST, phragmocone of macroconch, lateral view (GAUG 496—31). Paso del Espinacito.
 - 3 a, b. Paratype of *S. espinazitensis*, incomplete phragmocone, lateral and ventral views (GAUG 496—33). Paso del Espinacito.
- Figs. 4 a—6. *Sonninia (Papilliceras) cf. espinazitensis* TORNQUIST ♂ [= *S. bodenbenderi* TORNQUIST].
- 4 a—d. Syntype of “*Sonninia subdeltafalcata*” TORNQUIST, complete microconch with damaged aperture, lateral and ventral views (GAUG 496—44). Paso del Espinacito.
 5. Microconch (♂), phragmocone with one-half whorl body chamber, lateral view (MCM J1320 : 22). Bed 1c1, Sauzei Zone, Charahuilla.
 6. Approximately complete microconch (♂), body chamber damaged, lateral view (MCM J1314). Bed 9, Sowerbyi-Sauzei Zone, Los Molles.

Plate 22

(All figures natural size)

- Figs. 1—2. *Sonninia (Papilliceras) espinazitensis* (? subsp.) *altecostata* TORNQUIST ♀.
1. Lectotype of “*Sonninia altecostata*” TORNQUIST (1898), phragmocone with beginning of body chamber, crushed, lateral view (GAUG 496—30). Paso del Espinacito.

2. Paralectotype of "*Sonninia altecostata*" TORNQUIST (1898), phragmocone, crushed, lateral view (GAUG 496—29). Paso del Espinacito.
- Figs. 3 a—5 b. *Sonninia (Papilliceras) cf. espinazitensis* TORNQUIST ♂ [= *S. bodenbenderi* TORNQUIST].
- 3 a—c. Holotype of "*Sonninia bodenbenderi*" TORNQUIST (1898), phragmocone with one-third whorl body chamber, both lateral views and ventral view (GAUG 496—46). Paso del Espinacito.
- 4 a—b. Microconch with beginning of aperture, lateral and ventral views (MCM J1312:7). Bed 7, Sowerbyi-Sauzei Zone, Los Molles.
- 5 a, b. Microconch, phragmocone with one-half whorl body chamber, incomplete, lateral and ventral views (MCM J1313:2). Bed 6, Sowerbyi Zone, Los Molles.

Plate 23

(All figures natural size)

- Figs. 1 a—6 b. *Sonninia (Papilliceras) espinazitensis* TORNQUIST ♀. Sauzei Zone (? except fig. 4), Neuquén Province.
- 1 a, b. Phragmocone, lateral and ventral views, modal form (MCM J1311:4). Scree, Charahuilla.
2. Phragmocone with fragment of body chamber, involute variant, lateral view (MCM J1311:2). Scree, Charahuilla.
- 3 a, b. Phragmocone with beginning of body chamber, ornate form, lateral and ventral views (MCM J1320:38). Bed 1c₁, Charahuilla.
- 4 a—b. Inner whorls of phragmocone, lateral and ventral views (MCM J1316:3). Bed 8, Sowerbyi-Sauzei Zone, Los Molles.
- 5 a, b. Phragmocone, modal form, lateral and ventral views (MCM J1310:17). Bed 1b, Charahuilla.
- 6 a—b. Phragmocone, involute and weakly ornate form, lateral and ventral views (MCM J1320:5). Bed 1c₁, Charahuilla.

Plate 24

(All figures natural size)

- Figs. 1—4 b. *Sonninia (Papilliceras) espinazitensis* TORNQUIST ♀. Neuquén Province.
1. ? Subsp. *altecostata* TORNQUIST, phragmocone, involute form, lateral view (MCM J1312:1). Bed 7, Sowerbyi-Sauzei Zone, Los Molles.
2. Aptychus [*Cornaptychus*] within body chamber of *S. espinazitensis* (MCM J1312:50). Bed 7, Sowerbyi-Sauzei Zone, Los Molles.
- 3 a—b. Incomplete phragmocone, modal form, lateral and ventral views (MCM J1310:16). Bed 1b, Sauzei Zone, Charahuilla.
- 4 a—b. Almost complete adult specimen, modal form, lateral and ventral views (MCM J1320:4). Bed 1c₁, Sauzei Zone, Charahuilla.

Plate 25

(All figures natural size)

- Figs. 1 a—e. *Sonninia (Papilliceras) espinazitensis* TORNQUIST ♀, almost complete adult specimen, inflated and highly ornate variant/form; c—e, outer whorl removed, lateral and ventral views (MCM J1320:2). Bed 1c₁, Sauzei Zone, Charahuilla.

Plate 26

(Magnification as indicated)

- Figs. 1 a—b. *Sonninia (Papilliceras) espinazitensis* TORNQUIST ♀, complete specimen with damaged aperture, modal form, lateral and ventral views, X 0.82 (MCM J1320:25). Bed 1c₁, Sauzei Zone, Charahuilla.

Plate 27

(All figures natural size)

- Fig. 1. *Sonninia (Papilliceras?) peruana* JAWORSKI, holotype (plaster cast), phragmocone, lateral view (IPB). "Beds with *Otoites Sauzei*", Chumumayo, Peru.
- Figs. 2—3. *Sonninia (Papilliceras) cf. peruana* JAWORSKI ♀. Bed 12, Sowerbyi Zone, Cerro Puchenque.
2. Incomplete phragmocone, lateral view (MCM J1747:2).
3. Phragmocone, damaged, lateral view (MCM J1747:8).
- Figs. 4 a—5. *Dorsetensia aff. edouardiana* (D'ORBIGNY) ♀. Bed 11b, Sauzei Zone, Los Molles.
- 4 a—c. Lateral and ventral views; c, sector of opposite side with septal suture (MCM J1315:1).
5. Damaged specimen, lateral view (MCM J1315:2).

Plate 28

(All figures natural size)

- Figs. 1 a—2. *Dorsetensia mendozai* sp. nov., ♀. Sauzei (? basal Humphriesianum) Zone, Arroyo Blanco.
1 a—c. Phragmocone with incomplete body chamber, lateral and ventral views (MCM J 1324 : 6). Loose concretion 4b₁.
2. Large almost complete specimen with test, lateral view (MCM J 1746 : 20). Bed 10.
Figs. 3 a—c. *Dorsetensia* (?) cf. *mendozai* sp. nov. ♂, complete microconch with lappet, lateral and ventral views (MCM J 1324 : 8). Same concretion as fig. 1.

Plate 29

(All figures natural size)

- Figs. 1 a—c. *Dorsetensia mendozai* sp. nov., ♀, holotype; macroconch with incomplete body chamber, lateral, ventral and polished section views (MCM J 1324 : 7). Loose concretion 4b₁, Sauzei (? basal Humphriesianum) Zone, Arroyo Blanco.
Figs. 2 a—4 b. *Dorsetensia blancoensis* sp. nov., ♀.
2 a, b. Holotype, phragmocone with beginning of body chamber, with test, lateral and ventral views (MCM J 1749 : 1). Bed 1, Arroyo La Manga.
3. Damaged phragmocone, incomplete, lateral view (MCM J 1324 : 1). Loose concretion 4b₁, Sauzei (? basal Humphriesianum) Zone, Arroyo Blanco.
4 a, b. Incomplete phragmocone, lateral and ventral views (MCM J 1324 : 3). Same concretion as fig. 3.

Plate 30

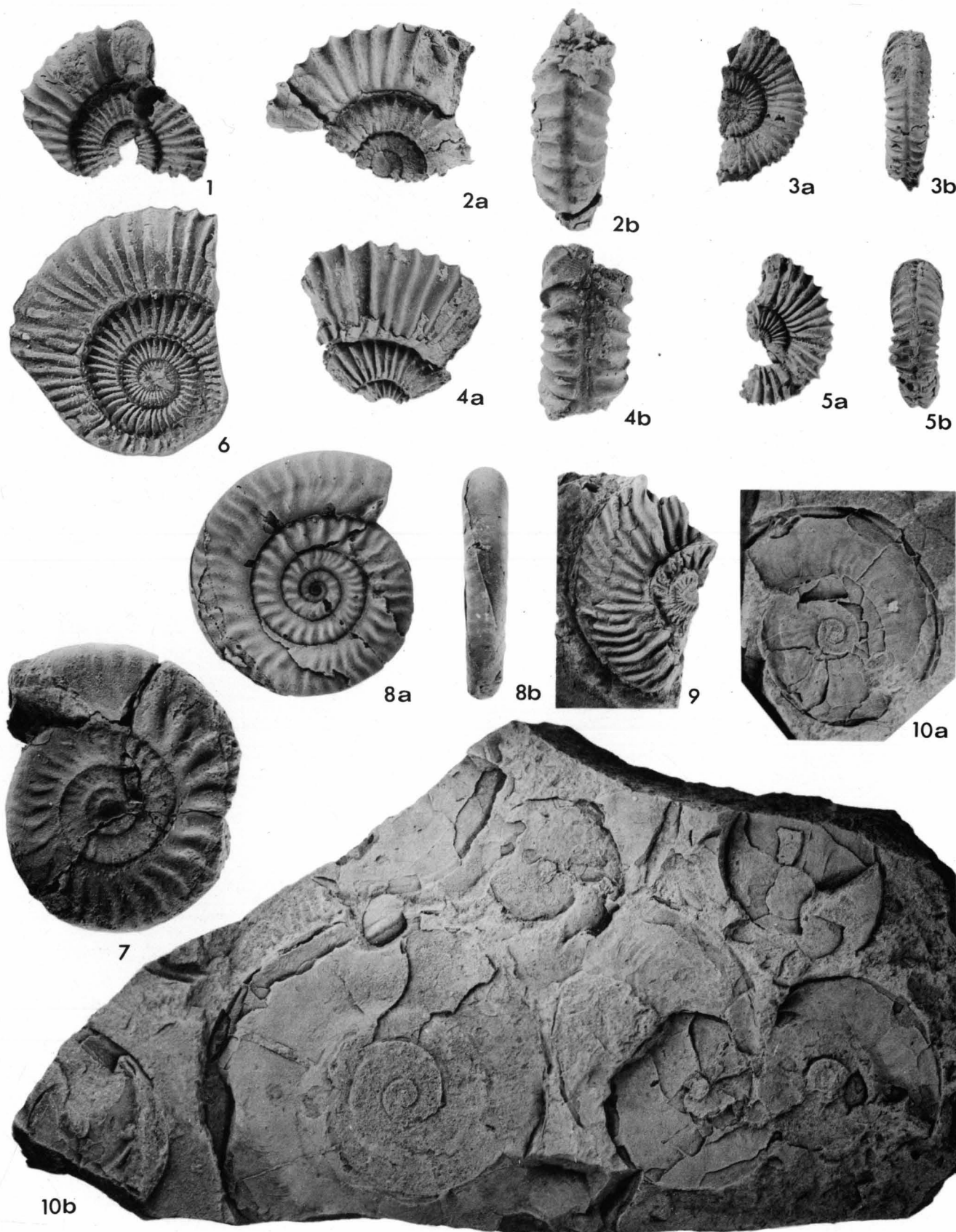
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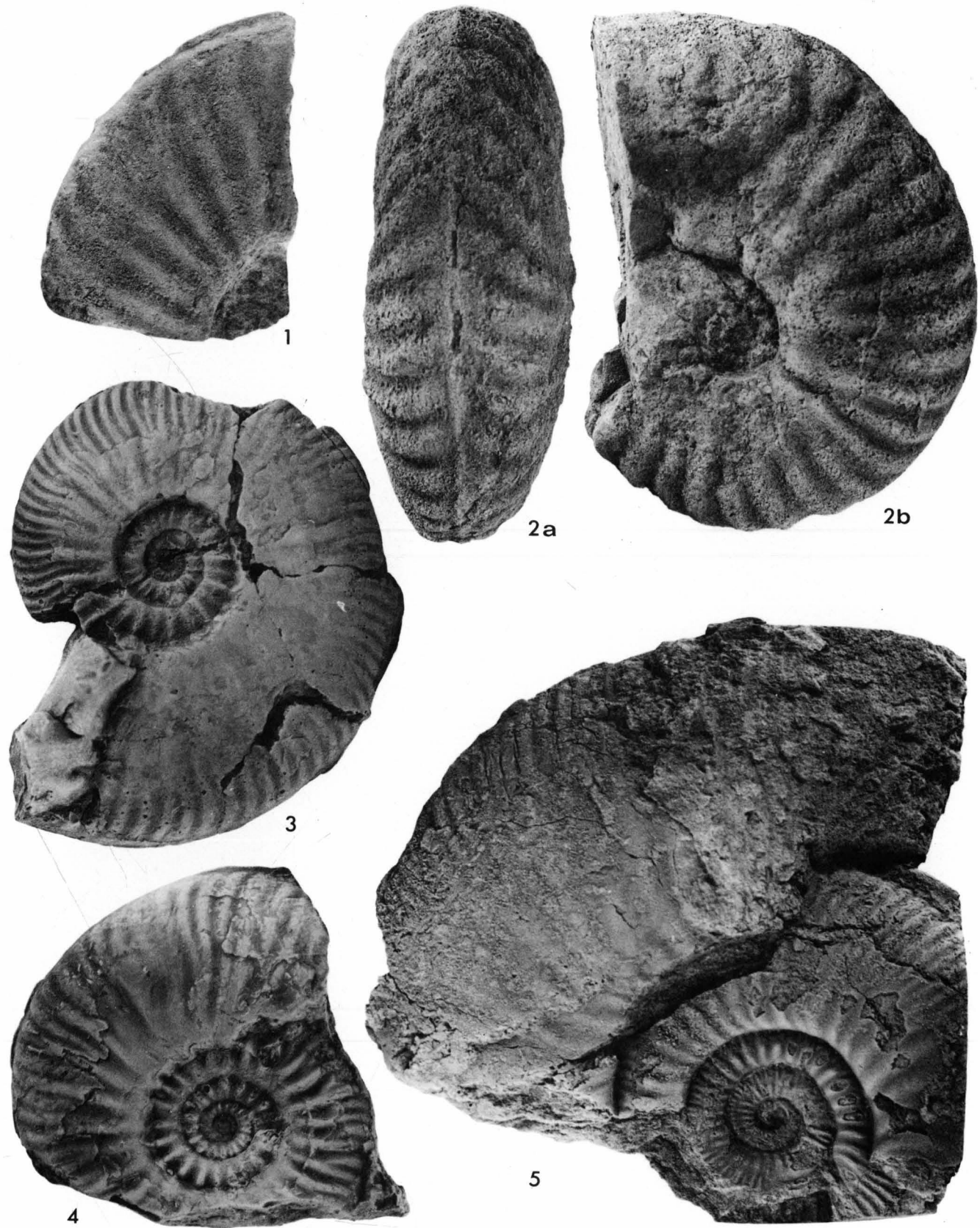
- Figs. 1 a—4 b. *Dorsetensia blancoensis* sp. nov., ♀ & ♂.
1 a—c. Macroconch (♀), fragment with beginning of body chamber, lateral, ventral and section views (MCM J 1324 : 2). Loose concretion 4b₁, Sauzei (? basal Humphriesianum) Zone, Arroyo Blanco.
2. Macroconch (♀), somewhat crushed fragment with part of body chamber, lateral view (MBR 5024). Charahuilla.
3 a, b. Microconch (♂), damaged specimen with complete aperture, lateral and ventral views (MCM J 1324 : 4). Same concretion as fig. 1.
4 a, b. Allotype, microconch (♂), damaged specimen with aperture, lateral and ventral views (MCM J 1324 : 5). Same concretions as figs. 1 and 3.
Figs. 5 a—c. *Dorsetensia* aff. *deltafalcata* (QUENSTEDT), (?) Humphriesianum Zone, Salar de Pedernales, Atacama Province, Chile (MHNS GA—1035).
Figs. 6—7. *Dorsetensia romani* (OPPEL), "Humphriesianum Zone", Salar de Pedernales, Atacama Province (coll. et fotogr. A. v. Hillebrandt).
6. Phragmocone fragment, lateral view (TUB 660714/6).
7. Macroconch (♀), approximately complete phragmocone with approximated septal sutures, lateral view (TUB 660714/6a).
Figs. 8—9. *Dorsetensia liostraca* BUCKMAN forma tecta BUCKMAN ♀. "Humphriesianum Zone", Salar de Pedernales, Atacama Province.
8. Fragment of inner whorls, lateral view (TUB 660714/6b).
9. Approximately complete phragmocone with approximated septal sutures, lateral view (TUB 660714/6b).

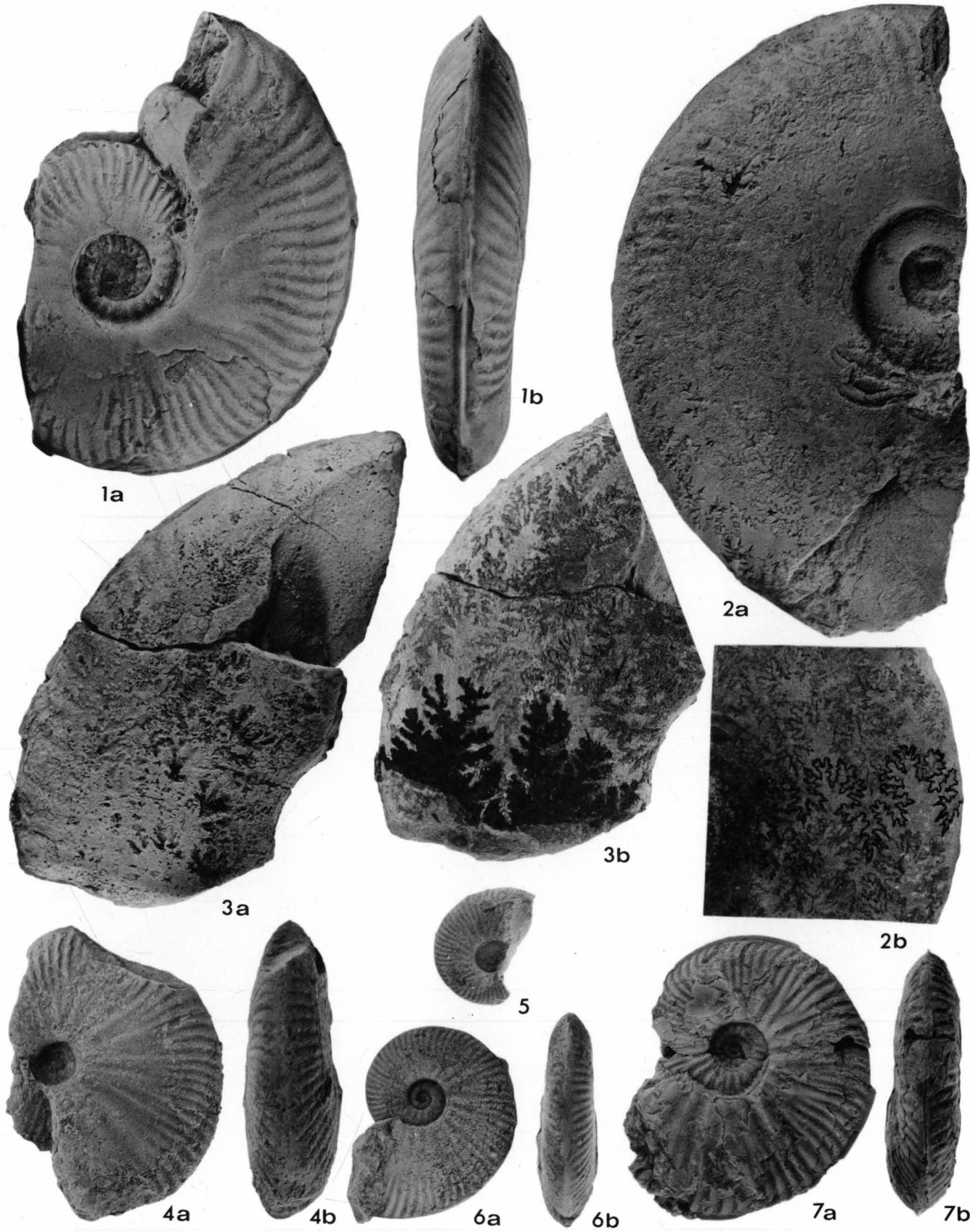
Plate 31

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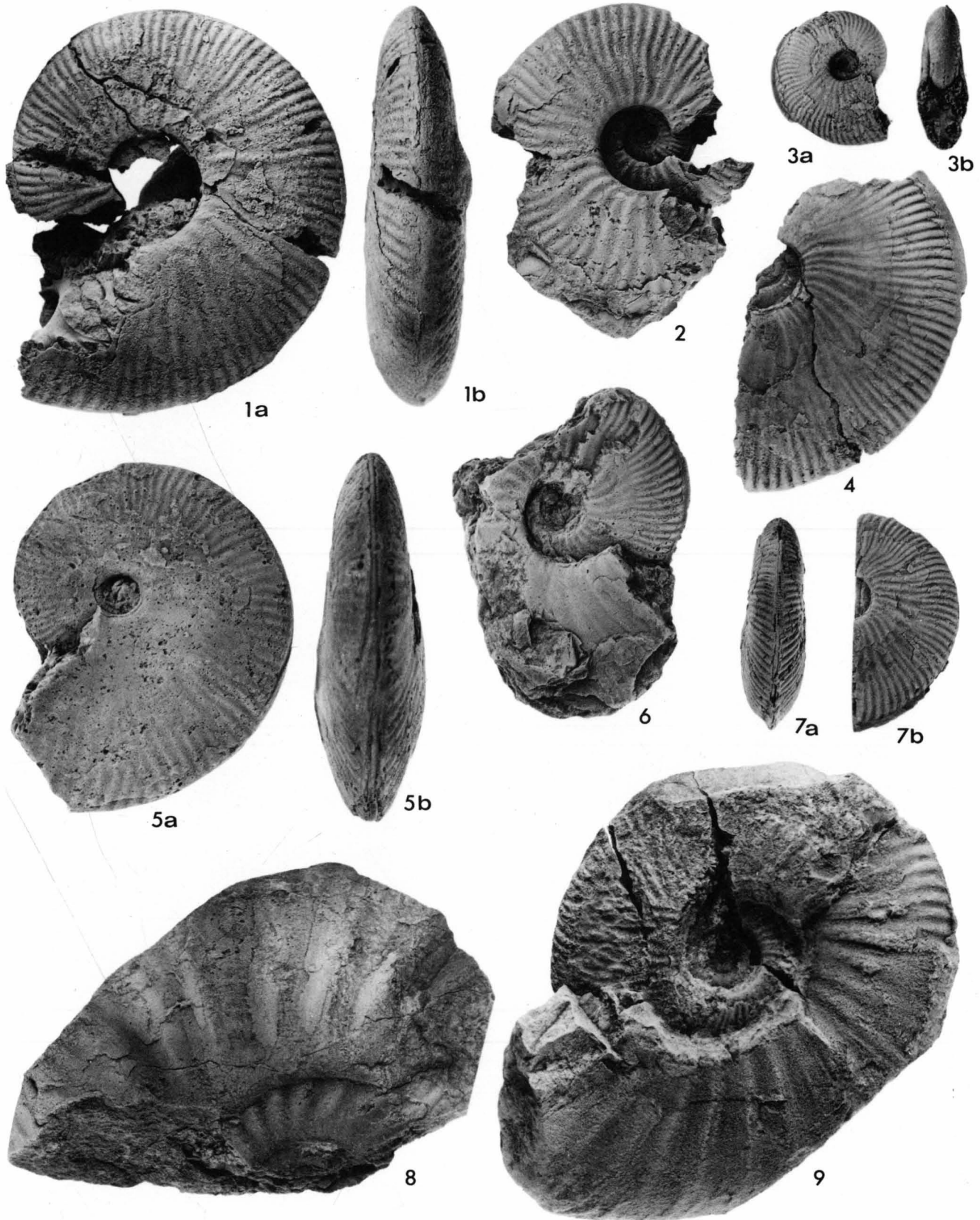
- Figs. 1 a—5. *Zurcheria groeberi* sp. nov.
1 a—c. Holotype, phragmocone with incomplete body chamber, both lateral views and ventral view (coll. P. Groeber, DNGM 236). "Zona de *Harpoceras Murchisonae*", Bardas Blancas.
2 a, b. Almost complete with somewhat crushed body chamber, lateral and ventral views; coll. Y.P.F. (MLP 11556a). Las Yeseras, Mendoza Province.
3 a, b. Inner whorls (or ? juvenile), lateral and ventral views (MCM J 1751 : 1). Concretion 9, Concava-Sowerbyi Zone, Arroyo Blanco.
4 a—d. Inner whorls (or ? juvenile), lateral and ventral views; c—d, X 2 (MCM J 1325 : 1). Block 1, Concava-Sowerbyi-Zone, Bardas Blancas.
5. Phragmocone, (?) with beginning of body chamber, somewhat crushed, lateral view; coll. Y.P.F. (MLP 11556b). Same collection as fig. 2.
Figs. 6 a—b. *Witchellia* sp. nov. indet. ♀, phragmocone; a, with traced septal suture; b, opposite side with better preserved inner whorls, lateral views (MCM J 1324 : 9). Loose concretion 4b₁, Sauzei (? basal Humphriesianum) Zone, Arroyo Blanco.

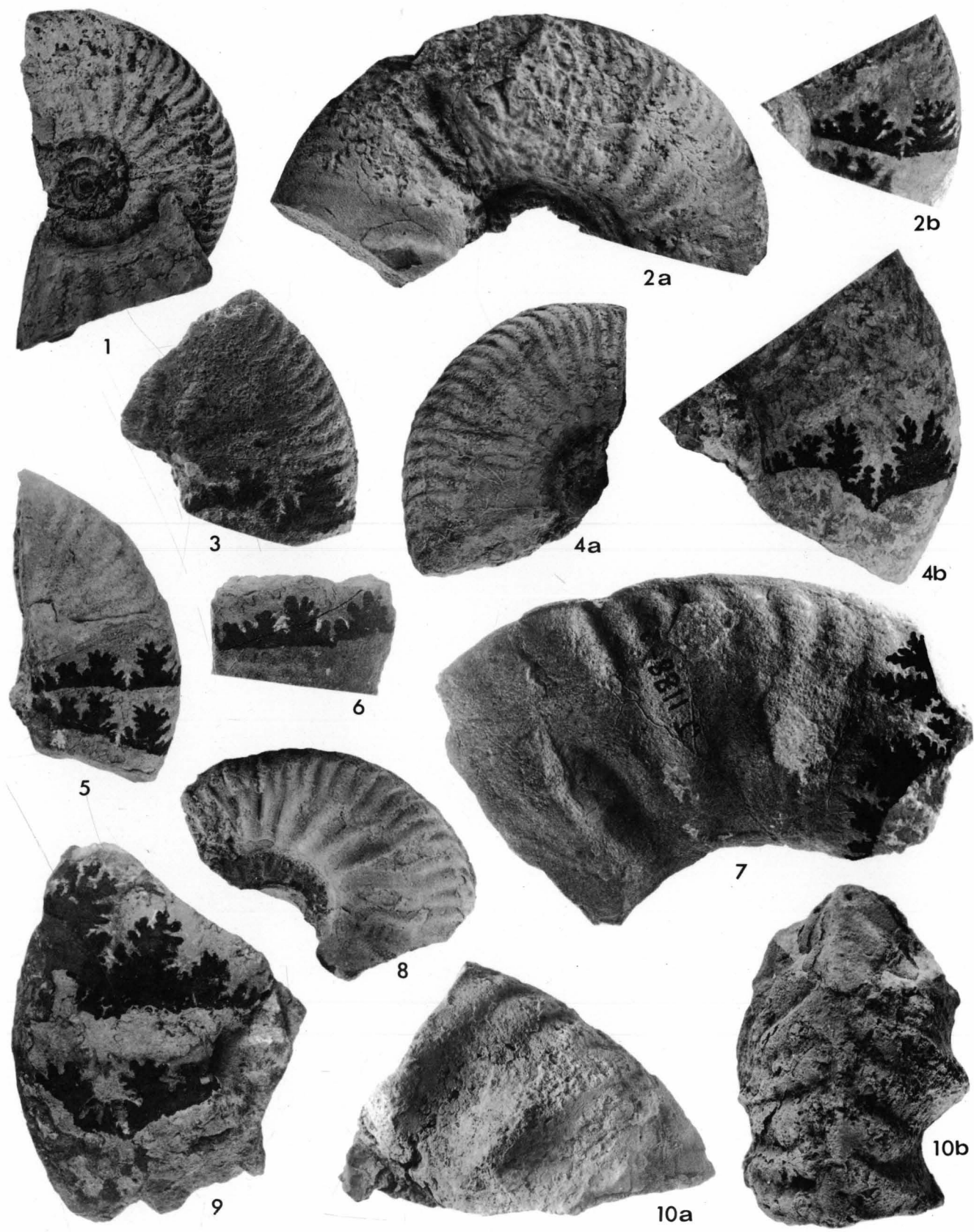




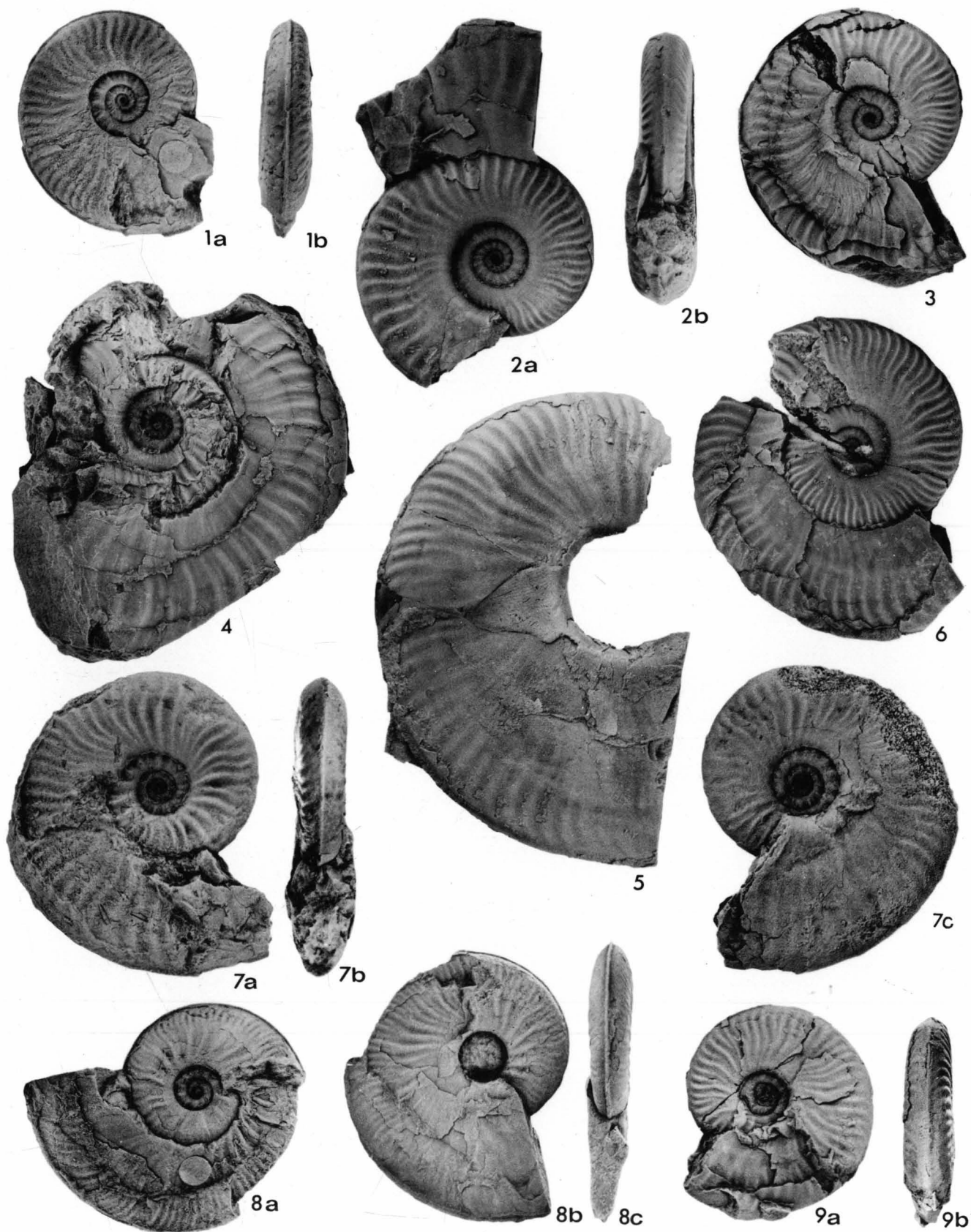


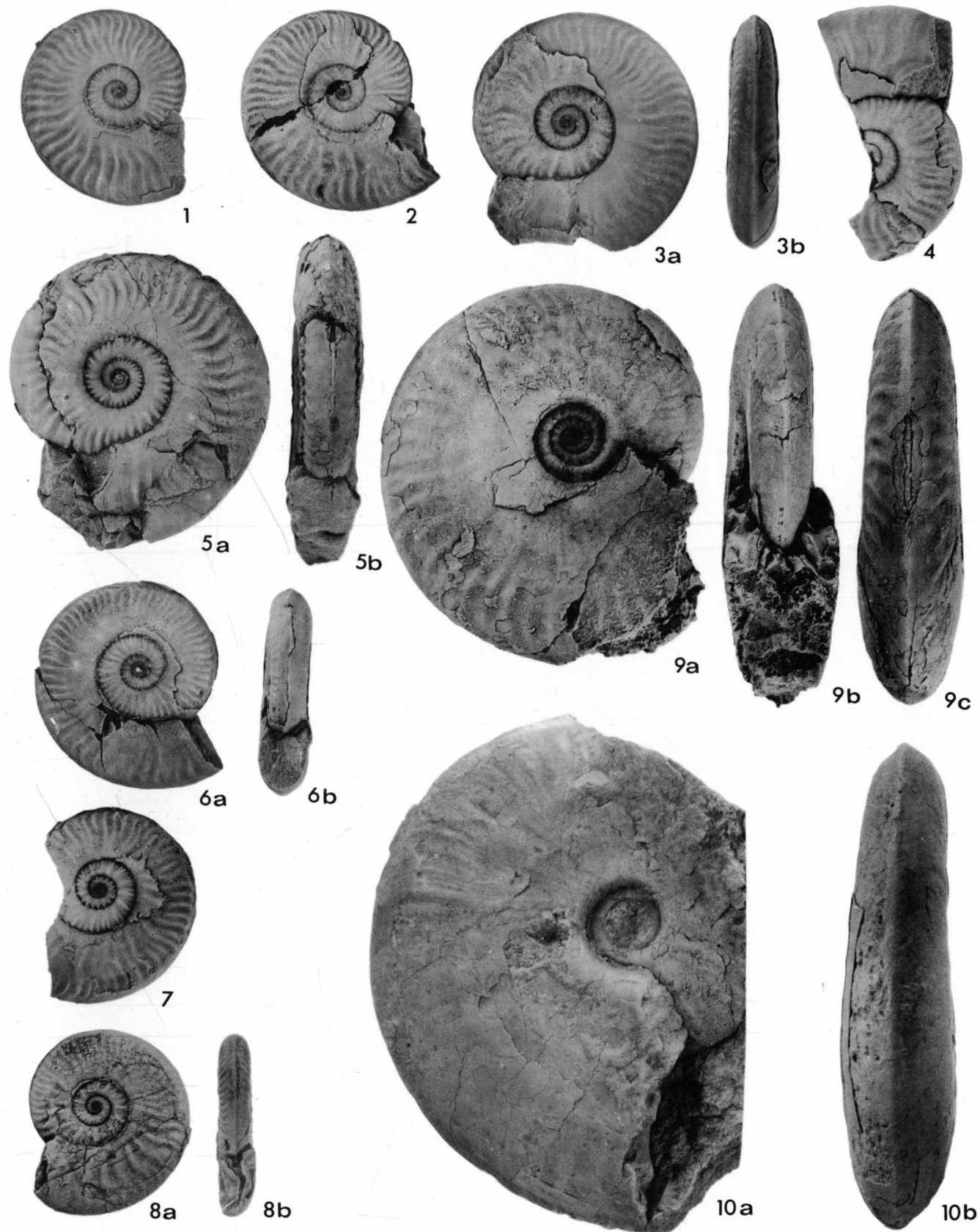
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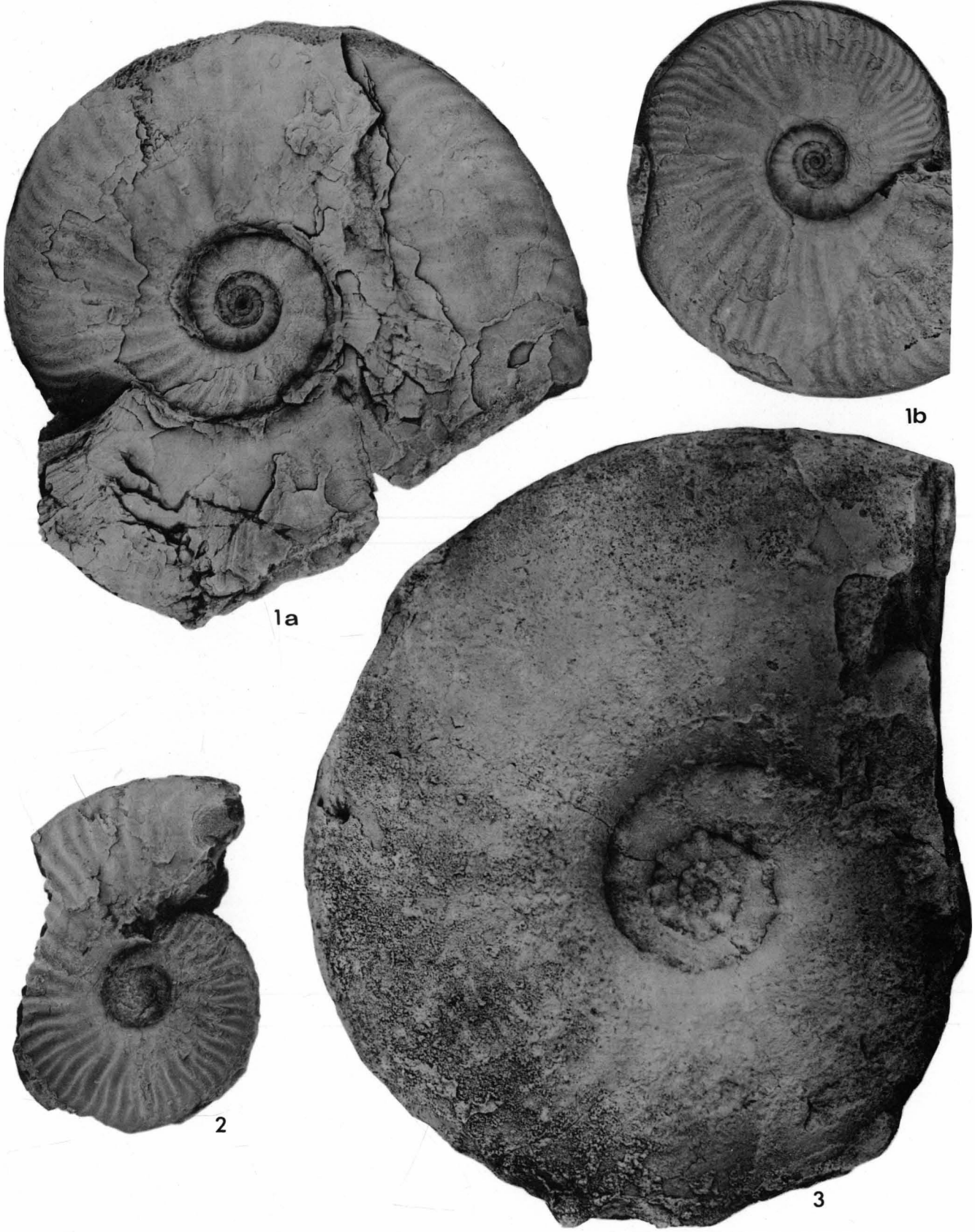


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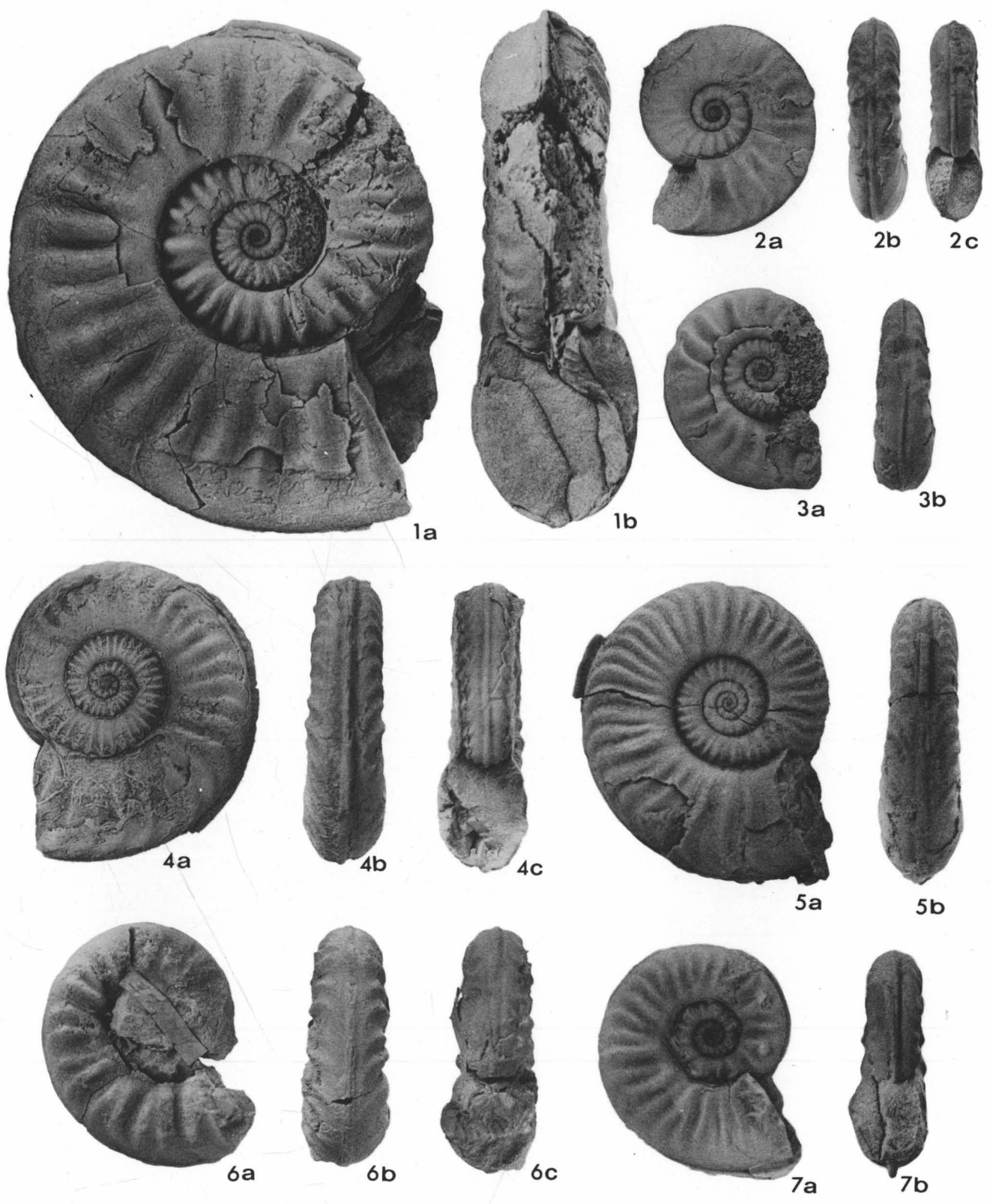
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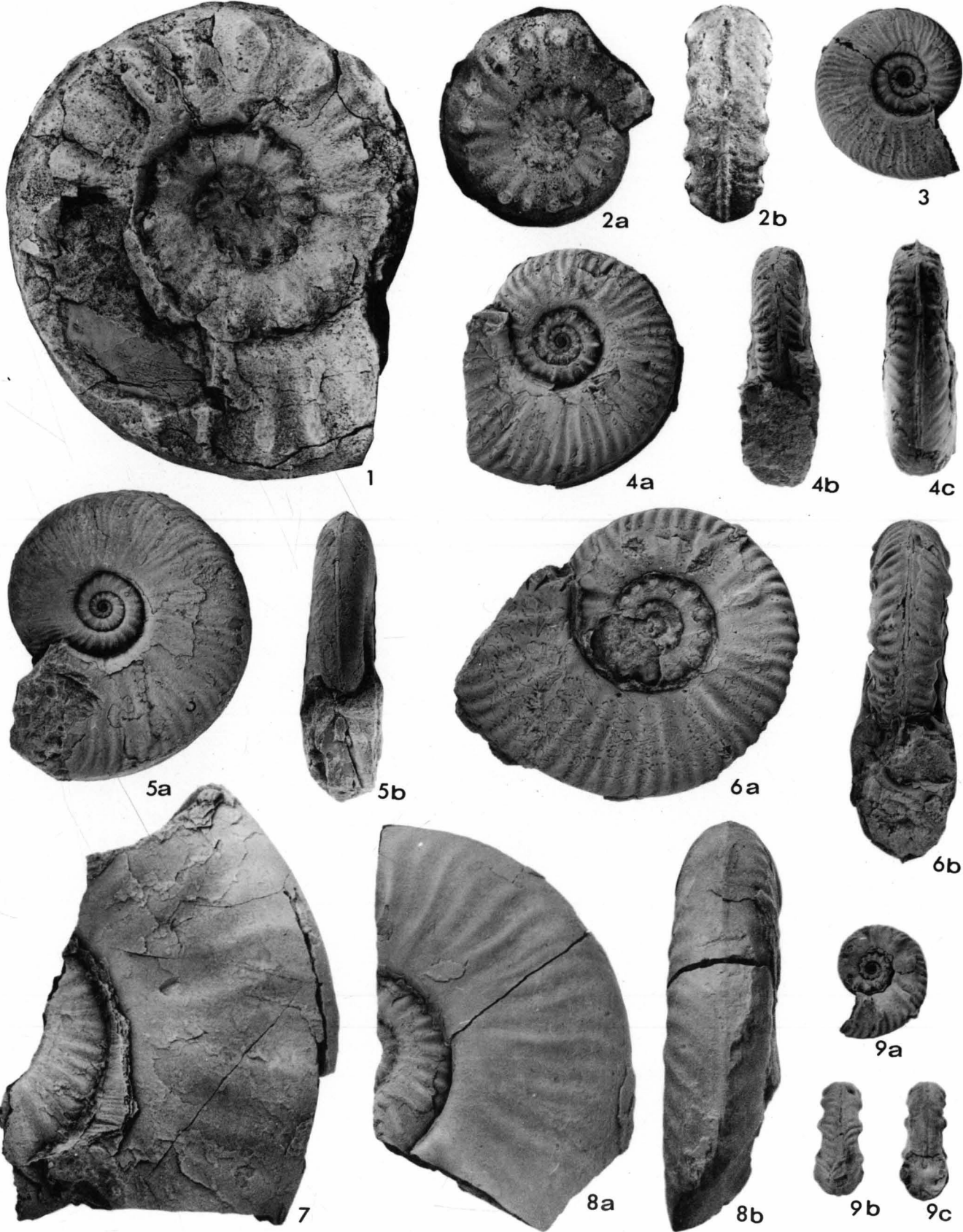
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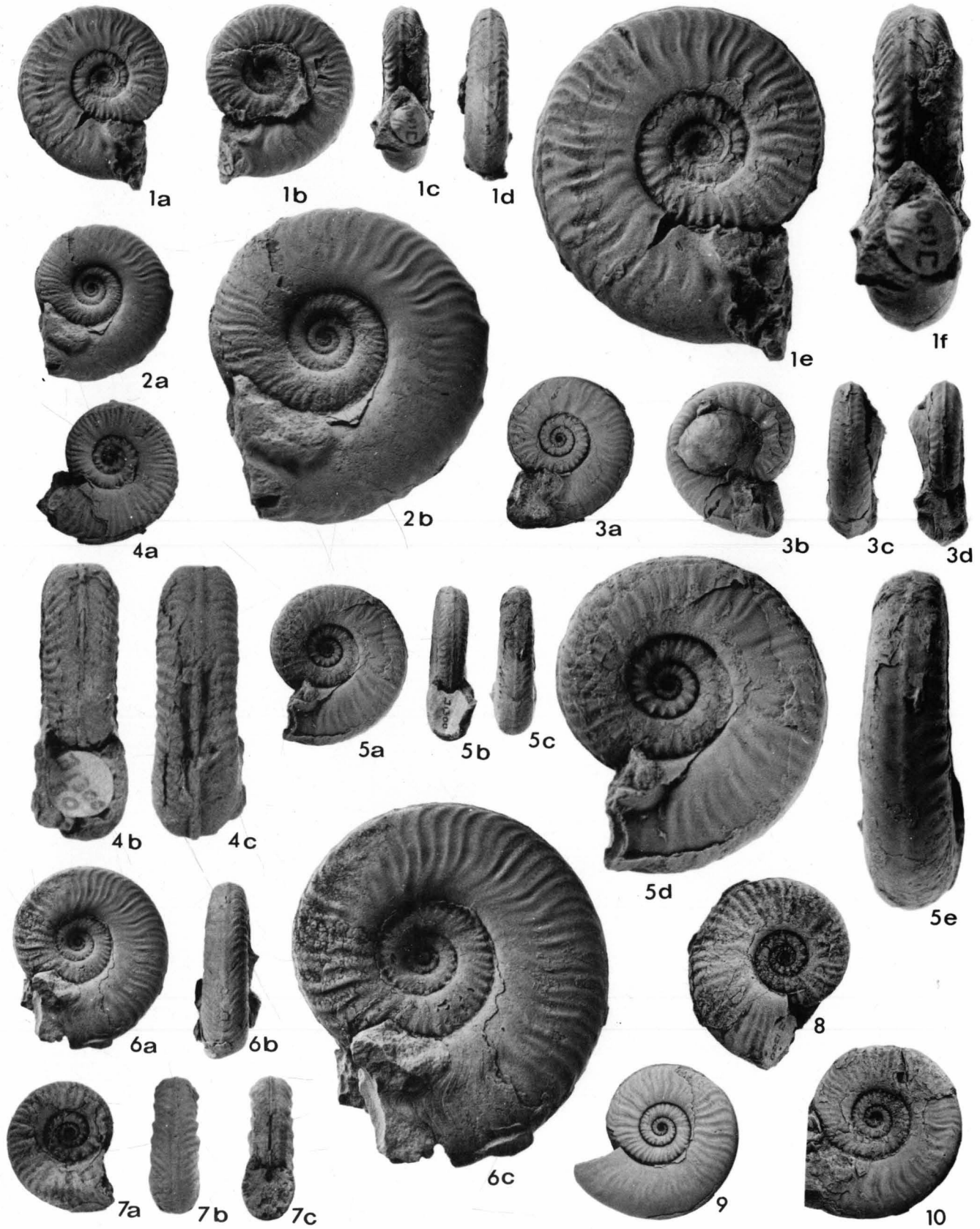
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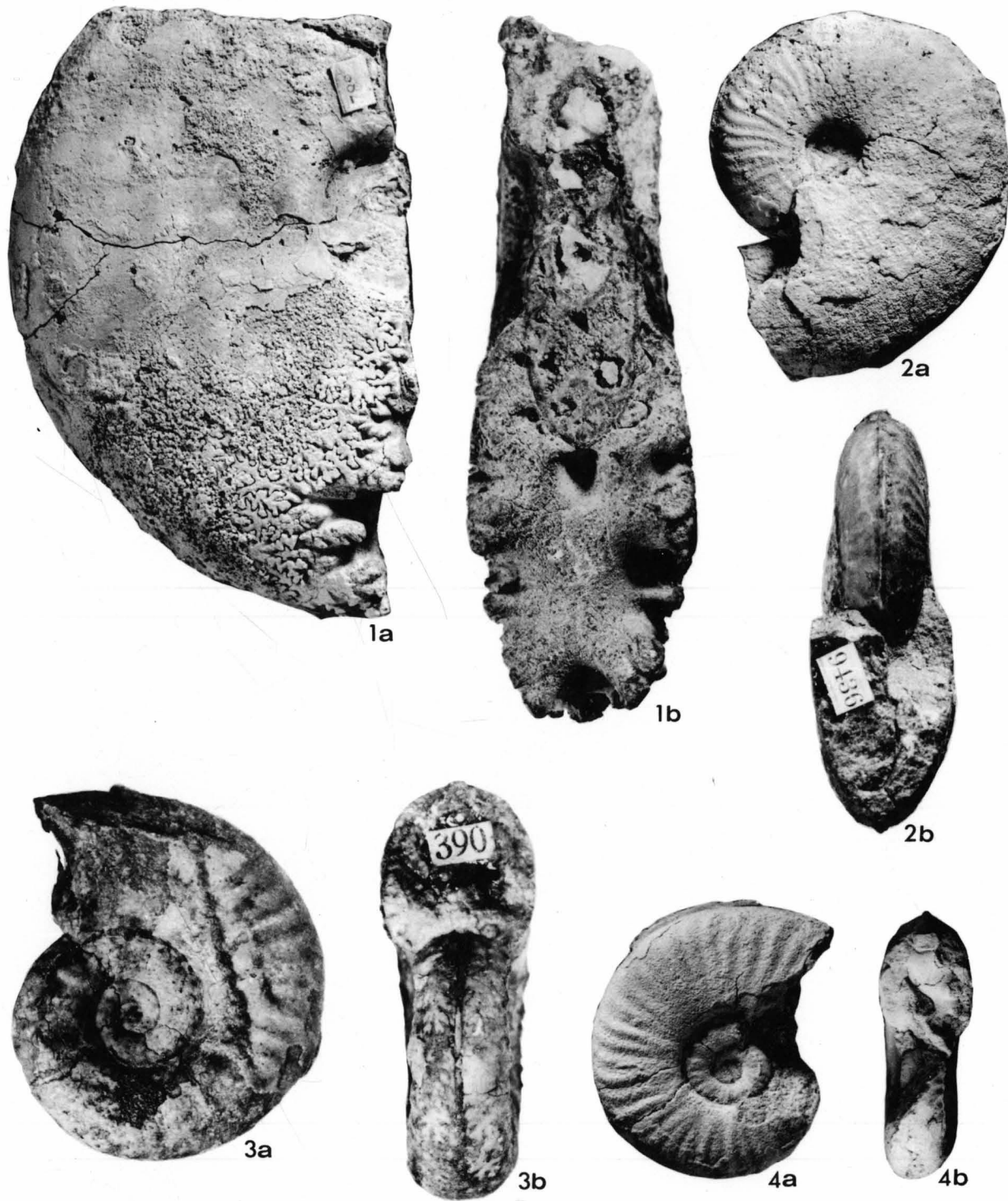
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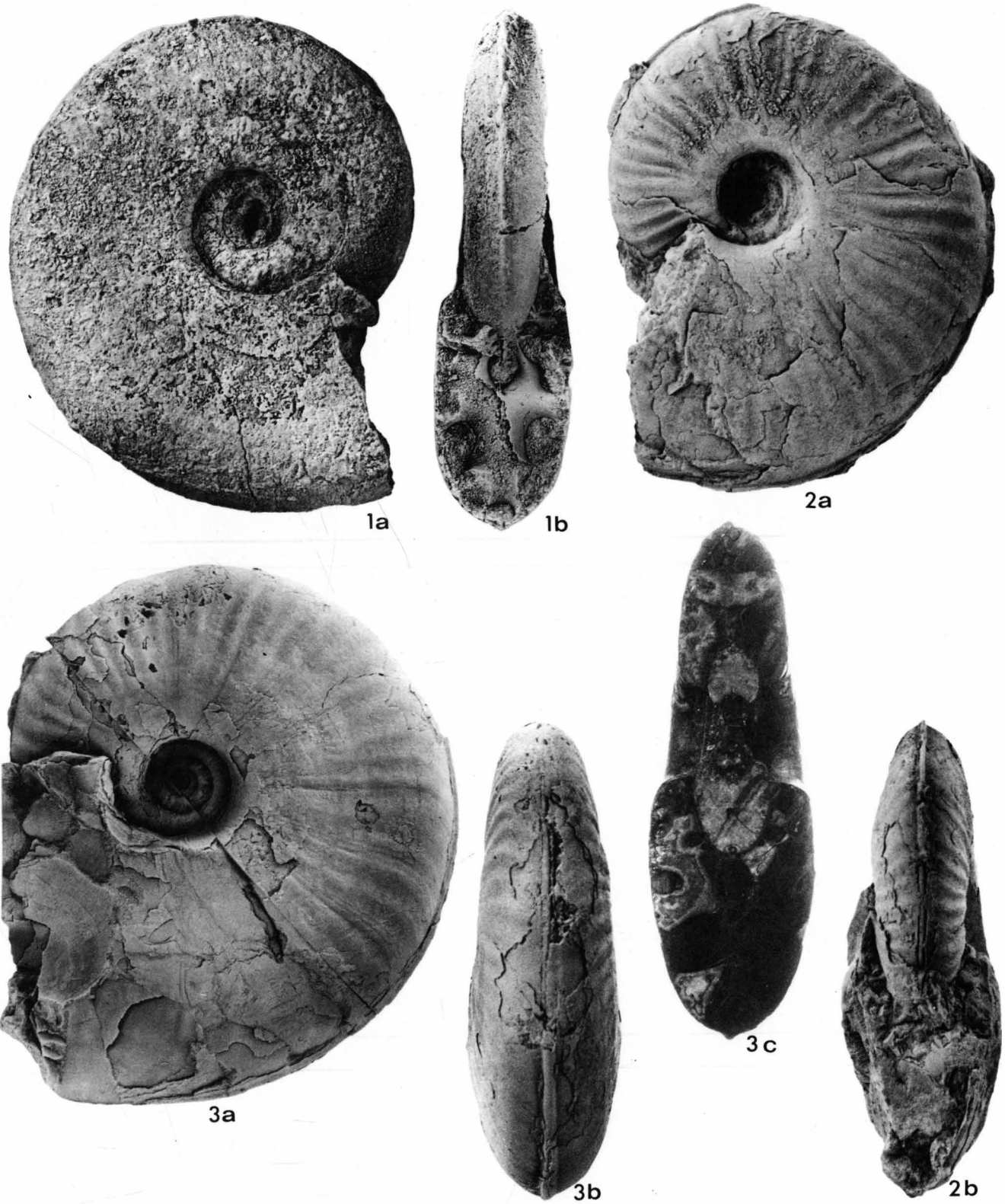
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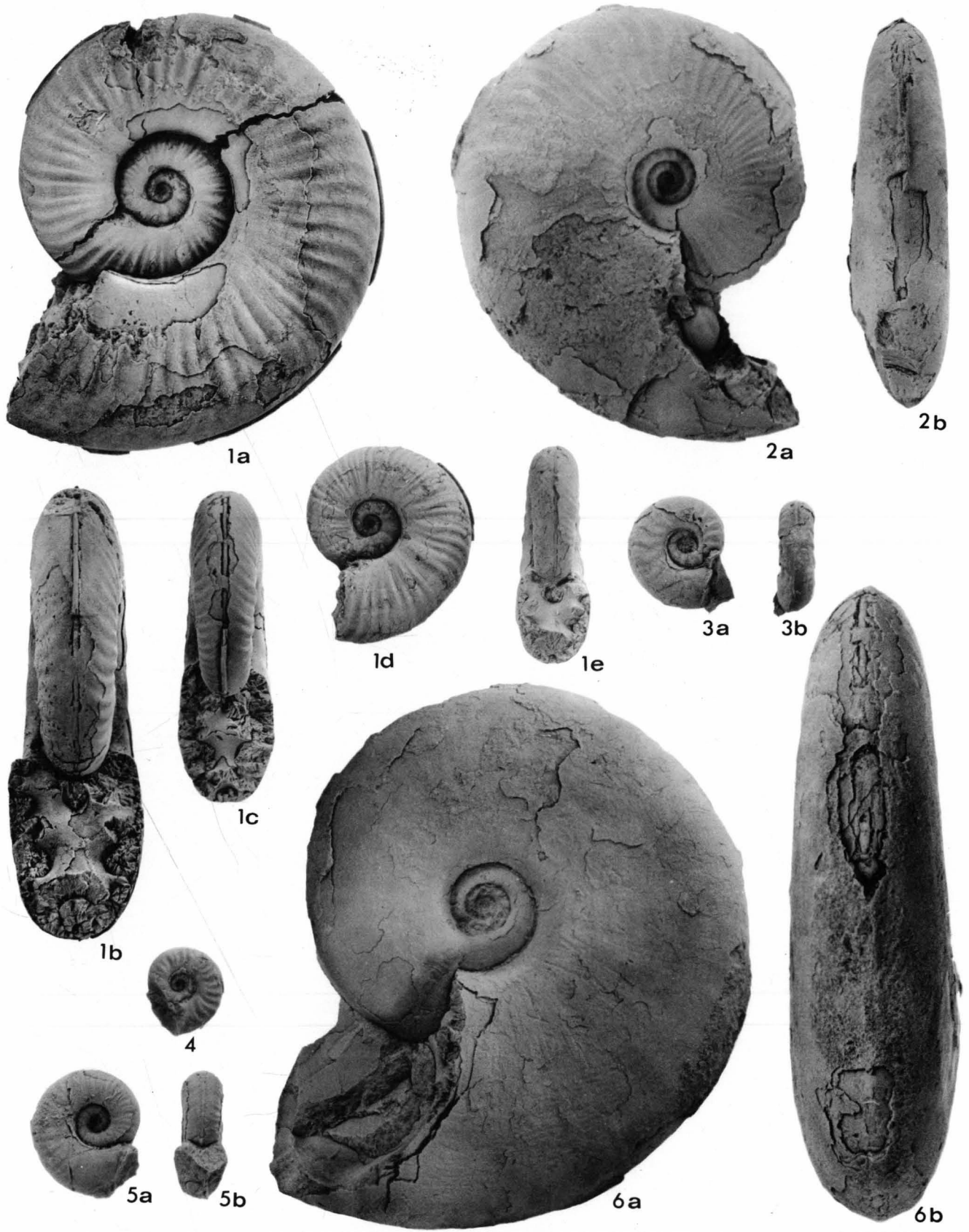
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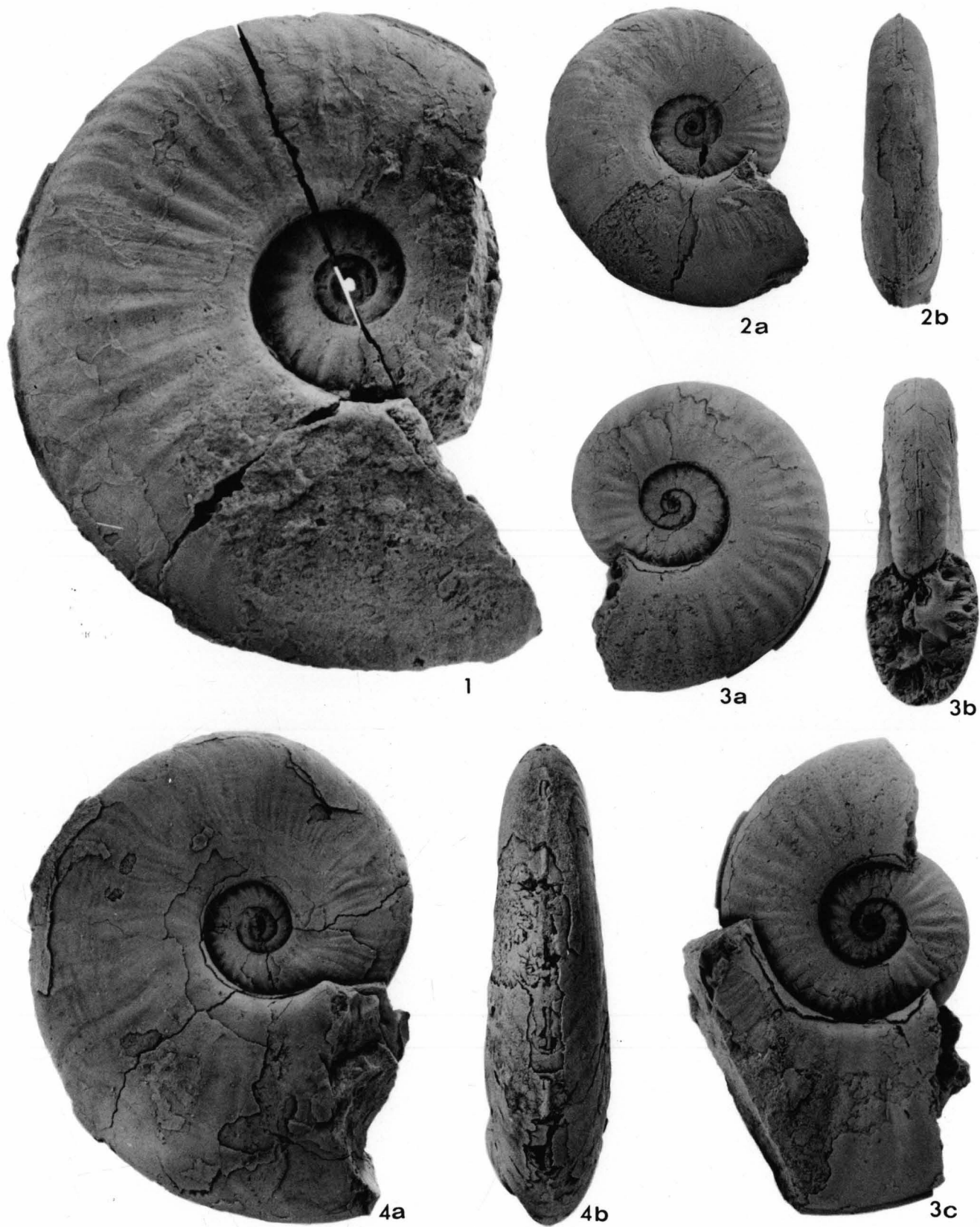
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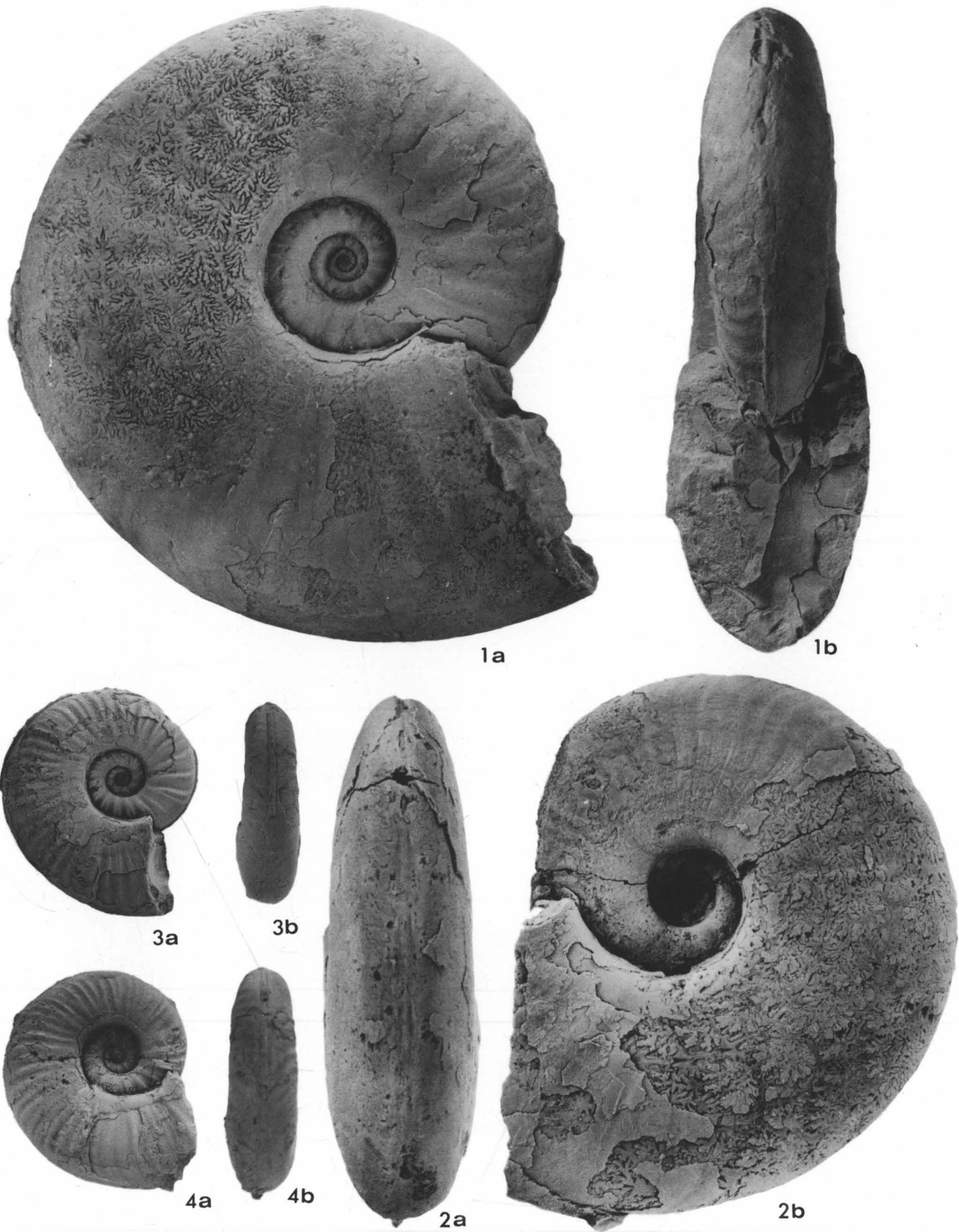
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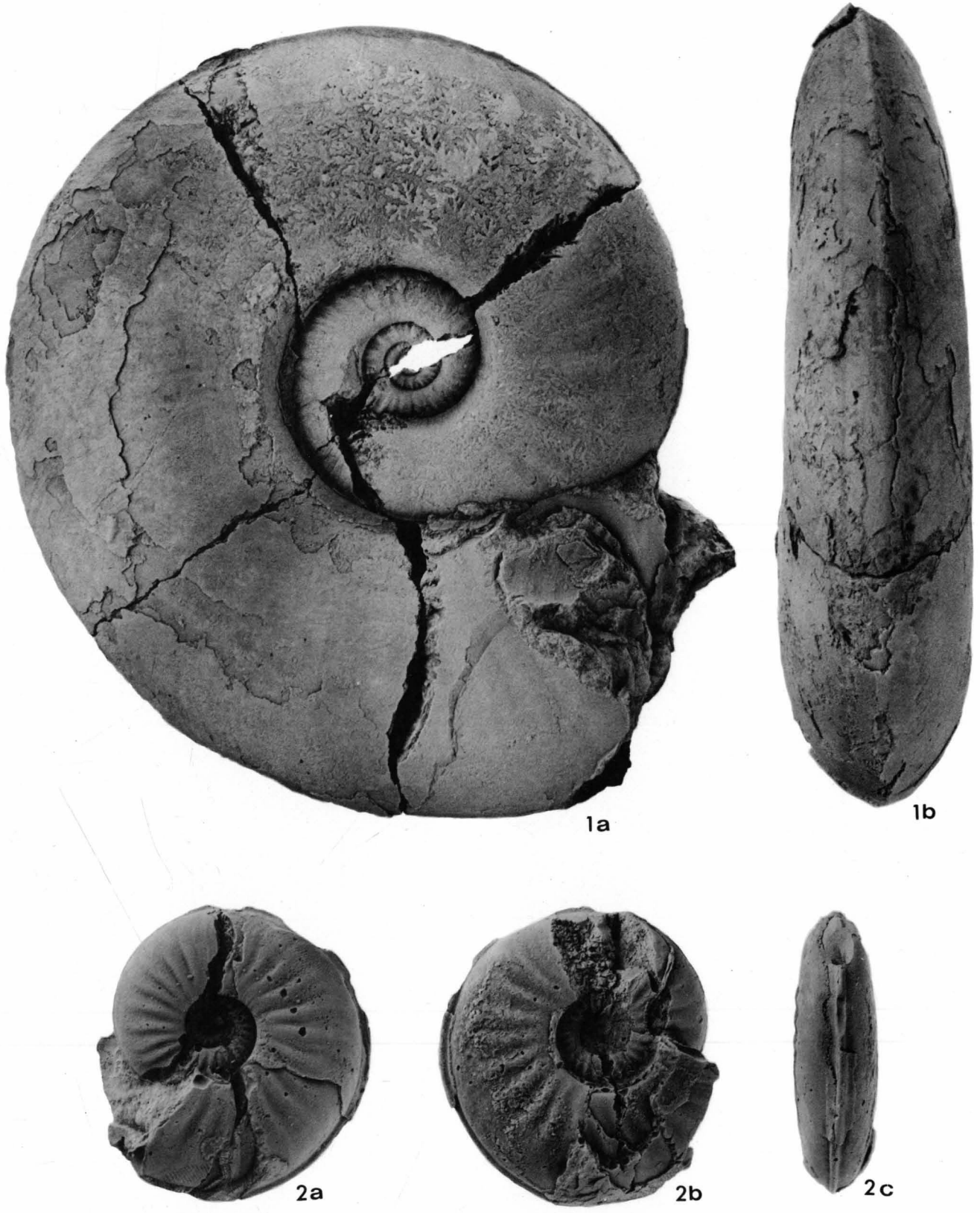


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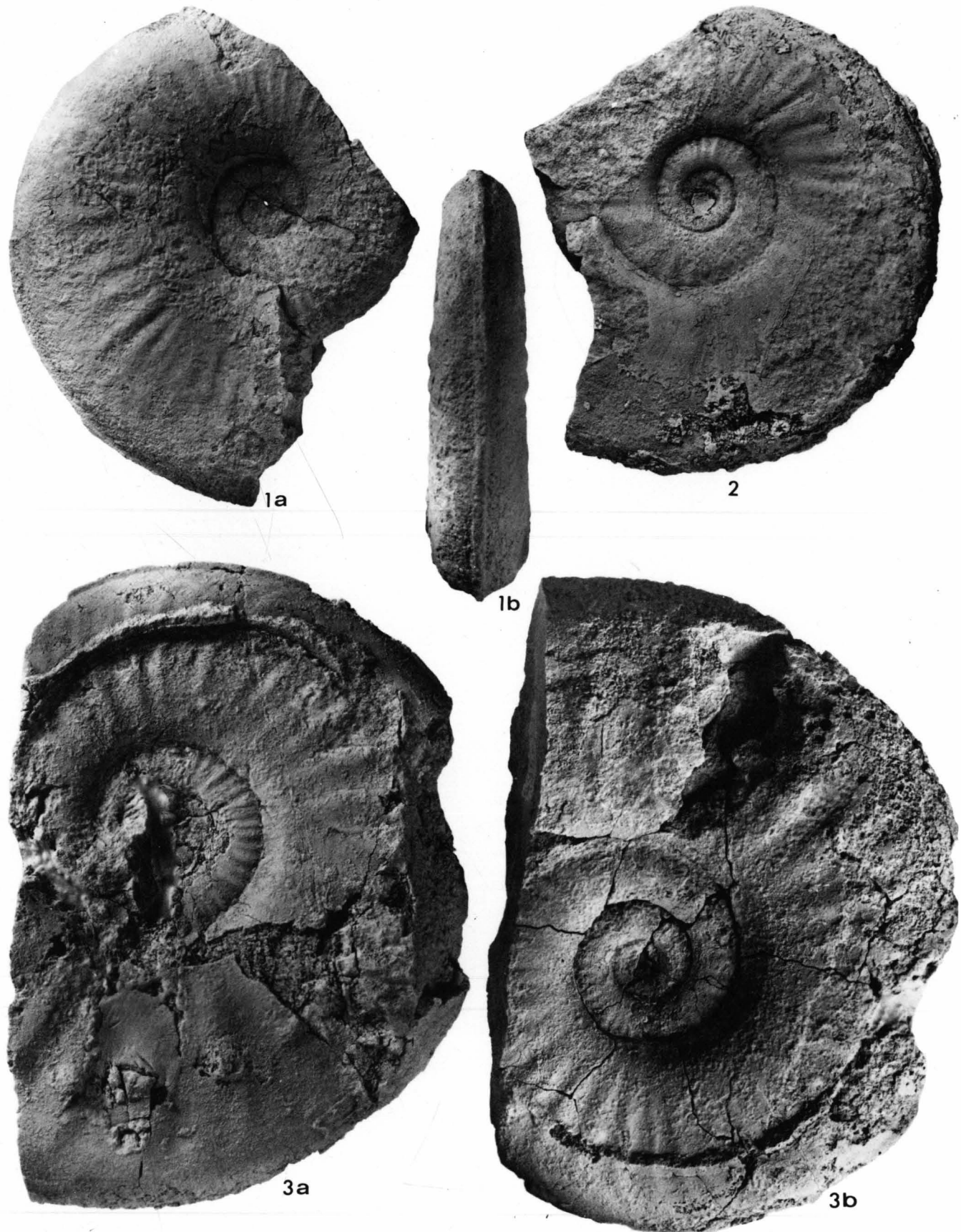


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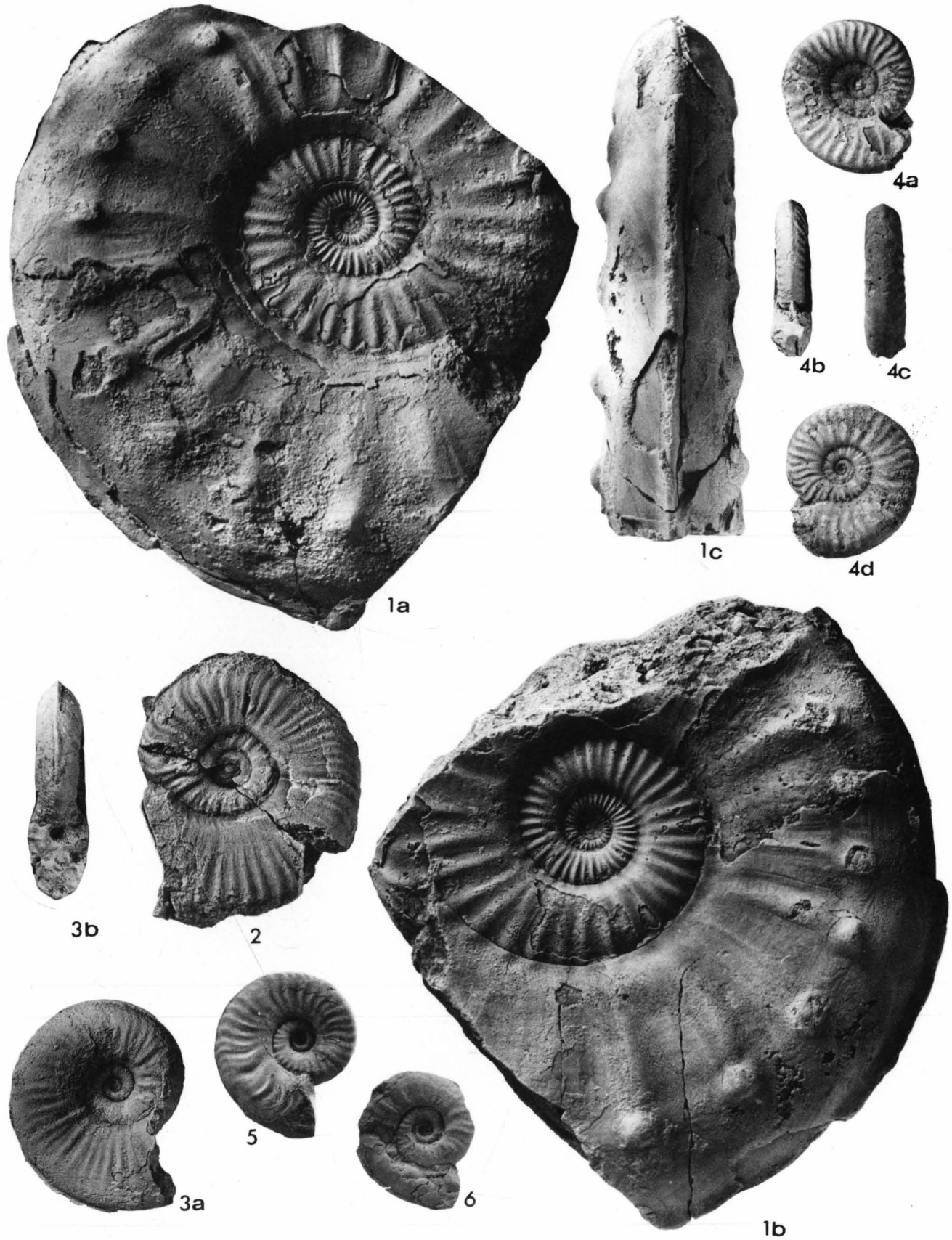




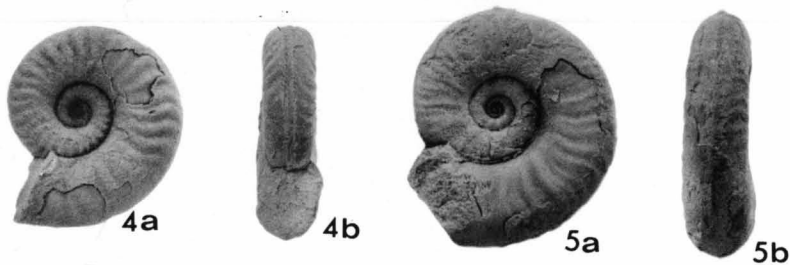
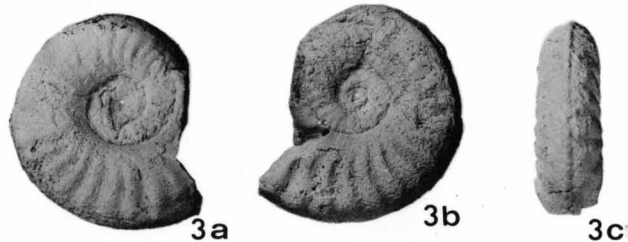
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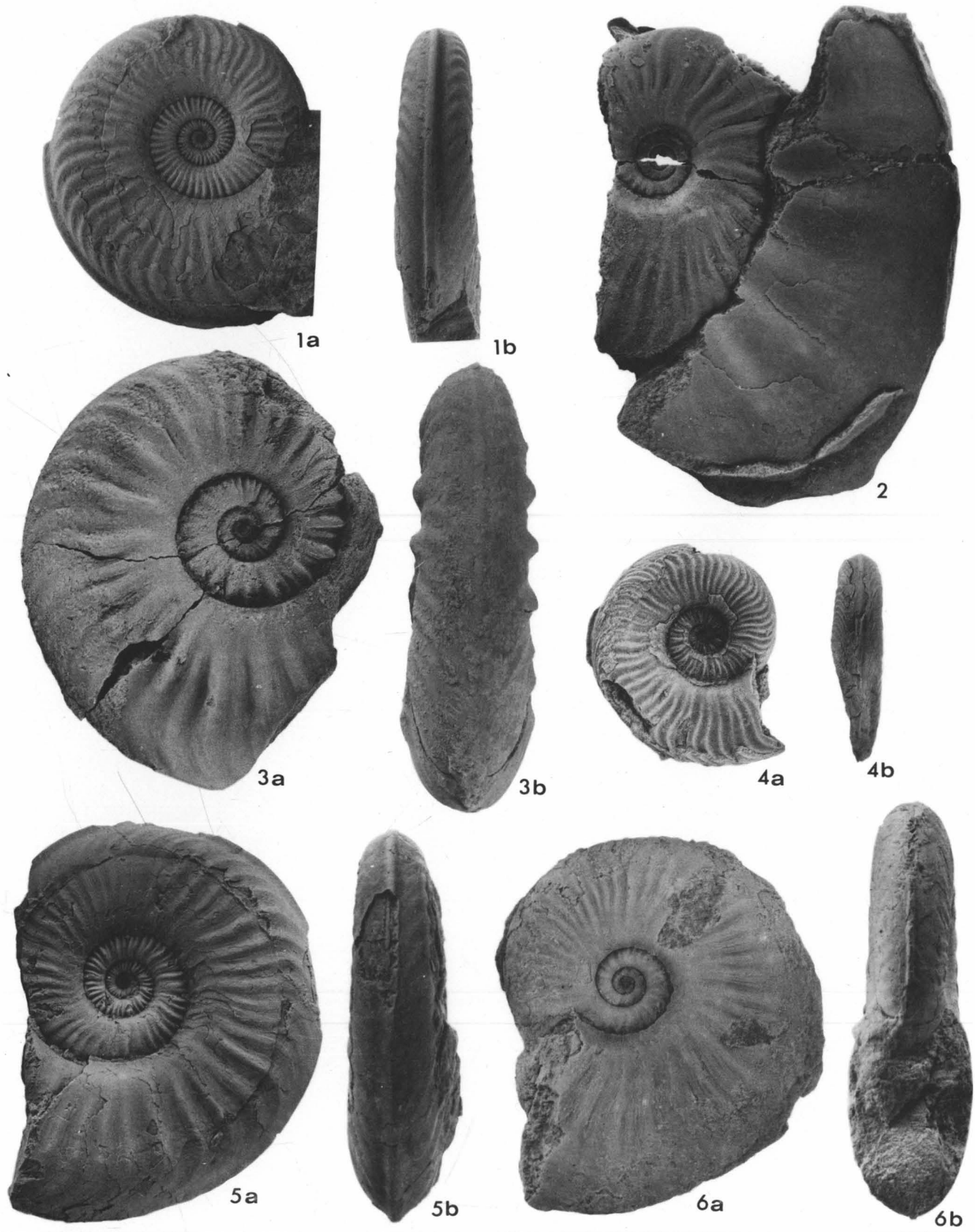
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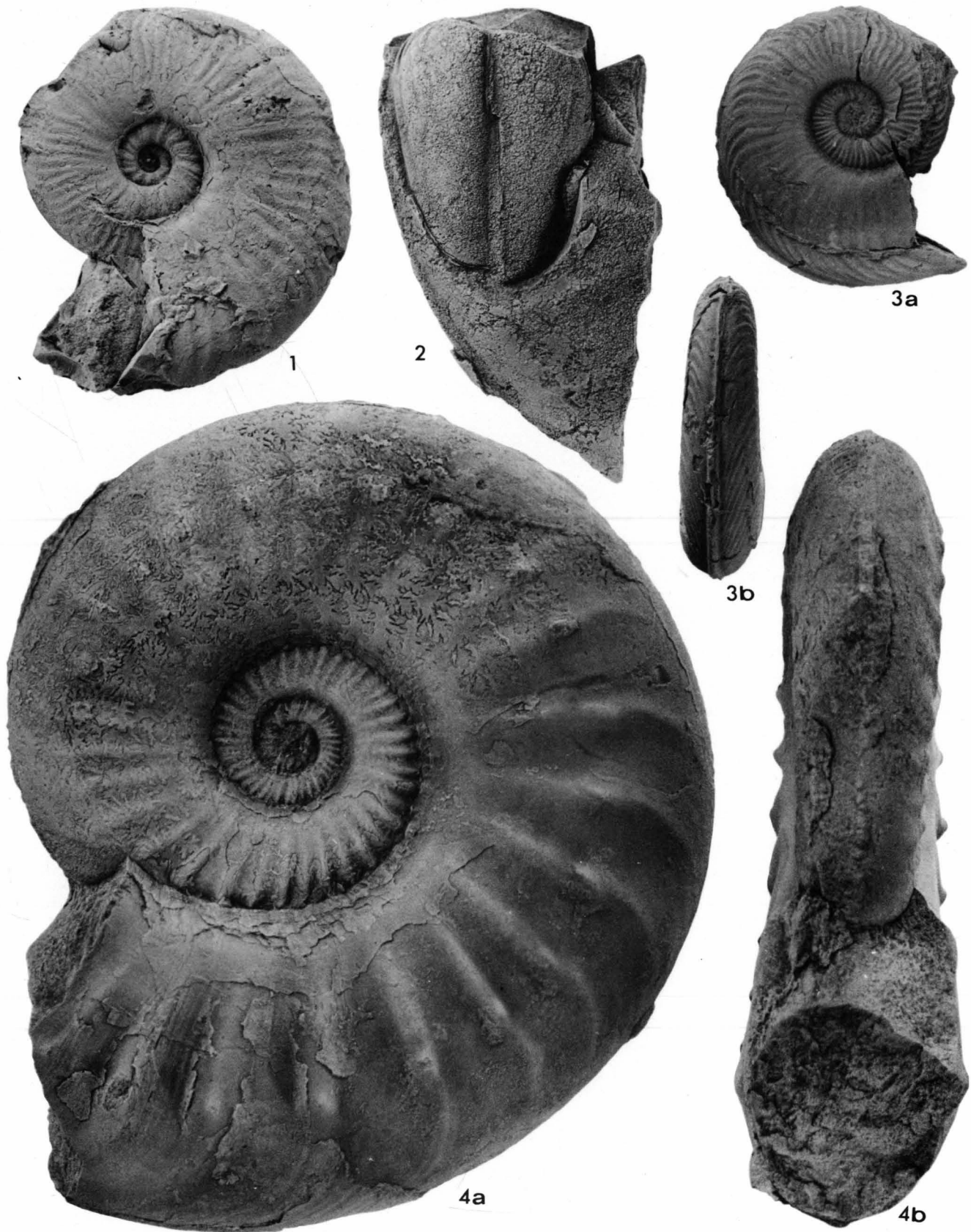
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1a



1b



1c



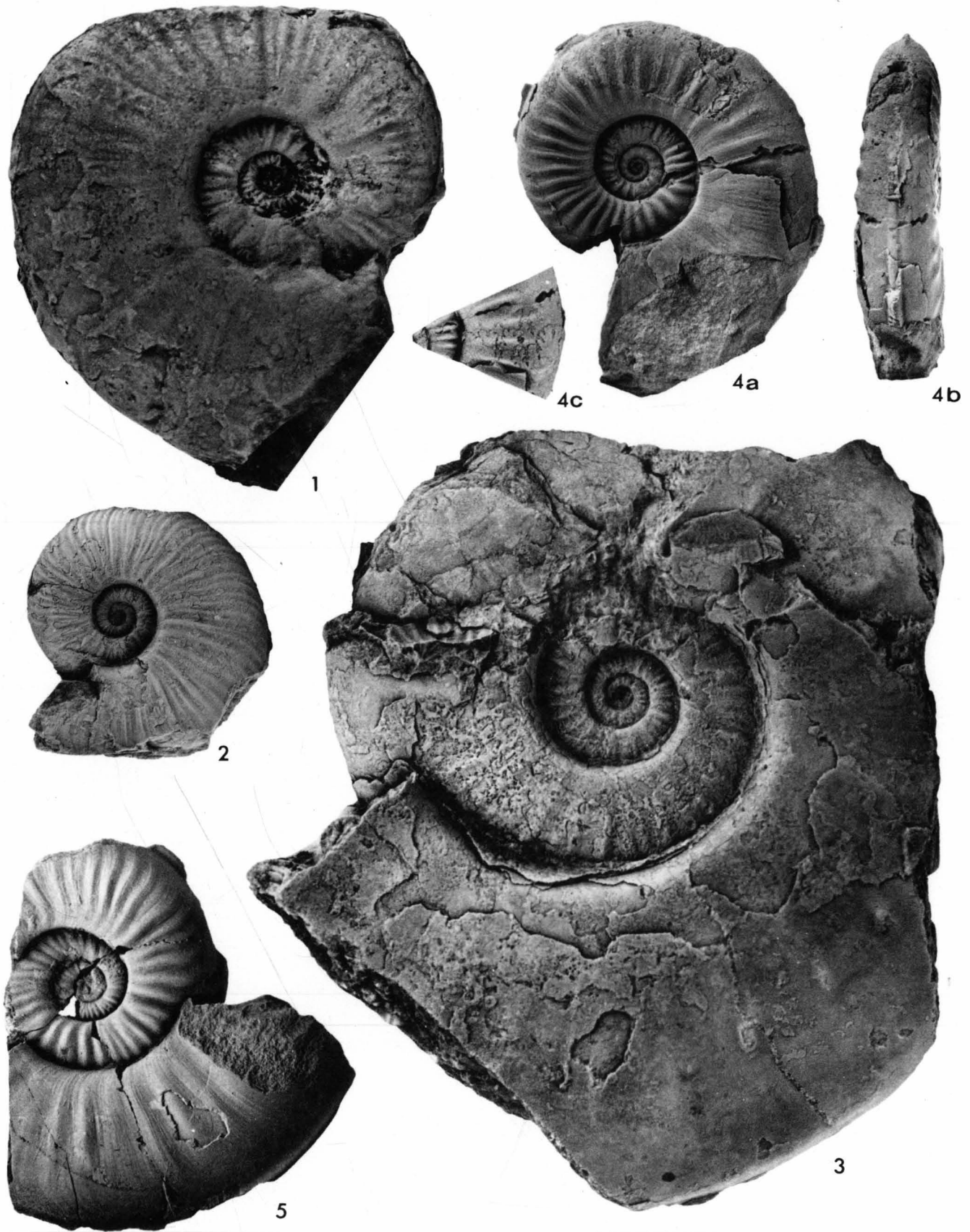
1d



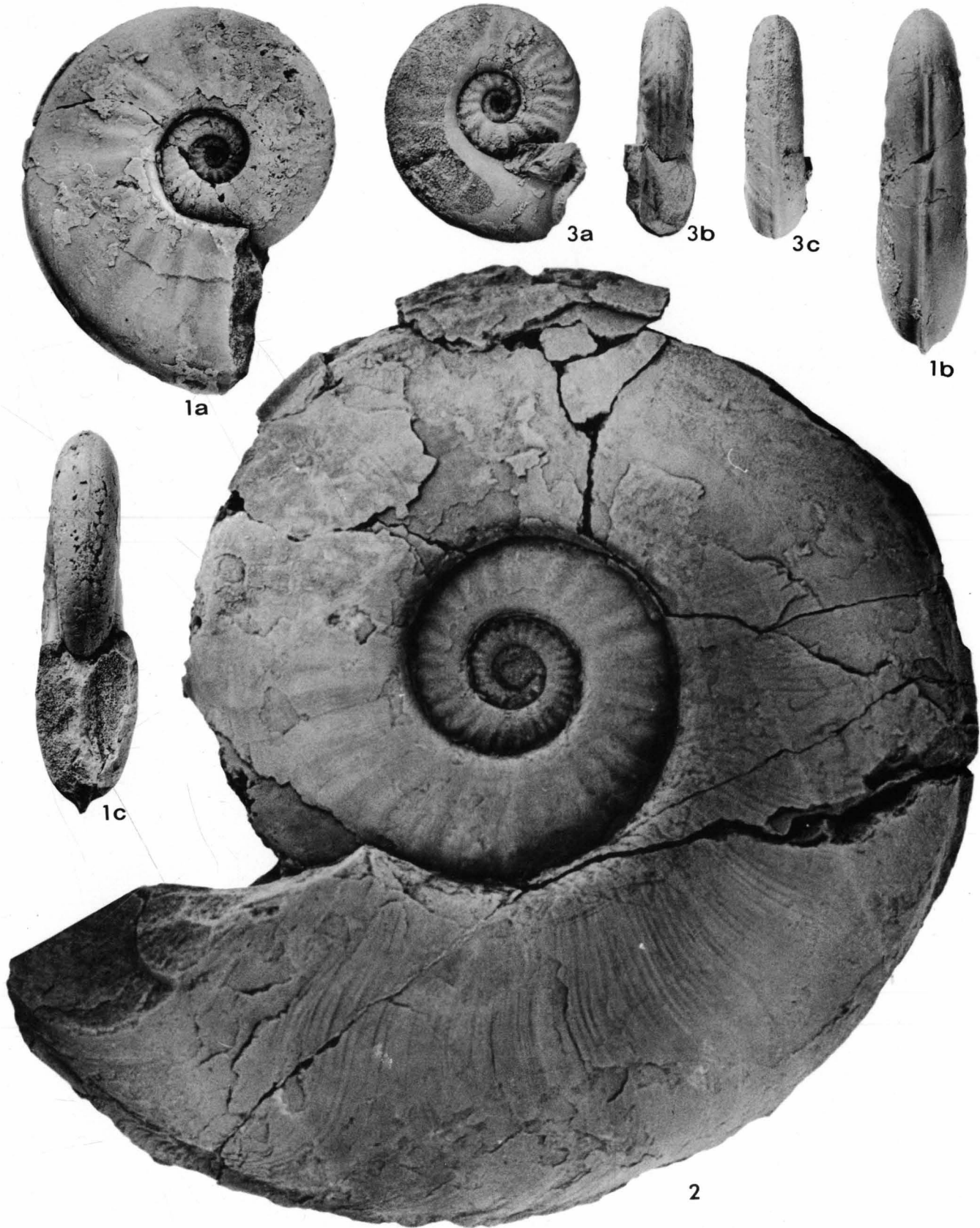
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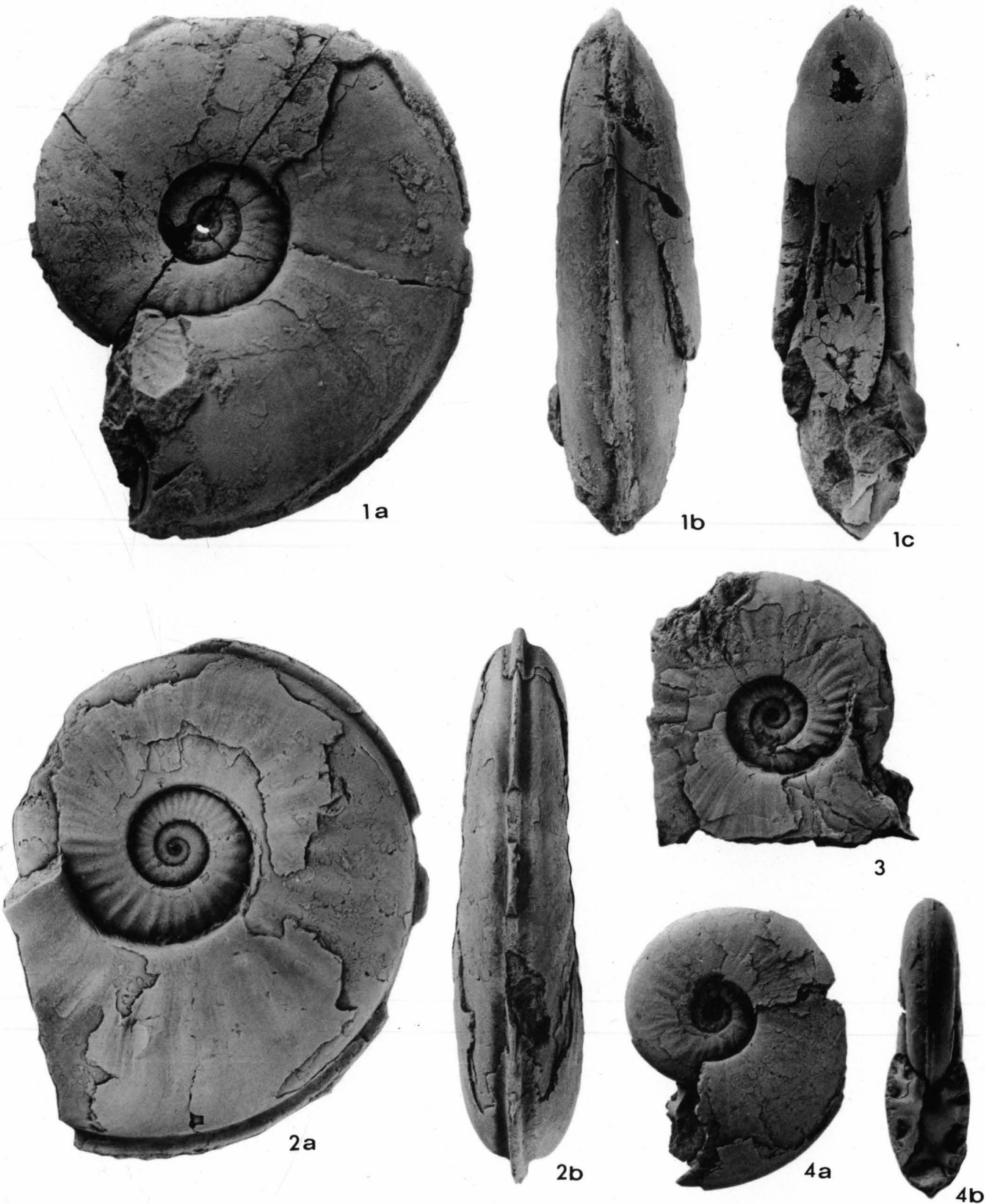
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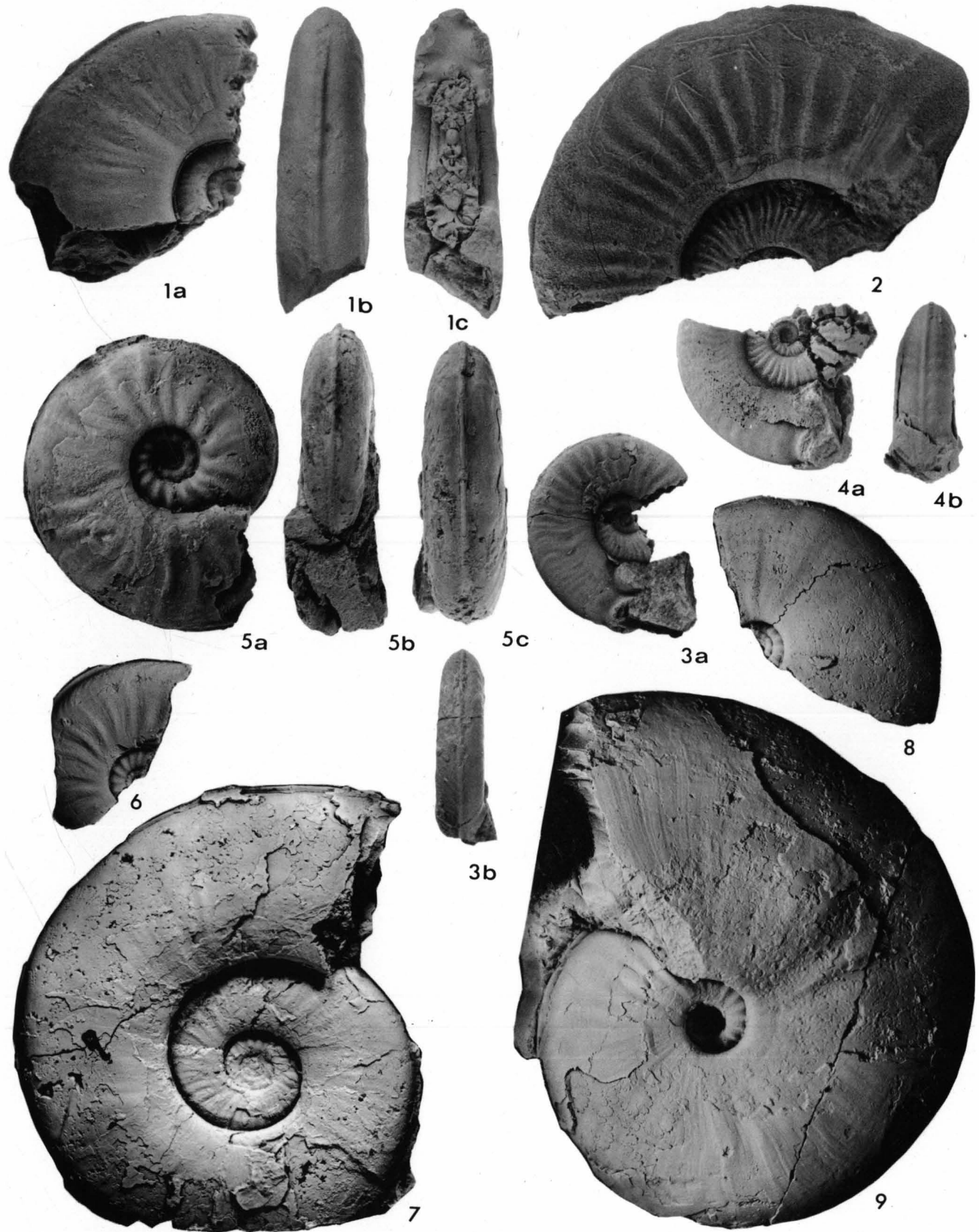
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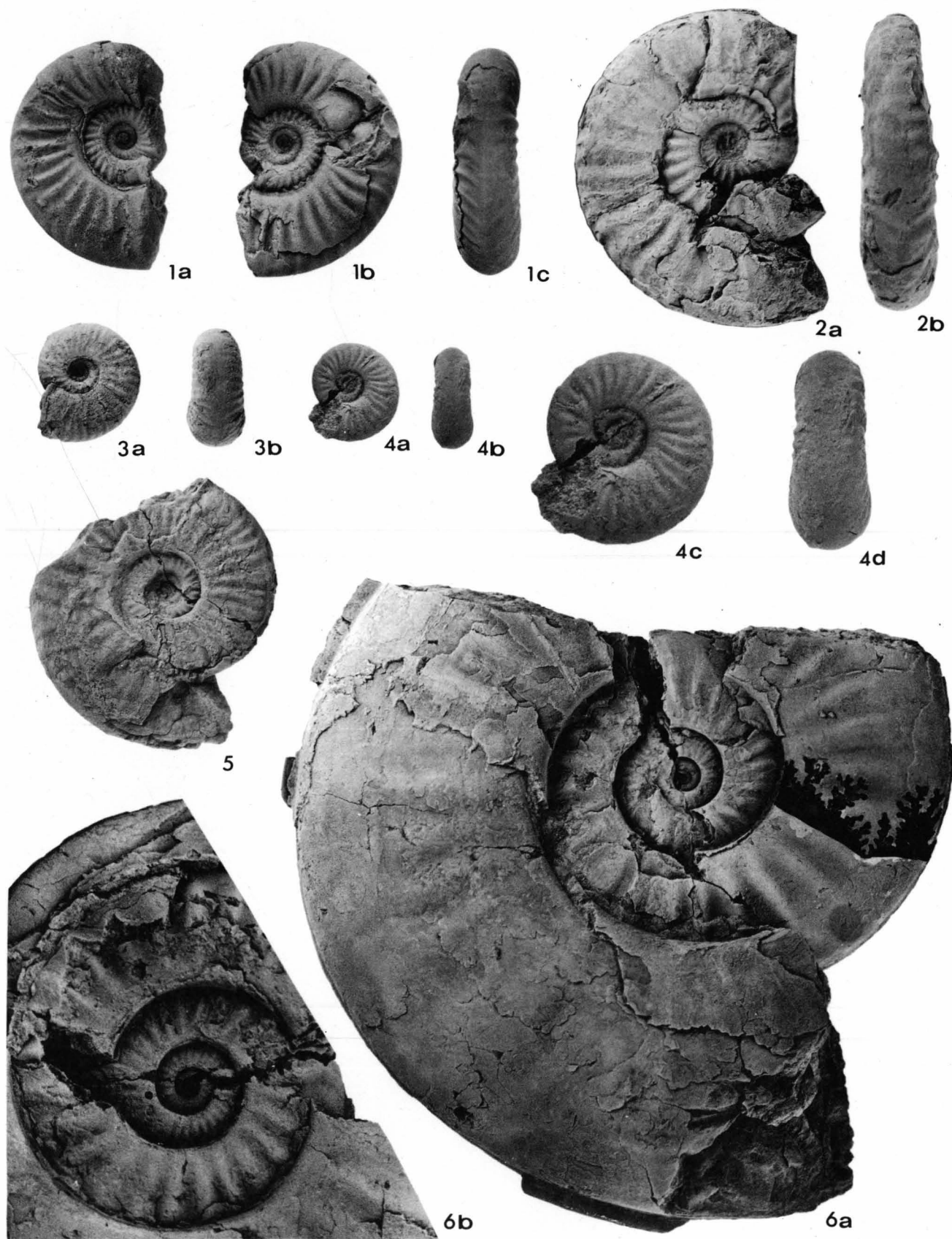


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1885 *Ammonites ixus* — QUENSTEDT, S. 5, Taf. 2, Fig. 4
1919 *Novoceras novus* MÜLLER, S. 10, Taf. 3, Fig. 2
non 1920 *Novoceras ixus* — SCHULZE, S. 8, Taf. 2, Fig. 5 (= *N. pulcher* SCHMIDT 1915)
e. p. 1925 *Ixoceras ixus* — MAYER, S. 9, Taf. 4, Fig. 6 (non Fig. 5, 7 = *N. carinatus* SCHNEIDER 1890)

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SCHINDEWOLF, O. H. (1950): Grundfragen der Paläontologie. — 1. Aufl., (E. Schweizerbart'sche Verlagsbuchhandlung), Stuttgart.

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herausgegeben von

Prof. Dr. H.-J. ELSTER, Konstanz/Bodensee, und Prof. Dr. W. OHLE, Plön/Holstein, erschien

Das Zooplankton der Binnengewässer

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Der 2. Teilband wird vor allem die wichtigen Kapitel über die Copepoden und Phyllopoden, die besonders umfangreiche Neubearbeitungen erforderten, enthalten. Eine allgemeine Übersicht über die Biologie und Ökologie des Zooplanktons wird als Ergänzung und Zusammenfassung der Einzelkapitel am Schluß folgen.

Interessenten: Hydrobiologen, Biologen, Botaniker, Zoologen, Wasserwirtschaftler, Geologen und deren Institute, wissenschaftliche Bibliotheken.

Katalog der fossilen Dinoflagellaten, Hystrichosphären und verwandten Mikrofossilien

Herausgegeben von Professor Dr. Alfred Eisenack

Geologisch-Paläontologisches Institut der Universität Tübingen

BAND II: DINOFLAGELLATEN

Von

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Geologisch-Paläontologisches Institut der Universität Tübingen

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