

CEPHALOPODA FROM THE CARBONIFEROUS OF ARGENTINA

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ABSTRACT. Orthoconic nautiloid Cephalopoda from the Carboniferous of west central Patagonia are described, including a new genus *Sueroceras*. Species described from the Carboniferous of Alaska, U.S.A., Ireland, U.S.S.R., Uruguay, and the Permian of Australia are included in the genus. Other specimens are doubtfully referred to *Reticyloceras* Gordon and *Cycloceras* M'Coy. *Pseudorthoceras* Girty is recorded for the first time from western Argentina. The goniatitid *Glaphyrites* Ruzhencev is also recorded. It is also noted that the goniatitid *Tornoceras* Hyatt seems to be restricted to the Middle Devonian of Argentina.

THE marine Carboniferous of western and southern Argentina has yielded representatives of most invertebrate phyla, but there are few records, particularly descriptions, of cephalopods. This paper describes new cephalopod material from both areas, but principally from Patagonia.

Southern Argentina. Suero (1948, 1952, 1953, 1958, 1961) described a succession of Upper Palaeozoic fossiliferous sediments in central-western Patagonia (Province of Chubut), which he included in his 'Sistema de Tepuel', and which were concentrated at seven levels. A Carboniferous age was assigned to the 'Sistema de Tepuel', although the possible presence of Devonian and Permian strata was not excluded. Suero's original material, together with some subsequent collections have been described by Sabattini and Noirat 1967; Mariñelarena 1970 (Cnidaria); Sabattini 1972 (Bryozoa); Amos 1958*b*, 1961*a*, *b* (Brachiopoda); Gonzalez and Sabattini 1972 (Calyptoptomatida); Sabattini and Noirat 1969 (Gastropoda); Gonzalez 1969, 1972 (Bivalvia); Rossi de García 1972 (Ostracoda); Amos, Campbell and Goldring 1960 (Trilobita).

Cephalopods from this region have been described by Miller and Garner (1953), who identified *Anthracoceras argentinense* and *Eoasianites* sp. Closs (1967) described three fragmentary nautiloids as *Dolorthoceras chubutense*.

Further laboratory and field studies have brought to light additional and better preserved cephalopod material. This includes a goniatite fragment, nine fragmentary phragmocones, and some twenty external moulds of nautiloids, most of which exhibit relatively well-preserved external and internal features.

Western Argentina. The Carboniferous sediments from western Argentina are known from a series of outcrops located from south to north in the Provinces of Mendoza, San Juan, and La Rioja. These sediments have been studied since the end of the last century by a number of authors including Amos (1964) and Polanski (1970) who reported various fossiliferous localities and levels. The invertebrate material has been described as follows: Sabattini 1972 (bryozoa); Reed (*in Du Toit* 1927); Keidel and Harrington 1938; Leanza 1945, 1948; Amos 1957, 1958*a*, 1961*b*; Amos, Baldis and Csaky 1963 (Brachiopoda); Reed (*in Du Toit* 1927); Sabattini and Noirat 1969 (Gastropoda); Reed (*in Du Toit* 1927); Keidel and Harrington 1938; Leanza 1948 (Bivalvia).

Antelo (1969, 1970) described *Protocanites scalabrinii*, from the Maliman Formation in the Province of San Juan. Recently, three fragmentary specimens of orthoconic nautiloid material, from the same locality and level, have become available.

STRATIGRAPHY AND LOCALITIES

1. Province of Chubut (central Patagonia)

The material described was collected from various localities in a region of approximately 5600 sq. km located in the north-western part of the province of Chubut, central Patagonia (43–44° S., 70–71° W.) (text-fig. 1B). The Upper Palaeozoic sediments outcrop in two north-south oriented mountain ranges; the known fossiliferous outcrops being located in the south-west (Sierra de Tepuel) and north-east (Sierra de Languiño).

In Arroyo Pescado (Rolleri 1970) the base of the Upper Palaeozoic unconformably overlies metamorphosed sediments of possible Lower to Middle Palaeozoic? age. The 'Sistema de Tepuel' is in turn overlain unconformably by a sequence of Liassic sediments.

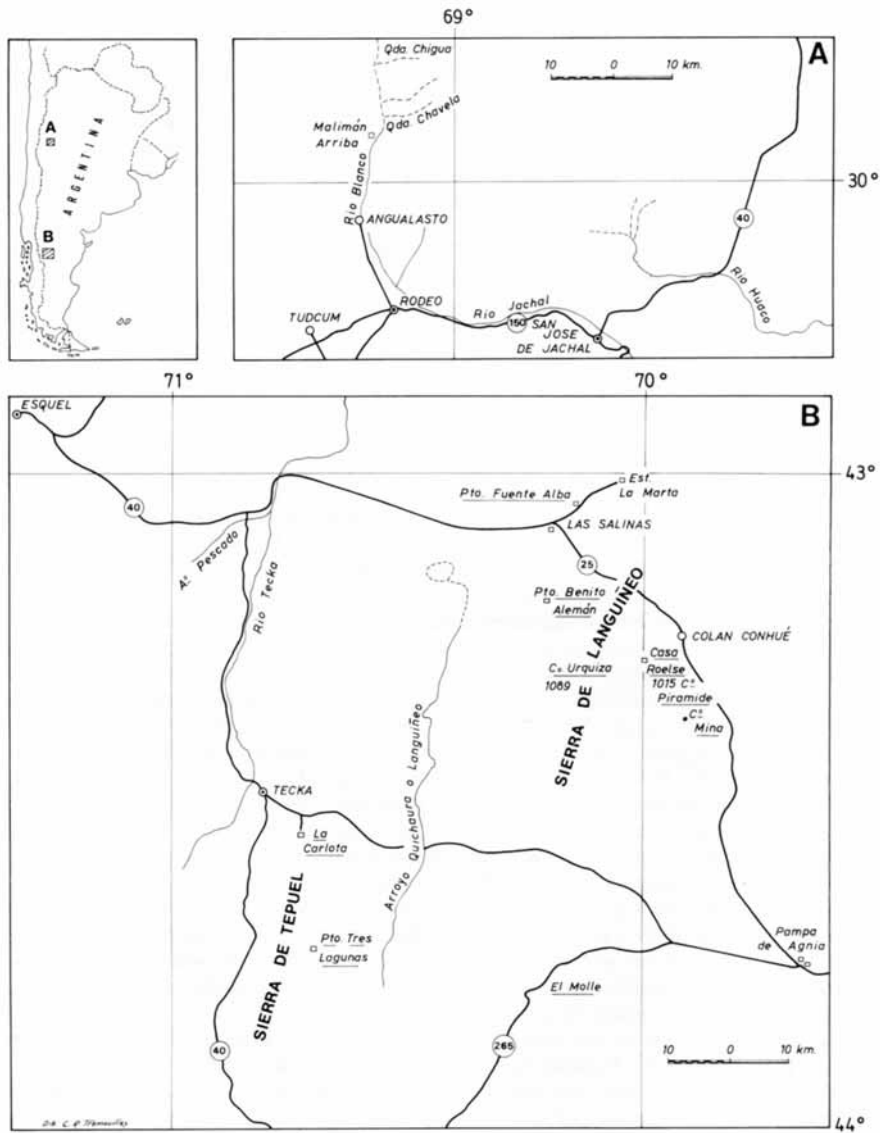
The Upper Palaeozoic sediments included by Suero (1948, p. 11) in the 'Sistema de Tepuel' are almost 5500 m thick. The lower part, 3200 m thick, comprises greywackes, sandstones, and shales intercalated with at least four diamictite and three fossiliferous levels (see also Frakes, Amos and Crowell 1969). The upper part, approximately 2000 m thick, comprises shales and sandstones with four fossiliferous levels. Greywackes and diamictites are absent.

In Suero's (1948) section of Sierra de Tepuel, made about 20 km south of La Carlota (near Puesto Tres Lagunas), there are only two levels with cephalopods. The lowest is almost at the top of the lower part of the 'Sistema de Tepuel' and contains a fauna of trilobites, gastropods, brachiopods, cnidarids, bryozoans, fish bones, and scales. This level, with a similar fauna, is present also in La Carlota (Suero 1948, p. 9) and due to its extensive areal distribution has been used as a marker for the division of the lower and upper parts of the 'Tepuel System' in Sierra de Tepuel and Sierra de Languiño (Suero 1948, p. 15; 1958, p. 25; Gonzalez 1972, p. 105).

According to Suero (1948, 1953, 1958; see also Amos *et al.* 1960, p. 229; Closs 1967, p. 124), specimens described under '*Anthracoceras? argentinense*' Miller and Garner, 1953 (now *Wiedeyoceras argentinense*, see Miller and Furnish 1958, p. 684; Gordon 1964, p. 245; Furnish and Spinosa 1968, p. 255), *Dolorthoceras chubutense* Closs (1967), and *Australosutura gardneri* Mitchell (*in* Amos *et al.* 1960) come from this level.

The second level with cephalopods recorded by Suero (1948, p. 9, under '21') is near the base of the upper part of the 'Sistema de Tepuel', about 600–700 m above the lower level, and has yielded only nautiloids. However, a goniatitid (*Eoasianites* sp., *in* Miller and Garner 1953) has been reported also from Sierra de Languiño (Puesto Urquiza), close to the base of the upper part of the 'Sistema de Tepuel' but only 200–250 m above the first level with cephalopods (Suero 1958, p. 25).

From Suero's geological map (1948, fig. 5) the presence of both fossiliferous levels can be inferred; the lower one, below and to the west of the diabase sill (Cresta de los Bosques) and the upper one above and to the east in the neighbourhood of Puesto



TEXT-FIG. 1. Index map for the regions with fossiliferous localities in Provinces of San Juan (A) and Chubut (B).

Tres Lagunas. The presence of *Suerocheras irregularis* gen. et sp. nov. at both localities suggests a large vertical distribution within this sequence for this species.

Although only the locality data are known for Suero's specimens described herein, from the stratigraphic information recorded above it is possible to infer that the material from La Carlota and that below the diabase sill to the west of Puesto Tres Lagunas came from the level located near the top of the lower part of the 'Sistema de Tepuel', whereas that from the neighbourhood of Puesto Tres Lagunas belongs to the level close to the base of the upper part.

No information is available about the stratigraphic position of the orthoconic nautiloids found by Suero in other localities, and although from the extensive areal distribution of the lower level with cephalopods it could be assumed that they belong to that part of the section, it is better to give them a general assignation to the middle part of the 'Sistema de Tepuel'.

2. Province of San Juan (western Argentina)

The fragmentary specimens here described as *Pseudorthoceras* sp. were collected from a locality 75 km north-west of Jachal in the north-western part of the Province of San Juan (30° S., 69° W.). The fossiliferous outcrop is in the Quebrada Chigua, about 30 km north of Angualasto (text-fig. 1A; Antelo 1969, p. 71, fig. 1).

In this area the Carboniferous sequence, described by Furque (1963, p. 52) has been revised recently by Scalabrini Ortiz (1970, 1973). The latter has divided the Carboniferous sediments into two formations: the Lower Carboniferous Maliman Formation, which consists of marine sandstones, and siltstones, and the Upper Carboniferous Cortaderas Formation which consists of continental conglomerates, sandstones, and siltstones, with a thickness of 1188 m and 1160 m respectively in the type sections. The two formations are separated by an unconformity.

The Carboniferous sequence, in this area, overlies with angular unconformity the marine Middle Devonian Chavela Formation (Scalabrini Ortiz 1973). An Upper Devonian age suggested for this unit (Leanza 1968; Antelo 1969; Scalabrini Ortiz 1970, 1973; Furque 1972) is based on *Tornoceras baldisi* Leanza, 1968, described from Quebrada Chavela, about 10 km south of Quebrada Chigua (text-fig. 1A).

The evidence given by Leanza to support an Upper Devonian age was that *Tornoceras* in its world-wide distribution is, with the exception of the subgenus *Protornoceras* restricted to the Upper Devonian. However, from the literature it is evident that *Tornoceras* is Middle-Upper Devonian (Miller 1938; Miller, Furnish and Schindewolf 1957; House 1965), a range exhibited by the type species *T. uniaangularis* (Conrad), which is fairly common in the Hamilton Group of New York and its equivalents, and which has been used for naming a biostratigraphical zone in the Middle Devonian (Oliver, de Witt, Dennison, Hoskins and Huddle 1968).

It is interesting to point out that Leanza compared his material with *T. discoideum* (Hall), type species of *Parodicerias* Hyatt, which is considered as a synonym or a subgenus of *Tornoceras*, and that *Parodicerias* is present in the lower part of the Hamilton Group (Marcellus Formation) (House 1965). *Parodicerias* Wedekind, to which Leanza compared some of his material, is synonymous with the Middle Devonian genus *Parodicerellum* Strand, and not with *Tornoceras* as indicated by Leanza (see Miller *et al.* 1957).

T. baldisi is associated with Middle Devonian trilobites (Baldis 1968; Padula, Roller, Mingramm, Criado Roque, Flores and Baldis 1968; Cuerda and Baldis 1971). The top of the Upper Carboniferous Cortaderas Formation is unknown in this area.

The orthoconic nautiloid material described below came from a fossiliferous level, with cnidarians, brachiopods, gastropods, bivalves, and crinoids, located in the middle part of the Maliman Formation, about 196 m (440 m if ten andesitic sills are included) above the contact with the marine Chavela Formation (Antelo 1969, p. 69; Scalabrini Ortiz 1970). From the same level came two specimens of goniatitids described as *Protocanites scalabrinii* Antelo (1969, 1970).

CARBONIFEROUS CEPHALOPODS IN THE SOUTHERN HEMISPHERE

As pointed out by Closs (1967, p. 123; 1969, p. 200) orthoconic nautiloids and goniatitids seem to be rare in the Upper Palaeozoic of South America (see also Closs and Kullman *in press*). Apart from some goniatitids from Peru (Berry 1928; Thomas 1928; Newell, Chronic and Roberts 1953), the only other Carboniferous goniatitids and orthoconic nautiloids seem to be those described from Argentina and Uruguay by Closs (1967, 1969) and Antelo (1969, 1970).

Indeed, in the southern hemisphere as a whole this class seems to be of uncommon occurrence in Carboniferous sediments (Hodson and Ramsbottom 1973). A goniatitid has been described from South West Africa (Martin, Walliser and Wilczewski 1970) and some orthoconic nautiloids and goniatitids from Australia (Delépine 1941; Cvacara 1958; Campbell 1962; Campbell and Engel 1963; Brown, Campbell and Roberts 1964; Roberts 1965; Campbell and McKellar 1969).

Brown *et al.* (1964, p. 682) have indicated that in Australia nautiloids seem to be more abundant and widespread than goniatitids, although the latter have been more often described and illustrated. This general statement can be applied to the whole southern hemisphere. Carboniferous orthoconic nautiloids in the southern hemisphere are known only from some specimens described and illustrated in a few papers (de Koninck 1876-1877, and Brown *et al.* 1964, for Australia; and Closs 1967, for Uruguay and Argentina).

It is interesting that there is almost no affinity at the generic level between the Carboniferous cephalopod fauna of Australia and the African and South American faunas.

In the Lower Carboniferous the cephalopod fauna of Argentina is represented only by *Protocanites* Schmidt and *Pseudorthoceras* Girty, whilst in Australia there are at least nine other genera besides *Protocanites*. No Upper Carboniferous cephalopods are known from Australia.

Bearing in mind the differences in the number of taxa involved in these intercontinental comparisons, it could be said that the cephalopod affinities conflict with the conclusions of Campbell and McKellar (1969) who postulated a closer affinity between Australia and Argentina in the Westphalian, and also with the results of Amos and Sabattini (1969) who postulate an affinity in the Westphalian in some cases at the specific level.

One would expect the cephalopods, being nektobenthonic, to be the one group with representatives in the two areas. However, this discrepancy may be due to

a difference in age of the strata in the two regions, or to differences in facies or in ecological conditions between the two areas.

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.

SYSTEMATIC DESCRIPTIONS

Subclass NAUTILOIDEA Agassiz, 1847

Order ORTHOCERIDA Kuhn, 1940

Superfamily PSEUDORTHOCERATAEAE Flower and Caster, 1935

Family PSEUDORTHOCERATIDAE Flower and Caster, 1935

Genus SUEROCERAS gen. nov.

Type species. *Sueroceras irregulare* sp. nov.

Derivatio nominis. For the late Dr. T. Suero, who studied the Upper Palaeozoic outcrops from NW. Chubut and collected most of the known fossil material from this region.

Range. Carboniferous-?Permian.

Diagnosis. Orthoconic nautiloids with gently and irregularly expanding conch; circular or subcircular in cross-section; surface ornamented by transverse and longitudinal lirae which form a reticulate pattern. Siphuncle central, with suborthochoanitic to subcyrtochoanitic septal necks; connecting rings subcylindrical to fusiform, contracted at the septal necks; siphuncular deposits continuous on both sides, or on the ventral side, or vestigial (?); cameral deposits of the mural and epihyposal type.

Other species included in the genus: *Sueroceras* sp., and doubtfully: *Orthoceras striata* J. Sowerby, 1814; '*Orthoceras striatum* J. Sowerby' de Koninck, 1876-1877; *Kionoceras?* sp. C, Gordon 1957; ?*Dolorthoceras reticulatum* Shimansky, 1968; *Dolorthoceras chubutense* Closs, 1967; *Dolorthoceras oklahomense* Smith, 1938.

Remarks. The distinctive reticulate pattern of the ornament, the morphology of the siphuncle and its related structures are sufficient to differentiate this material from all other Orthocerida genera.

The most similar material previously described is that from Alaska included under '*Kionoceras?* sp. C' by Gordon (1957, p. 23). However, *Kionoceras* Hyatt, 1884, a genus whose acme was in the Silurian (Troedsson 1932), has species with relatively more prominent longitudinal ribs (Sweet 1964, p. K229, fig. 159, 1a-c; Demanet 1941, p. 119, pl. 4, fig. 6; Shimansky 1968, p. 56, pl. 1, fig. 5; Foerste 1924, p. 29, pl. 14, fig. 1; Troedsson 1932; Grabau and Shimer 1910, p. 61). *Protokionoceras* Grabau and Shimer (1910), a Middle Ordovician-Middle Devonian genus, also has stronger longitudinal ribs, and in the concave interspaces there are finer ribs (Troedsson 1932, p. 14, pl. 7, fig. 7, text-fig. 3; Strand 1934, p. 23, pl. 3, fig. 4; Foerste 1924, p. 30). Furthermore, it has an orthochoanitic to suborthochoanitic siphuncle. *Palmeroceras* Flower has a siphuncular structure with features in common with *Adnatoceras* Flower and *Dolorthoceras* Miller (Flower 1939, p. 119), and 'the very fine, minutely undulating irregular, lamellose lines of growth', exhibited by the type species *P. fustis* (Hall 1879, p. 281, pl. 83, fig. 11 and pl. 113, figs. 16, 17), differ from the transverse lirae of *Sueroceras*.

The specimens described below are similar, in the structure of the siphuncle, to *Dolorthoceras* Miller, but differ mainly in the presence of a reticulate ornament. *Dolorthoceras* Miller, the type species of which, *D. circulare* Miller, is represented by a badly preserved specimen (Miller 1931, p. 419), has been characterized as possessing a smooth surface with only growth lines, and rare fine longitudinal lirae (Flower 1939, p. 93; Gordon 1964, p. 119). Some species, however, with a reticulate ornamentation have been included in it, i.e. *D. oklahomense* Smith (1938, p. 6, pl. 1, figs. 15, 16) and ?*D. reticulatum* Shimansky (1968, p. 77, pl. 5, fig. 2).

Closs (1967, p. 125), when studying the Chubut and Uruguayan material, pointed out that even if the internal features are coincident with those given in the original diagnosis of *Dolorthoceras* the ornament is different, and closer to that of *Mitorthoceras* Gordon, which is characterized by 'raised transverse lirae'. Closs, however, considered 'the morphology of the siphuncle and related structures basic for generic classification whereas the ornament only for specific level', and therefore emended the diagnosis of *Dolorthoceras*, including *Mitorthoceras*, implicitly, as a junior subjective synonym.

This criterion is debatable. Many nautiloid genera differ only in ornament (see Flower 1939), and this has been used in general as a diagnostic feature within the cephalopoda.

The incompleteness of our knowledge of the orthoconic nautiloids (Sweet 1964, p. K220) is plainly evident when studying the siphuncular and cameral deposits of fragmentary specimens such as those herein described, due to the fact that the observed features will vary according to the part of the shell and the growth stage of the specimen to which they belong (Flower 1955, pp. 92, 93, 96-98; Fischer and Teichert 1969, p. 7).

For these reasons, and because the ornament in the specimens described by Closs (op. cit.) is similar to that present in the material herein described it is not considered taxonomically significant, at the present state of our knowledge, that the specimens included in *Suerocheras* cf. *S.?* *chubutense* (Closs) have siphuncular deposits lying along both sides while in *S. irregulare* sp. nov. they occur only on one side. More and better material, representing different growth stages, is necessary for a definitive statement about the generic status of Closs's species.

A similar reticulate ornament is present also in *Dolorthoceras oklahomense* Smith (1938, pl. 1, figs. 15-16), a feature which led him to consider the possibility that 'this form represents a new genus'. Although other known internal features seem to be similar to those in *Suerocheras*, because Smith did not give a detailed description the inclusion of this species within *Suerocheras* gen. nov. remains questionable.

A similar case is found with *?Dolorthoceras reticulatum* Shimansky (1968, p. 77, pl. 5, fig. 2), which has a fairly regular ornament, but whose internal features are unknown.

Besides the Alaskan material described by Gordon (1957), the most similar to the present one is that described from Australia by de Koninck (1876-1877, p. 271, pl. 24, fig. 2) under '*Orthoceras striatum* J. Sowerby', although here also the internal features are virtually unknown. Furthermore, the Australian original material has been destroyed by fire (Dun 1898) and no new material has been recorded. The status of this species is unclear, especially when we consider that the type specimen from Ireland figured by J. Sowerby (1814) and the species diagnosis has been differently understood, in relation to the ornament, by M'Coy (1844, p. 8), Foord (1888, p. 190), and Etheridge (in Jack and Etheridge 1892, p. 293). However, it seems that Sowerby's specimen has the same reticulate ornament as the Australian and Patagonian specimens, while this feature is not present in the material described by the other named authors.

According to our definition of *Suerocheras* it should be restricted to the Carboniferous, with a possible extension into the Permian.

The material from Alaska described by Gordon (1957) under '*Kionoceras?* sp. C', which has the closest affinity with the specimen from Patagonia occurs together with *Goniatites crenistria* Phillips, a species which characterizes the lower part of the Upper Viséan.

'*Dolorthoceras reticulatum* Shimansky (1968) occurs in the Lower Carboniferous of the Dombar in the southern Urals.

'*Dolorthoceras oklahomense* Smith was reported from the Buckhorn Asphalt, Boggy Formation of the Pennsylvanian (Desmoinesian) (Smith 1938, p. 3; Fischer and Teichert 1969, p. 7).

The Australian '*Orthoceras striatum* J. Sowerby' (de Koninck 1876-1877) was reported from Wollongang, an area where only Permian sediments occur (David 1950), and the specimen could have come from the 'Shoalhaven Group or even higher, i.e. well up in the Australian Permian marine sequence' (written communication, Campbell 1973).

Sowerby's species was based on one Irish specimen 'found in the Black Rock near Cork' (Sowerby 1814, p. 129), and according to Dr. W. E. Nevill (written communication 1973) 'the locality is at or near the base of . . . (the) . . . Waulsortian Reef', whose range 'elsewhere in W. Europe is given as C₁ and C₂', i.e. on the Viséan-Tournaisian boundary.

Most of the Patagonian material is, apparently, from the top of the lower part of the 'Sistema de Tepuel', where also *Wiedeyoceras argentinense* (Miller and Garner), *Australosutura gardneri* Mitchell, and other invertebrates, have been recorded. The age of this part of the section has been considered, on different grounds, as Westphalian (Amos 1964, p. 62).

An Upper Carboniferous age for *Sueroceras* gen. nov. is supported by the possible association in Uruguay of *S.*? cf. *S.*? *chubutense* (Closs) with a species of *Eoasianites* (*Glaphyrites*) considered to be related to Upper Carboniferous species from North America (Closs 1967, p. 124; 1969, p. 204).

Sueroceras irregulare gen. et sp. nov.

Plate 22, figs. 1-12

Holotype. Incomplete phragmocone (Pl. 22, figs. 1-5) (MLP 11865).

Locus typicus. Puesto Benito Aleman, Sierra de Languiño, Province of Chubut.

Stratum typicum. ?Level 17, top of the lower part of the 'Sistema de Tepuel' (Suro 1948).

Derivatio nominis. Latin—from the irregular transverse lirae.

Diagnosis. Orthoconic nautiloids with gently expanding conch, circular in cross-section; surface ornamented by transverse and longitudinal lirae forming a reticulate pattern; transverse lirae irregularly elevated. Siphuncle central with suborthochoanitic to subcyrtchoanitic septal necks. Connecting rings subcylindrical, flat to slightly convex in the middle and abruptly contracted at the septal necks; siphuncular deposits continuous on the ventral side or (?) vestigial; cameral deposits ventral and dorsal, of the mural and epi-hyoseptal types, thickest on the ventral side.

Material. Sierra de Languiño, Province of Chubut: *a*, Point N255 from Cerro Pirámide, somewhat north of Cresta Baja, two incomplete phragmocones (MLP 11862-11863), internal mould (MLP 11866); *b*, concretions to the west of Puesto Benito Aleman, incomplete phragmocone and holotype (MLP 11864-11865); *c*, Cerro Mina, fragmentary external mould (MLP 11867); *d*, in neighbourhood of Puesto Fuente Alba, on right side of road to Estancia La Marta, three fragmentary external moulds (MLP 11868a, b, c), (?) crushed internal mould (MLP 11869); *e*, N260 from Casa Roelse, fragment of external mould (MLP 11870), fragment of body chamber (MLP 11871); *f*, El Molle, nivel Cañulef, three fragments of external moulds (MLP 11888).

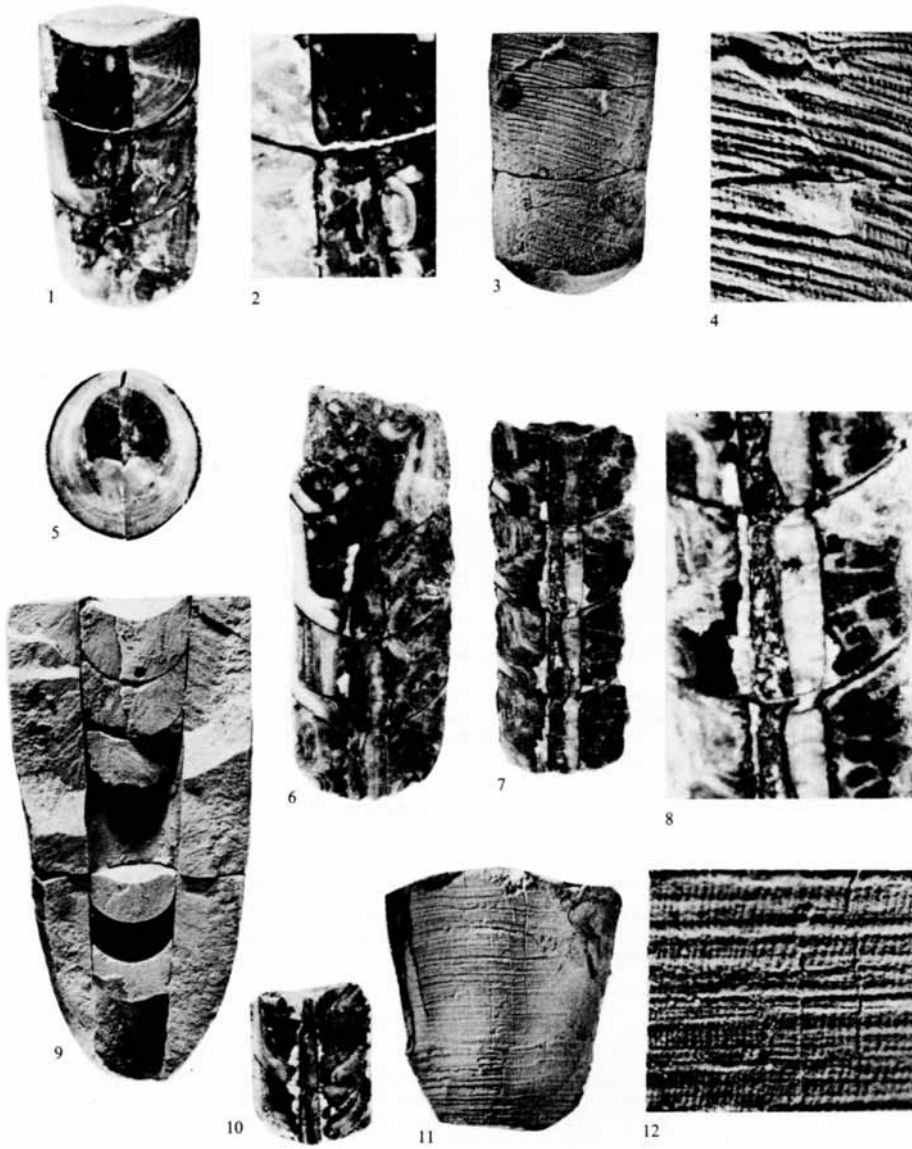
Sierra de Tepuel, Province of Chubut: *a*, La Carlota, 9 km to south-east of Tecka, partially preserved internal mould of phragmocone (MLP 11872); *b*, west of Puesto Tres Lagunas, below diabase sill, three fragmentary external moulds (MLP 11873-11875); *c*, north of Puesto Tres Lagunas, five external moulds of phragmocones (MLP 11876); *d*, N35 from Cerro Playo, about 600 m east of Puesto Tres Lagunas, internal mould of fragmentary phragmocone (MLP 11877).

Description. The holotype (MLP 11865, Pl. 22, figs. 1-5) is part of a phragmocone with circular cross-section, 22 mm long, 12.6 mm in diameter at its oral end, 11.5 mm at the apical end, and with an expansion rate of 1 mm in 19 mm. Septa are straight and shallowly saucer shaped (Pl. 22, fig. 1). There are three chambers preserved, averaging 1.6 in a length equal to the diameter. The surface of the conch is ornamented

EXPLANATION OF PLATE 22

All figures $\times 2$, unless otherwise stated.

Figs. 1-12. *Sueroceras irregulare* sp. nov., Province of Chubut. 1-5, MLP 11865, holotype, Puesto Benito Aleman, Sa. de Languiño; 1, ventrodorsal longitudinal section; 2, enlarged view of fig. 1, $\times 5$; 3, lateral view; 4, enlarged view of fig. 3, $\times 6$; 5, transverse section. 6, MLP 11862, paratype, N255 from Co. Pirámide, Sa. de Languiño, ventrodorsal longitudinal section. 7-8, MLP 11863, paratype, N255 from Co. Pirámide, Sa. de Languiño; 7, ventrodorsal longitudinal section; 8, enlarged view of fig. 7, $\times 6$. 9, MLP 11872, paratype, La Carlota, Sa. de Tepuel, internal mould showing septa spacing. 10, MLP 11864, paratype, west of Puesto Benito Aleman, Sa. de Languiño, fragment of a ventrodorsal longitudinal section. 11-12, MLP 11867, paratype, Co. Mina, Sa. de Languiño; 11, side view of a latex cast; 12, enlarged view of fig. 11, $\times 6$.



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with transverse and longitudinal lirae. The transverse sharp rounded lirae are irregularly elevated and are slightly (12°) inclined curving adapically on the ventral side. There are about five lirae per 1 mm. The longitudinal lirae are more regular, relatively less elevated and, therefore, less visible and being interrupted by the transverse lirae, they are more dense, seven per mm.

The siphuncle is central, 20.6% of the shell diameter. The connecting rings are subcylindrical, with the greatest diameter in the middle, and slowly decreasing towards both ends where they are abruptly constricted at the septal necks. The latter are suborthochoanitic to subcyrtchoanitic and have a length of 0.8 mm. The area of adnation is very small (0.5 mm) and equal to the brim.

Endosiphuncular deposits are almost non-existent or vestigial and irregularly distributed. Cameral deposits are of the plano mural, plano episeptal, and plano hyposeptal types. On the ventral side these three types fill the chambers almost completely (Pl. 22, figs. 1, 5), but on the dorsal side the deposits are relatively less thick.

Two specimens (MLP 11862-11863, Pl. 22, figs. 6 and 7-8), with the same type of ornament, 34.2 mm and 27.7 mm long respectively, exhibit four camerae also averaging 1.6 in a length equal to the shell diameter. In both specimens, however, the diameter of the connecting ring is larger than in the holotype, being 24% and 23% respectively of the conch diameter (Pl. 22, figs. 6-8). Furthermore, here the siphuncular deposits are continuous and restricted to one side of the siphuncle where they occupy about half the width of the siphuncle on the ventral side.

Another paratype (MLP 11864, Pl. 22, fig. 10) consists of a fragment of a phragmocone 20.5 mm long. It has a siphuncular diameter amounting to 18% of that of the conch, and continuous siphuncular deposits on the ventral side only. In this specimen, however, the camerae average two in a length equal to the conch diameter.

Only other two paratypes (MLP 11872 and MLP 11871) are preserved as internal moulds. The first (Pl. 22, fig. 9) is a phragmocone 62 mm long with a growth rate of 1 mm in 15 mm. The camerae average 1.8 in a length equal to the diameter and the siphuncle width amounts to 12% of the conch diameter. Due to poor preservation neither camerae nor siphuncular deposits are visible. The longitudinal lirae amount to eight per mm. The other paratype consists of a body chamber 77 mm long with an adoral width of 32 mm and an adapical of 26 mm, and a growth rate of 1 mm in 12.8 mm. The ornament is weaker than in the smaller specimens and the longitudinal lirae are only feebly developed.

Remarks. Some external moulds exhibiting the same type of ornament are also referred to this species, although the transverse lirae are less elevated and the longitudinal lirae less visible. It is possible that these moulds belong in *S. cf. S. ? chubutense* (Closs). However, due to the uncertain status of the latter, they are included tentatively in *S. irregulare* nov. sp.

Sueroceras cf. *S. ? chubutense* (Closs)

Plate 23, figs. 1-3, 7

v 1967 *Dolorthoceras chubutense* Closs, p. 125, pl. 1, figs. 1-5; ?non pl. 1, fig. 6 and pl. 2, figs. 1-3.

Material. Sierra de Languiño, Province of Chubut; *a*, west of Puesto Benito Aleman, incomplete phragmocone (MLP 11878); *b*, west of Puesto Benito Aleman, left bank of the Cañadon Aguada Champoza, (?) incomplete phragmocone (MLP 11879).

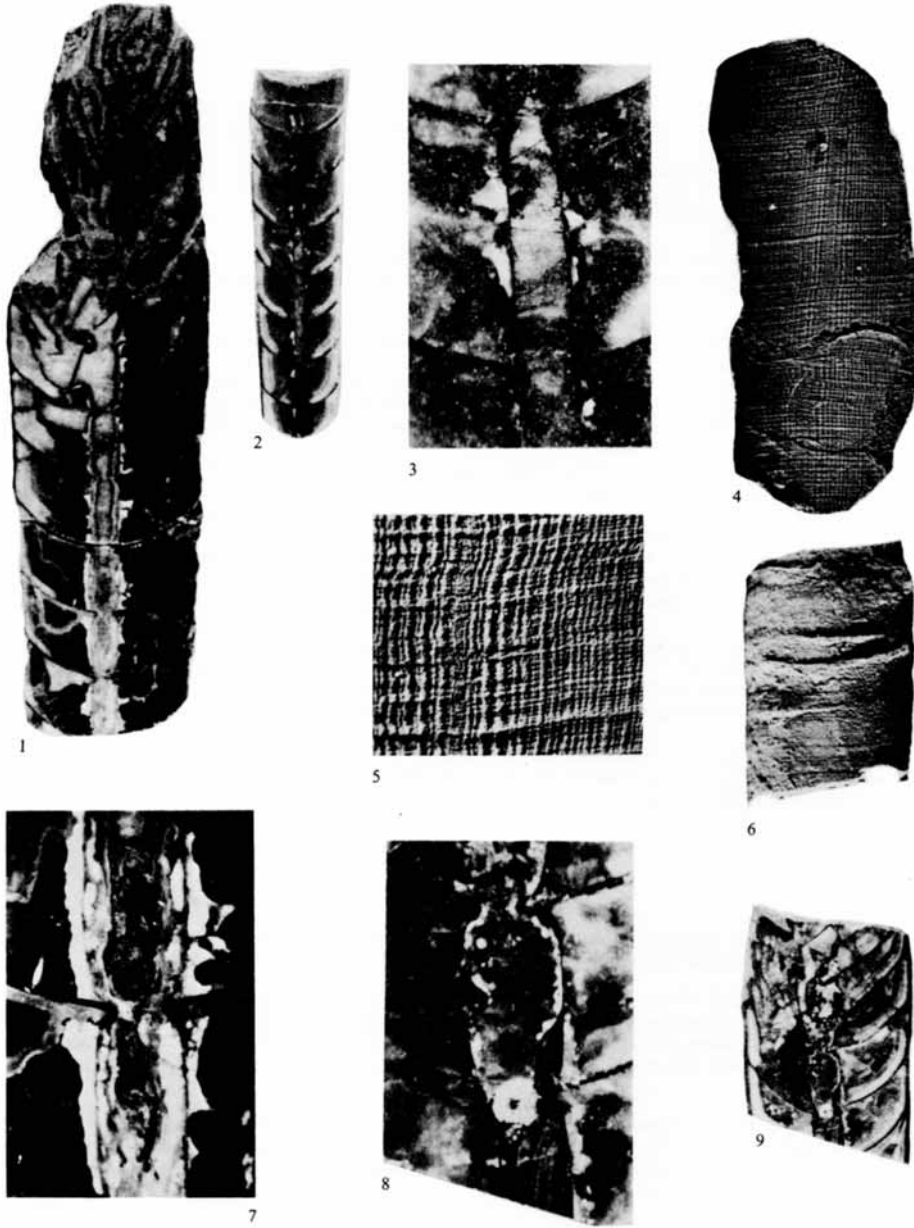
EXPLANATION OF PLATE 23

All figures $\times 2$, unless otherwise stated.

Figs. 1-3, 7. *Sueroceras* cf. *S. ? chubutense* (Closs), Sa. de Languiño, Province of Chubut. 1, 7, MLP 11878, west of Puesto Benito Aleman; 1, ventrodorsal longitudinal section; 7, enlarged view of fig. 1, $\times c. 6$. 2-3, MLP 11879, west of Puesto Benito Aleman, left bank of Cañadon Aguada Champoza; 2, ventrodorsal longitudinal section; 3, enlarged view of fig. 2, $\times c. 9$.

Figs. 4-5. *Sueroceras* sp., MLP 11881, La Carlota, Sa. de Tepuel, Province of Chubut. 4, side view of a latex cast; 5, enlarged view of fig. 4, $\times 6$.

Figs. 6, 8, 9. *Pseudorthoceras* sp., MLP 11189a, Quebrada Chigua, Province of San Juan. 6, lateral view; 8, ventrodorsal longitudinal section; 9, enlarged view of fig. 8, $\times c. 6$.



RICCARDI and SABATTINI, *Sueroceras*

Sierra de Tepuel, Province of Chubut: *a*, west of Puesto Tres Lagunas, below diabase sill, external mould (MLP 11880).

Description. One fragment (MLP 11878, Pl. 23, figs. 1, 7) of a phragmocone about 55 mm long, partially crushed adorally, shows the same external reticulate ornament as *S. irregularis* nov. sp., with sharp rounded irregularly raised transverse lirae and a more regular, and relatively less raised longitudinal component. With six camerae averaging 2.6 in a length equal to the conch diameter. Siphuncle central with sub-cyrtocoanitic septal necks. Connecting rings fusiform, slightly inflated in the middle and constricted at the septal necks. Siphuncular deposits continuous lying on both sides. Cameral deposits of the mural and epi-hyoseptal types.

Another phragmocone (MLP 11879, Pl. 23, figs. 2-3), tentatively included in this species, shows two camerae in a length equal to the shell diameter. The reticulate ornament is hardly visible, principally the longitudinal lirae.

Remarks. Justification for the inclusion of this species in *Sueroceras* gen. nov. is to be found in the discussion of the genus.

The ornament shows the same transverse and longitudinal lirae as in *S. irregularis* nov. sp. The first are irregular but are more numerous than in the previously described species averaging nine per mm in specimen MLP 11878. In the other specimen (MLP 11879) the lirae cannot be counted exactly due to the preservation, but they seem to be similarly numerous.

As we do not have specimens of a similarly small growth stage as specimen MLP 11879, that can be assigned without doubts to *S. irregularis* nov. sp., it is impossible to know if this specimen could belong to this species or not, especially taking into account that it has an increase in the spacing of the septa with age. Meanwhile it is tentatively included in *S. cf. S.? chubutense* (Closs).

Only one external mould (MLP 11880) with the reticulate ornament typical of this new genus is included in *S. cf. S.? chubutense* (Closs) because it also shows the sutures, which indicate a similar spacing of the septa (2.5 camerae in a length equal to the shell diameter) as shown by the other specimens referred to that species.

Although the specimens here described have the same features described by Closs (1967) for the species, his material from Patagonia is so poor that it is difficult to be sure about their identity with our specimens. Particularly if we consider that the specimens from Chubut described by Closs were placed together with some Uruguayan specimens which show relatively more prominent longitudinal lirae (Closs 1967, pl. 1, fig. 6).

The differences between *S. irregularis* nov. sp. and *S. cf. S.? chubutense* (Closs) lie in the spacing of the septa (2-2.6 and 1.6-1.8 respectively in a length equal to the shell diameter) and perhaps in the presence of siphuncular deposits lying one side and both sides respectively.

Sueroceras sp.

Plate 23, figs. 4-5; Plate 24, figs. 2-4

Material. Sierra de Tepuel, Province of Chubut, La Carlota, 9 km to the south-east of Tecka, three fragmentary external moulds (MLP 11881-11882).

Description. The only observable feature is the ornament, which is reticulate as in *Sueroceras* (above). However, here the transverse and longitudinal lirae are similar in size and regularity, with a close-web fabric. The longitudinal, as well as the transverse lirae amount to about 6-8 per mm, and although some lirae are more raised than others and the longitudinal components occur in pairs, the general aspect is fairly regular.

Remarks. Even if no other features are known, the reticulate ornament is clearly different from that exhibited by *S. irregularis* nov. sp. and *S. cf. S.? chubutense* (Closs). However, it is possible that these specimens could be extreme variants, in ornament, of any of the other two species, although there are no specimens with a clear intermediate ornament.

Genus *Pseudorthoceras* Girty, 1911

Remarks. The diagnosis of this genus given by Miller, Dunbar and Condra (1933), Flower (1939), Miller and Youngquist (1949), and Gordon (1964) is essentially coincident with that in the Treatise (Sweet 1964, p. K244), although there are some useful additions such as that of Gordon (op. cit., p. 109) pointing out that the 'surface is smooth, ornamented by faint slightly sinuous growth striae', and that the siphuncule in the early stages has subcylindrical connecting rings and is located ventral of centre, 'but rapidly migrate to center of conch . . . commonly with subspherical connecting rings in later stages'.

Concerning differences with the related genus *Mooreoceras* Miller *et al.* (1933), Miller and Youngquist (1949, p. 18), considered that in *Mooreoceras* the 'siphuncule is not quite central in position, and in so far as is known adapical portion of the conch is not curved', there are not 'indigenous cameral deposits' (p. 23), and the cross-section is 'very broadly elliptical (due to a slight dorsoventral depression)' whereas in *Pseudorthoceras* it is circular (p. 23) (see also Miller *et al.* 1933, p. 85).

The alleged absence of endosiphuncular and cameral deposits in *Mooreoceras* has been dismissed by Gordon (1964, p. 112).

Pseudorthoceras sp.

Plate 23, figs. 6, 8-9

Material. Quebrada Chigua, Province of San Juan, two fragments of phragmocones and a body chamber (MLP 11189).

Description. The best-preserved specimen (MLP 11189a) is a fragment 19.5 mm long with a diameter of about 12 mm and circular-subcircular cross-section. The sutures are straight and transverse. There are about three camerae in a length equal to the shell diameter. The siphuncule is central and the septal necks are suborthochoanitic to subcyrtchoanitic. Connecting rings slightly pyriform with the maximum diameter in the adoral part. Brim smaller than neck. Endosiphuncular deposits on the ventral side, with an incomplete development in the adoral direction (Pl. 23, figs. 8-9). Camerae lined with mural and episeptal deposits, thicker on the ventral side where also hyposeptal deposits are present. The shell surface is almost smooth, only with faint slightly sinuous transverse growth lines, and a few irregular wrinkles.

The fragment of another phragmocone (MLP 11189b) 17.5 mm long and with a diameter of about 13 mm has similar external features. A polished longitudinal ventrodorsal section revealed the presence of four camerae, averaging three in a length equal to the shell diameter. The siphuncule is central and the septal necks are suborthochoanitic to subcyrtchoanitic. No other internal structures are visible and the camerae are completely filled with sediment.

Remarks. No specific identification has been attempted. The presence of this genus in West Argentina has been questionably recorded before by Reed (*in Du Toit* 1927, p. 145), who described two fragments of orthoconic nautiloids from the Upper Carboniferous of Quebrada del Salto, Barreal, Province of San Juan, and compared one of them with '*P. knoxense* Girty' from the Pennsylvanian of U.S.A. (see Miller and Youngquist 1949, pp. 18, 21).

The present specimens can be dated as Lower Carboniferous because *Protocanites scalabrinii* Antelo (1969) occurs at the same stratigraphic level.

Genus *Reticycloceras* Gordon, 1960
 ?*Reticycloceras* sp. 1

Plate 24, figs. 1, 6

Material. Sierra de Languiño, Province of Chubut, Puesto Benito Aleman, fragmentary external mould (MLP 11883).

Description. The fragment is 50 mm long, with circular-subcircular cross-section. Surface ornamented with transverse annulations which are rounded, regular, and slightly inclined, bending adapically on the ventral side. There are about two annulations per mm, and on their surface and also on the spaces between them are lirae amounting to eight per mm.

Remarks. The specimen does not allow confidence as to taxonomic status. It bears some superficial resemblance to *Reticycloceras* Gordon and *Criptocycloceras* Shimansky in the presence of annulations and lirae, although in the present material the annulations are more closely spaced.

?*Reticycloceras* sp. 2

Plate 24, figs. 10-11

Material. Sierra de Languiño, Province of Chubut, Puesto Benito Aleman, fragmentary external mould (MLP 11884).

Description. The specimen is an orthoconic external mould about 17 mm long, with a circular cross-section, 12.8 mm in diameter at its oral end and 11.3 mm at the apical end, and an expansion rate of 1 mm in about 11 mm. The surface is ornamented with transverse annulations which are rounded, regular, and slightly inclined, bending adapically on the ventral side. There are about three annulations per mm. On the annulations and intervening conch surface are minute lirae amounting to 21 per mm, parallel to the annulations.

Superfamily and Family uncertain
 Genus *CYCLOCERAS* M'Coy, 1844

Remarks. The type species of the genus *Cycloceras* M'Coy 'is based on an internal mould of a body chamber on which even position of siphuncle is indiscernible' (Sweet 1964, p. K259). The status of this and related genera, such as *Perigrammoceras* Foerste, is unclear. According to Sweet 'no species other than the type species should be referred to *Cycloceras* until its type is better known' (see also Miller *et al.* 1933, p. 45; Demanet 1941, p. 97).

EXPLANATION OF PLATE 24

All figures $\times 2$, unless otherwise stated.

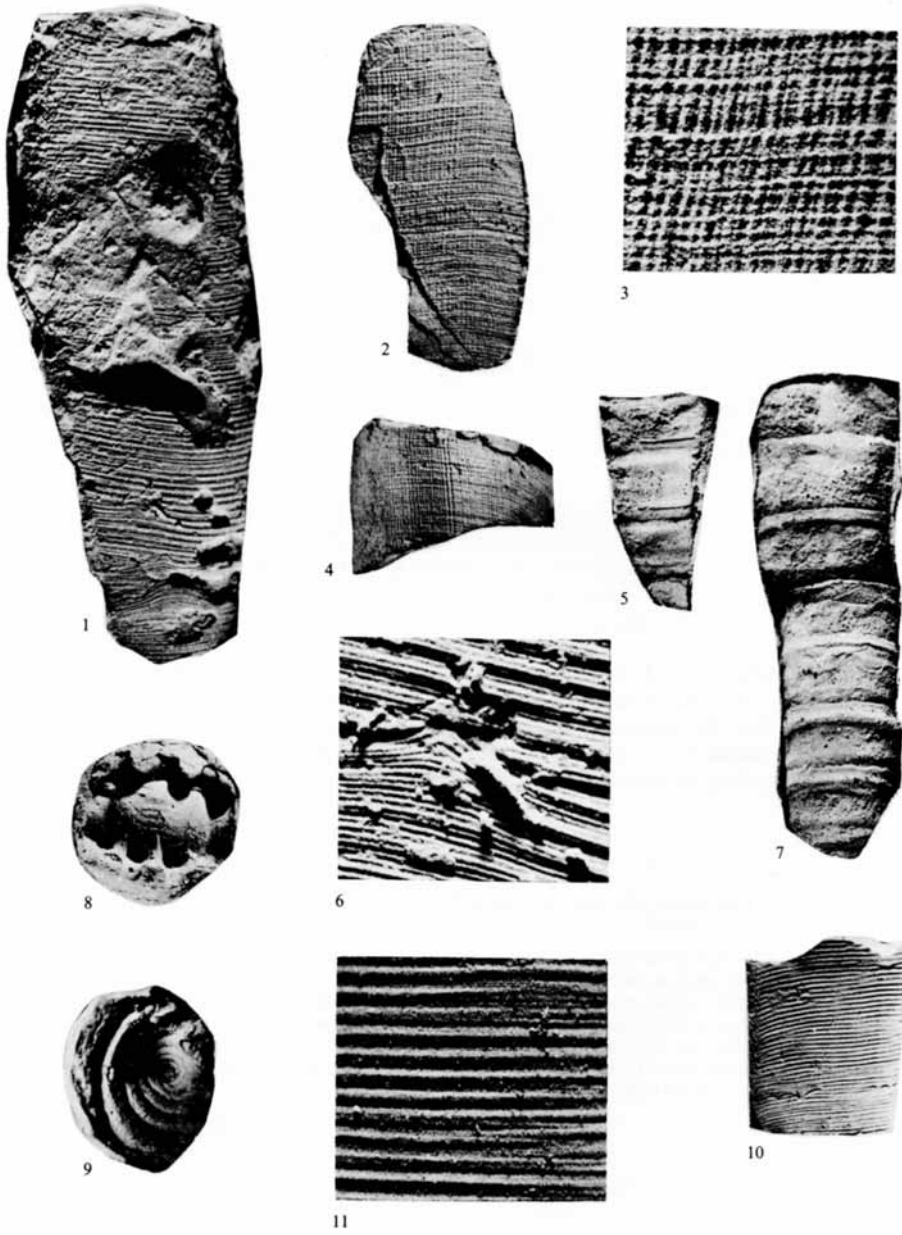
Figs. 1, 6. ?*Reticycloceras* sp. 1, MLP 11883, Puesto Benito Aleman, Province of Chubut. 1, side view of latex cast; 6, enlarged view of fig. 1, $\times 10$.

Figs. 2-4. *Sueroceas* sp., La Carlota, Sa. de Tepuel, Province of Chubut. 2-3, MLP 11882a; 2, side view of latex cast; 3, enlarged view of fig. 2, $\times 6$. 4, MLP 11882b, side view of a latex cast.

Figs. 5, 7. ?*Cycloceras* sp., MLP 11885-11886, Benito Aleman farm, Sa. de Languiño, Province of Chubut, side views of latex casts.

Figs. 8-9. *Glaphyrites* sp., MLP 11887, La Carlota, Sa. de Tepuel, Province of Chubut. 8, ventral view; 9, latex cast of the umbilical area.

Figs. 10-11. ?*Reticycloceras* sp. 2, MLP 11884, west of Puesto Benito Aleman, Sa. de Tepuel, Province of Chubut. 10, side view of latex cast; 11, enlarged view of fig. 10, $\times 10$.



RICCARDI and SABATTINI, Cephalopoda

?'*Cycloceras*' sp.

Plate 24, figs. 5, 7

Material. Sierra de Languiño, Province of Chubut, right side of road to Colán Conhué, in property of Benito Aleman, in front of gate to Roelse farm, two fragmentary external moulds (MLP 11885-11886).

Description. The two fragments are 39 and 19 mm long with circular to subcircular cross-section. The sutures are straight and there are about two camerae in a length equal to the shell diameter. The surface is smooth with the exception of annulations parallel to the sutures. These annulations are rounded, amount to two per camera, are close to the sutures, and the adoral ones are more prominent than the adapical.

Remarks. It is impossible at the present time to give a more precise identification of this material. The Patagonian specimens show some superficial resemblances to material from the Late Mississippian of South Oklahoma described by Elias (1958, p. 30, pl. 3, fig. 7) under *Cycloceras randolphensis*, and to that from the Lower Carboniferous of Belgium described by de Koninck (1880, p. 71, pl. 41, fig. 3) under '*Orthoceras annuloso-lineatum*, L. G. de Koninck', although in both of these cases there are specimens with fine transverse striae between the annulations, similar to those in the specimens referred to different species of *Cycloceras* by Shimansky (1968, pl. 2). These striae were not recorded by M'Coy (1844, p. 10) in *C. annulare* and '*C. laevigatum* M'Coy.

Subclass AMMONOIDEA Zittel, 1884

Order GONIATITIDA Hyatt, 1884

Superfamily GONIATITACEAE de Haan, 1825

Family NEOICOCERATIDAE Hyatt, 1900

Genus GLAPHYRITES Ruzhencev, 1936

Remarks. *Glaphyrites* Ruzhencev has been considered as a synonym of *Eoasianites* Ruzhencev by some authors (Miller and Furnish 1940, p. 77; Miller *et al.* 1957, p. L61) whilst others considered it to be a valid genus (Gordon 1964, p. 219) or subgenus of *Eoasianites* (see Closs 1969, p. 201). For the present we follow Gordon (op. cit.) in regarding *Glaphyrites* as a valid genus.

Glaphyrites sp.

Plate 24, figs. 8-9; text-fig. 2

Material. Sierra de Tepuel, Province of Chubut, La Carlota, 9 km south-east of Tecka, fragment of phragmocone (MLP 11887).

Description. The fragment available belongs to a phragmocone about 25 mm maximum diameter. The conch is depressed, globose, and moderately involute with a total of six whorls. The ventral and ventrolateral shoulders are rounded, whilst the umbilical shoulders are subangular and the umbilical wall is gently convex. The surface is ornamented with fairly thick transverse threads, which ventrally are bent slightly adorally. The suture has eight pointed lobes and spatulate saddles. The ventral lobe is shorter than the lanceolate and slightly curved first lateral lobe, while the umbilical lobe is shorter and sharply pointed. The dorsal and internal lateral lobes are lanceolate.

TEXT-FIG. 2. Suture of *Glaphyrites* sp., MLP 11887.

Remarks. A specimen belonging to this genus (Gordon 1964, p. 221) has been described as '*Eosianites* sp.' by Miller and Garner (1953). It came from Puesto Urquiza, Sierra de Languiño (see Suero 1958, p. 25). *Wiedeyoceras argentinense* (Miller and Garner 1953) came from the same locality as the specimen described here.

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