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THE INDO-PACIFIC AMMONITE *MAYAITES* IN THE OXFORDIAN OF THE SOUTHERN ANDES

By P. N. STIPANICIC[1], *G. E. G. WESTERMANN*[2] *and A. C. RICCARDI*[3]

ABSTRACT: Oxfordian litho- and biostratigraphy of the Chilean and Argentine Andes is reviewed (P. N. Stipanicic). Within the Chacay Group, the Lower to basal Upper Oxfordian La Manga Formation, below, mostly detrital and biogenic, and the Upper Oxfordian Auquilco Formation, above, mainly chemical, are distinguished. The La Manga Formation (with *Gryphaea calceola* lumachelle) is rich in ammonite faunas, particularly of the upper Cordatum to lower Canaliculatum Zones. In Neuquén and Mendoza provinces of Argentina, the Plicatilis Zone or Middle Oxfordian has yielded *Perisphinctes* spp., *Euaspidoceras* spp., *Aspidoceras* spp., together with *Mayaites (Araucanites) stipanicici, M. (A.) reyesi,* and *M. (A.) mulai,* Westermann et Riccardi subgen. et spp. nov. The first find of Mayaitidae outside the Indo-Pacific province is discussed in light of plate-tectonic theory.

RESUMEN: La revisión lito- y bioestratigráfica del Oxfordiano de los Andes de Argentina y Chile (P. N. Stipanicic) ha permitido reconocer dentro del Grupo Chacay: 1) abajo, la Formación La Manga, mayormente detrítica y biogénica, del Oxfordiano inferior-superior basal, y 2) arriba, la Formación Auquilco, mayormente química, del Oxfordiano superior. La Formación La Manga (con lumachelas de *Gryphaea calceola*) contiene abundante cantidad de amonitas, particularmente de las Zonas de Cordatum superior a Canaliculatum inferior. En las provincias de Mendoza y Neuquén, Argentina, la Zona de Plicatilis (Oxfordiano medio) contiene *Perisphinctes* spp., *Euaspidoceras* spp., *Aspidoceras* spp., conjuntamente con *Mayaites (Araucanites) stipanicici, M. (A.) reyesi,* y *M. (A.) mulai,* Westermann et Riccardi subgen. et spp. nov. El primer hallazgo de Mayaitidae fuera de la provincia Indo-Pacífica es discutido tomando en consideración la teoría de tectónica de placas.

[1] Academia Nacional de Ciencias en Córdoba. Juncal 3596, Buenos Aires, Argentina.
[2] Department of Geology, McMaster University, Hamilton, Ontario, Canadá.
[3] Museo de Ciencias Naturales, La Plata, Argentina.

THE OXFORDIAN OF THE ANDEAN GEOSYNCLINE OF ARGENTINA AND CHILE

By P. N. STIPANICIC

1. Lithostratigraphy

Oxfordian is well represented within the Argentine and Chilean part of the Mesozoic Andean Geosyncline where it forms part of the Chacay Group (*sensu* Stipanicic and Mingramm *in* Groeber, 1951), belonging to the Chacayano sedimentary cycle (Groeber, Stipanicic and Mingramm, 1953). The base is marked by a disconformity or unconformity (Rio Grande Phase) with Oxfordian directly overlying Bajocian to Middle Callovian beds; Upper Callovian appears to be missing in the entire basin except in the Domeyko mountain range (Hillebrandt, 1970). The Chacay Group is, in turn, unconformably overlain (Araucan Phase) by Lower to Upper Kimmeridgian or even Tithonian (Stipanicic, 1966, 1969; Stipanicic and Rodrigo, 1970).

The Chacay Group is divided into two distinct but intergrading sedimentary units, i.e., the lower one is mostly detrital and biogenic belonging to the Lower to basal Upper Oxfordian; the upper one, mainly chemical, belongs to the Upper Oxfordian. The upper unit has unusual facies homogeneity from 18° S in northern Chile to 39° S in Neuquén province, consisting of up to 400 m of gypsum and/or anhydrite and interbedded stinking whitish limestones in different proportions. In Argentina, this unit is known as the *Auquilco Formation* (Weaver, 1931; Groeber, 1946), formerly also as "Principal Gypsum" (Schiller, 1912); in Chile as Millonaria Formation (Harrington, 1961), Middle Member of the Lagunillas Formation (Aguirre Le Bert, 1960), Middle Member of the Valle Grande Formation (Gonzalez and Vergara, 1964), Rio Colina Formation (Gonzalez, 1963), Santa Elena Member of the Nacientes del Teno Formation (Klohn Giehm, 1960), and others.

The lower unit, although showing minor facies variation and varying in thickness from 0 to 220 m, was named *La Manga Formation* (Stipanicic and Mingramm *in* Groeber, 1951, as "Manguense"; Stipanicic, 1966). Formerly known as "blue limestones with *Gryphaea*" (Groeber, 1929), the formation appears in outcrop superficially homogeneous with brownish-bluish-gray weathering colour. Two main lithofacies can be distinguished: (a) a *nearshore* facies of thick hard limestones, sometimes arenaceous, dark grayish weathering bluish-gray, with corals, lumachelle of *Gryphaea calceola* (Qu.) and scarce ammonites; and (b) a *standard* facies, above with bluish-gray limestone with minimal amounts of clastic, intergrading upwards into the Auquilco Formation by increased interbedding of gypsum, with scarce ammonites, and below predominantly brownish-gray siltstone, shales, calcilutite and oolites, with more abundant ammonites (Groeber *et. al.*, 1953; Stipanicic, 1966).

The *standard* facies has been identified in the subsurface of Neuquén province (named Barda Negra Formation, Digregorio, 1965). In Chile, synchronic sediments in similar facies were given a number of formational names (Cecioni and Garcia, 1960 *a*, *b*; Galli and Ding-

Fig. 1. — Important Oxfordian localities, including those with **Mayaites (Araucanites)** subgen. et spp. nov., in Argentina and Chile between latitudes 33° and 39°S (cf. Stipanicic, 1966)

man, 1962; Harrington, 1961; Klohn Gichm, 1960), grading from nearshore facies in northern Chile to *standard* facies, often with andesite flows, in the central latitudes: i.e. Tarros Fm., Chacarilla Fm., Upper Agua Santa Fm., Doralisa Fm., and Upper Rinconada Member of the Nacientes del Teno Formation, etc.

2. Biostratigraphy and biochronology of the La Manga Formation.

The La Manga equivalents in northern Chile have yielded a rich fauna of the Plicatilis and Canaliculatum Zones (Middle and lower Upper Oxfordian) at Caracoles (Steinmann, 1881; Stehn, 1923; Leanza, 1947 *a*) including *Ochetoceras canaliculatum* (v. Buch), *Trimarginites arolicus* (Opp.), *Euaspidoceras* cf. *perarmatum* (Sow.), *E. chilense* Leanza, *Perisphinctes healeyi* (Neum.) *P. andium* Stein., *P. (Arisphinctes) harringtoni* Leanza. A very similar fauna occurs further north at Arica, together with doubtful *Progeronia* which would indicate Lower Kimmeridgian (Cecioni and Garcia, 1960 *a*, *b*; Corvalan, 1965; Salas *et al.*, 1966). Faunal lists of partially mixed Middle Callovian and Oxfordian faunas from the Santa Ana Formation of Negreiros (Cecioni and Garcia, 1960 *a*; Cecioni, 1961) need to be reexamined. In general, the northern Chilean faunas appear to be mainly Middle Oxfordian.

In the Domeyko Mountains, 25-26° S, the lower La Manga equivalents yielded *Gregoryceras (Pseudogregoryceras)* cf. *iteni* (Jeannet), *Campylites (Neoprionoceras)* cf. *henrici* (d'Orb.) and Perisphinctidae which Hillebrandt (1970) on page 192 considered to represent Lamberti or Plicatilis Zones, but only Plicatilis Zone in the table (p. 176). Plicatilis Zone and possibly part of the Cordatum Zone seems more probable. The upper beds, with *Gregoryceras toucasianum* (d'Orb.), *G.* cf. *transversarium* (Qu.), *Ochetoceras hispidum* (Opp.), *Perisphinctes (Arisphinctes?) andium Stein., P. (A.?) boehmi* Stein., *P. (A.?) gleimi* Stein., *Mirosphinctes* sp., and *Euaspidoceras* cf. *perarmatum* (Sow.), were placed in the Transversarium Zone (Hillebrandt, 1970). The lower Bimammatum Zone is indicated by *Decipia (?) gottschei* (Stein.), *Discosphinctes* cf. *lucingae* (Favre) and *Euaspidoceras* cf. *perarmatum,* while the upper part of the zone is indicated by *Decipia (?) desertorum* (Stehn), *Ochetoceras* cf. *hispidum* (Opp.), *Campylites* cf. *mexicanus* (Burckh.), *Euaspidoceras* sp. and *Idoceras* sp. (Hillebrandt, 1970). However, several species of the last two assemblages are already known from the Canaliculatum and even Plicatilis Zones of Europe (Arkell, 1956; Enay *et al.*, 1974).

Further south in Chile and Argentina, the La Manga Formation ("Manguenses" beds) was long regarded as Callovian (Groeber, 1918, 1929, 1933; Gerth, 1925; Lambert, 1956), in spite of some palaeontological evidence suggesting Oxfordian. The small poorly preserved assemblage from the Santa Elena Region (locality 19) originally described by Burckhardt (1900 *a*) as Athleta Zone and later (Burckhardt, 1903) reclassified and dated Callovian-Oxfordian boundary of Mariae Zone (Spath, 1931), needs to be enlarged and reexamined; the alleged *Quenstedtoceras ("Cardioceras* aff. *lamberti")* could be a crushed macrocephalitid accor-

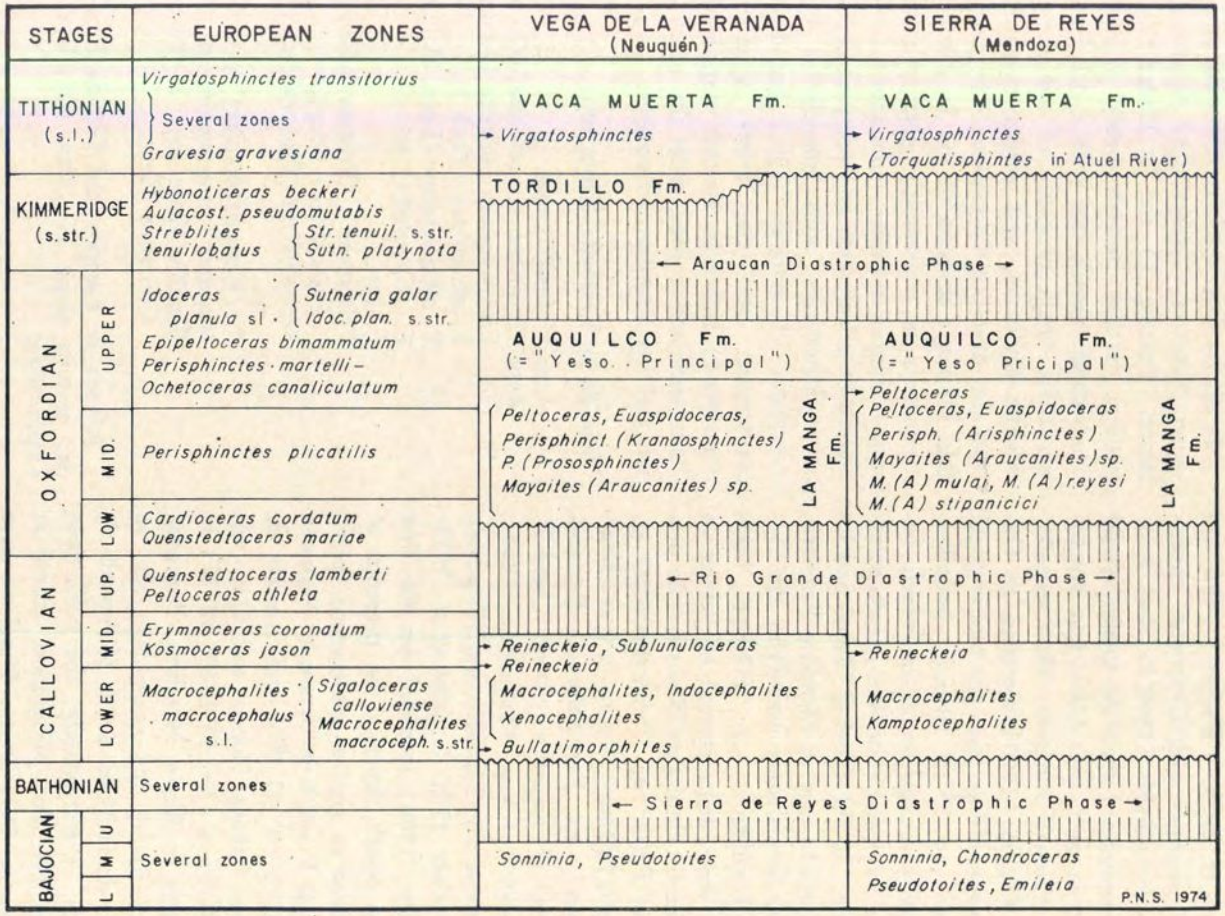


Fig. 2. — Correlation chart for the Jurassic sections of Neuquen and Mendoza Provinces, Argentina, which have yielded **Mayaites (Araucanites)** subgen. et spp. nov.

ding to reexamination of the specimen by Riccardi *(in litt.)*. The supposed *Perisphinctes* cf. *rotha* (Waagen) from the "blue limestones with *Gryphaea*" described by Burckhardt (1900 *b*) also needs to be reexamined since the species would suggest an early Late Oxfordian age for the La Manga Formation. More recently, Klohn Giehm (1960) recorded an Oxfordian assemblage from the international boundary at 35° S latitude, including supposed *Quenstedtoceras* sp. which, because of its boreal restriction, needs reexamination. In the classical Blanco and La Manga creeks area of Mendoza Province, the beds immediately underlying the Auquilco Formation (or "Principal Gypsum") were demonstrated to belong in the Plicatilis-Cordatum Zones by the presence of *Peltoceras (Peltoceratoides)* cf. *constantii* (d'Orb.), *Euaspidoceras (Neaspidoceras?)* sp., *Perisphinctes (Kranaosphinctes)* cf. *decurrens* (Buck.), and *P. (Arisphinctes)* spp. (Stipanicic, 1951).

Subsequently, Stipanicic and Mingramm (in Groeber, 1951; Groeber *et al.*, 1953; Stipanicic, 1966) recorded for the first time in South America the presence of Mayaitidae in similar associations, particularly at Vega de la Veranada, Neuquén (37° 10′ S/69° 55′ W), and Aguada de Campos, Cañada Honda and Quebrada de la Buitrera (36° 50′ S/69° 50′ W) in the Sierra de Reyes, Mendoza. Recently, Riccardi found this assemblage also in Aguada de la Mula, south of Aguada de Campos. Unfortunately, the collections of Stipanicic and Mingramm, stored at Yacimientos Petrolíferos Fiscales, were partially destroyed by fire, and only a part could be saved which will be described in the near future. The detailed description of the sections can be found in the mentioned articles.

In all localities yielding the new subgenus *Mayaites (Araucanites)* described herein (Text-fig. 1), the La Manga Formation overlies unconformably a thin sandy-conglomeratic bed with a rich Reineckeidae fauna probably of the early Middle Callovian, and grades upwards into the Auquilco Formation. The twofold lithologic division of the La Manga Formation is consistently present; the upper thinner member (unnamed) consisting of calcarenites and compact dolomitic limestones with lumachelles of *Gryphaea* cf. *calceola* (Qu.) but few ammonites, and the lower member (unnamed) richer in clastics, coquinoid limestones and oolites, with the siltstones yielding abundant ammonites.

Vega de la Veranada (from top)

3 m: Unfossiliferous
4 m: *Gryphaea* cf. *calceola* (Qu.)
Euaspidoceras chilense Leanza
E. akantheen (Buck.)
E. aff. *loricatum* (Bean, M. S.)
E. (Clambites) sp.
E. spp.
Peltoceras (Peltomorphites) hoplophorus (Buck.)
Perisphinctes (Prososphinctes) sp.
P. (Kranaosphinctes) sp.
Mayaites (Araucanites) sp.
Plicatilis Zone and ? upper Cordatum Zone.

Aguada de Campos and Cañada Honda, eastern slope of Sierra de Reyes (from top).

7-10 m: large *Peltoceras*
16 m: *Gryphaea* cf. *calceola*
Perisphinctes spp.
Euaspidoceras spp.

Peltoceras spp.
Mayaites (Araucanites) stipanicici subgen. et sp. nov.
? *Goliathiceras* sp. (specimen lost)

Aguada de la Mula, Sierra de Reyes. According to Riccardi, the faunal succession is as follows:

1.10 m: *Perisphinctes (Arisphinctes)* spp.
7.40 m: *Euaspidoceras* aff. *waageni* Spath
Aspidoceras? aff. *obesum* Spath
Perisphinctes (Dichotomites) cf. *wartae* Bukowski
Mayaites (Araucanites) mulai subgen. et sp. nov.
M. (A.) reyesi subgen. et sp. nov.
M. (A.) n. sp.?
3.5 m: *Gryphaea* sp.
Reineckeia spp.

Quebrada de la Buitrera, western slope of Sierra de Reyes (12-14 m).
lower 1-10 m:

Perisphinctes (Arisphinctes) spp.
Peltoceras spp.
Euaspidoceras sp.
Mayaites (Araucanites) sp.

The above assemblages from the Sierra de Reyes are regarded as time-equivalent to those at Vega de la Veranada, *i.e.* Plicatilis and ? upper Cordatum Zones.

3. Conclusions

The La Manga Formation and lateral equivalents belong consistently to the Plicatilis (entire) and the lower Canaliculatum Zones, respectively Middle and lower Upper Oxfordian. Where maximally developed, the formation may also include all or part of the Lower Oxfordian (Mariae and Cordatum Zones). The entire Lower Oxfordian seems to be present in the Santa Elena area ("Rinconada Superior";but the lost specimen of *Quenstedtoceras* needs confirmation) and possibly at Arroyo Blanco; the section begins with basal Cordatum Zone at Rio del Cobre, Barda Blanca, Poti Malal, Vaca Muerta, *et al.*, and possibly at the top of the Cordatum Zone in the thinner section of Sierra de Reyes and Vega de la Veranada. The interval yielding *Mayaites (Araucanites)* subgen. nov. clearly belongs in the Plicatilis Zone, and may extends downward into the upper Cordatum Zone.

The Auquilco Formation is Oxfordian in the entire Argentine-Chilean Basin and evidence for the inclusión of Lower Kimmeridgian in northern Chile (Cecioni, 1961) and the Domeyko mountain range (Hillebrandt, 1970) is inconclusive. The "Principal Gypsum" is clearly pre-Kimmeridgian; the base intergrades with the La Manga Formation of the lower Canaliculatum Zone, while limestones interbedded in the upper part have yielded *Perisphinctes andium* Stein. (Gonzalez, 1963) indicating the same zone. The oldest beds unconformably overlying the Auquilco Formation occur at Chacay Melehue and Rahueco where they have yielded *Nebrodites pressulus* Leanza, *Idoceras* spp., *Aspidoceras* sp., *Euaspidoceras ajax* Leanza, and *Streblites oxynotum* Leanza, (1946, 1947 *b*), indicating basal Kimmeridgian (Platynota Zone) or even uppermost Oxfordian (Galar Subzone) (Stipanicic, 1966, 1969).

SYSTEMATICS

By G. E. G. WESTERMANN and A. C. RICCARDI

Superfamily *STEPHANOCERATACEAE* Neumayr, 1875

Family *MAYAITIDAE* Spath, 1928

DISTRIBUTION

In this family, Spath (1928, p. 222) included the late Oxfordian macrocephalitid homeomorphs of the Indo-Pacific faunal province (or realm) *Mayaites, Epimayaites, Dhosaites, Paryphoceras, Prograyiceras,* and (?) *Grayiceras,* all his genera. The apparently sudden appearance and the phyletic origin of the family remain unsolved, with the Callovian Eucycloceratidae Spath most recently suggested as possible ancestors, rather than the Pachyceratidae (Westermann, 1973). The quite unique geographic distribution has been the focus of appreciable attention and was most competently discussed by Spath (1933) and Arkell (1956). One of us (G. E. G. Westermann) has recently examined the occurrences in Kenya and found the most eastern one in Papua, New Guinea.

The known occurrences of Mayaitidae have been plotted on the "pre-drift" Jurassic reconstruction of Gondwanaland by Seyfert and Sirkin (1973) (Text-fig. 3) which appears to be most consistent with recent geological, geophysical

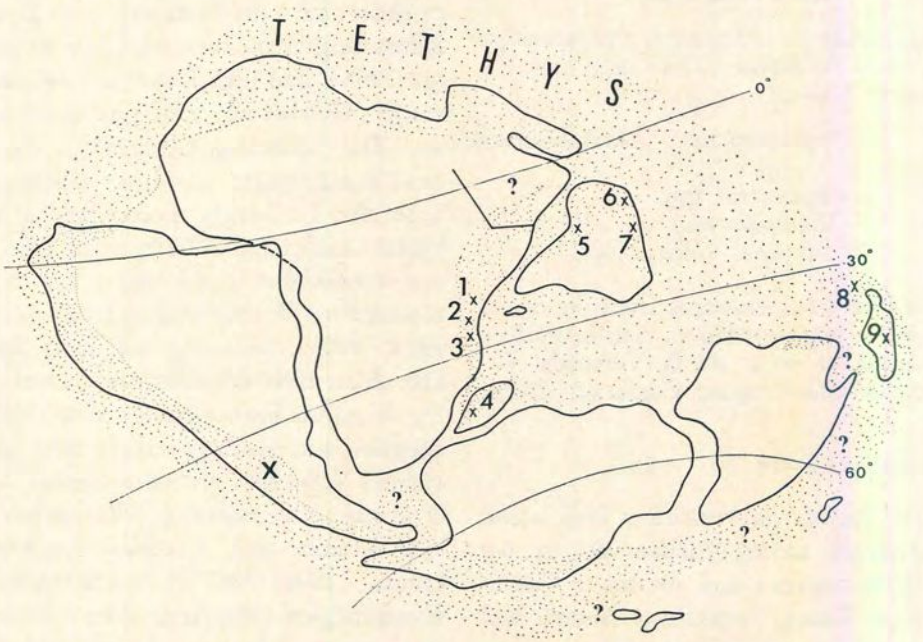


Fig. 3. — Geographic distribution of **Mayaites** plotted on the « pre-drift » Jurassic Gondwanaland as reconstructed by Seyfert and Sirkin (1973), with land-sea distribution added

and palaeontological data on the area of the Indian Ocean or Sinus Australis of Tethys (cf. Westermann, 1975, p. 34). From West to East, (1) Arkell (1956, p. 318) has recorded the most northerly African occurrence from the Plicatilis Zone of Daua Valley in northern Kenya; (2) from the Mombasa area, he (p. 323) identified one assemblage with *Epimayaites* and *Prograyiceras* together with the *Perisphinctes* subgenera *Arisphinctes* and *Kranaosphinctes,* and another with *Mayaites, Epimayaites* and *Dhosaites,* and dated both as Transversarium Zone (note however that Arkell, 1956, usually regarded Transversarium and Plicatilis Zones as time-equivalent); (3) from Tanga in northeastern Tanzania, Tornquist (1893) described a suite of *Mayaites* species which was associated with *P. (Kranaosphinctes)* and *Euaspidoceras,* and dated as (? Cordatum-) Plicatilis Zone by Arkell (1956, p. 328); (4) the entire family is richly represented in Madagascar probably ranging from the (?) late Cordatum to Transversarium Zones, as most recently profusely figured by Collignon (1959); (5) the Dhosa oolite of Cutch at the Pakistano-Indian border has borne the most complete assemblage of Mayaitids (all genera except the dubious *Grayiceras*) which seem to range from the probable Cordatum Zone *(Mayaites subkobyi* Spath with *Peltoceratoides)* to the Bimammatum Zone of the Kantkote Sandstone bearing *Epimayaites* and *Prograyiceras* with the "acme" in the Transversarium Zone (Waagen, 1873-5; Spath, 1927-33); (6) the Attock District north of the Salt Range and (7) Spiti in the central Himalayas have yielded a number of poorly described mayaitids (Waagen, 1873-5; Spath, 1927-33); (8) in the Sula Islands occur *Epimayaites, Paryphoceras* and *Prograyiceras,* together with what appears to be a new subgenus of *Perisphinctes* affiliated to *Kranaosphinctes,* and ? *Peltoceratoides* (Boehm, 1907) in what Arkell (1956) believed to be Plicatilis to possibly upper Cordatum Zone; (9) 20 km SW of Telefolmin in the Western Highlands of Papua New Guinea is a mountain slide from which Papuans brought a large (derived) fauna to the Telefolmin hospital, including the Sula Islands (Wai Galo) mayaitids assemblage. Significantly, Mayaitidae are absent from the *Kranaosphinctes* beds of Japan (Sato, 1964), but Oxfordian is unknown from the southwestern Pacific (New Caledonia, New Zealand). The known distribution, therefore, does not contradict the possibility of a southern faunal route for mayaitids, either around Gondwanaland *via* New Guinea or more directly through a possible passage between southern Africa and Antarctica. However, with taxonomic difference at the subgeneric level, no definite conclusion can be drawn at this point.

A direct faunistic connection of the southern Andes area with the "Ethiopic-Indo-Malagassi faunal province" *via* the Mozambique Channel of a separating Gondwanaland has recently been suggested for the Upper Jurassic by Cecioni and Charrier (1974). This is mainly based on the supposed common occurrence of *Gryphaea balli* (Stefanini).

Taxonomy

The five to six mayaitid "genera" appear to fall into two groups, *i.e.* the

large *Mayaites* and *Epimayaites* remaining involute and tending to become smooth on the body chamber, and the smaller *Paryphoceras, Prograyiceras,* (?) *Dhosaites,* and ? *Grayiceras* in which the adult body chamber becomes evolute and remains ornate. There is strong indication that the former are macroconchs or female shells and the latter the microconchs or male shells, with some yet unknown correspondences within the family, as suggested by Callomon (1963, p. 33).

In the Treatise (Arkell, 1957, p. L 297), *Mayaites* and *Epimayaites* were regarded as subgenera of a single genus; *Epimayaites* was said to be distinguished by the projected ribbing and the simpler septal suture. In fact the sutures are of similar complexity and their diagnostic difference is the shape of the E/L saddle and of the saddle envelope which is almost radial in *Mayaites* and convex in *Epimayaites* (Text-fig. 5). In both, E tends to be deeper than L and the U-lobes small and raised with U_2 ("2nd lateral") much shorter than L ("1st lateral"). However, the taxonomic consistency of the sutural characters will have to be thoroughly studied in conjunction with the other morphological features to resolve the taxonomic problem within this family which no doubt is mostly owing to the renowned taxonomic "splitting" of Spath (1927-33). Incomplete *Paryphoceras* and *Prograyiceras* closely resemble immatures or nuclei of *Mayaites* and *Epimayaites* as evident from the recent inspection by one of us (G. E. G. Westermann) of the entire collection studied by Boehm (1907), deposited in the Geological Institut of Utrech. Also the probable microconchiate *Paryphoceras* appears to be more frequent than previously assumed by Spath (1928), and apparent macroconchs and microconchs appear to be always closely associated. It is therefore suggested to classify not only *Epimayaites* but also *Paryphoceras* and the very similar *Prograyiceras* as subgenera of *Mayaites;* this would also conform to the Treatise classification of the Macrocephalitidae (Arkell, 1957, p. L 293).

Genus **MAYAITES** Spath, 1924

Subgenus **ARAUCANITES**
Westermann et Riccardi, subgen. nov.

TYPE SPECIES: *M. (A.) stipanicici* sp. nov.

DIAGNOSIS: Mayaitids with obvolute whorls (occluded umbilicus), smooth flanks, and septal suture as in *Mayaites* s. s.

DERIVATIO NOMINIS: Derived from the Araucanian Indian people of the central to southern Andes and Patagonia.

DISTRIBUTION: Plicatilis (? Upper Cordatum) Zone of Argentina.

DISCUSSION: The occluded umbilicus is unique among Mayaitidae and the suture is of the relatively "normal" type of *Mayaites* s.s., rather than as in *Epimayaites.* Since forms resembling mayaitids with smooth flanks arose independently several times (see below) —and mayaitids are known homeomorphs of Callovian macrocephalitids—, the family relationship of *M. (Araucanites)* is not entirely certain. However its Middle (or early Upper) Oxfordian age strongly supports this classification since all known homeomorphs of possible affinity are latest Oxfordian to early Kimmeridgian.

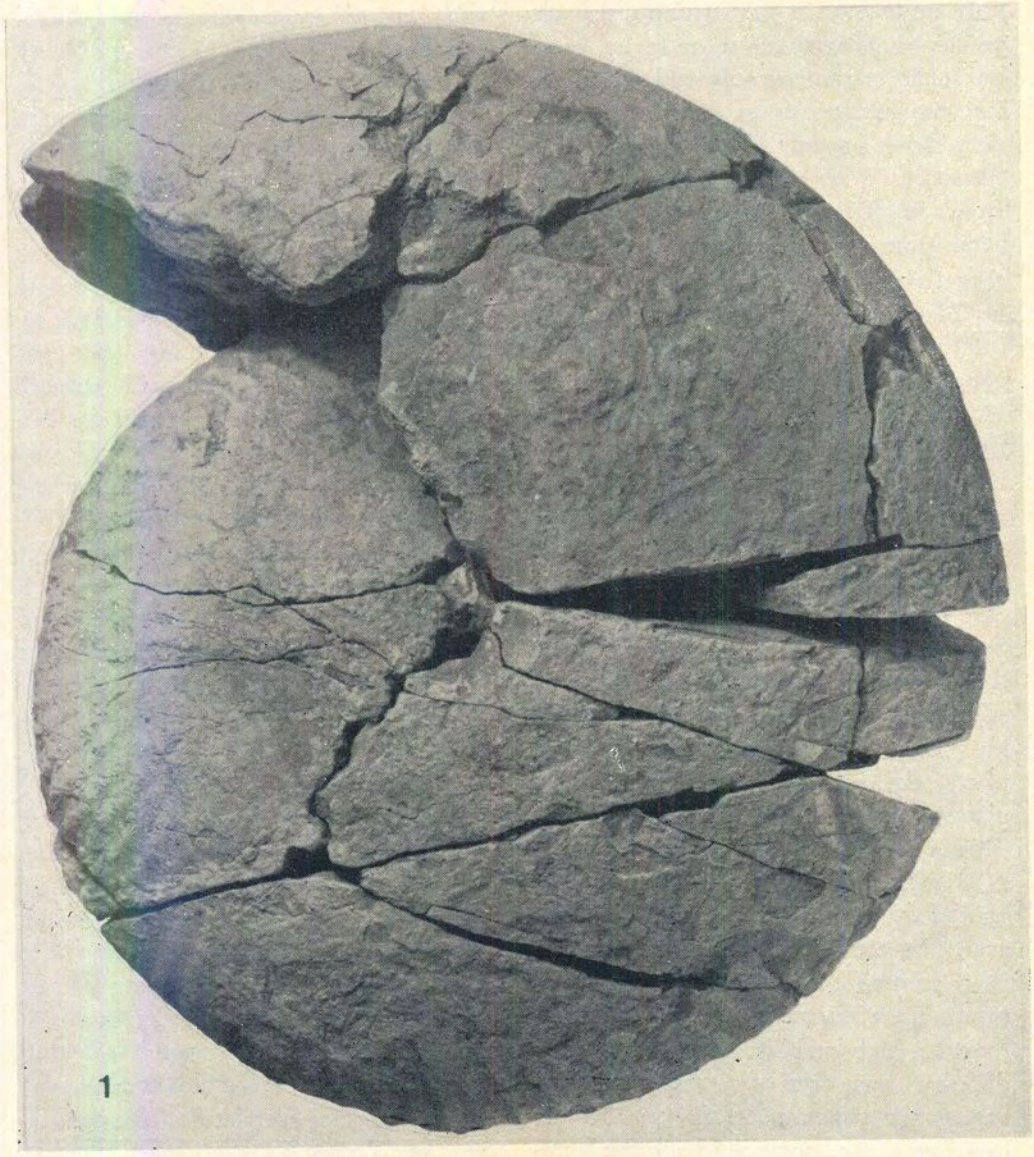
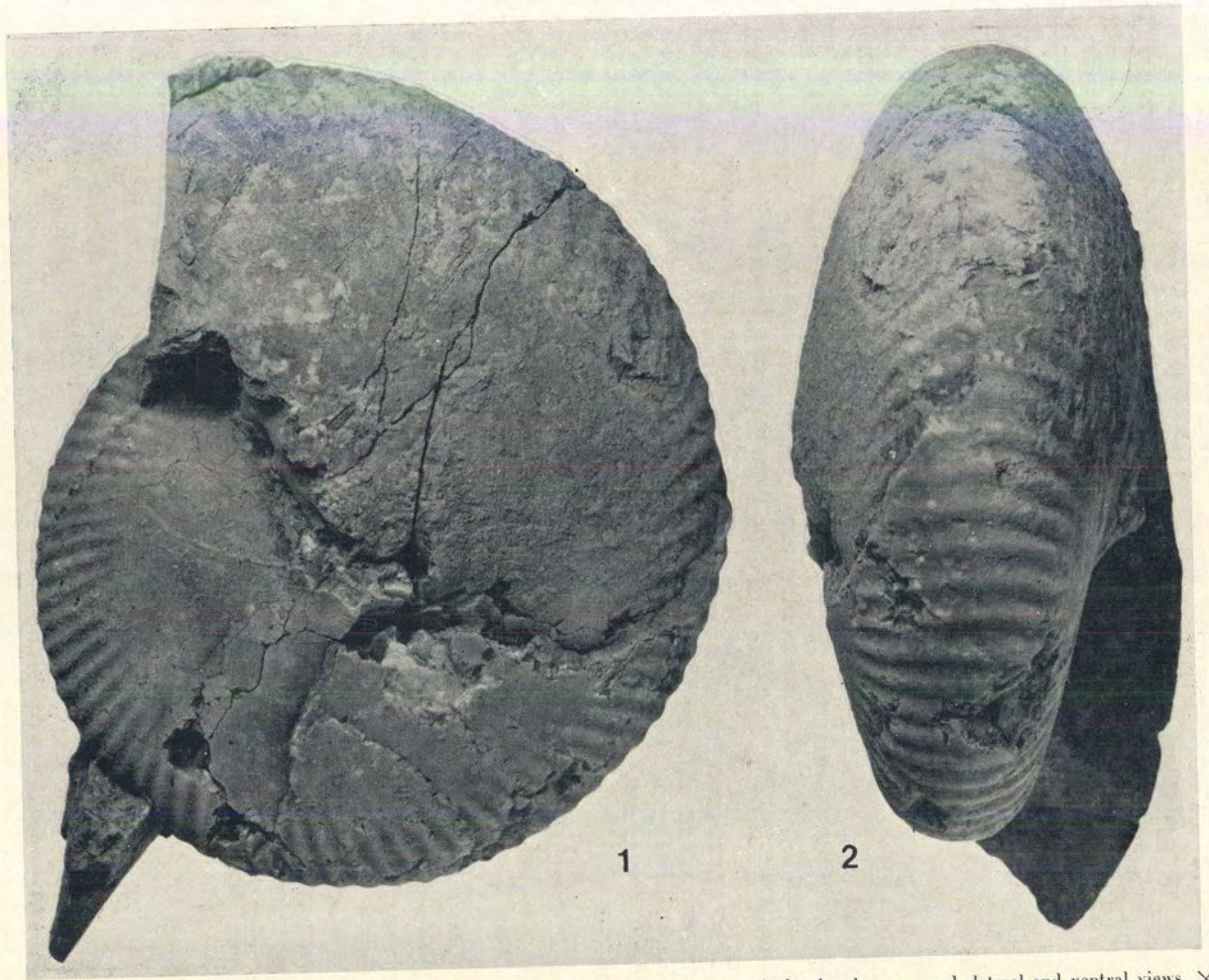


Fig. 1. **Mayaites (Araucanites) stipanicici** West. et Ricc., subgen. et sp. nov., holotype, complete specimen, lateral view, × 0.75 (MLP 12240). Plicatilis (? U. Cordatum) Zone, locality XI, Aguada de Campos, Sierra de Reyes.

Several mayaitds are known which appear to differ from *M. (Araucanites)* only or mainly in the involute, not obvolute, umbilicus; all seem to be based on single specimens only and are therefore rare accessories to the usually abundant more strongly ribbed forms. *"Stephanoceras" arenosum* Waagen (1875) from the Dhosa Oolite of Cutch has blunt primaries (smoother on the flanks than figured) and was tentatively placed in *"Mayaites ? (Paryphoceras)"* by Spath (1927-33, p. 232); the septal suture appears to be similar as in *Epimayaites*. However, Collignon (1959, fig. 248) figured a *M. (Epimayaites ?) arenosum* with smooth flanks from the "Lower Argovian" (? Cordatum-Plicatilis-? Transversarium Zone) of Madagascar, again with the highly raised umbilical lobes of that subgenus. *Epimayaites subarenosus* Spath (1931, pl. 121, fig. 7), also from the Dhosa Oolite, was defined in the plate description only as "characterized by prorsiradiate ribs, confined to periphery, the smooth sides and the high, almost perpendicular, umbilical wall". This is possibly identical with his earlier *M.* ? aff. *arenosus* of which he had only figured the suture (pl. 28, fig. 4). However, the umbilicus of the phragmocone is relatively large (18 %); the septal suture again resembles that of *Epimayaites* with high umbilical elements, clearly differing from that of *Araucanites*. *Epimayaites excentricus* Spath (p. 239) is based on a large specimen from the Kantcote Sandstone, Bimammatum Zone, and closely resembles the "species" based on much smaller incomplete phragmocones mentioned above; it was also recorded from the Transversarium Zone of Madagascar (Basse and Perrodon, 1952, p. 60). A similar large involute specimen with smooth outer whorls was already described by Noetling (1896, p. 14, pl. 11, fig. 1) under *"Macrocephalites polyphemus* Waagen" and identified with *Mayaites maya* by Spath (1927-33, p. 233).

On the other hand, there are several latest Oxfordian to early Kimmeridgian Perisphinctidae genera and subgenera which closely resemble the above mayaitids in the involute coiling (but not obvolute), whorl section and reduced ribbing. Among the Pictoniinae are *Balticeras* Dohm and *Ringsteadia (Vineta)* Dohm (cf. Geyer, 1961) and among the Aulacostephaninae, *Involuticeras* Salfeld and *Epicephalites* Spath. All differ in the perisphinctid septal suture with retracted, not raised, umbilical lobes and *Involuticeras* has also bullae-like primaries on the umbilical shoulder. Of particular interest because of its distribution is *Epicephalites,* based on *"Macrocephalites" epigonus* Burckhardt (1906) from the *"Idoceras* beds" of north-central Mexico, and reported in similar association from New Zealand (Arkell, 1956, p. 455). The holotype, the single known Mexican specimen, differs from *Araucanites* also in the rounded umbilical slope of the involute, not obvolute, whorls; in fact it seems affiliated to the almost *Haploceras*-like *Subneumayria ordonezi* (Burckhardt) with which it is associated. The even later (late Lower Kimmeridgian *Haploceras fialar* beds) *Procraspedites mazapilensis* (Burckhardt) from the same section is even more compressed than *M. (Araucanites) stipanicici* and differs again in the retracted simpler septal suture; it was



Figs. 1-2, **Mayaites (Araucanites) stipanicici** West. et Ricc.. subgen. et sp. nov., body chamber removed, lateral and ventral views, × 1 (MLP 12240). Plicatilis (? U. Cordatum) Zone, locality XI, Aguada de Campos, Sierra de Reyes.

probably correctly placed in the affinity of *Idoceras* by Arkell (1957, p. L 323). Thus, additionally to their age, all these perisphinctid near-homeomorphs appear to be more distinct from *Araucanites* than *Mayaites* s.l.

Mayaites (Araucanites) stipanicici

Westermann et Riccardi, sp. nov.

Pl. I, fig. 1; Pl. II, fig. 1-2; Text-fig. 4 *a*

HOLOTYPE: The large complete internal mould with test remains (MLP 12240) collected by P. N. Stipanicic in the La Manga Formation, at locality XI, Aguada de Campos, Sierra de Reyes, Mendoza (cf. Stipanicic, 1966, p. 424).

DIAGNOSIS: Large shell with compresed subtriangular whorls; ribbing (outer whorls) projected, blunt and rather distant, becoming obsolete on body chamber.

MATERIAL: The holotype.

AGE: Plicatilis (? Upper Cordatum) Zone.

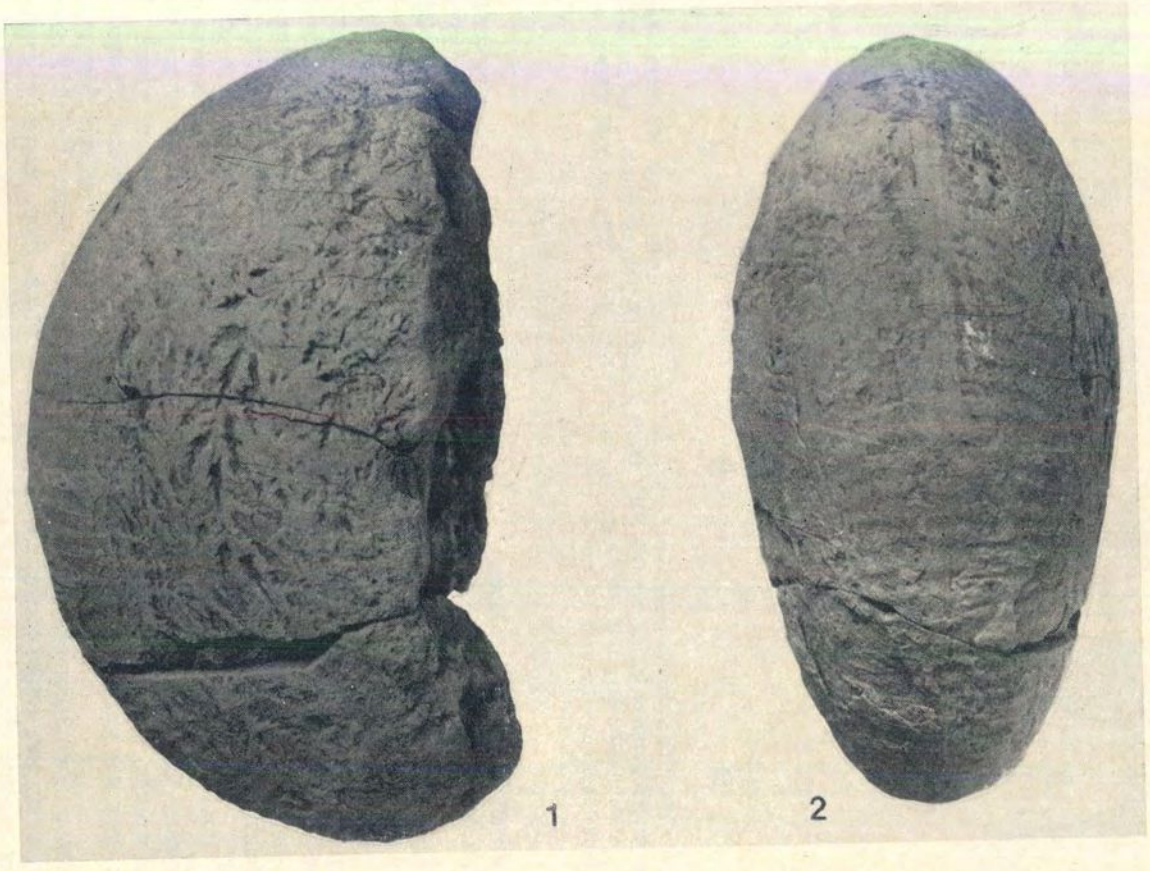
DESCRIPTION: The phragmocone has an occluded umbilicus (shell) at least from the beginning of the last whorl at 65 mm diameter. The flanks are flat and converge toward the rather narrowly rounded ventre resulting in a subtriangular whorl section which is markedely higher than broad. The flanks are perfectly smooth as far as exposed, probably also on the test which seems to be partially preserved in a recrystallized form. Commencing on the outer flanks and passing convexly over the ventre are rather widely spaced blunt ribs, 16-17 per quarter whorl. The septal suture is poorly preserved but can be seen to be complicated with thin long lobes and indentations, with small and high U_2 compared to L, and a straight radial saddle envelope. The last 3 or 4 sutures are approximated indicating adulthood.

The body chamber is slightly more than half a whorl in length remaining obvolute with occluded umbilicus of the thick shell; the internal mould is highly involute. The whorl section becomes slightly more inflated by rounding of the flanks and widening of the ventre. The peristome is obliquely inclined forward, apparently with more or less straight sides which are somewhat constricted on the internal mould. The peripheral ribbing is extremely blunt and distant at the beginning of the body chamber becoming obsolete after one quarter whorl, so that the second half is entirely smooth on the internal mould.

COMPARISON: The whorls are more compressed and the ribbing is more widely spaced than in *M. (Araucanites) reyesi* sp. nov.; *M. (A.) mulai* sp. nov. is much smaller.

MEASUREMENTS OF HOLOTYPE (in mm):

	Diameter	Whorl height	Width	Umbilical diameter
Phragmocone.....	114	66	52	0
	75	43	32	0
Body Chamber.....	172	c. 80	c. 70	0/(13 int. mould)



Figs. 1-2. **Mayaites (Araucanites) reyesi** West. et Ricc., subgen. et sp. nov., holotype, slightly crushed incomplete phragmocone, lateral and ventral views, × 1 (MLP 12241). Plicatilis (? U. Cordatum) Zone, Aguada de la Mula, Sierra de Reyes.

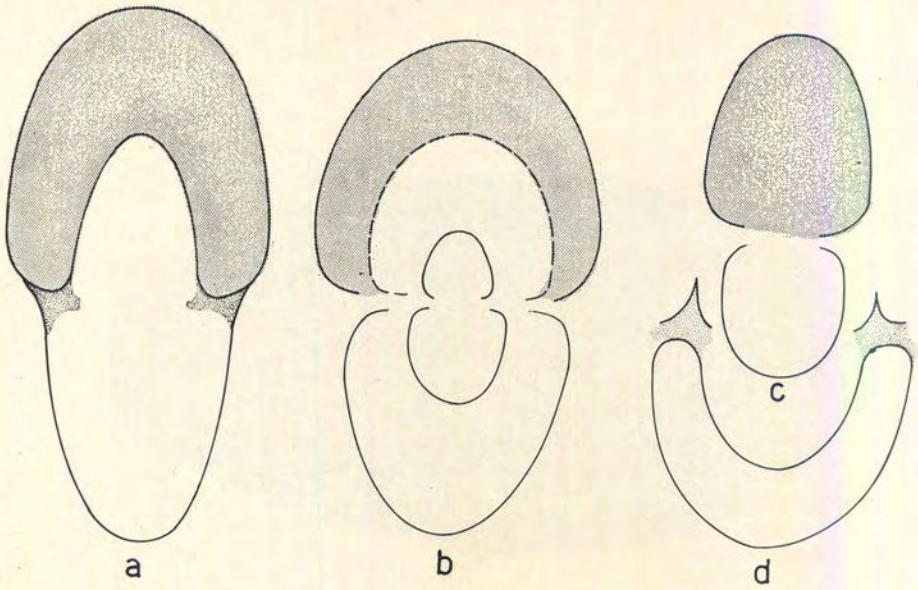


Fig. 4. — Cross-sections through phragmocone (white) and body chamber (grey) of: **a**, **Mayaites (Araucanites) stipanicici** sp. nov. holotype (MLP 12240); **b**, **M. (A.) reyesi** sp. nov., holotype and paratypes (MLP 12241-43); **c**, **M. (A.) mulai** sp. nov., holotype (MLP 12247) and **d**, **M. (A.)** sp. nov.? 1 (MLP 12246). c. × 1/2.

Mayaites (Araucanites) reyesi
Westermann et Riccardi, sp. nov.

Pl. III, figs. 1-2; Pl. IV, fig. 1; Pl. V, figs. 1-2;
Text-figs. 4 *b*, 5 *a*

HOLOTYPE: The slightly crushed incomplete phragmocone (MLP 12241), internal mould, from La Manga Formation, Aguada de la Mula, Sierra de Reyes, Mendoza.

DIAGNOSIS: Large shell with inflated subovate whorls; ribbing fine and dense, obsolete on outer whorl.

MATERIAL: Two incomplete phragmocones; probably two complete shells with somewhat crushed phragmocone and one nucleus. All from Aguada de la Mula.

AGE: Plicatilis (? Upper Cordatum) Zone.

DESCRIPTION: The phragmocone is compressed subglobular, with inflated ovate whorls which are about as high as broad. The umbilicus is highly involute on the internal mould, commencing at least already at about 30 mm diameter, and the shell was very probably obvolute with occluded umbilicus. The ornament of the phragmocone consists of fine dense, somewhat prorsiradiate ribs on the outer third of the flank which pass convexly over the rather broad ventre; there are 20-25 ribs per quarter whorl. The smallest specimen, at about 35 mm diameter, has also several very faint radial swellings on the inner flanks (internal mould) which then disappear entirely. The ornament becomes obsolete on the last half whorl of the phragmocone so that no ribbing is visible on the two large complete specimens. The septal suture is complicated (Tex-fig. 5 *a*), with

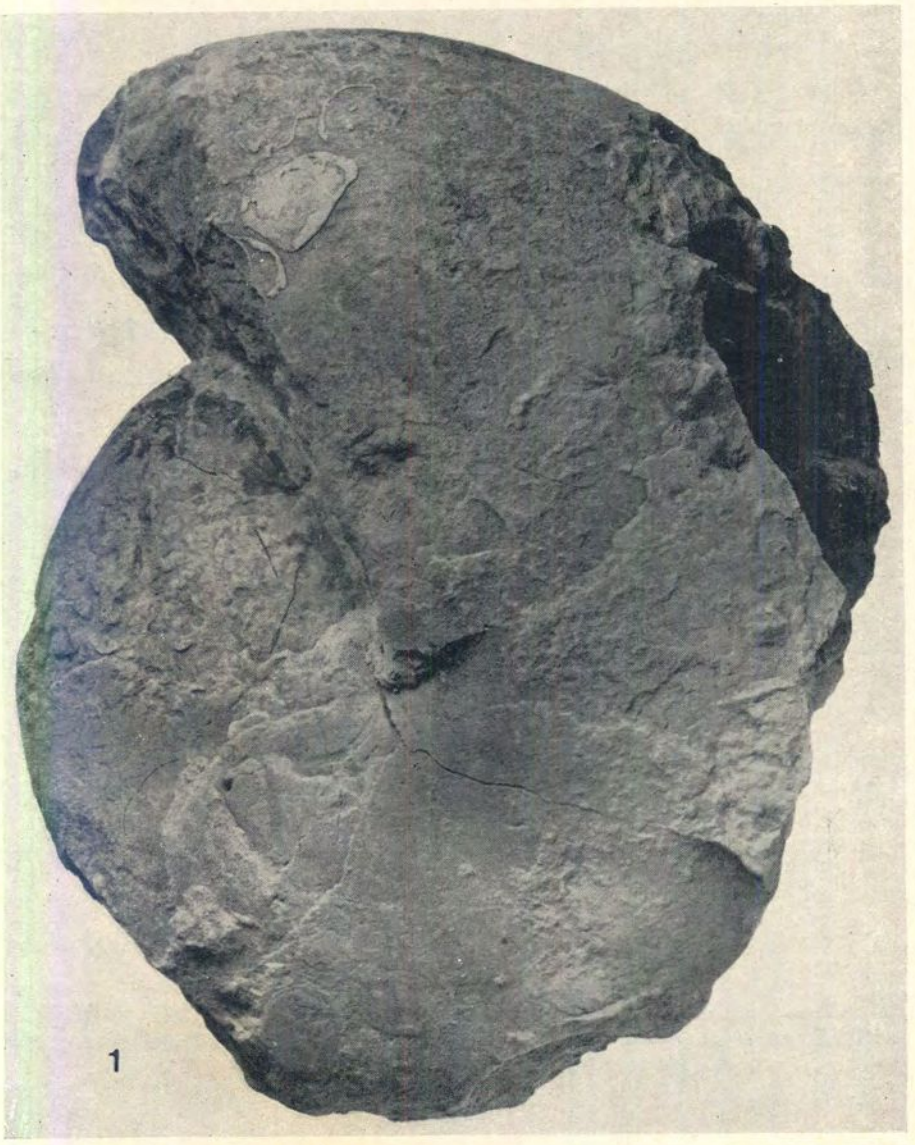


Fig. 1, **Mayaites (Araucanites) reyesi** West. et Ricc., subgen. et sp. nov., complete specimen, lateral view, ×1 (MLP 12242). Plicatilis (? U. Cordatum) Zone, Aguada de la Mula, Sierra de Reyes

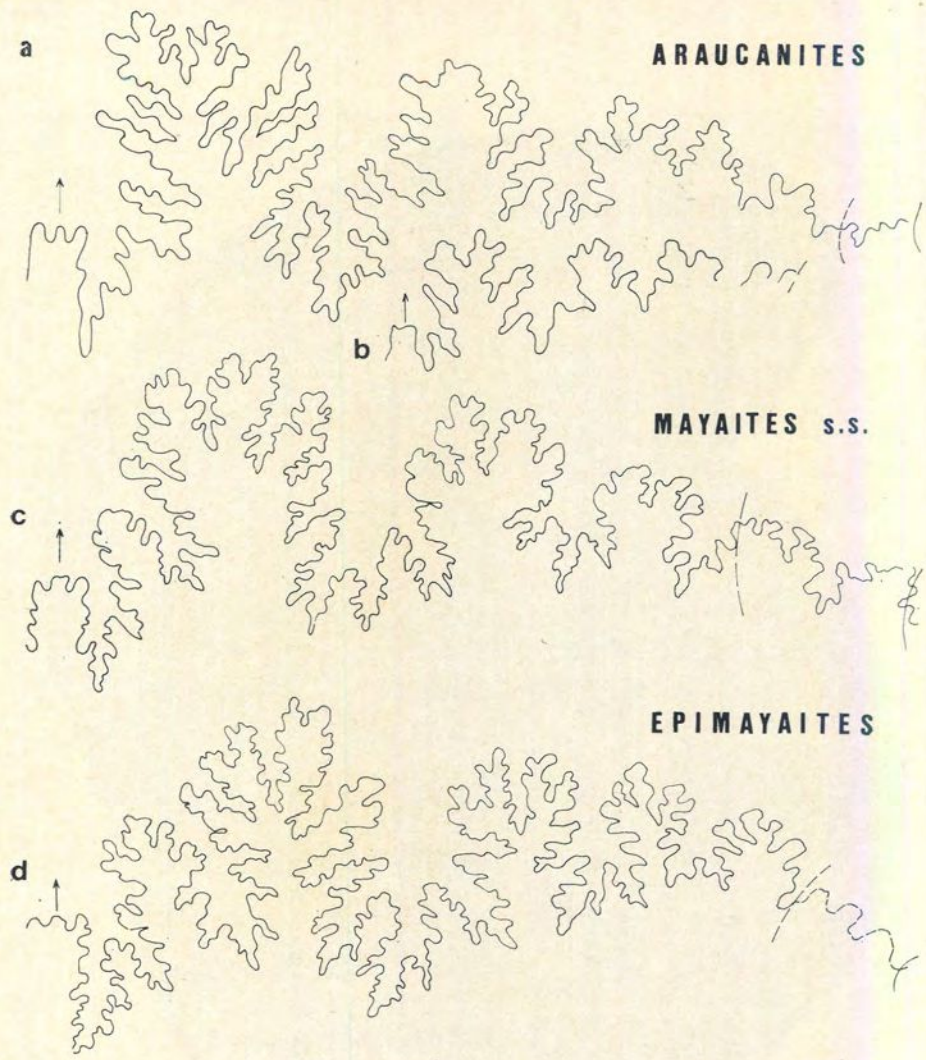
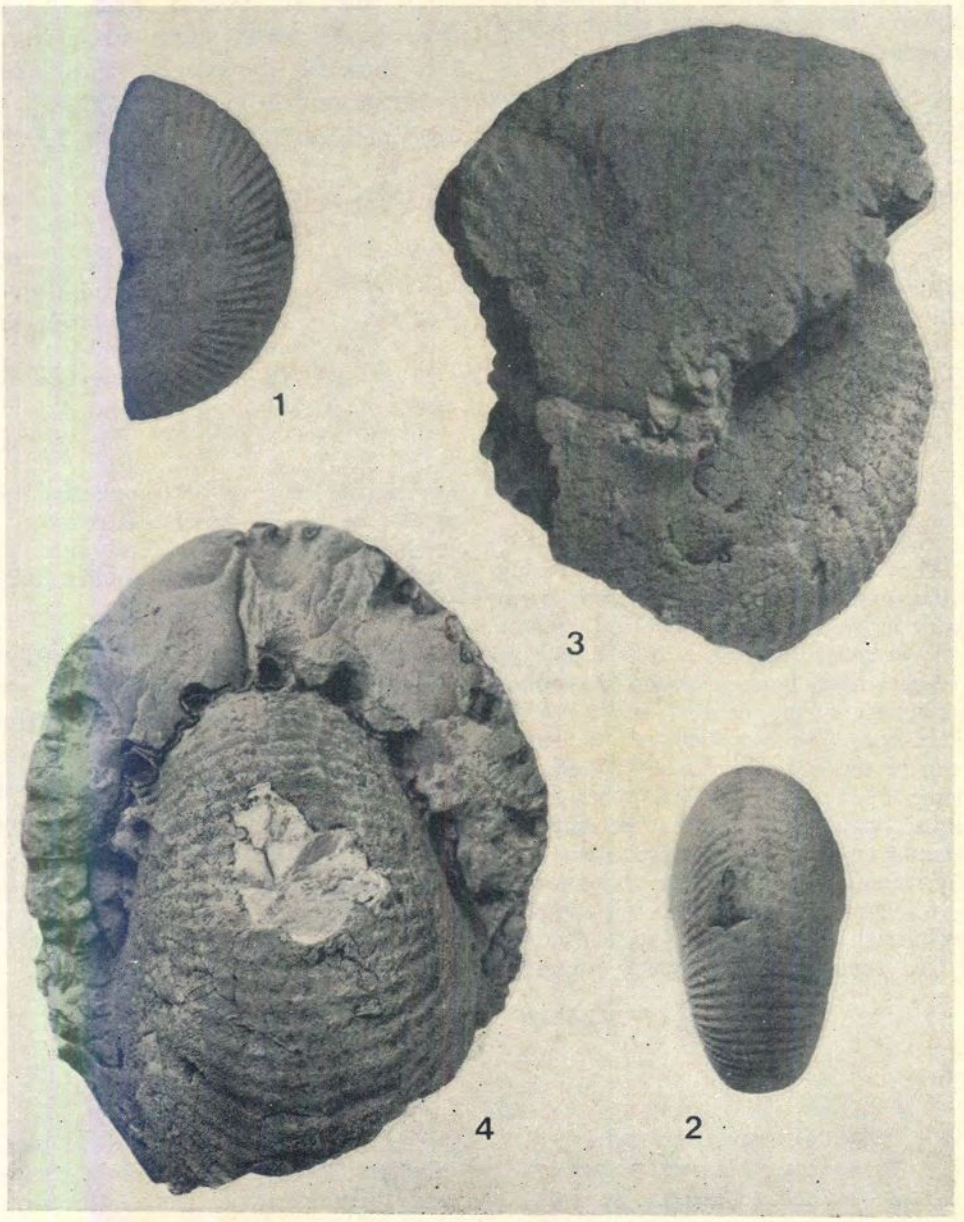


Fig. 5. — External septal sutures of: a, **Mayaites (Araucanites) reyesi** sp. nov., holotype (MLP 12241); b, **M. (A.) mulai** sp. nov., holotype (MLP 12247); c, **M. (Mayaites) rotundus** Spath (1927-33, pl. 44, fig. 7); d, **M. (Epimayaites) evolutus** Spath (1927-33, pl. 37, fig. 5).

E slightly deeper than L, a subsymmetrical E/L saddle, a small raised U_2 ("second lateral"), reduced additional umbilical elements, and an almost straight and radial saddle envelope. On the nucleus (D = 40 mm), the suture is rather simple with relatively somewhat larger U_2, but otherwise similar as in the adult (Text-fig. 5 *a*).

The body chamber, 3/5 to 3/4 whorls long, remains obvolute to extremely involute (internal mould). It becomes so-



Figs. 1-2, **Mayaites (Araucanites) reyesi** West. et Ricc., subgen. et sp. nov., juvenile phragmocone, lateral and ventral views, × 1 (MLP 12243). Plicatilis (? Cordatum) Zone, Aguada de la Mula, Sierra de Reyes; 3-4, **Mayaites (Araucanites)** sp. nov. ? I, damaged adult phragmocone, lateral and ventral views, × 1 (MLP 12246). Same age and locality.

mewhat depressed ovate to subtriagonal in section and ends in a simple obliquely inclined peristome, with slight lateral constriction on the internal mould.

COMPARISON: This species differs from *M. (A.) stipanicici* sp. nov. in the more inflated rounded whorls and the finer ribbing which becomes obsolete before the end of the adult phragmocone. *M. (A.) mulai* sp. nov. is much smaller. The external septal suture closely resembles those of *Mayaites* s.s. at different stages of growth (cf. Spath, 1927-33, pl. 28, fig. 5; pl. 34, fig. 7; pl. 44, fig. 7).

MEASUREMENTS: (in mm):

	Diameter	Whorl height	Width	Umbilical diameter
Holotype phragm.....	111	59	c.60	(5 int. mould)
MLP 12243 phragm.....	46.5	26.3	25.4	(c. 2 int. mould)
	36	19.5	20	
MLP 12244 aperture.....	c.145	80	76+	(c. 3 int. mould)
MLP 12242 aperture.....	150	c.80	c.81	c. 0

Mayaites (Araucanites) sp. nov. ? I

Pl. V, figs. 3-4; Text-fig. 4 *d*

The well preserved damaged adult phragmocone (MLP 12246) from Aguada de la Mula, Sierra de Reyes, Mendoza, is large and subspherical. The broad obvolute whorls have a section resembling a catenary curve, the shell occluding the umbilicus. The periphery of the beginning of the last whorl at 65-75 mm diameter (?recrystallized shell) has blunt rather dense and somewhat prorsiradiate complete ribs, while the flanks are entirely smooth; the end of the phragmocone at 85-95 mm diameter has still traces of peripheral ribbing on the internal mould.

The septal suture is poorly preserved but can be seen to be complicated and similar as in the other *Araucanites*; E is deep, while the umbilical lobes are small and raised, and the saddles follow a straight radial envelope.

COMPARISON: This phragmocone resembles *M. (A.) stipanicici* sp. nov. except for the much stronger inflation and the somewhat denser ribbing; *M. (A.) reyesi* sp. nov. has also more compressed whorls and a somewhat finer ribbing. It is possible, that this is a mere variant of one of these species, particularly of *M. reyesi.*

MEASUREMENTS (in mm):

	Diameter	Worl height	Width	Umbilical diameter
phrag.....	101	54	69	0

Mayaites (Araucanites) mulai

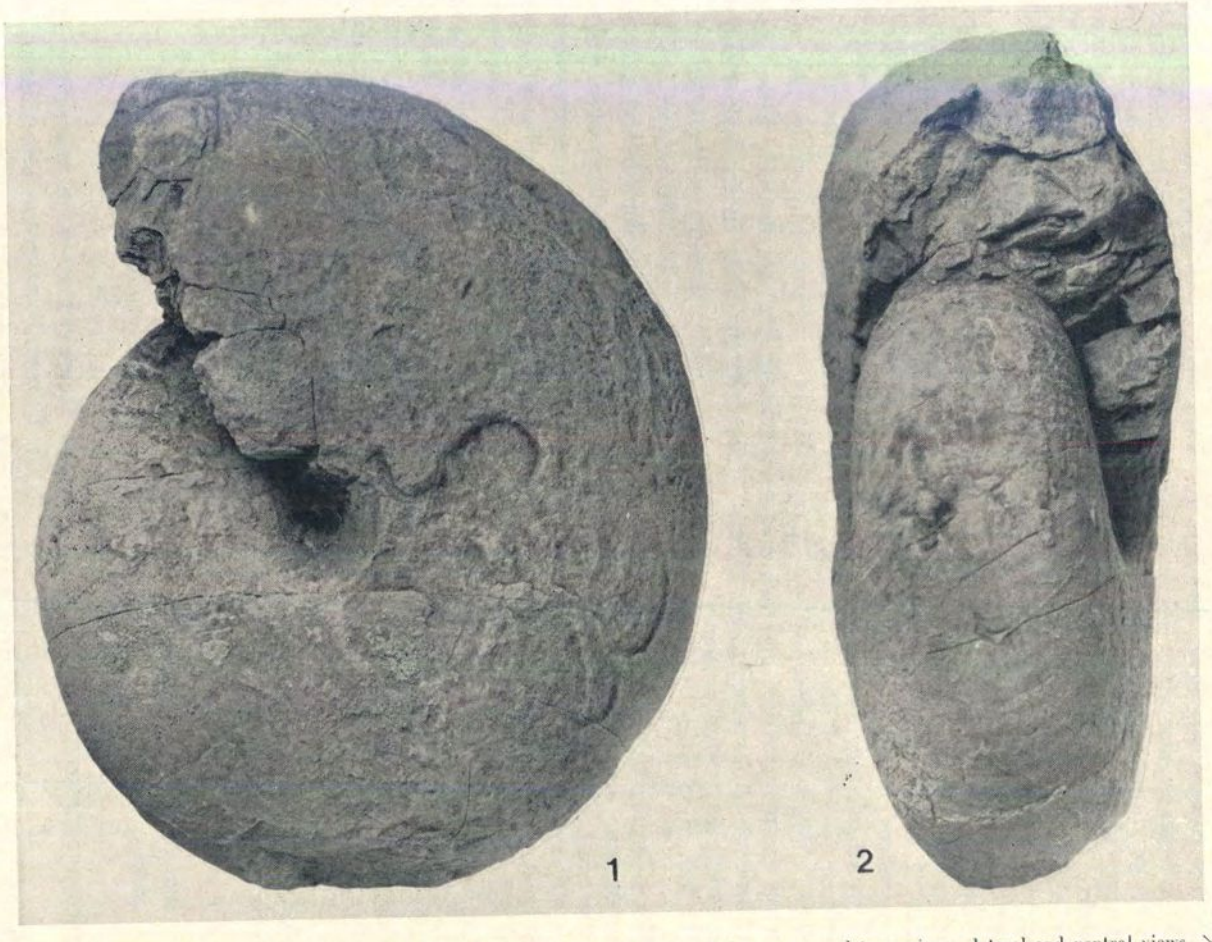
Westermann et Riccardi, sp. nov.

Pl. VI, figs. 1-2; Text-figs. 4 *c*, 5 *b*

HOLOTYPE: The complete internal mould (MLP 12247), collected in the La Manga Formation, Aguada de la Mula, Sierra de Reyes, Mendoza.

DIAGNOSIS: Small shell with highly involute (? obvolute), slightly compressed subrectangular whorls, becoming ovate with long body chamber; ornament extremely fine and dense, restricted to periphery of phragmocone.

MATERIAL: The holotype.



Figs. 1-2, **Mayaites (Araucanites) mulai** West. et Ricc., subgen et sp. nov., holotype, complete specimen, lateral and ventral views, ×1 (MLP 12247). Plicatilis (? U. Cordatum) Zone, Aguada de la Mula, Sierra de Reyes.

AGE: Plicatilis (? Upper Cordatum) Zone.

DESCRIPTION: The entire adult shell, with 4/5 whorls long body chamber; is only 110 mm in diameter. The exposed end of the phragmocone, at about 60 mm diameter, has a somewhat compressed, rounded subrectangular whorl section, with slightly convex flanks and broadly rounded ventre. The umbilicus of the internal mould is very small (c. 7 % of D) but with relatively well rounded shoulder in comparison to the other species of the subgenus; test remains in the umbilicus, however, attest to a thick shell which left only a minute cylindrical umbilicus (4-5 % of D), if it was not occluded. Shell remnants on the periphery of the phragmocone end bear dense and blunt somewhat prorsiradiate ribbing. The somewhat corroded internal mould of the last whorl is essentially smooth.

The last several septal sutures are approximated indicating that the specimen is adult. The last suture has a deep E, a sub-symmetrical E/L saddle; L is slightly shorter than E, U_2 ("second lateral") is somewhat more than half the size of L and raised; the remaining umbilical elements are not well preserved but can be seen to be aligned along the straight radial saddle envelope. There is good resemblance to the suture of *M. (A.) reyesi* sp. nov.

The body chamber is slightly more than three-quarters whorl long, becoming ovate by increasing convergence of the flanks. The umbilicus of the internal mould remains highly involute (?obvolute in the shell), possibly except for the very end. The peristome seems to be indicated on the left side of the internal mould as a sinuous line with shallow ventral sinus. Faint undulations are visible in oblique light on the periphery of the beginning of the body chamber only; the remainder is entirely smooth.

COMPARISON: The other species of *M. (Araucanites)* are consistently appreciable larger, have a clearly occluded umbilicus and a shorter body chamber (? with different peristome). The possibility that this is a microconch, while the other specimens are macroconchs, exists; however, the similarity in the body chamber which is also involute and smooth seems to argue against it. Because of the probable absence of complete occlusion and the longer body chamber with perhaps different peristome, this form is somewhat tentatively placed in the subgenus *Araucanites*. Because of the possible presence of an umbilicus, there is quite close resemblance to the smooth-sided involute mayaitids from the Indo-Pacific faunal province or realm discussed above under the subgeneric heading.

MEASUREMENTS OF THE HOLOTYPE (in mm):

	Diameter	Whorl height	Width	Umbilical diameter
phragm.....	c. 63	35	31	(c. 3-4 int. mould)
apert.....	110	59	c. 50	(6.5 int. mould)

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DEPOSITORY: The material is deposited in the collections of the División de Paleozoología Invertebrados, Museo de Ciencias Naturales, La Plata, Argentina, the numbers prefixed MLP.

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