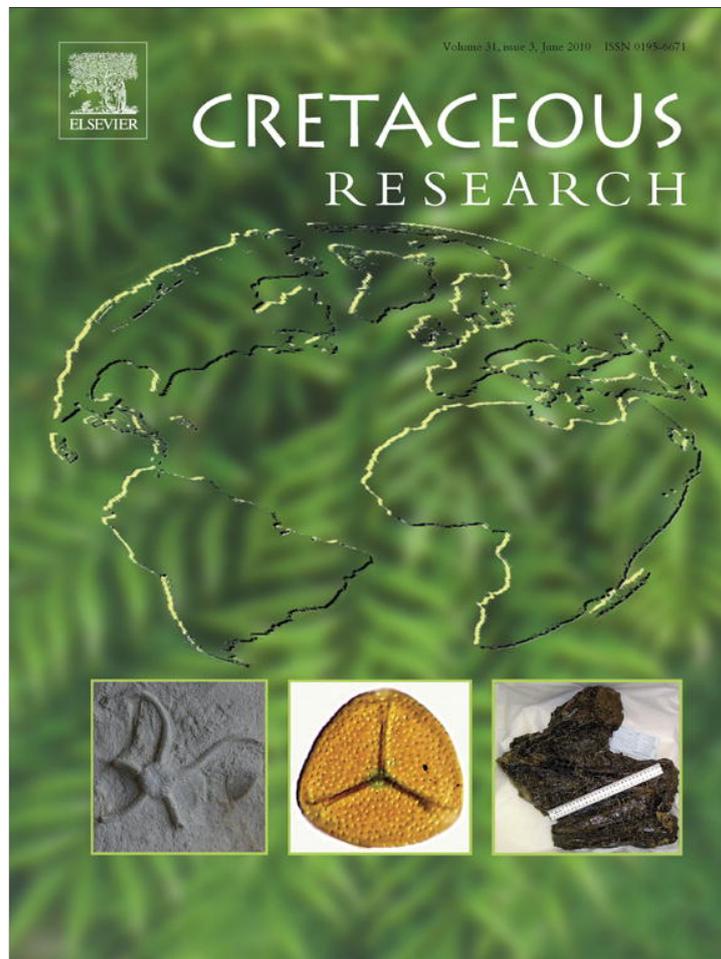


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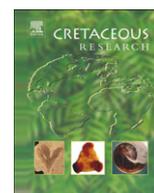
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## Lower Cretaceous ammonites from the Neuquén Basin, Argentina: the neocomitids of the *Pseudofavrella angulatiformis* Zone (upper Valanginian)

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### ABSTRACT

The *Pseudofavrella angulatiformis* Zone (upper Valanginian) of the Agrio Formation in the Neuquén Basin, Argentina, is characterized exclusively by a complex sequence of neocomitid faunas that are sandwiched between the olcostephanids of the underlying *Viluceras permolestus* Subzone beneath and the holco-discid faunas of the *Holcoptychites neuquensis* Zone above (lowermost Hauterivian). Three successive neocomitid genera, *Pseudofavrella*, *Chacantuceras* and *Decliveites* gen. nov., characterize three subzones. Over half the taxa are new: *Pseudofavrella robusta*, *P.* sp. nov. 1 and 2, *Chacantuceras casanuestrae*, *Chacantuceras coniunctum*, *Decliveites crassicosatus*, and *Decliveites agrioensis*.

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### 1. Introduction

Our continuing studies of the rich ammonite faunas of the Lower Cretaceous Agrio Formation of the Neuquén Basin, west-central Argentina, have resulted in a detailed biozonation reviewed most recently by Aguirre-Urreta et al. (2007). The value of any such biozonation relies on accurate taxonomy, and this paper is the latest of a series in which we describe previously undescribed or poorly known faunas.

Many of the zonal boundaries represent marked turnovers in the ammonite faunas (Rawson, 2007), which in the Valanginian represent an alternation of neocomitid and olcostephanid genera. The exclusively neocomitid faunas of the highest Valanginian zone, that of *Pseudofavrella angulatiformis*, are the subject of this paper. They occur in the Pilmatué (lower) Member of the Agrio Formation, sandwiched between an olcostephanid fauna characterising the *Viluceras permolestus* Subzone lowermost (described by Aguirre-Urreta and Rawson, 1999), and the lowermost Hauterivian holco-discid faunas of the *Holcoptychites neuquensis* Zone above (described by Aguirre-Urreta and Rawson, 2003).

The *Pseudofavrella angulatiformis* Zone has yielded a varied succession of forms, many of them new or previously poorly known taxa. It is to the lower part of this zone that we can now assign

*Lyticoceras pseudoregale* (Burckhardt), based on evidence from newly collected material from Burckhardt's (1903) original locality in southern Mendoza and from Pichaihue Valley and Upper Pichaihue in Neuquén. *Pseudofavrella* itself is limited to the lower part of the zone, and it is into this genus that we place both *Lyticoceras pseudoregale* and a small number of specimens from Pichaihue Valley described by Leanza and Wiedmann (1980) as *Lyticoceras australe*, *Acanthodiscus vacecki* and *Neocomites crassicosatus*. Higher in the sequence, some distinctive trituberculate, *Acanthodiscus*-like neocomitids were described by Aguirre-Urreta and Rawson (1999) as a new genus, *Chacantuceras*, for which two new species are described in this paper. In the upper part of the zone *Chacantuceras* is joined by, and eventually replaced by, previously undescribed ammonites provisionally placed in *Neocomites* (Aguirre-Urreta and Rawson 1997, figs. 7d–f) but now assigned to a new genus, *Decliveites*. The three successive genera allow the zone to be divided into three subzones (section 4 below).

### 2. Lithostratigraphy and fossil localities

Sediments belonging to the *Pseudofavrella angulatiformis* Zone of the Pilmatué Member of the Agrio Formation are distributed widely across the Neuquén Basin. They reach a maximum thickness of about 250 m. In the more basinal areas they rest on earlier marine sediments and the sharp transition from the underlying *Viluceras permolestus* Subzone can be seen. In some of the more

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marginal areas *angulatiformis* Zone ammonites are the first to appear above the Mulichinco Formation, the upper boundary of which is markedly diachronous. We describe here ammonites from 27 localities and we have measured sections through at least part of the zone in 13 of them. The localities are described below, from north to south. The first six localities are in Mendoza Province and were visited only by MBA-U; the remainder are in Neuquén Province and have been visited by both authors. Some localities show the whole or a significant part of the zone and the sequence of faunas therein. These are described in some detail even if not much material has been collected. Others are important only for a particular fauna or faunas and are described more briefly. Preservation of individual taxa varies considerably from horizon to horizon and locality to locality, and despite extensive search over many years, well-preserved specimens of some taxa remain elusive. Hence in the systematic section (3) some species remain under open nomenclature (Fig. 1).

2.1. Arroyo Relincho (32°38'S, 69°55'W)

This remote locality is east of mount Aconcagua, in northern Mendoza. Access is on foot or by horse from Punta de Vacas, along the Río Vacas and then to the Arroyo Relincho headwaters. The Mendoza Group forms a north–south trending anticline and the lower part of the Pilmatué Member is composed of mudstones, oyster wackestones and packstones with bivalves. The mudstones yielded fragmentary unidentified neocomitids and *Pseudofavrella australis* (CPBA 17504).

2.2. Puente del Inca (32°49'S, 69°55'W)

On the northern bank of Río Cuevas, 500 m west of the Argentine Custom building along national route 7, in northern Mendoza. The locality was described by Schiller (1912): only a few metres of the Agrio Formation are exposed. The basal beds are composed of reddish conglomerates with abundant bivalves: *Steinmannella transitoria*, *Trigonia carinata*, *Ptychomya koeneni*, *Cucullaea gabrielis*, etc. Only one specimen of “*Hoplites*” was recovered by Schiller. It is presently housed in the paleontological collections of the University of Bonn, Germany, and is here assigned to *Chacantuceras ornatum* (cast CPBA 20638).

2.3. Río Diamante bridge (34°31'S, 69°39'W)

On the southern bank of the Río Diamante, a few hundred metres south of the old wooden bridge, patchy outcrops of bluish-grey limestones of the Agrio Formation are exposed. They yielded isolated specimens of *Pseudofavrella angulatiformis* (CPBA 20662) and *Decliveites agrioensis* (CPBA 20625).

2.4. Arroyo La Carpa (34°33'S, 69°38'W)

The Arroyo La Carpa is a western tributary of the Río Diamante, running 4.2 km northwest of Cerro Mala Dormida. The Agrio Formation, 156 m thick, rests on massive oyster coquinas of the Chachao Formation. Its lower part is composed of a monotonous succession of limestones with *Pseudofavrella angulatiformis* (CPBA 20663), gastropods and bivalves. The upper part is formed of interbedded shales and bioclastic limestones with abundant ammonites and inoceramids.

2.5. Lomas Bayas (34°39' S, 69°31'W)

This locality is close to the southern margin of the Río Diamante, a few kilometres northeast of the Las Aucas settlement in southern

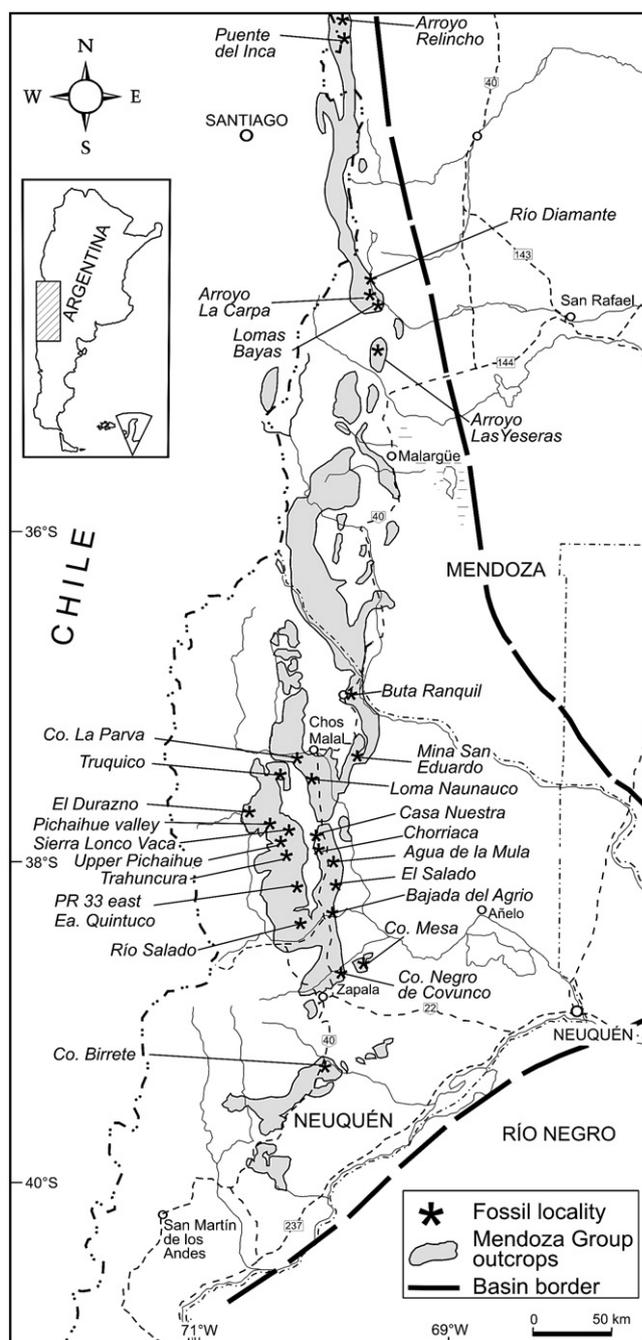


Fig. 1. Map showing localities for the *Pseudofavrella angulatiformis* fauna in the Neuquén Basin.

Mendoza. The complete Agrio Formation is less than 100 m thick here, as this locality represents the easternmost border of the basin at these latitudes. *Chacantuceras ornatum* (CPBA 20637) is found in the basal beds of the formation, in whitish conglomerates that rest unconformably on continental red beds.

2.6. Arroyo Las Yeseras (34°45' S, 69°42'W)

This small creek is a tributary of Arroyo La Manga which in turn is an important tributary on the northern bank of Río Atuel. Access is by unpaved roads from El Sosneado. This is a classic locality that was studied by Hauthal in 1894 when he collected the ammonites

that were subsequently described by Burckhardt (1903), including a new species, *Hoplites pseudoregalis*. Borrello (1953) revisited the section and showed that it was the same as the “section VII” measured by Gerth (1925, plate 10, fig. 16). Here the Agrio Formation is less than 300 m thick. Borrello (1953) mentioned the ammonoids *Acanthodiscus radiatus* (probably *Pseudofavrella australis* or *Chacantuceras ornatum*) and *Neocomites pseudoregalis*, though the paper was devoted to the bivalves and their palaeobiogeographic affinities. In 2005 MBA-U measured a section here. The Pilmatué Member rests on the Chachao Formation, and consists of limestones and shales reaching a thickness of 155 m. *Pseudofavrella pseudoregalis* (CPBA 20655.1–13) was found 23 m above the base of the member.

#### 2.7. Buta Ranquil (37°02'S, 69°52'W)

The section is immediately north of the town, on the north side of the road opposite a YPF garage. The Agrio Formation here is in a calcareous shale facies – mainly hard, splintery shales and thin argillaceous limestone bands, but with occasional thin, orange-coloured sandstone bands in the upper part. At the base, resting on the Mulichinco Formation is a horizon with occasional flattened *Pseudofavrella garatei*, only 2.2 m above the contact. Some 30 m higher, a thin nodular level (2–3 irregular bands) contains uncrushed fragments of *Pseudofavrella australis* (CPBA 20668.1–6). Considerably higher, at 165 m above the base, flattened *Decliveites agrioensis* (CPBA 20609.1–3) occur.

#### 2.8. Cerro La Parva (37°16'S, 70°26'W)

The cerro is approximately 25 km northwest of Chos Malal, on the southern side of the provincial road 43 to Andacollo. On the northern slope is a section through the whole of the Pilmatué Member, though some parts are covered. Here, black and grey green silty shales with rare *Viluceras* are capped by a 0.25 m thick red-brown weathering, hard calcareous siltstone. Above are black shales with *Pseudofavrella garatei* (CPBA 20661.1–2) 5.0 m above the base and *P. angulatifformis* (CPBA 18017.1–4, 20664.1–8) 5.9 m above the base.

#### 2.9. Mina San Eduardo (37°31'S, 70°01'W)

The section is adjacent to the abandoned San Eduardo coal mine, 7 km west-southwest of Curaco. The whole of the Pilmatué Member has been measured here, but the *angulatifformis* Zone faunas are mainly crushed flat and only two *Pseudofavrella australis* are recorded in the following systematic descriptions. However, the section is important for showing the relationship between the *angulatifformis* Zone and underlying beds. Above the Mulichinco Formation the lowest 3.5 m of the Pilmatué Member contain *Viluceras duraznoensis* (Aguirre-Urreta and Rawson, 1999). An overlying 0.8 m sandstone yields many crushed *Pseudofavrella*, including *P. australis* (CPBA 16269.1–2). Above are about 31 m of black silty shales with some harder, more silty/sandy beds. The lower beds contain flattened *Pseudofavrella*, while 3 m below the top of the shales abundant, poorly-preserved *Chacantuceras ornatum* occur in a band of large concretions. The overlying sequence consists of about 51 m of greenish-brown weathering, sometimes grey, very silty shales with some 20 courses of fine sandstones and red-weathering siltstones, sometimes concretionary. Poorly preserved *Decliveites* occur in the lowest course and in two of the highest ones. *Holcoptychites (neuquensis Zone)* first appears many metres higher in the section. From these scattered records it appears that the *ornatum* Subzone is very thin here.

#### 2.10. Truquicó

To the south-east of the road to Tres Chorros, some 4 km southwest of the junction by Estancia Chiappe, a ridge to the east of the Truquicó stream and about 1.6 km from the road is crossed by a slight col (at 37°28' S, 70°19'W). On the south side of the col the lowest beds of the *angulatifformis* Subzone are exposed, while beyond the col, to the east, several gullies cut through an extensive outcrop of the Pilmatué Member. The lower part of the *angulatifformis* Zone and its contact with the underlying *Viluceras permolestus* Subzone below is exposed in several places. The sequence is summarized in Fig. 2. Ammonites are common: the fauna consists of *Pseudofavrella garatei* (CPBA 20660.1–11), *P. angulatifformis* (CPBA 20659.1–22, 20665.1–2, 20666.1–3), and *P. australis* (CPBA 20657.1–30, 20656.1–5). The last *Viluceras* co-occur here with *Pseudofavrella garatei*.

Bodenbender's locality “Triuguico”, from which Behrendsen (1892) first described *Hoplites angulatifformis*, was in this area.

#### 2.11. Loma Naunauco (37°38'S, 70°12'W)

From national road 40 at Naunauco, Provincial Road 4 towards El Huecu skirts the northern termination of the Chorriaca anticline. Black shales (weathering blue-grey) overlain by creamy-green, friable fine sandstones, some slightly argillaceous, are exposed on the south side of the road round the nose of the anticline, and yield *angulatifformis* Zone faunas. Here, late *Chacantuceras* overlap with early *Decliveites*. *Decliveites agrioensis* (CPBA 20623) also occurs here.

#### 2.12. El Durazno (37°43'S, 70°29'W)

Twelve km northwest of Colipilli there is a well exposed section from the top of the Mulichinco Formation to the *Chacantuceras ornatum* Subzone, published in Aguirre-Urreta and Rawson (1999). Higher beds are hidden. *Pseudofavrella garatei* (CPBA 20669.1–14) appears about 4.3 m above the last *Viluceras* horizon, followed by *P. australis* (CPBA 20674.1–4); while upwards there are three levels with *Chacantuceras ornatum* (CPBA 18388.1–10).

#### 2.13. Pichaihue valley (37°47'S, 70°12'W)

The Arroyo Pichaihue cuts a valley west of the Sierra de Chorriaca: access is along a track running due east off provincial road 4, 12 km east of Colipilli. The whole of the *angulatifformis* Zone crops out over a considerable area to the east of the stream and south-east of the more southerly puesto, though the higher part is only patchily exposed. This is a key section for the lower part of the zone, for which a lithic log is given in Fig. 2. Between the last *Viluceras* of the *permolestus* Subzone and the first *Pseudofavrella* are about 4.5 m of sandstones and silty shales without ammonites. The following 54 m belong to the *angulatifformis* Subzone and have yielded abundant *P. garatei* (CPBA 20559.1–86, 13155, 13961), *P. angulatifformis* (CPBA 20667.1–32), *P. australis* (CPBA 13956, 20673.1–63), *P. pseudoregalis* (CPBA 20654.1–5), *Pseudofavrella* sp. nov. 1 (CPBA 20650) and *Pseudofavrella* sp. nov. 2 (CPBA 20649.1–10). The *angulatifformis* Subzone ammonites figured by Leanza and Leanza (1973) and Leanza and Wiedmann (1980) as *Lyticoceras australe*, *Neocomites crassicosatus*, *Acanthodiscus vacecki*, *Pseudofavrella garatei* and *P. angulatifformis* are from this locality.

Higher beds yield abundant, mainly fragmentary, *Chacantuceras ornatum* (CPBA 13954, 18380, 18381.1–2, 18382.1–38), described by Aguirre-Urreta and Rawson (1999).

*Decliveites crassicosatus* (CPBA 20608.1–2, 20630) and *D. agrioensis* (CPBA 20608.1–2, 20624) also occurs here.

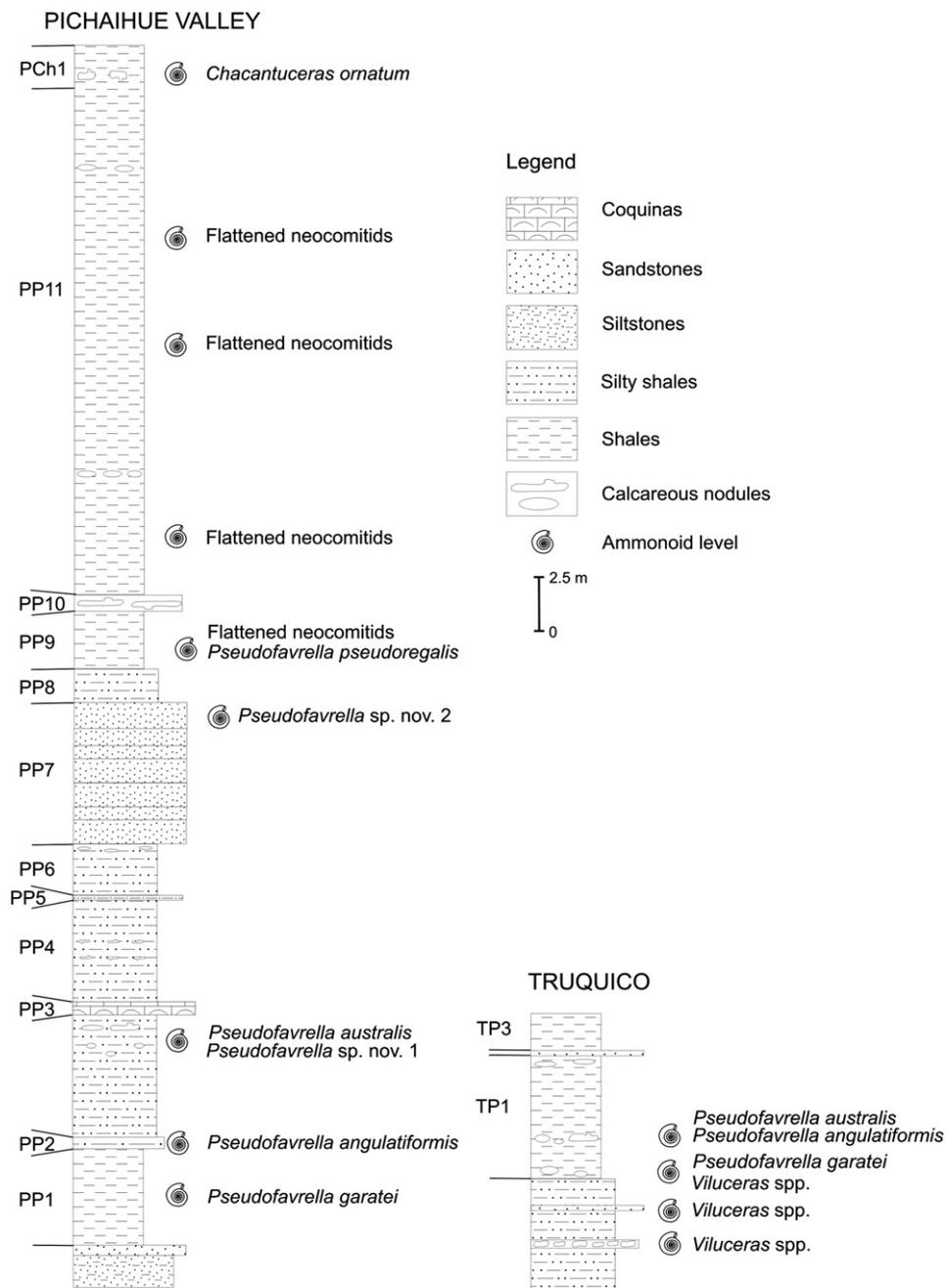


Fig. 2. The Pichaihue valley and Truquicó sections.

2.14. Upper Pichaihue (*Pichaihue arriba*) (37°54'S, 70°19'W)

Access is along a track running northeast to Upper Pichaihue, some 4 km from Huncal. The transition between the Mulichinco and Agrío Formations, and the lower part of the Pilmatué Member are well exposed. Silty shales in the Pilmatué Member yield abundant flattened neocomitids, but in places the shales are partially lithified and contain uncrushed specimens of *Pseudofavrella pseudoregalis* (CPBA 20652.1-15).

2.15. Casa Nuestra (37°53'S, 70°04'W)

Casa Nuestra lies immediately off national road 40, 60 km south of Chos Malal. The *angulatiformis* Zone extends for some

2 km south from here; it is exposed mainly to the west of the road but extends eastwards too. Ammonites are common, and a detailed section has been measured from the base of the zone to the lower part of the *Decliveites crassicosatus* Subzone (Fig. 3); the highest part is mainly covered. The taxa represented are: *Pseudofavrella australis* (CPBA 18333.1-20), *Chacantuceras ornatum* (CPBA 18127, 16972.1-11, 16966.1-5, 18335.1-16, 18336.1-4, 16968.1-7, 16969.1-7, 20644.1-3, 20641), *C. casanuestrae* (CPBA 20636.1-19), *C. coniunctum* (CPBA 16985, 20603.1-2), *Decliveites crassicosatus* (CPBA 18334.1-2, 20626.1-22, 20606.1-2) and *D. agrioensis* (CPBA 16971.1-3, 18051, 20613, 20614.1-28, 20615.1-7, 20616.1-2, 20617.1-7). The last two species are characteristic of the *Decliveites crassicosatus* Subzone, for which this is an important locality.

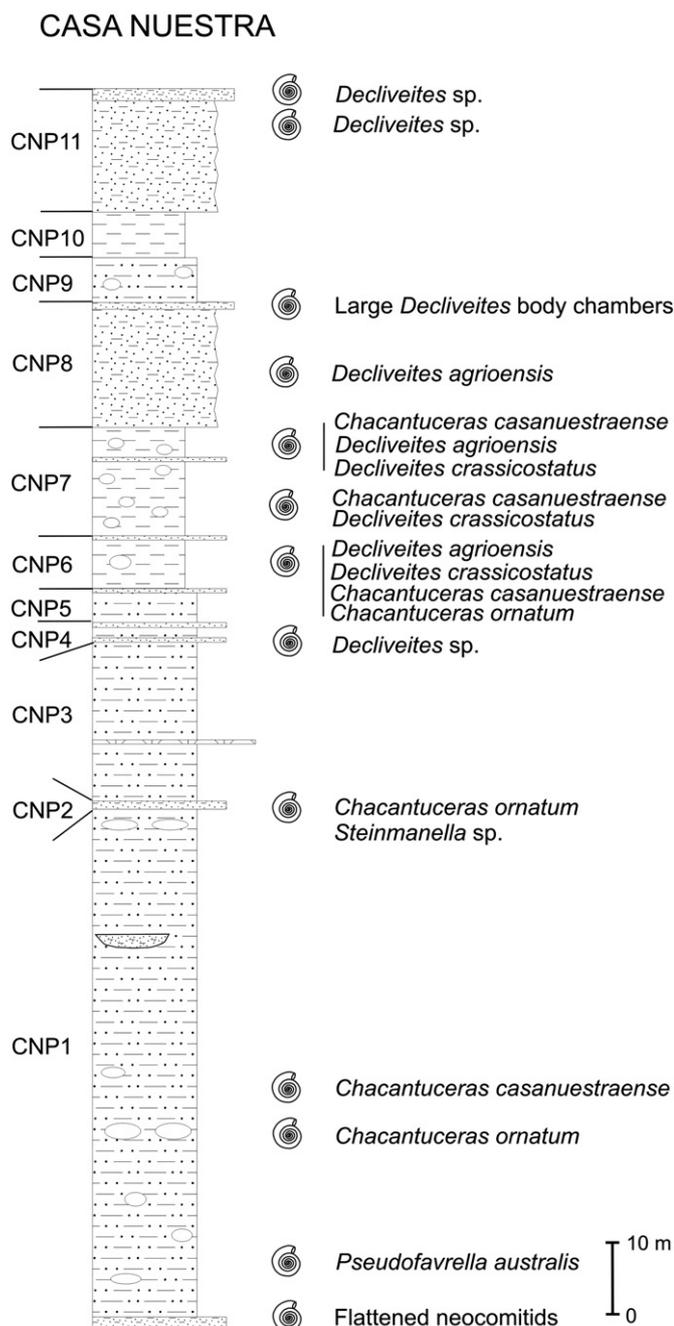


Fig. 3. The Casa Nuestra section. References as in Fig. 2.

2.16. Sierra Lonco Vaca (37°47'S, 70°10'W)

This locality is on the western flank of the Sierra Lonco Vaca anticline, north of Chorriaca. Access is from Pichiaihue valley along the eastern bank of Arroyo Chacays. The lower part of the Pilmatué Member is well exposed and few *Chacantuceras ornatum* have been collected (CPBA 20642.1–4).

2.17. Chorriaca (37°54'S, 70°03'W)

Chorriaca is a small settlement close to national road 40, 65 km south of Chos Malal. The locality is situated on the eastern flank of the Chorriaca anticline, near its southern nose. Access is by walking

some 500 m westward from national road 40, along a small dry gully. There are good exposures of the lower and middle part of the *angulatiformis* Zone. Ammonites include *Pseudofavrella australis* (CPBA 20670.1–5), *Chacantuceras ornatum* (CPBA 20643.1–4), *C. casanuestraense* (CPBA 20635.1–3) and *Decliveites crassicosstatus* (CPBA 19295.1–3).

2.18. Trahuncura (37°59'S, 70°14'W)

This locality is on the eastern flank of the Cerro Mocho-Cerro Mulichinco anticline. Access is from national road 40, 100 km south from Chos Malal and then along the provincial road that leads to Coihueco. The Mulichinco-Agrío transition is well exposed, and a few metres above the boundary *Pseudofavrella pseudoregalis* (CPBA 20653.1–5) is preserved in yellowish-orange fine sandstones.

2.19. Agua de la Mula (38°03' S 70°01' W)

Access is from the east side of national road 40, 80 km south of Chos Malal, along a track to a dry oil well. The section lies on the western flank of the anticline Cordillera del Salado. The lower part of the Pilmatué member forms a slight depression here in front of the axial ridge formed by the Mulichinco Formation and is mainly covered, but there are patchy exposures of the *angulatiformis* Zone, which here rests directly on the Mulichinco Formation. Above a thick sandstone at the top of the latter are about 3 courses of very hard, reddish-brown-weathering, almost black, calcareous, argillaceous, fine sandstone. The top course contains numerous flattened ammonites, mainly *Pseudofavrella angulatiformis* plus some *P. australis* (not collected) and *P. cf. robusta* (CPBA 18351, 18352). Above are 55 m of shales with *Chacantuceras ornatum* (CPBA 16970.1–11, 18379 (Colln Dásquez), 20639.1–6, 20640, 20645.1–3) followed by more sandy beds with *C. casanuestraense* (CPBA 20631.1–2) and *Decliveites crassicosstatus* (CPBA 20629, 20607). Then, there are some coarsening-up cycles (silty shales to thin siltstones), one of the lowest yielding rare, well-preserved fragments of *D. agrioensis* (CPBA 18353.1–2, 18354, 20619.1–8). About 11 m higher in the sequence *Holcoptychites* appears: Aguirre-Urreta and Rawson (2003) provide a detailed log of the top of the 'Neocomites' beds and the *Holcoptychites* beds above.

2.20. El Salado (38°11'S, 70°03'W)

The section lies 15 km south of Agua de la Mula; access is eastward from national road 40 along a track leading to the Pampa Amarga oil wells. About 1 km south of the track there are extensive exposures of the Agrío Formation, dissected by several gullies. Here the Mulichinco Formation and the lowest few metres of the Pilmatué Member shales above are vertical to slightly overturned on the west-facing slope of the Cordillera del Salado anticline. The outcrop extends westward downslope from here. The lowest part is poorly exposed, but *Chacantuceras ornatum*, *C. coniunctum* (CPBA 18251), and *Decliveites agrioensis* (CPBA 20610) occur.

2.21. Provincial road 33, between national road 40 and Estancia Quintuco

Access is from provincial road 31, which branches off national road 40 just south of the bridge over the Río Salado. PR 33 branches off PR 31 and 'Estancia Quintuco' (38°10'S, 70°16' W) is signposted. About 8 km from national road 40, at 30°10'S, 70°10'W, PR 33 cuts across the *Chacantuceras* beds. Some thin siltstone/fine sandstone beds occur, and the intervening shales,

partially covered, are full of nodules but almost totally unfossiliferous; they yielded two fragmentary *Decliveites agrioensis* (CPBA 20619.1-2) and, slightly higher, one fragment of *Chacantuceras coniunctum* (CPBA 20602).

About 4.5 km further along PR 33, at 38°10'S, 70°12'W, the upper *Chacantuceras* and *Decliveites* beds crop out to the south of the road. The upper *Chacantuceras* beds here are grey-black shales packed with small, irregular nodules. Within these beds is a fine sandstone with occasional large *Decliveites agrioensis* (CPBA 20618), while the nodules above and below yield rare fragments of both late *Chacantuceras casanuestraense* (CPBA 20634) and *Chacantuceras/Decliveites* intermediates. Above the upper *Chacantuceras* beds is a sequence of thin (2–3 m) silty shales grading up into siltstones capped by a thin hard fine-grained sandstone. Some of these silty shales contain abundant nodules up to 12 cm across. Scattered through at several levels in both silts and sandstones are very large *Decliveites agrioensis* – up to 0.7 m in diameter and still septate. All are crystalline internal moulds but some shell is also preserved on some. Some have attached serpulids and oysters. Most have broken up but in three examples inner whorls were preserved (CPBA 20620.1-4).

About 1.7 km further west, and exactly 5 km east of Estancia Quintuco, is a small track running south from the road to an abandoned puesto (at 38°10'S, 70°12'W) about 1.75 km from the road. There are extensive exposures of the Pilmatué Member to the south of the puesto, on hillsides and in a gorge. In the latter, the upper part of the Mulichinco Formation is exposed. The base of the overlying Pilmatué Member is marked by a siltstone with very poor impressions and fragments of *Pseudofavrella* sp. indet. Above are shales and silty shales with several interbedded sandstones with *Pseudofavrella* spp., including *P. australis* (CPBA 20671.1-3). Above this sequence black shales appear. The lower beds include the last *Pseudofavrella*, while *Chacantuceras ornatum* (CPBA 18383.1-8, 18384.1-3, 18385.1-5, 18386.1-2, 18383.1-11, 18387.1-13) occurs higher up. Above are siltstones, mainly covered.

The records of *Chacantuceras ornatum* from 'Pilmatué' and 'Arroyo Pilmatué' (Aguirre-Urreta and Rawson, 1999, p. 357) are from this general area.

2.22. Río Salado (38°17'S, 70°04'W)

Río Salado is located 70 km north of Zapala, some 7 km downstream from the bridge on national road 40 over the Río Salado. The Mulichinco Formation and most of the Pilmatué Member crop out west of the road. *Pseudofavrella australis* (CPBA 16976.1-13, 16977.1-2) occurs 25 m above the base of the Pilmatué Member, *Chacantuceras ornatum* (MLP 20995, 20996, 20997, 20999, 21000) occurs at three levels spread through 7.5 m of shales, 10 m above the last *P. australis*.

2.23. Arroyo Pilmatué

Aguirre-Urreta and Rawson (1999) recorded 5 specimens of *Chacantuceras ornatum* (MLP 21634, 21639, 21641) that A. Gutierrez collected from Arroyo Pilmatué (a tributary of the Río Agrio) about 7 km south-west of the bridge over the Río Salado on national road 40. The exact co-ordinates are not known.

2.24. Río Agrio, southwest of Bajada del Agrio (38°27'S 70°04'W)

There are extensive exposures of the Pilmatué Member along the south bank of the Río Agrio south-west of Bajada del Agrio. The lowest few metres of the *angulatiformis* Zone, just above the Mulichinco Formation, have yielded *Pseudofavrella australis* (CPBA 20672.1-25), *P. robusta* (CPBA 20658.1-7) and *P. sp. nov. 1* (CPBA

20651.1-4). Some of the overlying beds are partially obscured by glacial downwash, but we have measured a section in the mid part of the *angulatiformis* Zone, through the upper part of the *Chacantuceras ornatum* Subzone into the lowest part of the *Decliveites crassicosatus* Subzone (Fig. 4). This sequence has yielded numerous *Chacantuceras casanuestraense* (CPBA 20633.1-15),

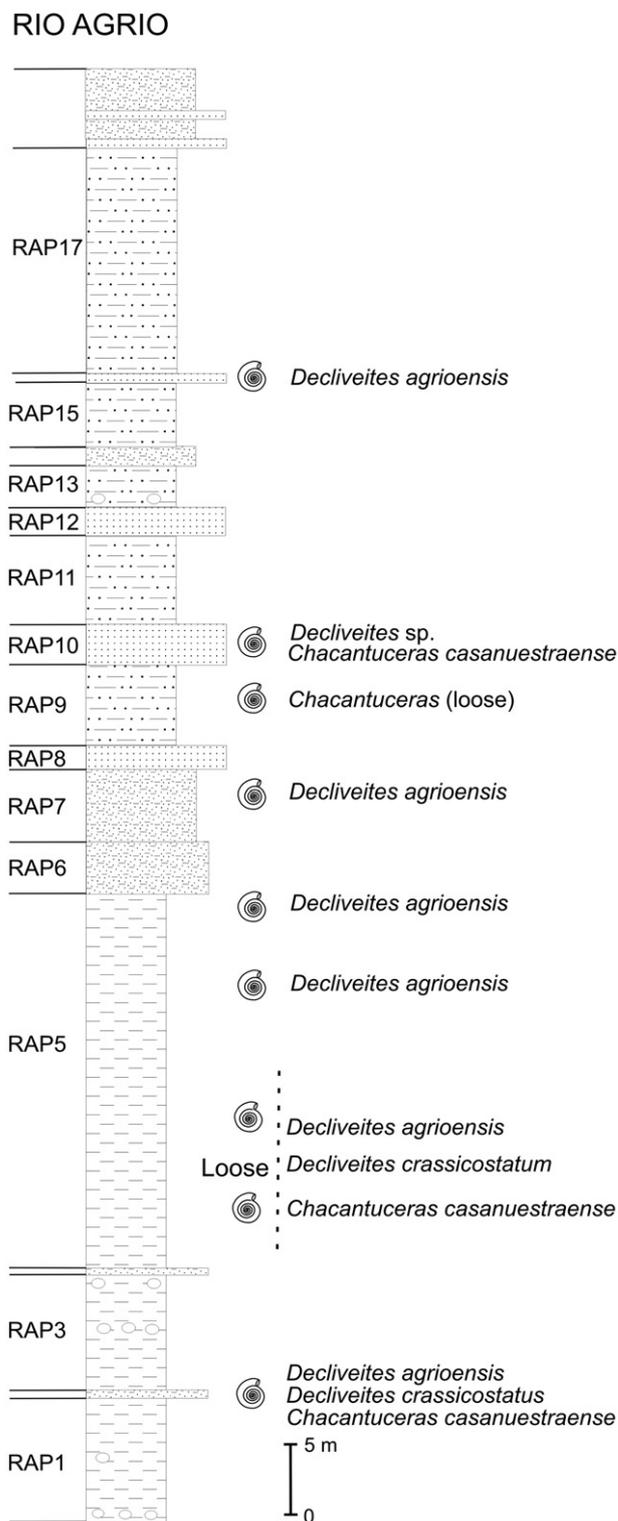


Fig. 4. The Río Agrio section. References as in Fig. 2.

*Decliveites crassicostatus* (CPBA 20604, 20627.1–10) and *D. agrioensis* (CPBA 20621.1–29).

#### 2.25. Cerro Negro de Covunco (38°46'S 69°59'W)

Cerro Negro lies 17 km north-east of Zapala within the Covunco military base and is of limited access to civilians. Windhausen (1914) gave a general description of the section here. On the low-lying ground near the Cerro are shelly siltstones/coquinas with fragments of *Pseudofavrella*, including *P. australis* (CPBA 19276). A platform halfway up the Cerro is formed mainly by a hard sandy, oolitic limestone - apparently the limestone with corals of Windhausen (1914), though no corals were found. The sandstones and silts just below, forming the upper part of the lower face belong to the *Decliveites* beds. The sequence above the platform is not well exposed, but Windhausen's bed with echinoids is visible. A few metres higher, a calcareous siltstone yields *Holcoptychites* (Aguirre-Urreta and Rawson, 2003, p. 593), marking the base of the overlying *H. neuquensis* Zone.

An old collection from this locality includes *Decliveites crassicostatus* (CPBA 7596.1–2) and *D. agrioensis* (CPBA 7598.1–2).

#### 2.26. Cerro Mesa (38°44'S 69°54'W)

Cerro Mesa lies some 30 km east of Cerro Negro and 8 km east of Mariano Moreno village. Gentili (1950) described this section in the lower part of the Pilmatué Member. *Pseudofavrella australis* (CPBA 18026.1–4, 20648) and *P. robusta* (CPBA 20647.1–2) occur in the lower part of the section, appearing in one of the first marine bands above the Mulichinco Formation and in a bivalve-rich coquina a little higher. *Chacantuceras ornatum* (CPBA 18025.1–3, 20646) occurs higher in the sequence (Aguirre-Urreta and Rawson, 1999, p. 357).

#### 2.27. Cerro Birrete (39°17'S 70°05'W)

This is an isolated hill on the south-east side of the junction of provincial road 20 with national road 40, 40 km south of Zapala. Here the lowest slopes are formed by the sandstones and pebbly sandstones of the Bajada Colorado Formation. The Pilmatué Member forms the rest of the hill. The base is only patchily exposed but is very variable, in places a very shelly sandy limestone, elsewhere a grey-green silty shale which becomes more silty upward. The lower beds consist of alternations of such shales with rubbly-weathering, cream-coloured, shelly, silty limestones. They yield *Chacantuceras casanuestrae* (CPBA 20632), *Decliveites crassicostatus* (CPBA 20628) and *D. agrioensis* (CPBA 20622.1–6).

### 3. Systematic palaeontology

The material described here is stored in the Palaeontological collections of the University of Buenos Aires (CPBA), the Geological Survey of Argentina (SNGM), and in the Natural Sciences Museum of La Plata (MLP).

Dimensions of specimens are indicated as follows: d = diameter; wh = whorl height; wt = whorl thickness; wu = width of umbilicus.

Superfamily Perisphinctoidea Steinmann, 1890

Family Neocomitidae Salfeld, 1921

Subfamily Neocomitinae Salfeld, 1921

Genus *Pseudofavrella* Leanza and Leanza, 1973

*Type species: Hoplites angulatiformis* Behrendsen, 1892, p. 16, by original designation.

**Diagnosis.** Shell moderately evolute to involute, typically with an irregular rib pattern in which some ribs stand out more strongly and may become bituberculate or trituberculate in the more advanced growth stages, though earlier growth stages may show a more regular neocomitid ribbing. Ribs form chevrons over the venter.

**Discussion.** There is a very variable plexus of neocomitids in the lower part of the *P. angulatiformis* Zone, including the two taxa that Leanza and Leanza (1973) included in their original definition of *Pseudofavrella*, *Hoplites angulatiformis* (Behrendsen 1892) and their new species, *P. garatei*. We recognise 7 distinct species (2 of which are left in open nomenclature) which because of their stratigraphical inter-relationships we regard as members of one variable genus. Our field research shows that *P. garatei* is the first species to appear and overlaps in range with *P. angulatiformis*. The latter co-occurs in the upper part of its range with forms described by Leanza and Wiedmann (1980) as *Acanthodiscus vaceki* (Neumayr and Uhlig) and a new species, *Lyticoceras australe*: we regard these as two different growth stages of a single taxon, *P. australis*. The later members of the plexus appear to represent two distinct lineages, both probably derived from *P. australis*. One branch includes coarsely ribbed, moderately inflated to inflated forms (*P. robusta* sp. nov. and *P. sp. nov. 2*). The other retains the regular ribbing characteristic of the earlier growth stage of *P. australis* to a more advanced, and possibly adult stage, passing via *P. sp. nov. 1* to a *Neocomites*-like form, *P. pseudoregalis* (Burckhardt 1903).

None of the European neocomitids in the "classic" French or Spanish upper Valanginian/ lower Hauterivian faunas revised by Company (1987), Bulot 1995 and Reboulet (1995) show the strong ribbing coupled with moderately evolute shell that typical *Pseudofavrella* species have. Some *Teschinites* and *Criosarasinella* have a similar ornament on the body chamber but the septate whorls are much more finely ribbed. Some of Collignon's (1962) *Besaireiceras* from Madagascar have a rib pattern and density similar to that in the earlier stages of *P. australis*, but have a more compressed shell and a vertical umbilical wall. Aguirre-Urreta and Rawson (1995, 1997) initially placed *P. australis* in *Besaireiceras*, a suggestion followed by Klein (2005). But further research has shown that *P. australis* is closely related to *P. angulatiformis*.

Outside the Neuquén Basin *Pseudofavrella* may be represented in Colombia by *Favrella colombiana* Haas (1960) and *Pseudofavrella? fabrei Etayo-Serna* (1985), the latter author indicating a Valanginian age for these forms, which occur above the main *Lissonia*/*Acantholissonia* fauna.

*Pseudofavrella garatei* Leanza and Leanza, 1973  
Fig. 5 A–N

- v 1971 *Favrella angulatiformis* (Behrendsen): Riccardi et al., pl. 14, fig. 3 only
- v\* 1973 *Pseudofavrella garatei* Leanza and Leanza, p. 133, fig. 3.
- v\* 1980 *Pseudofavrella garatei* Leanza and Leanza: Leanza and Wiedmann, p. 955, pl. 5, figs 2, 3.
- v 1988 *Pseudofavrella garatei* Leanza and Leanza: Riccardi, pl. 6, fig. 1.
- v 1995 *Pseudofavrella garatei* Leanza and Leanza: Aguirre-Urreta and Rawson, p. 11, pl. 1, fig. h.
- v 2007 *Pseudofavrella garatei* Leanza and Leanza: Aguirre-Urreta et al. fig. 11 A.

**Holotype.** The original of Leanza and Leanza (1973, p. 133, Fig. 3). SNGM 14974.

**Type locality.** Pichaihue Valley.

**Material.** 115 specimens: 88 from Pichaihue valley (CPBA 20559.1–86, 13155, 13961), 11 from Truquicó (CPBA 20660.1–11), 2 from Cerro La Parva (CPBA 20661.1–2) and 14 from El Durazno (CPBA 20669.1–14).

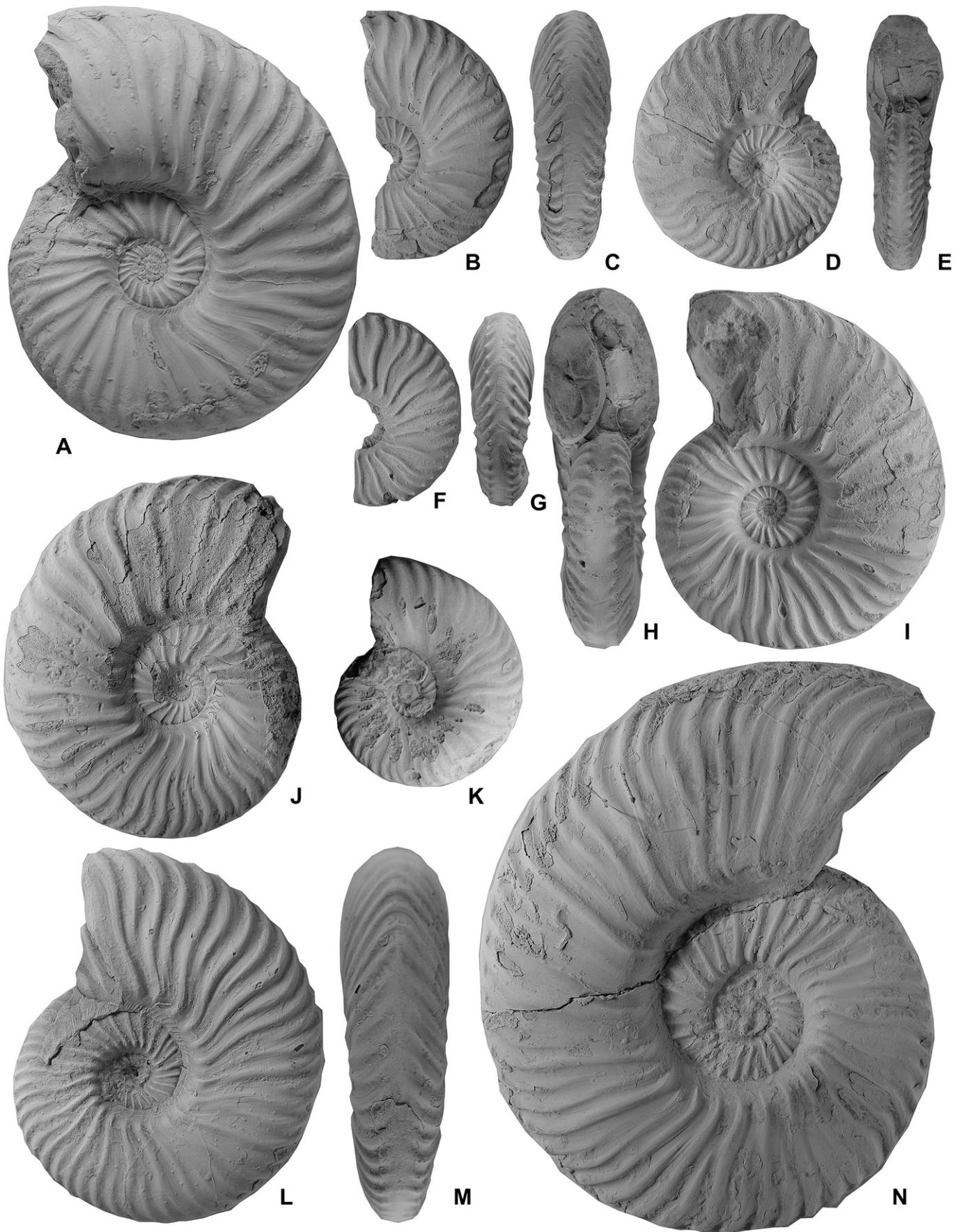


Fig. 5. *Pseudofavrella garatei* Leanza and Leanza. A, CPBA 20559.74; B-C, CPBA 20559.6; D-E, CPBA 20559.13; F-G, CPBA 20559.3; H-I, CPBA 20559.2; J, CPBA 20559.50; K, CPBA 20559.5; L-M, CPBA 20559.72; N, CPBA 20559.81, Pichaihue valley. All specimens x 1, coated with ammonium chloride.

**Description.** The maximum diameter is at least 180 mm. The shell is moderately compressed, slightly to moderately evolute. The flanks and venter are almost flat on the inner whorls, gently curved in later whorls, the whorl section changing from sub-trapezoidal to suboval, becoming broadest in mid flank. The umbilical wall slopes inwards. The ribs are strong, especially on the outer whorls, slightly flexuous, with an irregular pattern. Primary ribs arise singly or occasionally in pairs high on the umbilical wall, just beneath the umbilical shoulder. They sometimes swell slightly over the shoulder but do not form a distinct tubercle. There are about 23–26 primary ribs per whorl at about 70 mm diameter. Primary ribs branch, or a secondary is intercalated, at varying levels; sometimes low on the flank, but normally on the outer half; some primaries remain single. In the earliest whorls all ribs are of more or less equal strength, but by about 60 mm diameter some or all of the primaries may stand out slightly more strongly than the secondaries. The number of secondaries per primary is more or less constant and the primaries become almost straight, gently rursiradiate. There are 45–52 ribs in the ventral region; the ratio of ventral to umbilical ribs varies from about 1.6 to 2. The ribs curve forward close to the venter. In earlier growth stages they bear small ventro-lateral clavi and form obtuse to right-angled chevrons on the outer margins of the venter, the middle of which is usually slightly raised and almost smooth. Above 30–60 mm diameter the tubercles gradually disappear and the ribs cross the venter in a forward curve rather than a chevron, diminishing in strength over the gently rounded venter, where the stronger ribs may stand out slightly more.

The largest specimen, a body chamber, has strong ribs still, with some standing out more than others; nearly all the ribs, stronger and weaker, start on the umbilical wall and remain unbranched.

Dimorphism may occur, as some small body chambers, e.g. CPBA 20559.5 (Fig. 5K) and 20559.14 develop the rounded venter very early, by about D = 45 mm–50 mm diameter.

*Dimensions of figured specimens*

	d	wh	wh%d	wt	wt%d	wu	wu%d	pr. <sup>a</sup>	sec. <sup>a</sup>
CPBA 20559.3	37.1	17.7	47.7	12	32.3	10.2	27.4	12	21
CPBA 20559.5	45.3	18.8	41.5	13.3	29.3	11.8	26	13	20
CPBA 20559.6	48.4	21.7	44.8	14.6	30.1	13.5	27.8	16	25
CPBA 20559.13	48.8	22.1	45.2	13.3	27.2	12.1	24.7	12	24
CPBA 20559.72	71.1	31.9	44.8	20.9	29.3	20.9	29.3	13	26
CPBA 20559.50	73.4	29.7	40.4	19.1	26	21.7	29.5	12	25
CPBA 20559.62	73.9	33.3	45.1	21.7	29.3	22.1	29.9	11	24
CPBA 20559.74	86.6	36.1	41.7	–	–	26.1	30.1	11	23
CPBA 20559.81	109.3	44.2	40.4	27.7	27.1	33.4	30.6	15	31

<sup>a</sup> primary and secondary ribs per half whorl.

**Discussion.** *P. garatei* is the first *Pseudofavrella* species to appear in the Neuquén Basin, and has no immediate predecessor there; at some localities its first appearance overlaps with the last *Viluceras*, an olcostephanid genus.

*Pseudofavrella angulatifformis* (Behrendsen 1892)

Fig. 6 A–K

v*	1892	<i>Hoplites angulatifformis</i>	Behrendsen, p. 16, pl. 4, fig. 2b, c. (Refigured Behrendsen 1922, pl. 4, fig. 10b, c; Riccardi et al. 1971, pl. 14, fig. 1).
v	1892	<i>Hoplites angulatifformis</i>	Behrendsen, p. 16, pl. 4, fig. 2a. (Refigured Behrendsen 1922, pl. 4, fig. 10a; Riccardi et al. 1971, pl. 14, fig. 2).
	1909	<i>Favrella angulatifformis</i> :	Douvillé, p. 166.
?	1925	<i>Favrella</i> cf. <i>angulatifformis</i>	(Behrendsen); Gerth, p. 111.
?	1931	<i>Favrella angulatifformis</i>	(Behrendsen); Weaver, p. 460, pl. 57, fig. 366.
v	1939	<i>Favrella angulatifformis</i> :	Spath, p. 147.

	1971	<i>Favrella angulatifformis</i>	(Behrendsen); Riccardi et al., p. 115, pl. 14, figs 1, 2, 4, 5.
non	1971	<i>Favrella angulatifformis</i>	(Behrendsen); Riccardi et al., pl. 14, fig. 3
	1973	<i>Pseudofavrella angulatifformis</i>	(Behrendsen); Leanza and Leanza, p. 131, fig. 2. (Refigured Wright 1996, p. 64, pl. 48, fig. 2)
	1980	<i>Pseudofavrella angulatifformis</i>	(Behrendsen); Leanza and Wiedmann, p. 954, pl. 4, fig. 1. (Refigured by Leanza 1981, pl. 7, figs 5, 6)
	1988	<i>Pseudofavrella angulatifformis</i>	(Behrendsen); Riccardi, pl. 5, figs 5, 6.
v	1997	<i>Pseudofavrella angulatifformis</i>	(Behrendsen); Aguirre-Urreta and Rawson, figs 7h,i.
v	2005	<i>Pseudofavrella angulatifformis</i>	(Behrendsen); Aguirre-Urreta et al. fig. 5 c, d.

**Lectotype.** The original of Behrendsen (1892, pl. 4, figs 2b, c) designated by Spath (1939, p. 147, footnote). Bodenbender collection, Geowissenschaftliches Museum, Göttingen University, catalogue no. 498–24.

**Type locality.** Truquicó.

**Material.** 73 specimens: 1 from Río Diamante bridge (CPBA 20662), 1 from Arroyo La Carpa (CPBA 20663), 12 from Cerro La Parva (CPBA 18017.1–4, 20664.1–8), 27 from Truquicó (CPBA 20659.1–22, 20665.1–2, 20666.1–3) and 32 specimens from Pichaihue valley (CPBA 20667.1–32).

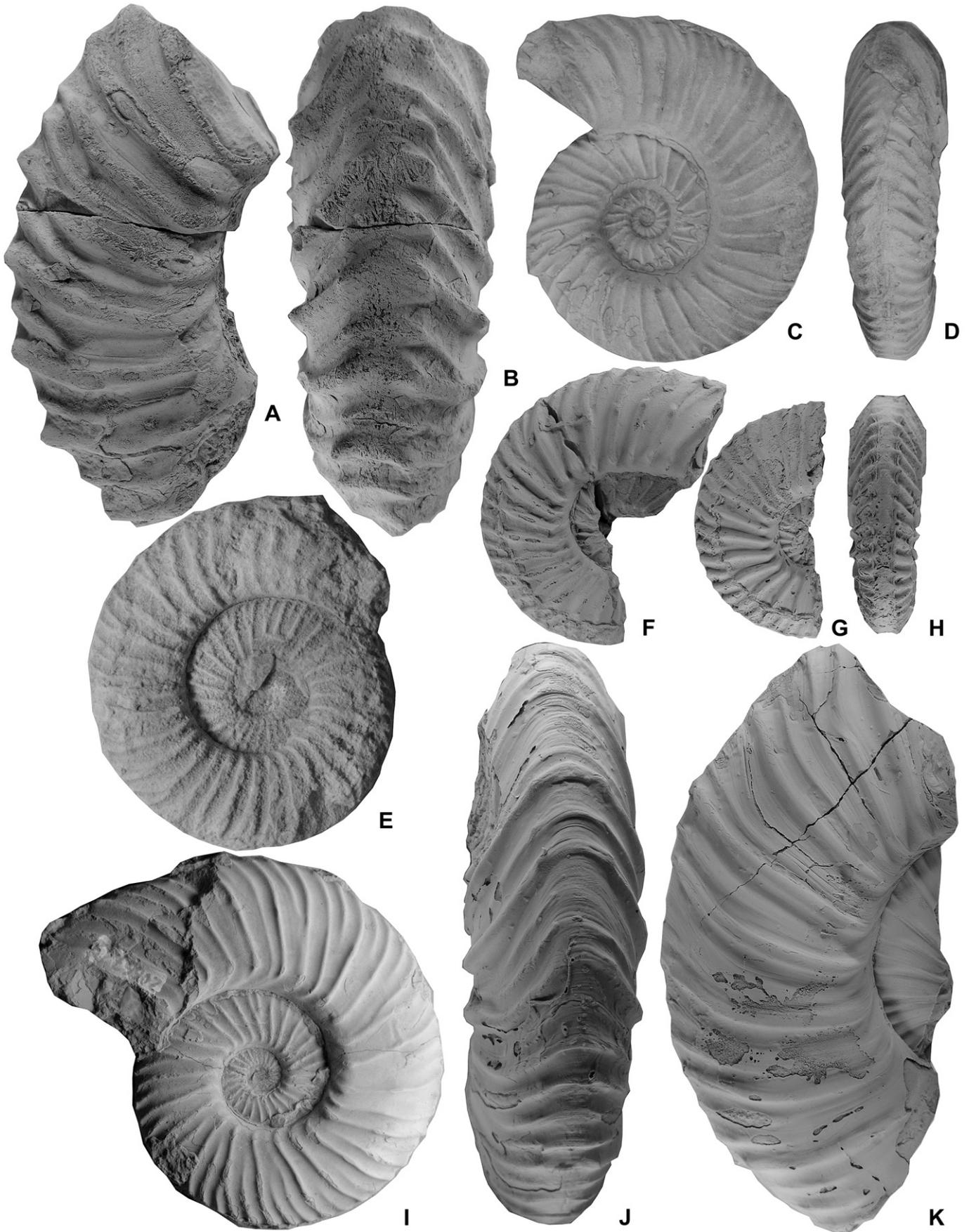
**Description.** Maximum diameter at least 132 mm (CPBA 20667.27). The body chamber occupies at least 2/3 of a whorl. Shell moderately compressed, evolute, flat or slightly curved on the lower flank then converging gently towards the venter; whorl broadest in mid flank. Umbilical wall slopes inwards. Strong, almost straight primary ribs arise singly on the umbilical wall, where they are slightly rursiradiate. On the flanks the primary ribs are prorsiradiate, bending forward more strongly on the outer part of the flank. Normally they are trituberculate, bearing umbilical, mid-lateral and ventro-lateral tubercles, but occasionally the mid-lateral tubercle is not developed. The strength of the tubercles varies from one individual to another, from very weak to almost spinose. There are about 38 primary ribs per whorl at about 70 mm diameter. Rarely, a secondary is intercalated low on the flank, but normally they are intercalated, or a primary rib divides, at or just above the mid-lateral tubercle; some primaries remain single. Secondaries bear ventro-lateral tubercles which are sometimes smaller than those on the primaries. The trituberculate primaries usually stand out more strongly than the bituberculate primaries and the secondaries, especially in more advanced growth stages. There are 60 ribs in the ventral region at diameters of 70 mm; the ratio of ventral to umbilical ribs varies from about 1.6 to 2. The ribs form obtuse chevrons across the venter until the adult body chamber, where they curve across it; the mid-line of the venter is usually slightly raised. On the adult body chamber of specimen CPBA 20667.27 fine radial striae occur between the ribs.

*Dimensions of figured specimens*

	d	wh	wh%d	wt	wt%d	wu	wu%d	pr. <sup>a</sup>	sec. <sup>a</sup>
CPBA 20667.1	46.1	19.6	42.5	14.7	31.8	13.4	29.1	12	24
CPBA 20667.8	60.8	22.7	37.3	–	–	23.1	38	16	26
CPBA 20663	69.7	22.3	32	–	–	29.6	42.5	19	30
CPBA 20667.12	72.2	24.5	33.9	20.7	28.7	27.5	38	20	32
CPBA 20667.29	82.5	28.5	34.5	–	–	30.4	36.8	15	29

<sup>a</sup> primary and secondary ribs per half whorl.

**Discussion.** *P. angulatifformis* differs from *P. garatei* in being more evolute, with almost straight rather than slightly flexuous ribs, and in the development of umbilical and mid-lateral tubercles.



**Fig. 6.** *Pseudofavrella angulatiformis* (Behrendsen). A-B, CPBA 20664.2, Cerro La Parva; C-D, CPBA 20667.12, Pichaihue valley; E, CPBA 20663, Arroyo La Carpa; F, CPBA 20667.8, Pichaihue valley; G-H, CPBA 20667.1, Pichaihue valley; I, CPBA 20667.29, Pichaihue valley; J-K, CPBA 20667.18, Pichaihue valley. All specimens x 1, coated with ammonium chloride.

Spath (1939, p. 147, footnote) suggested that the smaller of the two syntypes figured by Behrendsen (1892, p. 16, pl. 4, fig. 2a) “cannot be of the same genus as the larger fragment” and referred to its “*Deshayesites*-aspect”. However, Riccardi et al. (1971) retained the specimen in “*Favrella*” *angulatiformis*. Examination of the original (Bodenbender collection, Göttingen University, catalogue no. 498-25) by one of the authors (PFR) confirms that it is conspecific with the lectotype.

*Pseudofavrella australis* (Leanza and Wiedmann 1980)

Fig. 7 A–L

- ? 1950 *Lyticoceras pseudoregale* (Burckhardt): Giovine, p. 46, pl. 1, figs 1, 2.
- \* 1980 *Lyticoceras australe* Leanza and Wiedmann, p. 950, pl. 4, figs 2, 3.
- 1980 *Acanthodiscus vaceki* (Neumayr and Uhlig): Leanza and Wiedmann, p. 952, pl. 6, fig. 2. (Refigured Leanza 1981, pl. 7, figs 9, 10)
- ? 1980 *Neocomites crassicosatus* Gerth: Leanza and Wiedmann, p. 952, pl. 5, fig. 1.
- 1981 *Lyticoceras australe* Leanza and Wiedmann: Leanza, pl. 7, fig. 7
- v 1995 “*Lyticoceras*” *australe*: Aguirre-Urreta and Rawson, p. 11, pl. 2, figs b, c

**Holotype.** The original of Leanza and Wiedmann (1980, pl. 4, fig. 2). SNGM 15006.

**Type locality.** Pichaihue Valley.

**Material.** 186 specimens: 1 from Arroyo Relincho (CPBA 17504), 6 from Buta Ranquil (CPBA 20668.1-6), 35 from Truquicó (CPBA 20657.1-30, 20656.1-5), 2 from Mina San Eduardo (CPBA 16269.1-2), 5 from Chorriaca (CPBA 20670.1-5), 64 from Pichaihue valley (CPBA 13956, 20673.1-63), 3 from Provincial Road 33 (CPBA 20671.1-3), 4 from El Durazno (CPBA 20674.1-4), 20 from Casa Nuestra (CPBA 18333.1-20), 15 from Río Salado (S4) (CPBA 16976.1-13, 16977.1-2), 25 from Río Agrio (CPBA 20672.1-25), 5 from Cerro Mesa (CPBA 18026.1-4, 20648) and 1 from Cerro Negro de Covunco (CPBA 19276).

**Description.** The maximum diameter is at least 230 mm (CPBA 20657.29). The body chamber occupies at least half a whorl. The shell is slightly to moderately inflated, slightly evolute to involute, maximum width at or below mid flank, with very steep to vertical umbilical wall and an almost flat venter. There are two distinct growth stages. In the earlier whorls (normally to 70–80 mm diameter) the shell is slightly to moderately evolute and the flanks are slightly curved, converging towards the venter. Primary ribs arise singly on the umbilical wall, where they are slightly rursiradiate. At the umbilical margin most ribs swell and bear a tubercle, but some remain more subdued and non-tuberculate. The primaries normally branch, or a secondary is intercalated, either just above the tubercle or at varying levels in mid flank. The ribs are slightly flexuous and gently prorsiradiate over the flank, bending forward a little more strongly near the venter, where they form obtuse chevrons that tend to fade along the mid-line of the venter. All the ribs bear small, sharp, ventro-lateral tubercles. During growth some of the primary ribs begin to stand out more strongly than others and develop a mid-lateral tubercle in addition to the umbilical and ventro-lateral ones, leading to the second growth stage. This is characterised by a slightly more inflated, more evolute shell crossed by strong, trituberculate primary ribs. The strength of the tubercles varies from one individual to another, and occasionally the mid lateral tubercles are not developed. Between the primaries a much weaker secondary may be intercalated at varying positions on the flank, but with further growth these often disappear. There are about 28–30 primary ribs and 50–60 secondary ribs per whorl at about 60–80 mm diameter.

*Dimensions of figured specimens*

	d	wh	wh%d	wt	wt%d	wu	wu%d	pr. <sup>a</sup>	sec. <sup>a</sup>
CPBA 20673.1	46.7	18.8	40.2	17.7	37.9	15.4	33	14	25
CPBA 20673.3	53.2	22.7	42.7	–	–	15.9	29.9	13	30
CPBA 19276	69.1	31.1	45	27.3	39.5	20.3	29.4	14	29
CPBA 20673.19	72.9	28.1	38.5	28.0	38.4	28.5	39.1	15	26
CPBA 20673.22	77.7	29.1	37.4	25.4	32.7	28.1	36.2	14	25
CPBA 20672.25	81.6	34.6	42	30.6	37.5	23.6	28.9	14	25
CPBA 20673.99	127	50.1	39.4	40.2	31.6	46.1	36.3	14	23

<sup>a</sup> primary and secondary ribs per half whorl.

**Discussion.** This form shows considerable variation in the stage at which the stronger, bi- or trituberculate ribbing develops and in the strength of the tuberculation. Leanza and Wiedmann’s (1980) holotype of their new species *Lyticoceras australe* represents only the earlier growth stage of the species, before the stronger ribs develop. The ample material in our collection showing both this and the more advanced growth stage demonstrates without doubt that the specimen which Leanza and Wiedmann (1980, pl. 6, fig. 2) figured as the European species *Acanthodiscus vacecki* is simply the more advanced growth stage of *Lyticoceras australe*. The true *A. vacecki* is more involute and in early to intermediate growth stages the ventro-lateral swellings are clavate rather than tuberculate.

The specimen from Pichaihue that Leanza and Wiedmann (1980) figured as *Neocomites crassicosatus* Gerth may be a variant of *P. australis* in which stronger ribbing sets in early in ontogeny. But the ribs are also more bundled in the inner whorls than in our examples.

*Pseudofavrella pseudoregalis* (Burckhardt)

Fig. 8 A–I

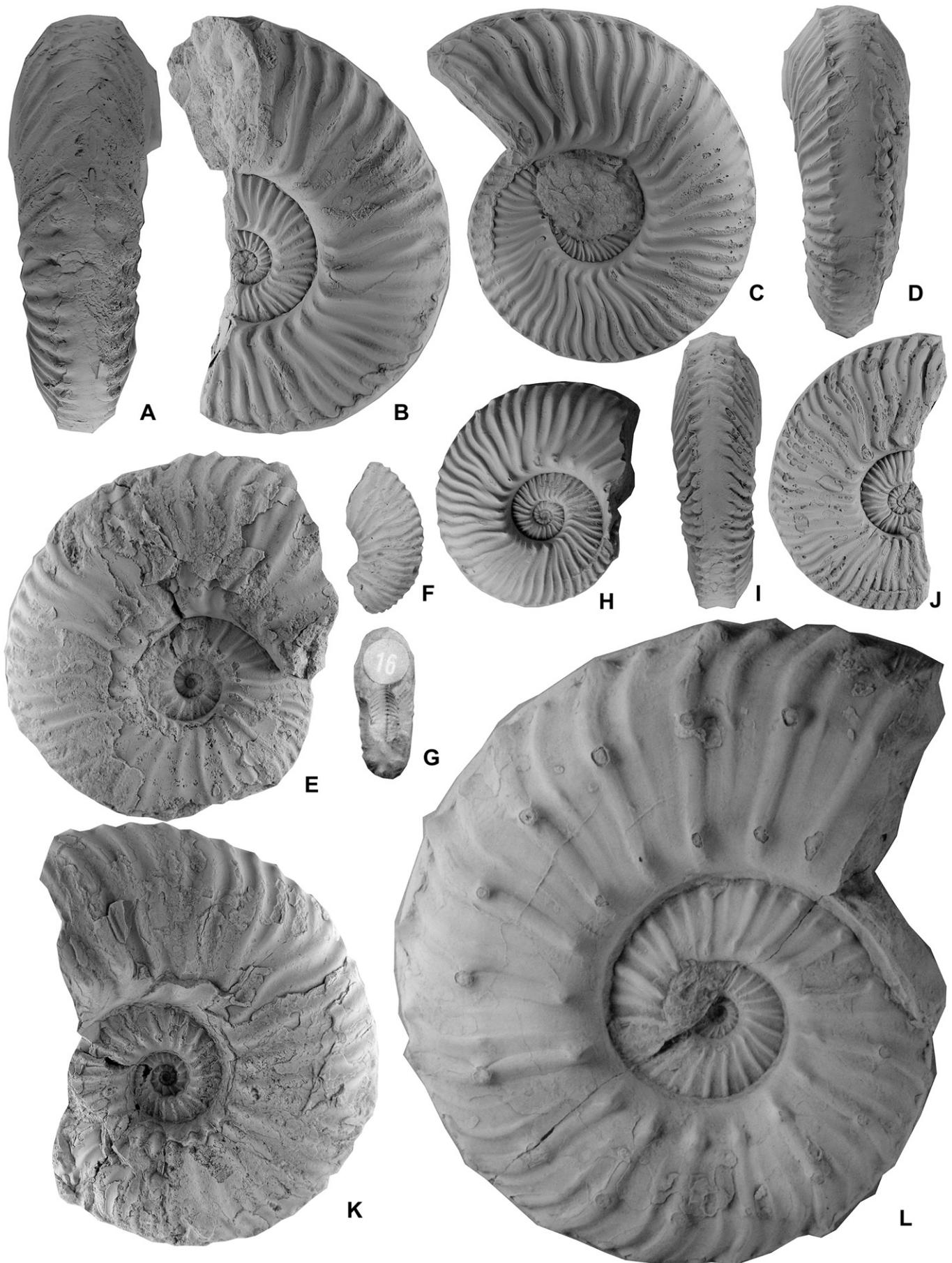
- \* 1903 *Hoplites pseudoregalis* Burckhardt, p. 68, pl. 11, figs 18–22.
- 1921 *Neocomites pseudoregalis* (Burckhardt): Gerth, p. 147
- 1925 *Neocomites pseudoregalis* (Burckhardt): Gerth, p. 105
- 1931 *Neocomites pseudoregalis* (Burckhardt): Windhausen, pl. 35, fig. 3 a–b (re-illustration of Burckhardt 1902, pl. 11, figs. 18, 20).
- non 1966 *Neocomites pseudoregalis* (Burckhardt): Fuenzalida Ponce, p. 140, figs 32, 33.
- 1988 *Lyticoceras pseudoregale* (Burckhardt): Riccardi, pl. 6, figs 2, 3.
- v non
- 1993 *Lyticoceras pseudoregale* (Burckhardt): Aguirre-Urreta, pl. 3, fig. 2.

**Lectotype.** The original of Burckhardt 1903, pl. 11, figs 18–20, designated here. The specimen was in the Hauthal collection but has not been traced.

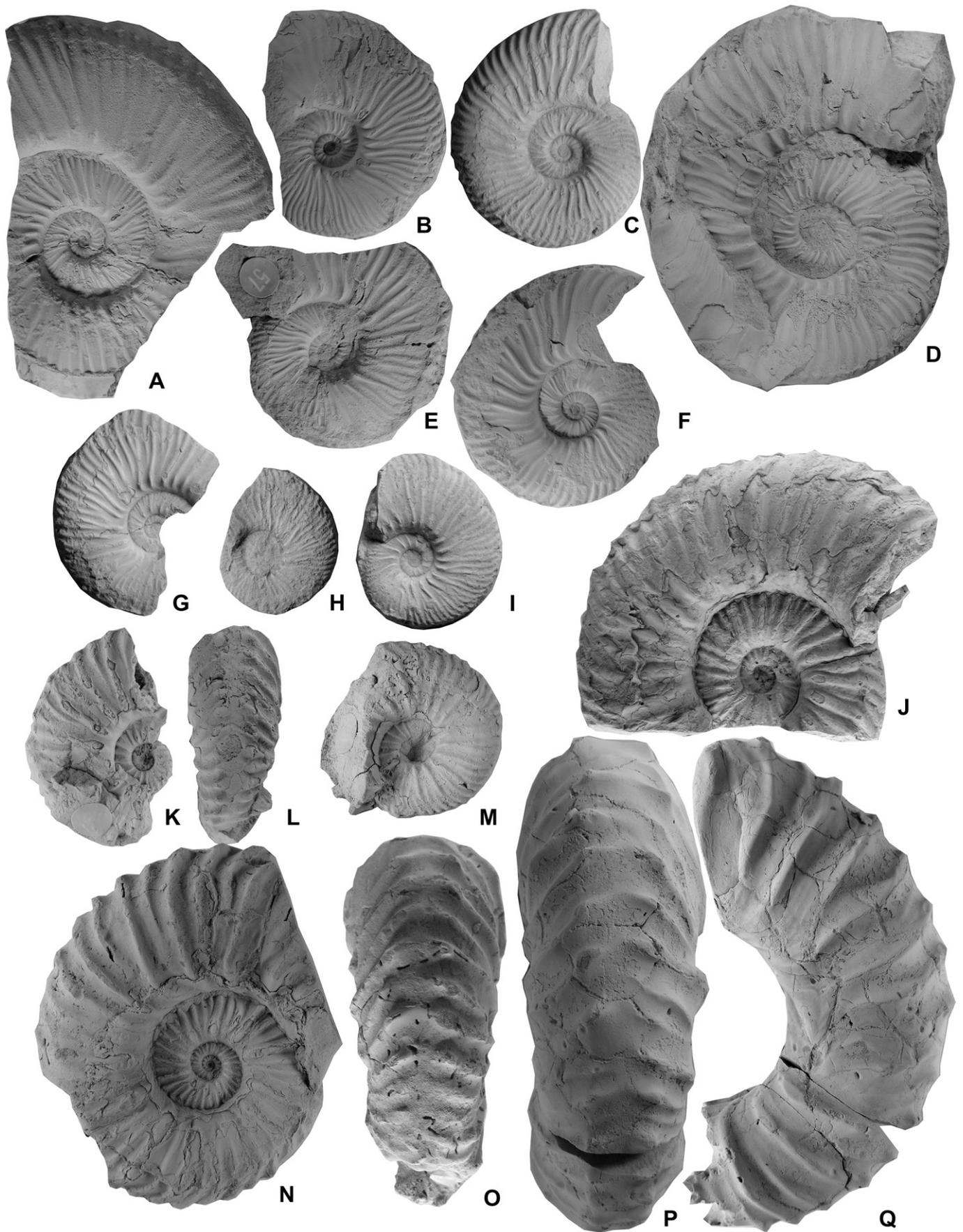
**Type locality.** Arroyo Las Yeseras.

**Material.** 38 specimens: 13 from Arroyo Las Yeseras (CPBA 20655.1-13), 5 from Pichaihue valley (CPBA 20654.1-5), 15 from Upper Pichaihue (CPBA 20652.1-15) and 5 from Trahuncura (CPBA 20653.1-5).

**Description.** The largest specimen is 70 mm diameter (CPBA 20655.3). The shell is moderately compressed, moderately involute to slightly evolute, with almost flat to gently curved flanks that converge gently towards the venter; whorl broadest at mid flank; whorl section compressed-oval. Umbilical wall arched. Primary ribs arise singly on the umbilical wall, and swell slightly to form an incipient tubercle on the umbilical margin. On the flanks they are prorsiradiate and normally gently flexuous. The rib pattern is irregular; some ribs branch from the umbilical tubercle, others are intercalated at about the same level, while others branch or are intercalated on the mid flank. The ratio of ventral/primary ribs decreases with growth, from 3.3 at 35 mm diameter to 2.25 at



**Fig. 7.** *Pseudofavrella australis* (Leanza and Wiedmann). A-B, CPBA 20673.22, Pichaihue valley; C-D, CPBA 20673.19, Pichaihue valley; E, CPBA 19276, Cerro Negro de Covunco; F-G, CPBA 20672.23, Río Agrío; H, CPBA 20673.1, Pichaihue valley; I-J, CPBA 20673.3, Pichaihue valley; K, CPBA 20672.25, Río Agrío; L, CPBA 20673.99, Pichaihue valley. All specimens x 1, coated with ammonium chloride.



**Fig. 8.** A-I, *Pseudofavrella pseudoregalis* (Burckhardt). A, CPBA 20655.2, Arroyo Las Yeseras; B, CPBA 20655.9, Arroyo Las Yeseras; C, CPBA 20652.1, Upper Pichaihue; D, CPBA 20655.1, Arroyo Las Yeseras; E, CPBA 20655.10, Arroyo Las Yeseras; F, CPBA 20655.6, Arroyo Las Yeseras; G, CPBA 20652.2, Upper Pichaihue; H, CPBA 20652.4, Upper Pichaihue; I, CPBA 20652.3, Upper Pichaihue. J-Q, *Pseudofavrella robusta* sp. nov. J-M, Paratypes, J, CPBA 20658.4; K-L, CPBA 20658.6, M, CPBA 20658.7; N-O, Holotype, CPBA 20658.1; P-Q, Paratype, CPBA 20658.3, Río Agrio. All specimens x 1, coated with ammonium chloride.

75 mm diameter. All ribs bear small ventro-lateral clavi and form very obtuse chevrons on the venter, which is feebly arched.

#### Dimensions of figured specimens

	d	wh	wh%d	wt	wt%d	wu	wu%d	pr. <sup>a</sup>	sec. <sup>a</sup>
CPBA 20652.4	29.3	13.6	46.4	9.9	33.8	–	–	–	–
CPBA 20652.3	33.9	15.9	46.9	12.3	36.3	8.8	25.9	15	37
CPBA 20655.10	43.4	18.7	43.1	–	–	11.6	26.7	13	–
CPBA 20652.1	46.3	19.3	41.7	11.7	25.3	13.2	28.5	19	35
CPBA 20655.9	46.6	20.7	44.4	14	30	11.7	25.1	13	34
CPBA 20655.6	50.3	20.3	40.3	13.6	27	16.1	32	13	30
CPBA 20655.2	74.8	27.2	36.4	21.2	28.3	28.3	37.8	22	–
CPBA 20655.1	74.9	27.2	36.3	–	–	28.5	38	19	–

<sup>a</sup> primary and secondary ribs per half whorl.

**Discussion.** Most of our specimens from Arroyo La Yesera are partially distorted and/or incomplete, but it is clear that most are more evolute than the lectotype and other previously figured specimens. But we regard them as variants of one species; they were collected from the same horizon as Burckhardt's original material and specimen CPBA 20655.9 (Fig. 8 B) is as involute as the original material, while CPBA 20655.3 is a well-preserved intermediate form. The specimens collected in Upper Pichaihue are very close to those of the type locality, though some of the smaller specimens (e.g. CPBA 20652.3, Fig. 8 I) show more curved flanks resulting in a rounded whorl section.

The exact position of *P. pseudoregalis* in the Neuquén ammonite sequence has long been problematic. The stratigraphical relationships of specimens from the type locality remains unknown as no other ammonites have been found above or below. The specimens from Upper Pichaihue are also an isolated find. However, in Pichaihue valley there are flattened ammonites just above the beds with *P. australis* and below the *Chacantuceras* beds that appear identical to flattened specimens of *P. pseudoregalis* that occur with 3-dimensional ones at Upper Pichaihue. *P. pseudoregalis* differs from the younger *Decliveites agrionensis* described below in becoming more evolute with growth, having less flexuous ribs, and a steep umbilical wall.

We place this species in *Pseudofavrella* despite its uniformly fine ribbing to an advanced, and possibly adult, growth stage because of its similarity to the inner whorls of *P. australis* and its stratigraphical relationship with other late *Pseudofavrella*.

#### *Pseudofavrella robusta* sp. nov.

Fig. 8 J–Q

**Holotype.** The specimen CPBA 20658.1 designated here.

**Etymology.** From 'robustus' (latin), referring to the robust nature of the ribbing.

**Type locality.** Río Agrio, SW of Bajada del Agrio.

**Paratypes.** 8 specimens: 6 from Río Agrio (CPBA 20658.2–7) and 2 from Cerro Mesa (CPBA 20647.1–2).

**Description.** Maximum diameter more than 90 mm. The body chamber occupies at least half of a whorl. Shell moderately inflated, moderately evolute, maximum width at or below mid flank, with very steep to vertical umbilical wall and an almost flat venter. In the earlier whorls the primary ribs are of uniform size to about 25 mm diameter, when some start to become more prominent and umbilical, mid-lateral and weak ventro-lateral tubercles appear. These ribs are separated by one or two long, weaker ribs which bear umbilical and ventro-lateral tubercles only. Occasionally a non-tuberculate secondary rib is intercalated at mid flank. On the body chamber, weaker ribs alternate with the stronger and are intercalated on mid flank, while the mid lateral tubercles diminish on the stronger ribs.

#### Dimensions of figured specimens

	d	wh	wh%d	wt	wt%d	wu	wu%d	pr. <sup>a</sup>	sec. <sup>a</sup>
CPBA 20658.7	34.8	16.6	47.7	12.1	34.8	11.7	33.6	11	28
CPBA 20658.1 (holotype)	74.4	31	41.7	30.3	40.7	26.2	35.2	11	–
CPBA 20658.2	82	35.1	42.8	31.5	38.4	25.3	30.8	11	23
CPBA 20658.3	96.5	35.7	37	33.2	34.4	33.0	34.2	9	16

<sup>a</sup> primary and secondary ribs per half whorl.

**Discussion.** Most of the material is from Río Agrio, where *P. robusta* co-occurs with *P. australis*. *P. robusta* has not been found with that species at Pichaihue valley but may be represented by flattened impressions in the red-weathering beds just above the main *P. australis* horizon. Two fragmentary specimens from Cerro Mesa are included in this species for their inflated whorl section and prominent ornamentation. Some flattened fragments from a sandstone just above the base of the Pilmatué Member at Agua la Mula are identified as *P. cf. robusta* (CPBA 18351–52).

*P. robusta* is more coarsely ribbed and has a more inflated shell than *P. australis*, and the trituberculate rib stage appears much earlier.

#### *Pseudofavrella* sp. nov. 1

Fig. 9 A–E

**Discussion.** Four fragmentary specimens from Río Agrio (CPBA 20651.1–4) and one specimen from Pichaihue valley (CPBA 20650, Fig. 9 C–D) have a slightly involute, slightly inflated shell with oval whorl section and slightly rounded venter. The primary ribs branch or a secondary is intercalated, a third to half-way over the flank. There are about 3 secondaries per primary. The specimens CPBA 20651.1 and 20651.4 (Fig. 9 A–B, E) are the best-preserved and preserve part of the body chamber. The Pichaihue valley specimen is a body chamber. The ribs curve forwards very gently over the venter, where they all bear very small ventro-lateral tubercles. This form is more involute than *P. australis* and lacks the trituberculation of that species.

#### *Pseudofavrella* sp. nov. 2

Fig. 9 F–H

**Discussion.** Ten body chamber fragments (CPBA 20649.1–10) from bed PP7 in Pichaihue valley (Fig. 3) are inflated, with an almost triangular whorl section. The ribs curve forward over the flank, and occasionally branch or secondaries are intercalated. They form very obtuse chevrons across the venter.

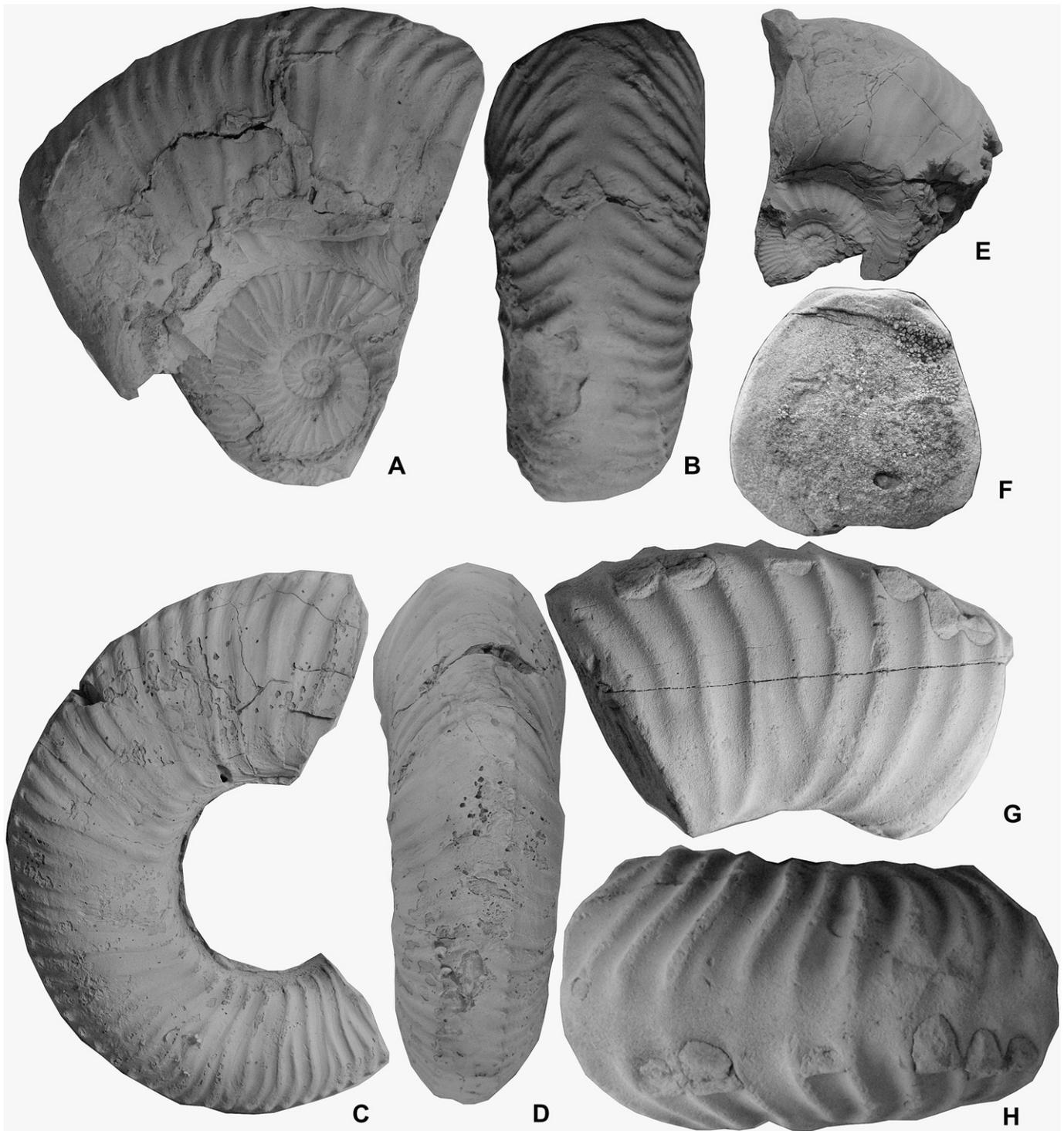
#### Genus *Chacantuceras* Aguirre-Urreta and Rawson, 1999

**Type species.** *Neocosmoceras ornatum* Olivero, 1983

**Diagnosis.** Large (probably to at least 500 mm diameter), evolute with strong, bi-spinose or tri-spinose ribs from an early growth stage.

**Discussion.** *Chacantuceras* was proposed for some evolute, strongly-ribbed, trituberculate Valanginian ammonites that had previously been confused with either the Berriasian genus *Neocosmoceras* or the early Hauterivian European genus *Acanthodiscus*. It is limited to the mid part of the *Pseudofavrella angulatiformis* Zone of the Agrio Formation, whereas *Neocosmoceras* occurs considerably lower, in the Vaca Muerta Formation. *Hoplitocrioceras*, which occurs higher than *Chacantuceras* (Aguirre-Urreta and Rawson, 2001) differs from *Chacantuceras* in uncoiling slightly, and in having a more inflated, sub-triangular whorl section, and more widely spaced primary ribs with more numerous secondaries.

*Chacantuceras* probably evolved from the immediately preceding *Pseudofavrella*, whose later forms include the inflated, trituberculate body chamber fragments assigned to *P. robusta*.



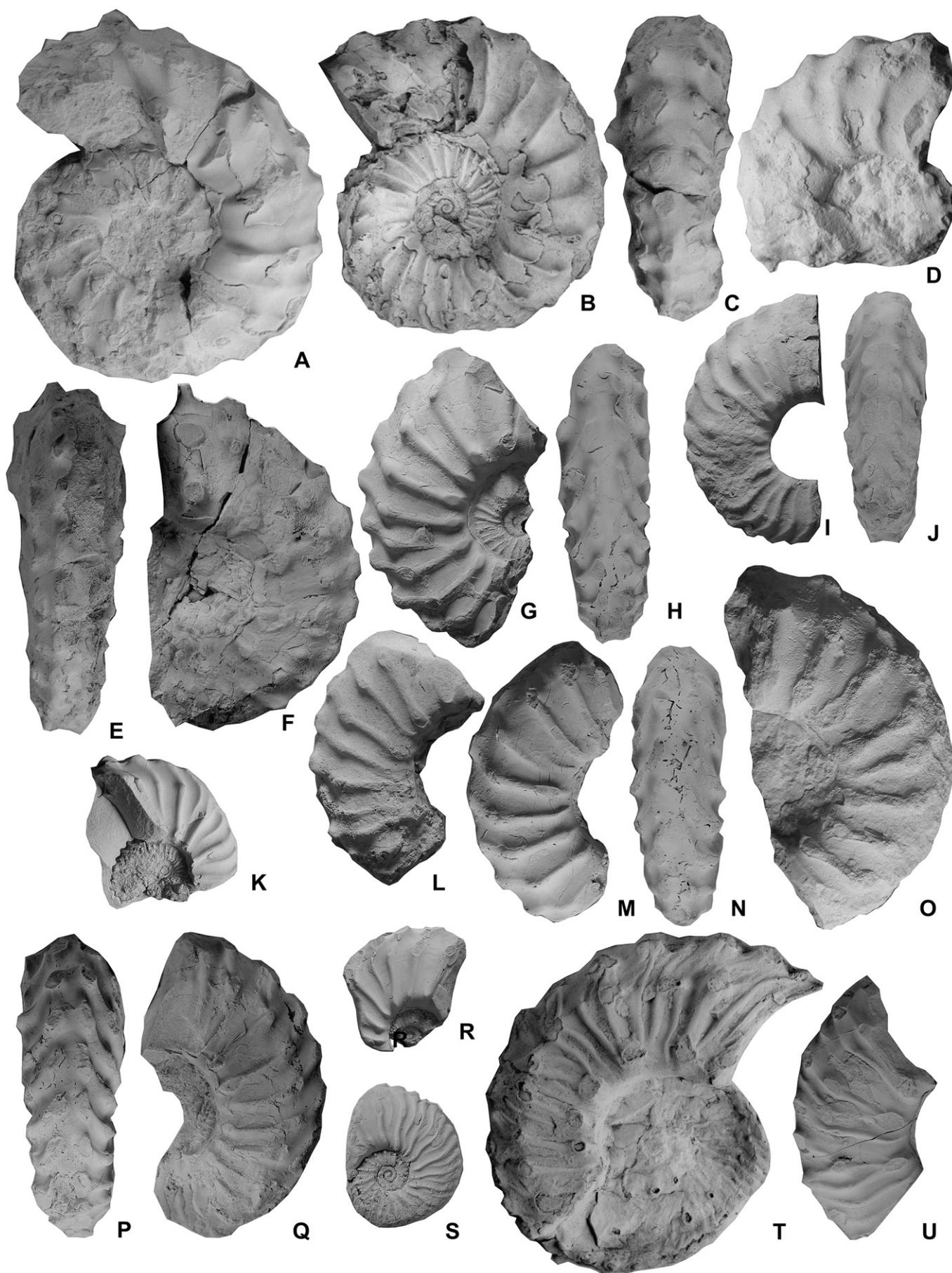
**Fig. 9.** A-E, *Pseudofavrella* sp. nov. 1. A-B, CPBA 20651.1, Río Agrio; C-D, CPBA 20650, Pichaihue valley; E, CPBA 20651.4, Río Agrio. F-H. *Pseudofavrella* sp. nov. 2, CPBA 20649.8, Pichaihue valley. All specimens x 1, coated with ammonium chloride.

*Chacantuceras ornatum* (Olivero, 1983)

Fig. 10 A–F

- ?1980 *Acanthodiscus* ex. aff. *hookeri* (Blanford); Leanza and Wiedmann, pl. 7, fig. 1  
 v\* 1983 *Neocosmoceras ornatum* Olivero, p. 17, pl. 1, figs a–c, text-fig. 2 (figs a, c refigured Aguirre-Urreta and Rawson 1999, figs 3a, b)

- v 1983 *Neocosmoceras* sp. Olivero, p. 18, pl. 1, figs d, e  
 v 1995 '*Acanthodiscus*' sp. nov. Aguirre-Urreta and Rawson, pl. 2, figs. d, e. (refigured Aguirre-Urreta and Rawson 1999, figs 4j, 5e)  
 v 1997 '*Acanthodiscus*' sp. nov. Aguirre-Urreta and Rawson, fig. 7a, b.  
 v 1999 *Chacantuceras ornatum* (Olivero), Aguirre-Urreta and Rawson p. 359, figs 3–6 (Fig 5b refigured Aguirre-Urreta et al. 2005, fig. 5f; Aguirre-Urreta et al. 2007, fig. 11 B)  
 v 2001 *Chacantuceras ornatum* (Olivero), Aguirre-Urreta, p. 82.



**Fig. 10.** A-F, *Chacantuceras ornatum* (Olivero). A, CPBA 20640, Agua de la Mula; B-C, CPBA 18380, Pichaihue valley; D, CPBA 20638 cast, Puente del Inca; E-F, CPBA 18381.2, Pichaihue valley. G-S, *Chacantuceras casanuestraeense* sp. nov. G-H, Holotype, G-H, CPBA 20636.1, Casa Nuestra; I-S, Paratypes: I-J, CPBA 20633.2, Río Agrio; K, CPBA 20636.4, Casa Nuestra; L, CPBA 20633.3, Río Agrio; M-N, CPBA 20636.3, Casa Nuestra; O, CPBA 20632, Cerro Birrete; P-Q, CPBA 20633.1, Río Agrio; R, CPBA 20636.8, Casa Nuestra; S, CPBA 20633.15, Río Agrio. T-U, *Chacantuceras coniunctum* sp. nov. T, Holotype, CPBA 20603.1, Casa Nuestra; U, Paratype, CPBA 18251, El Salado. All specimens x 1, coated with ammonium chloride.

**Holotype.** An external mould and silicone rubber cast figured by Olivero (1983, pl. 1, fig. c), CIRGEO PI 253.

**Type locality.** Tres Lagunas, Chubut, Austral Basin.

**Material.** 218 specimens: 1 from Puente del Inca (CPBA 20638 cast), 1 from Lomas Bayas (CPBA 20637), 42 from Pichaihue valley (CPBA 13954, 18380, 18381.1-2, 18382.1-38), 4 from Sierra Lonco Vaca (CPBA 20642.1-4), 57 from Casa Nuestra (“Lonco Vaca” (CPBA 18127, 16972.1-11, 16966.1-5, 18335.1-16, 18336.1-4, 16968.1-7, 16969.1-7, 20644.2, 20641, MLP 20379-20382 (Col. Gutiérrez)), 4 from Chorriaca (CPBA 20643.1-4), 23 from Agua de la Mula (CPBA 16970.1-11, 18379 (Col. Dásquez), 20639.1-6, 20640, 20645.1-3, MLP 20446 Col. Gutiérrez), 42 from Provincial Road 33 (CPBA 18383.1-8, 18384.1-3, 18385.1-5, 18386.1-2, 18383.1-11, 18387.1-13), 3 from Arroyo Pilmatué (MLP 21634, 21639, 21641), 20 from “Pigmatué” (CPBA 16965.1-20, Humprey collection, the exact position of this locality is unknown), 5 from Río Salado (MLP 20995-20997, 20999-21000 (Col. Gutiérrez)), 2 from Río Agrio (MLP 21917 (Col. Gutiérrez)), 4 from Cerro Mesa (CPBA 18025.1-3, 20646) and 10 from El Durazno (CPBA 18388.1-10).

**Description** (slightly modified from Aguirre-Urreta and Rawson 1999, p. 359). Large (to at least 500 mm diameter), evolute. The earliest whorls, to about 20 mm in diameter, are hardly visible, but appear to be coarsely ribbed from only a few mm diameter, with flat flanks. In juvenile to intermediate growth stages (20 mm to 150-200 mm diameter) the whorl section is sub-hexagonal, moderately compressed to slightly inflated, with flat flanks and venter. Strong, coarse ribs are convex forward across the flank, terminating at a ventro-lateral spine. Most ribs are trispinose, with stout umbilical, mid-lateral and ventro-lateral spines (represented on internal moulds by a swollen tubercle). Sometimes a weaker rib appears, either at the umbilical edge or on the lower part of the flank, with no umbilical spine, only a weak mid-lateral spine, but a ventro-lateral spine as strong as the adjacent ones. In rare cases, such a rib swings forward from the mid-lateral swelling to share a ventro-lateral spine with the stronger rib in front. The umbilical and mid-lateral spines stand perpendicular to the shell, while the ventro-lateral spines point obliquely outward, to rest against the umbilical seam of the next larger whorl. Opposing ventro-lateral spines are usually joined by a slightly ridge across the ventral margin.

In large specimens the strength of the ribs and spines diminishes at a varying growth stage, but usually above about 200 mm diameter. Initially the umbilical spine is reduced to a slight swelling, then the mid-lateral spine, and eventually the ventro-lateral spine too. Thus large (though still septate) fragments often appear almost smooth, but one specimen of c. 300 mm diameter retains strong ribs and tubercles. As these changes take place the whorl section becomes slightly rounded.

Dimorphism apparently occurs, though because most specimens are incomplete it is difficult to prove. Strongly ribbed body chamber fragments of specimens some 50–100 mm diameter are very common and probably represent the mature microconch. Conversely, there are whorl fragments of specimens up to 300 mm diameter which are still septate, and must represent individuals of 500 mm or more in diameter.

The external suture line is rather simple, with large asymmetrical L and shorter E and U (Aguirre-Urreta and Rawson 1999, fig. 3d).

**Dimensions of figured specimens**

	d	wh	wh%d	wt	wt%d	wu	wu%d
CPBA 18380	60.6	23.3	38.4	19.4	32	21.8	36
CPBA 18381.2	65.1	25.4	39	17.8	27.3	20.1	30.9
CPBA 20640	70.4	29	41.2	25.2	35.8	24.5	34.8

**Discussion.** Aguirre-Urreta and Rawson (1997) initially recorded this taxon as “*Acanthodiscus*” sp. nov., but it subsequently became apparent that it was conspecific with a taxon originally described from the Austral Basin. It thus provides one of the few examples of a species common to both the Austral and Neuquén basins. The holotype is one of the five fragmentary specimens known from the Austral Basin but *C. ornatum* is a widely distributed and common species in the Neuquén Basin. In museum collections it is often misidentified as “*Acanthodiscus*”.

Two specimens (CPBA 20644. 1, 3) from Casa Nuestra are late forms of the *C. ornatum* group in which the venter is slightly narrower than in typical forms though the ribs are similar and the tubercles/spine bases still strong. Two specimens from Río Salado (CPBA 16978.1-2) appear similar. All four ammonites are identified as *C. aff. ornatum* and are probably an evolutionary link to the overlying *C. casanuestraense* fauna.

*Chacantuceras casanuestraense* sp. nov.

Fig. 10 G–S

**Holotype.** The specimen CPBA 20636.1 designated here.

**Etymology.** Named after the type locality of the species.

**Type locality.** Casa Nuestra.

**Paratypes.** 40 specimens: 18 specimens from Casa Nuestra (20636.2-19), 3 from Chorriaca (CPBA 20635.1-3), 1 from Provincial Road 33 (CPBA 20634), 2 from Agua de la Mula (M6) (CPBA 20631.1-2), 15 from Río Agrio (CPBA 20633.1-15), and 1 from Cerro Birrete (CPBA 20632).

**Description.** *C. casanuestraense* is known almost exclusively from body chamber fragments of specimens between about 40 and 70 mm diameter, though one small specimen (CPBA 20633.15, Fig. 10 S) of 28 mm diameter is partially septate, and shows that the characteristic ribs and tubercles have appeared by about 15 mm diameter. The shell is evolute, and moderately compressed. The flanks are almost flat on the lower two thirds, converging towards the venter on the outer third. The ribs are strong, trispinose, slightly or moderately prorsiradiate on the lower two thirds of the flank, strongly prorsiradiate on the outer part, the change occurring at the level of the lateral tubercle. They are mainly single and of constant strength, but an occasional one branches either at or near the umbilical tubercle or at the lateral, and on some specimens some ribs are a bit weaker than others. The venter is quite narrow, and smooth along the mid line.

The umbilical, lateral and ventro-lateral spines are represented on internal moulds by a swollen tubercle. Normally, the umbilical tubercle is the smallest, the ventro-lateral one the largest. But on some specimens there is a tendency for the lateral spines to be represented only by a very weak tubercle or almost disappear. The umbilical and mid-lateral spines stand perpendicular to the shell, while the ventro-lateral spines point obliquely upward.

**Dimensions of figured specimens**

	d	wh	wh%d	wt	wt%d	wu	wu%d
CPBA 20633.15	27.9	11.6	41.6	9.7	34.8	8.3	29.7
CPBA 20633.2	47.6	19.9	41.8	14.4	30.2	12.7	26.7
CPBA 20636.1 (holotype)	56.5	24.8	43.9	15.7	27.8	17.5	31
CPBA 20633.1	57.8	23.9	41.3	19.4	33.6	18.4	31.8
CPBA 20632	70.4	28	39.8	20.6	29.2	23.4	33.2

**Discussion.** Although it is known almost exclusively from microconch (?) body chambers, *Chacantuceras casanuestraense* is readily distinguished from microconchs of *C. ornatum*. The new species is more compressed and less strongly tuberculate, the ribs

are generally more prorsiradiate on both flanks and venter, and the venter is narrower than in typical examples of *C. ornatum*.

*Chacantuceras coniunctum* sp. nov.

Fig. 10 T–U

*Holotype*. The specimen CPBA 20603.1, designated here.

*Etymology*. ‘Coniunctus’, latin for ‘connected’, referring to the way some ribs join with others at a tubercle.

*Type locality*. Casa Nuestra.

*Paratypes*. 4 specimens: 2 from Casa Nuestra (CPBA 16985, 20603.2), 1 from El Salado (CPBA 18251), and 1 from Provincial Road 33 (CPBA 20602).

*Description*. The holotype is a half whorl corresponding to the body chamber and crushed phragmocone. The shell is evolute, moderately compressed and with steep umbilical wall. The whorl section is sub-hexagonal, with flat flanks on the lower two thirds, converging towards the venter on the outer third. The venter is narrow, and smooth along the mid line. The ribs are strong, most trispinose, rectiradiate on the lower two thirds of the flank, and prorsiradiate on the outer part, the change occurring at the level of the lateral tubercle. The ribs bear umbilical, mid-lateral and ventro-lateral spines, which are usually represented in the internal moulds by a rounded tubercle. The umbilical and mid-lateral spines stand perpendicular to the shell, while the ventro-lateral spines point obliquely upward. Sometimes a thin rib appears, either at the umbilical edge or on the lower part of the flank, with no umbilical spine, only with mid-lateral and/or ventro-lateral spine weaker than those of the adjacent ones. These thinner ribs may join the lateral tubercle and sometimes also the ventro-lateral tubercle of a strong rib forming a loop. In rare cases, two continuous fine ribs join the ventro-lateral tubercles also forming a loop.

*Dimensions of figured specimen*

	d	wh	wh%d	wt	wt%d	wu	wu%d
CPBA 20603.1 (holotype)	70	27	38.6	22	31.4	23	32.8

*Discussion*. Although this new species is also known almost exclusively from microconch (?) body chambers, it is readily distinguished from microconchs of both *Chacantuceras ornatum* and *C. casanuestrae*. The new species has a very narrow venter and the ribs are irregularly looped.

Genus *Decliveites* gen. nov.

*Etymology*. From ‘declive’ (latin), referring to the gently inward-sloping umbilical wall characteristic of the genus.

*Type species*. *Decliveites crassicosatus* sp. nov.

*Diagnosis*. Slightly evolute to moderately involute, moderately compressed, with *Neocomites*-like ribbing that varies from coarse in the earlier forms to moderately fine in the later. Umbilical wall slopes gently inward at all growth stages.

*Discussion*. *Decliveites* is one of a number of neocomitid genera that bear a superficial resemblance to the true *Neocomites*. It differs firstly in having an umbilical wall that slopes inward, whereas that of *Neocomites* is vertical or arched. The earlier *Decliveites* (*D. crassicosatus*) are also more coarsely ribbed than any true *Neocomites*, and the venter is slightly depressed along the mid-line. These forms are believed to be derived from late *Chacantuceras*, with which they overlap in range. Later forms (*D. agrioensis*) are more finely ribbed and therefore more *Neocomites*-like, but appear to represent the

end-member of this local Neuquén Basin lineage rather than being derived from the typical Mediterranean forms.

*Decliveites crassicosatus* gen. et sp. nov.

Fig. 11 A–R

v	2005 <i>Neocomites</i> sp. Aguirre-Urreta et al., fig. 5 g
v	2007 <i>Neocomites</i> sp. Aguirre-Urreta et al., fig. 11 C

*Holotype*. The specimen CPBA 19295.1 designated here.

*Etymology*. From ‘crassus’ (latin) referring to the coarse nature of the ribbing.

*Type locality*. Chorriaca.

*Paratypes*. 47 specimens: 3 from Pichaihue valley (CPBA 20608.1–2, 20630), 2 from Agua de la Mula (CPBA 20629, 20607), 26 from Casa Nuestra (CPBA 18334.1–2, 20606.1–2, 20626.1–22), 2 from Chorriaca (CPBA 19295.2–3), 11 from Río Agrio (CPBA 20604, 20627.1–10), 2 from Cerro Negro de Covunco (CPBA 7596.1–2) and 1 from Cerro Birrete (CPBA 20628).

*Description*. Maximum diameter at least 180 mm in the macroconch, but known mainly from body chamber fragments of ?microconch forms, to about 70 mm diameter. The body chamber occupies at least two thirds of a whorl. The shell is moderately compressed, slightly involute with almost flat flanks that converge gently towards the venter; the whorl is broadest on lower flank. The umbilical wall slopes gently inwards. Primary ribs arise singly or occasionally in pairs at the umbilical shoulder, where they may swell to form a feeble tubercle. There are about 16–24 primary ribs per whorl at about 40 mm diameter. Secondary ribs may be intercalated low on the flank or on the outer third, but in most specimens there are few intercalatories. The secondary/primary ratio varies from 2.7 to 1.4. The ribs are gently prorsiradiate on the lower flank but curve forward more on the outer flank. They bear strong ventro-lateral clavi and form right-angled chevrons on the venter, the mid-line of which is usually slightly depressed and almost smooth.

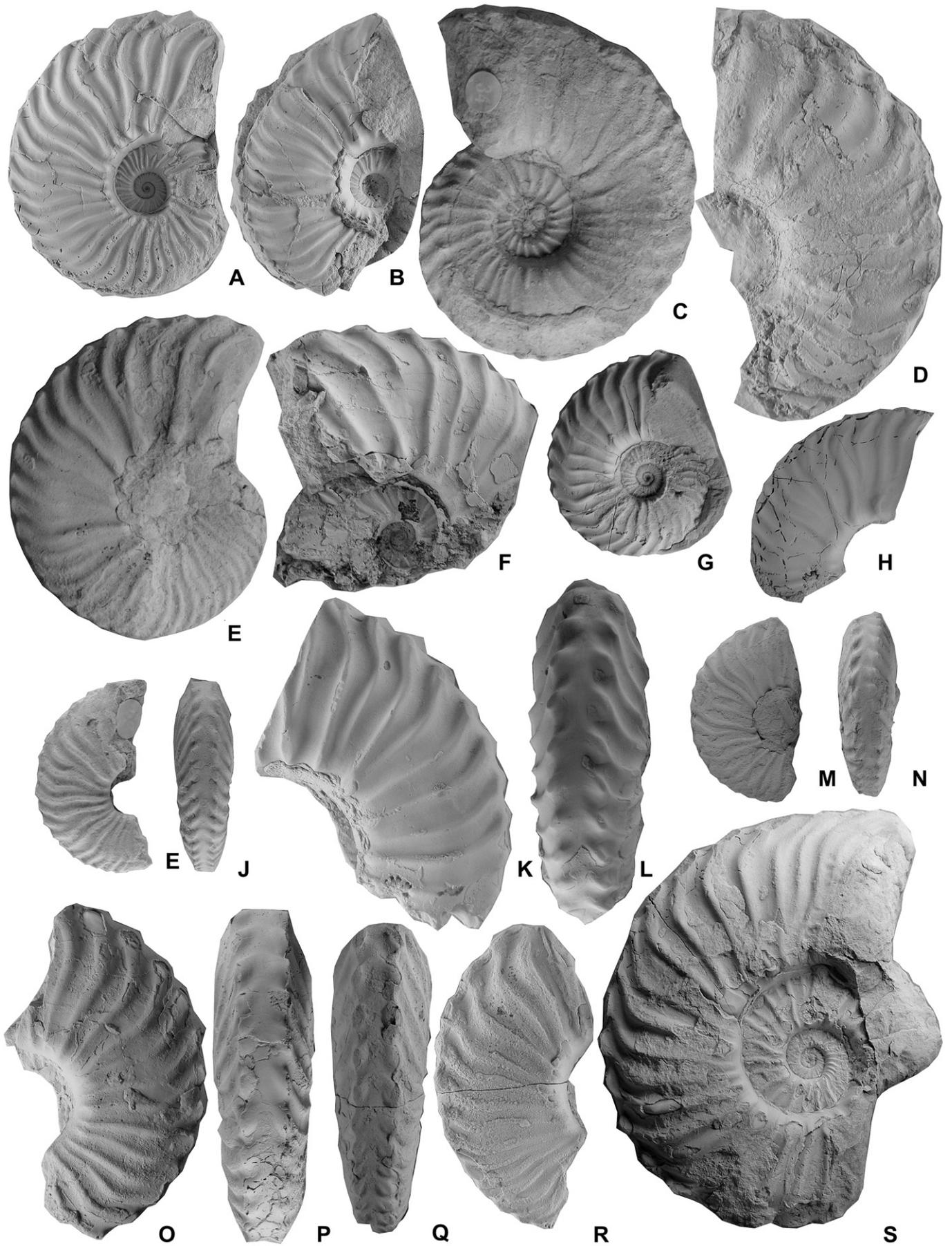
*Dimensions of figured specimens*

	d	wh	wh%d	wt	wt%d	wu	wu%d	pr <sup>a</sup>	sec <sup>a</sup>
CPBA 19295.2	36.1	16.2	44.9	11.2	31	–	–	11	16
CPBA 20627.3	37.8	18.4	48.7	11.6	30.7	10.1	26.7	8	17
CPBA 20626.1	39.5	18.3	46.3	12.8	32.4	10.1	25.6	12	16
CPBA 19295.1 (holotype)	57.5	26.2	45.6	–	–	14.5	25.2	12	19
CPBA 20627.2	67.8	30.6	45.1	20.9	30.8	–	–	7	19
CPBA 20629	70.4	31.4	44.6	22.4	31.8	20.3	28.8	14	22
CPBA 20606.1	80	37.1	46.4	26.9	33.6	20.6	25.7	8	14

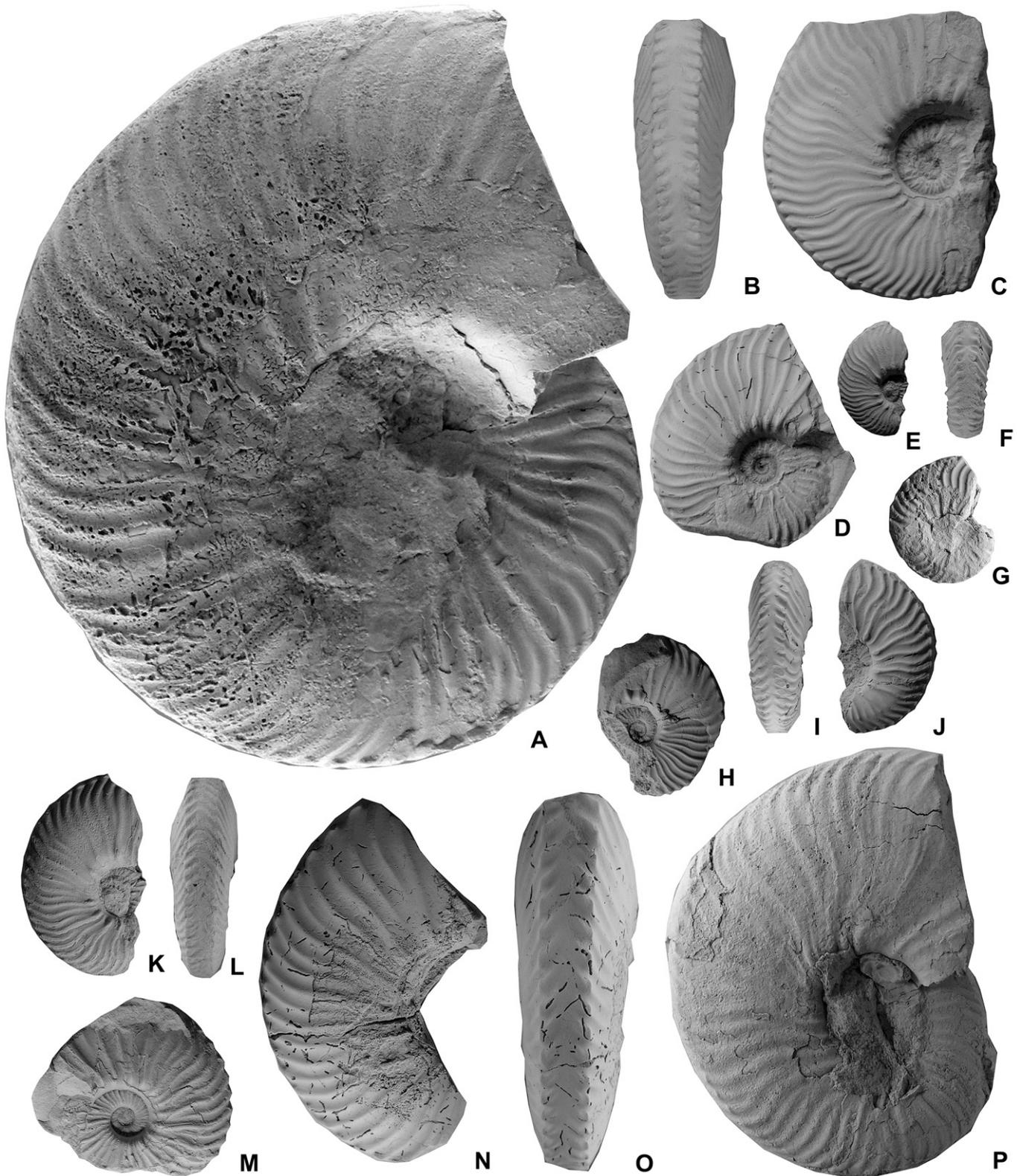
<sup>a</sup> primary and secondary ribs per half whorl.

*Discussion*. Dimorphism probably occurs for the body chambers appear to be of two very different sizes, though there is no other evidence from this incomplete material.

*D. crassicosatus* appears to be derived from *Chacantuceras casanuestrae* through loss of the mid lateral tubercle and a diminution in strength of the ventro-lateral tubercle, accompanied by an increase in the flexure of the ribs. Some fragments assigned to *D. crassicosatus* appear to represent an intermediate stage of this process, while a few specimens (CPBA 20605, Fig. 11 S and CPBA 20600.1–2) assigned to *D. aff. crassicosatus* are more evolute than most *D. crassicosatus* and have stronger ventro-lateral clavi.



**Fig. 11.** A-R, *Decliveites crassicostratus* gen. et sp. nov. A, Holotype, CPBA 19295.1, Chorriaca; B-R, Paratypes. B, CPBA 20626.10, Casa Nuestra; C, CPBA 20629, Agua de la Mula; D, CPBA 20606.1, Casa Nuestra; E, CPBA 20627.2, Río Agrio; F, CPBA 20626.13, Casa Nuestra; G, CPBA 20626.1, Casa Nuestra; H, CPBA 20626.11, Casa Nuestra; I-J, CPBA 20627.3, Río Agrio; K-L, CPBA 20628, Cerro Birrete; M-N, CPBA 19295.2, Casa Nuestra; O-P, CPBA 20606.2, Casa Nuestra; Q-R, CPBA 20626.17, Casa Nuestra. S, *Decliveites* aff. *crassicostratus*. CPBA 20605, Río Agrio. All specimens x 1, coated with ammonium chloride.



**Fig. 12.** *Decliveites agrioensis* sp. nov. A, Holotype, CPBA 20621.1, Río Agrio. B-P, Paratypes. B-C, CPBA 7598.1, Cerro Negro de Covunco; D, CPBA 20614.4, Casa Nueva; E-F, CPBA 20617.5, Casa Nueva; G, CPBA 20621.7, Río Agrio; H, CPBA 20614.25, Casa Nueva; I-J, CPBA 20621.7, Río Agrio; K-L, CPBA 20614.23, Casa Nueva; M, CPBA 20614.20, Casa Nueva; N-O, CPBA 20615.4, Casa Nueva; P, CPBA 20620.2, Provincial Road 33. All specimens x 1, coated with ammonium chloride.

*Decliveites agrioensis* sp. nov.

Fig. 12 A–P

v	1997 <i>Neocomites</i> sp. nov. Aguirre-Urreta and Rawson, p. 454, figs 7d-f.
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**Holotype.** The specimen CPBA 20621.1 designated here.

**Etymology.** Named after the Río Agrio.

**Type locality.** Río Agrio, south-west of Bajada del Agrio.

**Paratypes.** 114 specimens: 1 from Río Diamante (CPBA 20625), 3 from Buta Ranquil (CPBA 20609.1-3), 1 from Loma Naunauco (CPBA 20623), 3 from Pichaihue valley (CPBA 20608.1-2, 20624), 49 from Casa Nuestra (CPBA 16971.1-3, 18051, 20613, 20614.1-28, 20615.1-7, 20616.1-2, 20617.1-7), 11 from Agua de la Mula (CPBA 18353.1-2, 18354, 20611.1-8), 1 from El Salado (CPBA 20610), 1 from Río Salado (CPBA 16983), 7 from Provincial Road 33 (CPBA 20618, 20619.1-2, 20620.1-4), 28 from Río Agrio (CPBA 20621.2-29), 2 from Cerro Negro de Covunco (CPBA 7598.1-2), 1 from Cerro Mesa (CPBA 20612) and 6 from Cerro Birrete (CPBA 20622.1-6).

**Description.** The largest specimen is still septate at 300 mm diameter, indicating a maximum diameter of at least 450 mm. The body chamber occupies at least half a whorl. The shell is moderately compressed, moderately involute with almost flat flanks that converge gently towards the venter; the whorl broadest on the lower flank. The umbilical wall slopes gently to steeply inwards. Primary ribs arise singly on the umbilical slope. Occasional ribs branch low on the flank, but most branches, or a rib is intercalated, just below mid flank. Other secondaries may appear higher on the flank. There are about 18–26 primary ribs per whorl at about 30–40 mm diameter. The ribs are gently flexous, but slightly prorsiradiate in overall trend. They bear small ventro-lateral clavi and form right-angled chevrons on the venter, the mid-line of which is slightly raised.

Dimensions of figured specimens

	d	wh	wh% <sup>a</sup> d	wt	wt% <sup>a</sup> d	wu	wu% <sup>a</sup> d	pr <sup>a</sup>	sec <sup>a</sup>
CPBA 20617.5	20.5	9.2	44.9	8.1	39.5	6	29.3	11	–
CPBA 20621.7	30.8	14.3	46.1	10.5	34.1	8.4	27.2	9	22
CPBA 20614.23	35.7	17.8	49.8	11.3	31.6	8.6	24.1	10	25
CPBA 20614.4	41.5	21.7	52.3	14.4	34.7	9.2	22.2	13	–
CPBA 20620.2	77.6	37.8	48.7	23.6	30.4	–	–	–	–
CPBA 20621.1 (holotype)	137.7	64.3	46.7	42.7	31	–	–	–	–

<sup>a</sup> primary and secondary ribs per half whorl.

**Discussion.** *Decliveites agrioensis* shows some variation in degree of involution and strength of ribbing. One or two examples that we have assigned to the species have very occasional mid lateral tubercles on some primary ribs, and some of those ribs swell slightly. These forms occur low in the species' range. On the other hand, several fragments that are from high in the range are particularly finely ribbed with more numerous secondaries per primary and more material may show that these merit separation as a distinct species.

*D. agrioensis* differs from *D. crassicosatus* in being more compressed, more involute and more finely-ribbed, with more secondaries per primary. It also has a slightly raised mid-ventral line rather than a slightly depressed one. But the two forms are linked by several specimens that show some intermediate morphological characteristics. The lower part of the range of *D. agrioensis* overlaps with that of both *D. crassicosatus* and *Chacantuceras casanuestraense*.

4. Biostratigraphy

The *Pseudofavrella angulatiformis* Zone was named by Aguirre-Urreta and Rawson (1995) as a replacement for the former 'Lyticoceras' *pseudoregale* Zone (Gerth, 1925) as *Pseudofavrella* was the characteristic component of the lower part of the zone while 'L.' *pseudoregale* was poorly known and its exact horizon uncertain. Aguirre-Urreta and Rawson (1997) then divided the *angulatiformis*

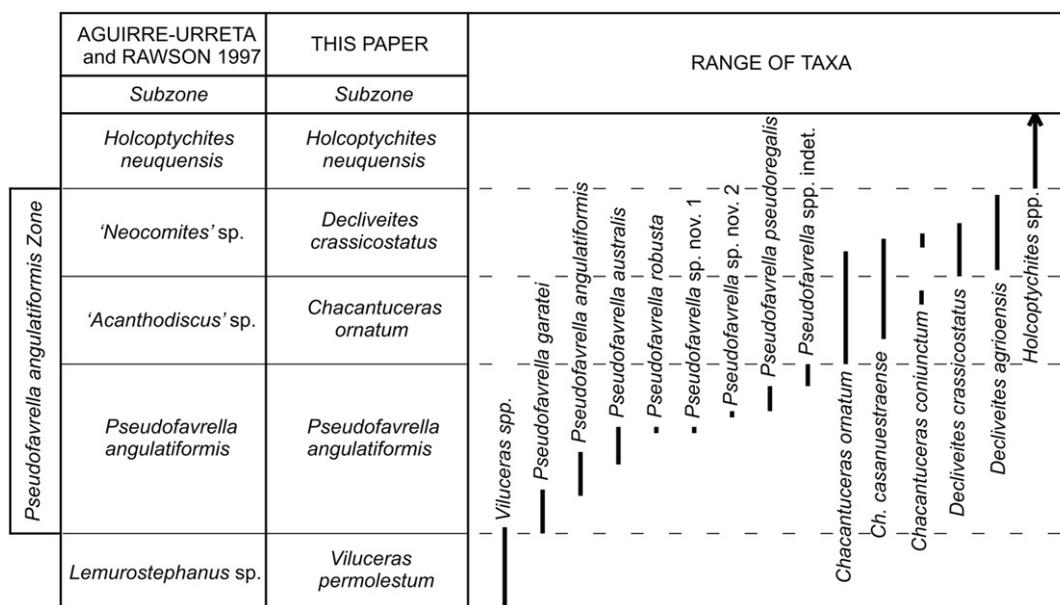


Fig. 13. Subzones of the *Pseudofavrella angulatiformis* Zone, and approximate ranges of species.

Zone into three subzones, of *P. angulatiformis*, '*Acanthodiscus*' sp., and '*Neocomites*' sp. (Fig. 13). Our subsequent taxonomic revision placed the '*Acanthodiscus*' sp. fauna into a new genus, *Chacantuceras*, which necessitated a change of name for the middle subzone to that of *Chacantuceras ornatum* (Aguirre-Urreta and Rawson 1999). We now rename the upper subzone, formerly the '*Neocomites*' sp. Subzone, as the *Decliveites crassicosatus* Subzone.

The faunas of the *P. angulatiformis* Subzone are widely distributed, though best preserved at Pichaihue Valley (loc. 2.13). The base of the subzone (and zone) is defined by the first appearance of *Pseudofavrella garatei*. At Pichaihue Valley this is some 14.5 m above the last preserved *Viluceras* spp., but at Truquicó (loc. 2.10) the two species overlap in bed TP1. At localities where *Pseudofavrella* is the first species to appear above the Mulichinco Formation, *P. garatei* and *P. angulatiformis* are often found together, or crushed *P. spp.* occur in a thin sandstone.

The base of the *Chacantuceras ornatum* Subzone is marked by the first appearance of the index species. There is no evidence of overlap with the highest *Pseudofavrella* faunas just below, though the latter are commonly so flattened and fragmentary that the material is usually unidentifiable. *C. ornatum* is joined by *C. casa-neustraense* higher in the subzone.

The base of the *Decliveites crassicosatus* Subzone is defined by the first appearance of the index species, which overlaps with *Chacantuceras* in the lower part. The highest part of the subzone is characterised by the more finely-ribbed *D. agrioensis* alone. In most localities ammonites at this higher level are represented only by flattened films, sometimes of very large forms, that are unidentifiable at specific level.

The base of the overlying *Holcoptychites neuquensis* Zone is defined by the first appearance of *Holcoptychites*, though the lowest beds yield very few ammonites (Aguirre-Urreta and Rawson 2003, p. 607) and there are usually several to many metres of shale between the last flattened *Decliveites* and the first *Holcoptychites*.

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