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# Carboniferous deposits of northern Sierra de Tecka, central-western Patagonia, Argentina: paleontology, biostratigraphy and correlations

Los depósitos carboníferos del norte de la Sierra de Tecka, centro-oeste de Patagonia, Argentina: paleontología, bioestratigrafía y correlaciones

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## ABSTRACT:

A narrow upper Paleozoic belt crops out in the northern tip of Sierra de Tecka through the Quebrada de Güera-Peña (Patagonia, Argentina). There, black shales of the Pampa de Tepuel Formation contain marine fossil invertebrates previously listed as belonging to the "*Levipustula*" fauna. Material recently recorded by the authors comprises, in order of abundance, gastropods [*Glabrocingulum* .*Glabrocingulum*. *poperimense* (Maxwell), *G. .Stenozone. argentinum* (Reed), *G. .Stenozone*) sp., *Peruvipira teckaensis* sp. nov., *Ananias riccardii* Pinilla], bivalves [*Nuculopsis* .*Nuculopsis*. *patagoniensis* González, *Phestia tepuelensis* González, *Streblochondria sueroi* González, *Streblopteria* sp.], conulariids [*Paraconularia* cf. *ugartei* Cúneo and Sabattini], brachiopods [*Amosia sueroi* Simanaukas, *Languigneotus laevicaudatum* (Amos), *Beecheria patagonica* Amos], trilobites [*Australosutura argentinensis* Hahn and Hahn], cephalopods [*Pseudoorthoceratidae* Flower and Caster, *Sueroceras?* sp., *Mitorthoceras?* sp.],

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and rugose corals [?Lophophyllidiidae Moore and Jeffords]. In addition, the present study includes the new key brachiopods *Languigneotus dammanorum* gen. et sp. nov. and *Tuberculatella waterhousei* sp. nov. from younger localities of the Tepuel-Genoa Basin. The *Languigneotus laevicaudatum* and *Languigneotus-Verchojaniasubzones* (late Pennsylvanian) are proposed herein to replace the former *Tuberculatella* Zone. In addition, previous stratigraphic relationships and correlations of the study section with the Arroyo Pescado (Estancia Ap Iwan) and Esquel areas are discussed. The general stratigraphic profile of a glacial-related section cropping out at Estancia Ap Iwan includes lower conglomeratic beds, which are reinterpreted as early Jurassic in age, and glacial levels that are partially equivalent to the Pampa de Tepuel Formation but older than those of Quebrada de Güera-Peña. A correlation of the Esquel Formation with the Arroyo Pescado Formation and other contemporaneous units on the paleopacific margin is assessed, implying that the Esquel Formation should be segregated from the Tepuel Group. The Esquel and Arroyo Pescado formations can be regarded as the basement of the glaciomarine column of the Tepuel-Genoa Basin.

**KEYWORDS:** Brachiopoda, Bivalvia, Gastropoda, Trilobita, Cnidaria, Carboniferous, Patagonia, Argentina.

## RESUMEN:

Una estrecha faja neopaleozoica aflora atravesando el extremo norte de la Sierra de Tecka a lo largo de la Quebrada de Güera-Peña (Patagonia, Argentina). Allí, lutitas negras de la Formación Pampa de Tepuel contienen invertebrados marinos previamente asignados a la fauna de “*Levipustula*”. Nuevo material coleccionado por los autores incluye, en orden de abundancia, gastrópodos [*Glabrocingulum*, *Glabrocingulum*, *poperimense* (Maxwell), *G. .Stenozone. argentinum* (Reed), *G. .Stenozone* sp., *Peruvispira teckaensis* sp. nov., *Ananias riccardii* Pinilla], bivalvos [*Nuculopsis*, *Nuculopsis*, *patagoniensis* González, *Phestia tepuelensis* González, *Streblochondria sueroi* González, *Streblopteria* sp.], conuláridos [*Paraconularia* cf. *ugartei* Cúneo y Sabbatini], braquiópodos [*Amosiasueroi* Simanaukas, *Languigneotus laevicaudatum* (Amos), *Beecheria patagonica* Amos], trilobites [*Australosutura argentinensis* Hahn y Hahn], cefalópodos [*Pseudoorthoceratidae* Flower y Caster, *Sueroceras?* sp., *Mitorthoceras?* sp.] y corales rugosos [?Lophophyllidiidae Moore y Jeffords]. El presente estudio incluye además los nuevos braquiópodos clave *Languigneotus dammanorum* gen. et sp. nov. y *Tuberculatella waterhousei* sp. nov. provenientes de otras localidades más jóvenes de la cuenca. Se proponen formalmente las subzonas de *Languigneotus laevicaudatum* y de *Languigneotus- Verchojaniasubzones*, en reemplazo de la anteriormente equivalente Zona de *Tuberculatella*. Se discuten las relaciones estratigráficas y correlaciones previamente propuestas para la sección estudiada en relación a las áreas de Arroyo Pescado (Estancia Ap Iwan) y Esquel. El perfil estratigráfico general de la sección con influencia glacial aflorante en la Estancia Ap Iwan incluye una parte inferior con conglomerados que son reasignados al Jurásico inferior, y tramos superiores que son parcialmente equivalentes a la Formación Pampa de Tepuel pero más antiguos que los aflorantes en la Quebrada de Güera Peña. Por otro lado, se refuerza la correlación de la Formación Arroyo Pescado con la Formación Esquel, así como con otras unidades contemporáneas reconocidas hacia el oeste, sobre el margen paleopacífico. La correlación de las formaciones Esquel y Arroyo Pescado implica segregar la primera del Grupo Tepuel, así como considerar a las mismas como basamento de la columna estratigráfica de la Cuenca de Tepuel-Genoa.

**PALABRAS CLAVE:** Brachiopoda, Bivalvia, Gastropoda, Trilobita, Cnidaria, Carbonífero, Patagonia, Argentina.

## 1. INTRODUCTION

A narrow ENE-WNW-trending upper Paleozoic belt crops out in the northern tip of Sierra de Tecka (central-west Patagonia, Argentina). This belt has a maximum width of nearly two kilometers, and extends for about eight kilometers by the High Tension Line that stretches from the Futaleufú Hydroelectric Station in the Patagonian Andes to Puerto Madryn City on the Atlantic coast (Fig. 1). Outcrops include black shales with marine fossil invertebrates that were previously referred to the “*Levipustula* fauna” (Sabbatini in Alberti, 1988; Vizán et al., 1996). Although this material was not originally described in detail, it enabled Vizán et al. (1996) (see also Alberti, 1988; Revol, 1988) to assign these rocks to the Pampa de Tepuel Formation (Lesta and Ferello, 1972; emend. Page et al., 1984).



FIG. 1

General southeastward view of the Quebrada de Güera-Peña

Field-work carried out by different working groups at different times (C.R. González, A.C. Taboada and M.A. Aredes in 1992; J. Hlebszevitsch and M.A. Pagani in 1999; A.C. Taboada, M.A. Pagani and M.K. Pinilla in 2015) allowed to recover hundreds of samples from the Quebrada de Güera-Peña locality (Fig. 2). Fossils include, in order of abundance, gastropods, bivalves, conulariids, brachiopods, trilobites, cephalopods and corals. The aim of this work is to carry out a systematic study of this material and some related taxa in order to refine the knowledge of the paleontology and biostratigraphy of the northern Sierra de Tecka. On the basis of the studied fauna, the current biostratigraphic scheme of the upper Paleozoic of central-west Patagonia is updated. Also, correlations of this Carboniferous belt with other well-known sections of the Tepuel-Genoa Basin are discussed, testing in particular stratigraphic ties previously made at other northern outcrops such as those of the Esquel and Arroyo Pescado areas.

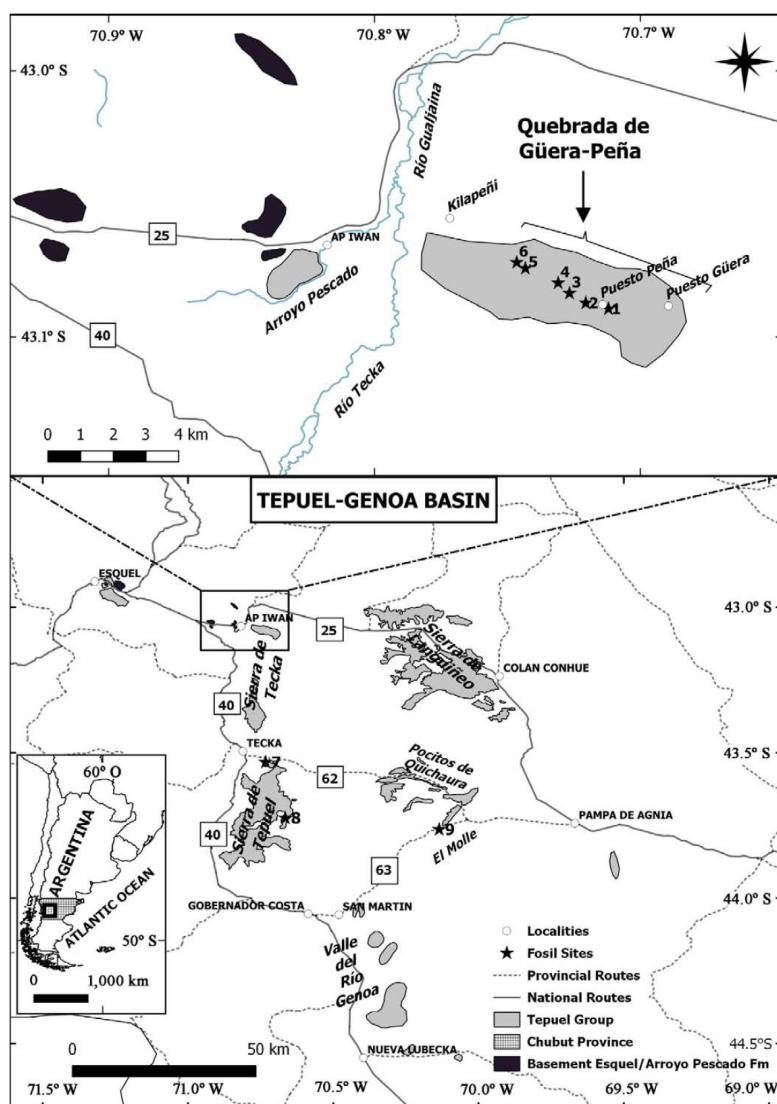


FIG. 2

Location map showing main Carboniferous outcrops of the Tepuel-Genoa Basin, its basement (Esquel and Arroyo Pescado formations) and fossiliferous localities 1-9. Fossil sites 1-6, located upstream at right bank of Quebrada de Güera-Peña, northern Sierra de Tecka, upper half of Pampa de Tepuel Formation; Fossil-site 7, 900 m ENE of Puesto La Carlota, upper half of Pampa de Tepuel Formation; Fossil-site 8, 4 km to the east of Puesto Tres Lagunas, Sierra de Tepuel, upper part of Mojón de Hierro Formation; Fossil-site 9, 1 km to the east of Puesto Lefiú, El Molle area, upper part of Pampa de Tepuel Formation.

## 2. GEOLOGICAL AND STRATIGRAPHIC SETTING

The Upper Paleozoic deposits of central-west Patagonia infilled the Tepuel-Genoa Basin, which extends between 43°-44° 20' S and 69° 30'-71° W for approximately 250 km in central-western Chubut Province. Patagonia was located at the southwestern margin of Gondwana and was possibly separated from southern South America as an independent block that collided with the continental margin during late Paleozoic times (Ramos, 1984, 2008; Pankhurst *et al.*, 2006). Upper Paleozoic rocks of the basin are widely exposed in the north-south arranged Sierras de Tepuel, Tecka, Languineo, Cerro Excursión and Valle Chico (near the town of Esquel), Valle del Río Genoa, El Molle and Pampa de Agnia regions (Fig. 2). After the

pioneer studies of Keidel (1922) and Piatnitzky (1933, 1936), Suero (1948, 1953, 1958) first outlined the general stratigraphy of the basin and determined the Late Paleozoic age of these deposits, based mainly on preliminary identifications of plants and marine invertebrates remains. Many subsequent studies allowed a better understanding of the stratigraphy, paleoenvironment and paleontological content of the basin (Pagani and Taboada, 2010 and references therein). The most commonly used stratigraphic nomenclature was proposed by Page *et al.* (1984), who identified a tripartite succession that includes the Jaramillo, Pampa de Tepuel and Mojón de Hierro formations (Freytes in Lesta and Ferello, 1972; emend. Page *et al.*, 1984). The Río Genoa Formation (Lesta and Ferello, 1972; emend. Andreis *et al.*, 1986) assembles the southernmost outcrops of the basin, and is interpreted as partially equivalent to the Mojón de Hierro Formation (Lesta and Ferello, 1972; Page *et al.*, 1984; Andreis *et al.*, 1986; Hlebszebitsch and Sabattini, 2005). Recently, Taboada and Pagani (2010) and Pagani and Taboada (2011) suggested a possible minor lateral interfingering between the uppermost part of the Mojón de Hierro Formation and the lowermost part of the Río Genoa Formation. These formations constitute the Tepuel Group, a major lithostratigraphic unit with its type section in the Sierra de Tepuel (Suero, 1948; *nom. subs.* Borrello, 1969; emend. Page *et al.*, 1984). The Tepuel Group is a late Tournaisian-Artinskian glacial-influenced siliciclastic sequence nearly 6,000 m thick that unconformably overlies the Catreleo Devonian granite (Robbiano, 1971) and underlies Lower Jurassic marine strata.

Upper Paleozoic strata are also exposed in the northeast corner of the basin, in the Sierra de Languineo, where they are assigned to the Las Salinas Formation (González, 1972), and in a region close to Esquel City, where the Esquel (Feruglio, 1941; *nom. subs.* Cazau, 1972; emend. Cucchi, 1980) and Valle Chico (Cucchi, 1980) formations crop out. These units were correlated to the lower and middle parts of the Tepuel Group (González, 1972; López Gamundi, 1980; Cucchi, 1980; Andreis *et al.*, 1986; Carrizo and Azcuy, 2006; Taboada and Shi, 2011).

A few kilometers east the northern tip of Sierra de Tecka, near the Arroyo Pescado/Estancia Ap Iwan, there is another area with Upper Paleozoic deposits (González *et al.*, 1995 and references therein) (Fig. 2). The stratigraphy of this region was compiled by Vizán *et al.* (1996), and is further discussed below.

## 2.1. Summary of key biota events throughout the Tepuel Group

Abundant invertebrate fossil remains have been reported from the Pampa de Tepuel, Mojón de Hierro, and Río Genoa formations, whereas the Jaramillo Formation is poorly fossiliferous (Pagani and Taboada, 2010 and references therein). Several glacial-related intervals with coarse diamictites and black shales with and/or without dropstones, together with intercalated conglomerates and siltstones, characterize the middle and upper thirds of the Pampa de Tepuel Formation. Intercalated black shales (interglacial horizons) bear marine invertebrate fossils of the *Lanipustula* fauna, whereas faunal assemblages characterized by *Verchojania* and *Languigneotus* (a new brachiopod genus herein proposed) appear toward the top of the unit. The overlying Mojón de Hierro Formation exhibits black shales with intercalated pinkish sandstone beds in the lower half of the unit, while yellowish to greenish sandstones and minor intercalated conglomerates, diamictites, shales with and/or without dropstones and siltstones are present upward. The lower half of the formation is characterized by the *Cimmeriella* fauna, and the upper half bears a *Glossopteris* flora (below and above a glacial-related horizon) (Taboada *et al.*, 2005, 2009; Taboada, 2008, 2010; Pemberton, 2010; Taboada and Pagani, 2010) and the *Kochiprproductus-Costatumulus* faunal assemblage (Pagani and Taboada, 2011). Further south, the Río Genoa Formation consists of yellowish to greenish sandstones and black shales with some intercalated conglomerates and siltstones bearing the *Glossopteris* flora and faunal associations characterized by the brachiopods *Jakutopproductus* Kaschirtzev, *Costatumulus* Waterhouse, *Piatnitzkya* Taboada and *Magniplicatina* Waterhouse (Pagani and Taboada, 2011) (Fig. 3).



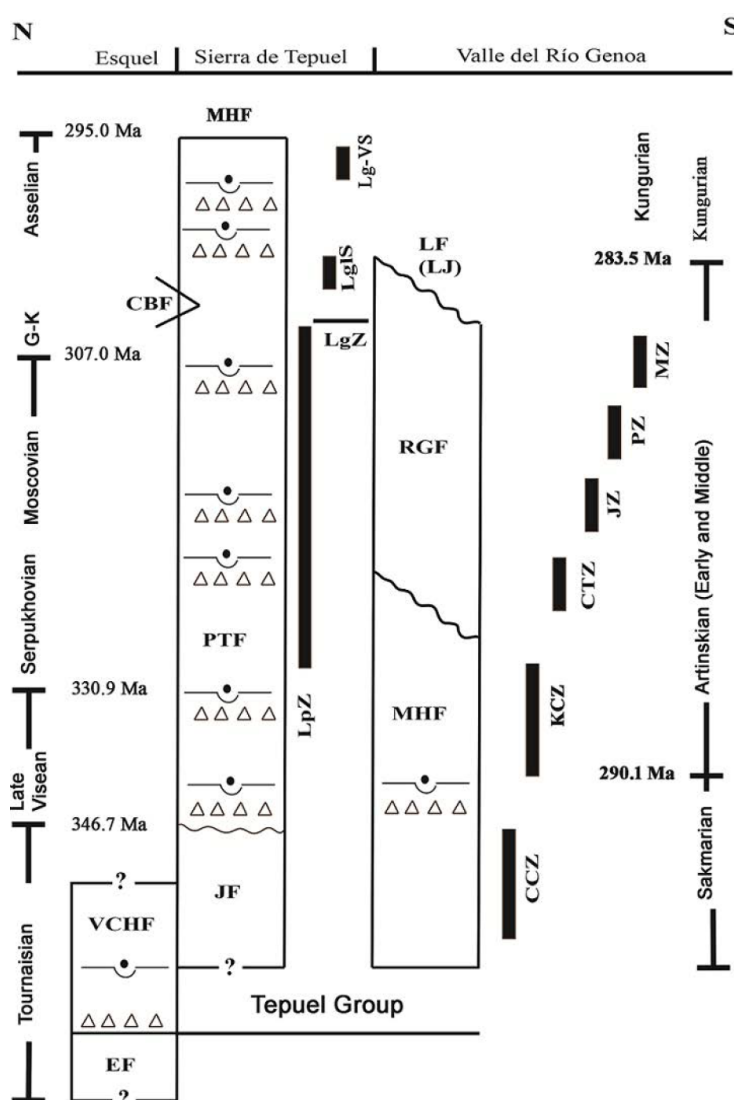


FIG. 3

Time-space scheme showing the stratigraphic column of the Tepuel Group with its main lithostratigraphic units, recognized mayor glacial-related horizons throughout the sequence and stratigraphic position of brachiopod Zones and Subzones characterizing the Tournaisian-Artinskian column in Patagonia (based on Suero, 1948; Taboada, 2008, 2010; Taboada and Pagani, 2010; Pagani and Taboada, 2011; Taboada and Shi, 2011; and updated authors observations). Reference for diamictites and associated facies of glacial-related horizons are white triangles below dropstone symbol. Reference for lithostratigraphic units and brachiopod Zones and Subzones: EF: Esquel Formation; VCHF: Valle Chico Formation; JF: Jaramillo Formation; PTF: Pampa de Tepuel Formation; MHF: Mojón de Hierro Formation; RGF: Río Genoa Formation; CBF: Cresta de Los Bosques Formation; LF: Lepá Formation; LJ: Lower Jurassic; LpZ: Lanipustula patagoniensis Zone; LgZ: Languigneotus Zone; LglS: Languigneotus laevicaudatum Subzone; Lg-VS: Languigneotus-Verchojania Subzone; CCZ: Cimmeriella-Costatulumulus Zone; KCZ: Kochiproductus-Costatulumulus Zone; CTZ: Costatumulus-Tivertonia Zone; JZ: Jakutoproductus Zone; PZ: Piatnitzkyia Zone; MZ: Magniplicatina Zone; G-K: Gzhelian-Kasimovian. Lithostratigraphic units and Global Stages without scale. Stage-Age boundaries based on Cohen et al. (2013).

### 3. STRATIGRAPHY AND PALEONTOLOGICAL CONTENT AT NORTHERN SIERRA DE TECKA

The studied section was mapped near the northwestern corner of the “Geological Chart 44c Tecka” by Turner (1982), although it was not segregated from the Jurassic Lepá Formation until Vizán *et al.* (1996) regarded it as a fossiliferous Carboniferous succession. An E-W stratigraphic section of unknown base near Puesto Güera is about 700 m thick and unconformably underlies the Jurassic marine Lepá Formation at both sides of the Quebrada de Güera- Peña. Alternations of sandstones and conglomerates with intercalations of shales characterize the lower half of the section, while black shales with fossiliferous concretions dominate the upper half (Alberti, 1988; Vizán *et al.*, 1996) (Fig. 4A).



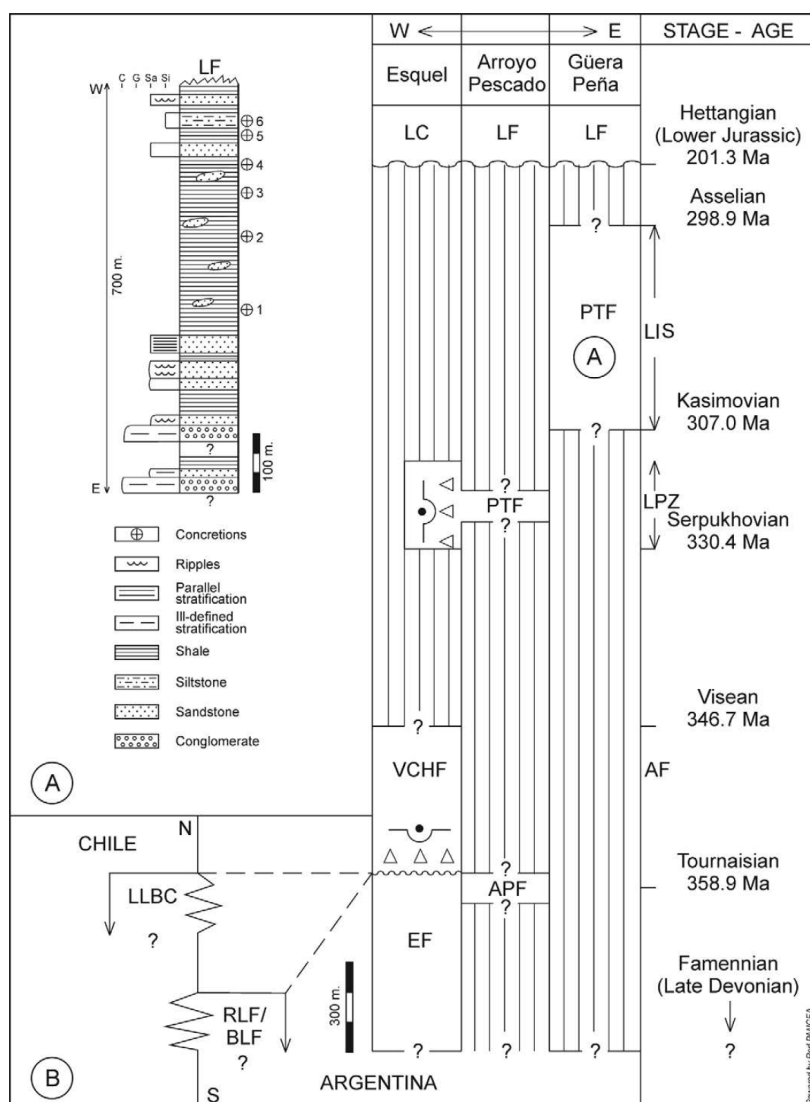


FIG. 4

A. Stratigraphic column at Quebrada de Güera-Peña with location of fossil-sites 1-6. B. Time-space scheme showing stratigraphic relationship of outcrops at Quebrada de Güera-Peña, Arroyo Pescado (Estancia Ap. Iwan) and Esquel areas, and correlation with coeval units westward to the Argentine-Chilean border. EF: Esquel Formation; APF: Arroyo Pescado Formation; VCHF: Valle Chico Formation; PTF: Pampa de Tepuel Formation; LC: La Cautiva Formation; LF: Lepá Formation; RLF: Río Lácteo Formation; BLF: Bahía de la Lancha Formation; LLBC: Llanquihue basement complex; AF: Archaeosigillaria Flora; LPZ: Lanipustula patagoniensis Zone; LIS: Languigneotus laevicaudatum Subzone. Lithostratigraphic units at Esquel, Arroyo Pescado and Quebrada de Güera-Peña at scale. Global Stages without scale. Stage-Age boundaries based on Cohen et al. (2013).

Sabattini (in Alberti, 1988) provided a preliminary list of the faunas of northern Sierra de Tecka (see also Vizán *et al.*, 1996), including the brachiopod *Beecheria patagonica* Amos, 1958, the conulariid *Paraconularia* sp., the trilobite *Australosutura gardneri* (Mitchell, 1922), and the gastropods *Glabrocingulum argentinum* (Reed, 1927) and *Mourlonia. Pseudobaylea. poperimensis* (Maxwell, 1964). This association was referred to the currently *Lanipustula* Zone, which at that time was regarded as middle Carboniferous in age (Amos, 1964; Amos and Roller, 1965; Riccardi and Sabattini, 1975; González, 1985; Archangelsky *et al.*, 1980).

The material described herein allows us to confirm the presence of *Beecheria patagonica* Amos, *Paraconularia* cf. *P. ugartei* Cúneo and Sabattini, 1987, *Australosutura argentinensis* Hahn and Hahn, 1969, *Glabrocingulum* (*Glabrocingulum*) *poperimense* (Maxwell, 1964) and *Glabrocingulum* (*Stenozone*) *argentinum* (Reed, 1927). New records include the brachiopods *Amosia sueroi* Simanauskas, 1996 and *Languigneotus laevicaudatum* (Amos, 1960); the gastropods *Peruvispira teckaensis* sp. nov., *Ananias riccardii* Pinilla, 2012 and *Glabrocingulum* (*Stenozone*) sp. 1; the bivalves *Nuculopsis* (*Nuculopsis*) *patagoniensis* González, 1969, *Phestia tepuelensis* González, *Streblochondria sueroi* González, 1969, and *Streblopteria* sp.; the cephalopods *Sueroceras*? sp., *Mitorthoceras*? sp. and Pseudoorthoceratidae indet; and the rugose coral? Lophophyllidiidae indet. In addition, the brachiopods *Languigneotus dammanorum* gen. et sp. nov. and *Tuberculatella waterhousei* sp. nov. from younger beds at the top of the Pampa de Tepuel Formation and the upper part of the Mojón de Hierro Formation, respectively, are here proposed in order to discuss and clarify the generic and specific relationships of these key taxa.

### 3.1. Biostratigraphy

The marine invertebrates of the Carboniferous section at northern Sierra de Tecka include species that are restricted to the Tepuel-Genoa Basin, as well as species that have also been described from central-western Argentina (Uspallata-Iglesia Basin) and eastern Australia (Yarrol Basin).

Among the brachiopods, the commonest species is *Beecheria patagonica*, which was first reported from the upper half of the Pampa de Tepuel Formation at northern Sierra de Tepuel and Sierra de Languiño (Amos, 1958). In addition, *B. patagonica* has recently been described from El Paso Formation in central-western Argentina (Uspallata-Iglesia Basin) (Cisterna and Sterren, 2016; Cisterna *et al.*, 2017) in association with the Serpukhovian *Rugosochonetes*-*Bulahdelia* fauna (Taboada, 1989, 2010). On the other hand, *Languigneotus laevicaudatum*, *Amosia sueroi* Simanauskas, and the trilobite *Australosutura argentinensis* have been reported so far in the Tepuel-Genoa Basin at Sierra de Tepuel and Sierra de Languiño (Amos, 1960; Simanauskas, 1996; Simanauskas and Sabattini, 1997), suggesting a potencial endemism of these taxa in the region during the Late Paleozoic. *Paraconularia* cf. *P. ugartei* closely resembles conulariids that have previously been described from the younger Río Genoa Formation (Cúneo and Sabattini, 1987). Although *Peruvispira teckaensis* sp. nov. and *Glabrocingulum* (*Stenozone*) sp. 1 are known so far only from northern Sierra de Tecka, other gastropods such as *Glabrocingulum* (*Glabrocingulum*) *poperimense* and *Glabrocingulum* (*Stenozone*) *argentinum* exhibit a wider geographic distribution. *G. (G.) poperimense* was originally described by Maxwell (1964) from the Branch Creek and Poperima formations of the Yarrol Basin (Queensland, Australia), in association with *Levipustula levis* Maxwell, 1951, whereas in Patagonia it occurs in the upper third of the Pampa de Tepuel, Mojón de Hierro and Río Genoa formations (Sabattini and Noirat, 1969; Simanauskas and Sabattini, 1997) of northern Sierra de Tepuel, Sierra de Languiño, Pampa de Agnia and Ferrarotti (see Pinilla, 2014). Likewise, *Glabrocingulum* (*Stenozone*) *argentinum* (Reed) is known from the Pituil and Hoyada Verde formations in the Uspallata- Iglesia Basin (central-western Argentina), associated with the *Marginovatia*-*Maemia* and *Levipustula levis* faunas, respectively (Reed, 1927; Sabattini, 1980; Taboada, 1997, 2010). In Patagonia, *G. (S.) argentinum* (Reed) was reported from the Pampa de Tepuel Formation at Sierra de Languiño, as well as from younger faunal assemblages of the Mojón de Hierro and Río Genoa formations at Sierra de Tepuel and south of José de San Martín Town, respectively (Sabattini and Noirat, 1969; Sabattini, 1978). Finally, *Ananias riccardi* was previously described from the Pampa de Tepuel Formation at Cerro Mina, Sierra de Languiño (Sabattini, 1978; Pinilla, 2012). The bivalves recorded in Sierra de Tecka show a wide stratigraphic distribution in the Tepuel-Genoa Basin from the Pampa de Tepuel Formation to the Río Genoa Formation.

### 3.2. The *Languigneotus laevicaudatum* and *Languigneotus-Verchojania* subzones

Most of the taxa described herein have a stratigraphic range that was constrained to the *Tuberculatella* Zone, a biostratigraphic unit originally described from the Tepuel-Genoa Basin by Simanaukas and Sabattini (1997). This unit is renamed herein as *Languigneotus* Zone by the reassignment of “*Tuberculatella laevicaudata*” to the new brachiopod genus *Languigneotus*, and the recognition of its stratigraphic record as the *L. laevicaudatum* Subzone plus a slightly younger new unit named *Languigneotus-Verchojania* Subzone (Fig. 3).

Simanaukas and Sabattini (1997) proposed an holostatotype for the “*Tuberculatella*” Zone just below a layered gabbroid intrusion of the diabase Cresta de los Bosques Formation of Márquez et al., 2001 in the upper part of the lower Tepuel System (section C17) of Suero (1948) (upper half of the Pampa de Tepuel Formation in Sierra de Tepuel). Simanaukas and Sabattini (1997) indicated also two parastratotypes, one at Puesto La Carlota (northern Sierra de Tepuel) and another at Cerro Mina (Sierra de Languiño).

The holostatotype of the *Languigneotus laevicaudatum* Subzone at Sierra de Tepuel underlies glacial-influenced horizons of the uppermost levels of the Pampa de Tepuel Formation, where *Amosia sueroi* and *Tuberculatella laevicaudata*, among other invertebrates under study, were preliminary identified (Taboada, 2008). Nevertheless, the systematic affinities of the latter material deserve revision (= *Amosia* sp.; *Languigneotus dammanorum* sp. nov. -see below-). Both brachiopods occur in association with *Verchojania archboldi* in two stratigraphic intervals within the Pampa de Tepuel Formation. One of them is just “above” the gabbroid intrusion of the Cresta de los Bosques Formation at Puesto Tres Lagunas (Sierra de Tepuel) (fossiliferous level 2 of Taboada, 2001; section E21 of Suero, 1948, in part), and the second one represents a thin metric section at the topmost beds cropping out through the Cañadón Lefú, El Molle area (Taboada, 2008) (uppermost section of the lower part of the Tepuel System of Perrot, 1960). Both intervals are assigned herein to the new *Languigneotus-Verchojania* Subzone (Fig. 3).

### 3.3. Age

Simanaukas and Sabattini (1997) assigned the *Languigneotus laevicaudatum* Subzone to the Sakmarian based mainly on the affinities of the gastropod faunas. Subsequently Taboada (2008) discussed this age based on the biostratigraphy and paleontological content of the key stratigraphic section of Puesto La Carlota (parastratotype; fossil-site 7 in Fig. 2) and its correlative holostatotype in Sierra de Tepuel. Changes in faunal composition through levels 3 and 4 (according to terminology of Suero, 1948) of Puesto La Carlota section was emphasized by Hlebszevitch (2004) and Taboada (2008), who clarified the incoming of the *Languigneotus* fauna overlying fossil-bearing beds with *Verchojania inacayali* Taboada, 2008. The fauna of level 3 (“*Spirifer*” horizon of Suero, 1948) bears key bryozoans such as *Australopolypora neerkolensis* (Crockford) and *Australofenestella stroudensis* (Campbell) (Sabattini, 1972, 1986, 2002), as well as Acrocrinidae echinoids (Hlebszevitch, 2004; Hlebszevitch and Sabattini, 2005), among other invertebrates (see Taboada, 2008 for full references). This fauna was estimated to be no older than Moscovian-Kasimovian in age, constraining the base of the *Languigneotus laevicaudatum* Subzone to the early Late Pennsylvanian (late Kasimovian?-Ghzelian). The younger *Languigneotus-Verchojania* Subzone (=top of the “*Tuberculatella*” Zone in Taboada, 2008) would be no younger than Asselian, based on the known range of *Verchojania* and because the *Cimmeriella* fauna of Sakmarian age occurs above (Taboada, 2008; Taboada and Pagani, 2010).

On the other hand, Kasimovian to Asselian maximum ages ( $306.05 \pm 3.7$  Ma to  $301.3 \pm 4.5$  Ma) were obtained by Griffis et al. (2014) based on U-Pb analysis of detrital zircons from shales with dropstones of the Mojón de Hierro Formation at Arroyo Garrido locality (stratigraphically about 1,000 m. above the

top of the *Languigneotus* Zone), representing the younger glacial-related horizon recognized in the Tepuel-Genoa Basin (Taboada *et al.*, 2005; Pagani and Taboada, 2010; Taboada, 2010; Taboada and Shi, 2011). This glacial-related interval overlies fossil-bearing strata with the *Cimmeriella* fauna and the *Glossopteris* flora, and underlies beds with *Glossopteris* and the *Kochiprproductus*-*Costatumulus* assemblage, all of them estimated as Cisuralian (Sakmarian-early Artinskian) in age (Taboada, 2010; Taboada and Shi, 2011; Pagani and Taboada, 2011). The maximum U-Pb detrital zircon ages provided by Griffis *et al.* (2014) do not imply refutation of the younger relative ages suggested by the paleontological studies. Further absolute ages would be desirable in order to constrain and/or reevaluate the biochronology of the faunal/floral successions as well as the timing of glacial-related intervals and final waning of the Late Paleozoic Ice Age in Patagonia.

#### 4. CORRELATION OF THE CARBONIFEROUS OF THE ARROYO PESCADO, ESQUEL AND NORTHERN SIERRA DE TECKA AREAS

##### 4.1. The Arroyo Pescado (Estancia Ap Iwan) deposits

An unfolded Carboniferous glacial-related section of 127 m thick was described in Estancia Ap-Iwan by González *et al.* (1995). The lower two thirds of the succession are characterized by conglomerates, diamictites and shales with dropstones, while the upper third is constituted by sandstones, siltstones and shales. Scarce fossil remains (invertebrates and plants) were recovered from this section, including the ostracode *Graphyadactilloides* sp. (Díaz Saravia in González *et al.*, 1995), which supporting previous interpretations (Suero, 1948, 1953; Roller, 1970) allowed for the recognition of affinities with the *Lanipustula patagoniensis* Zone of the Pampa de Tepuel Formation (González *et al.*, 1995; Díaz Saravia and Jones, 1999). Another unit that crops out in the Estancia Ap-Iwan area is the folded, fossil-barren, slightly metamorphosed Arroyo Pescado Formation (Roller, 1970), which is less than 100 m thick (González Bonorino, 1986). It is composed of alternating thin beds of dark grey metasandstones and low-grade quartz-schists, and is separated from the overlying glacial-related section by an inferred angular unconformity (Roller, 1970; Spikermann, 1978). The folding of this section was generally ascribed to the Caledonian orogeny (González, 1985), although some authors suggested that it could have been caused by younger and local tectonic efforts tied to the uprising of the Sierra de Tecka (Vizán *et al.*, 1996). A Rb/Sr age of  $349 \pm 29$  My has been obtained for the low-grade metamorphic event that affected the Arroyo Pescado Formation (Linares *et al.*, 2001).

##### 4.2. The Carboniferous of Esquel

Two folded lithostratigraphic units were proposed for the Carboniferous near Esquel City (Esquel Schists of Feruglio, 1941), the Esquel Formation (Cazau, 1972) and the overlying Valle Chico Formation (Cucchi, 1980). The former has a thickness of 600 m and is constituted by alternating thin beds of fossil-barren sandstones and shales (López Gamundi, 1980), whereas the latter is about 600 m thick and shows diamictites, mudstones and siltstones with dropstones and shales containing scarce fossil remains in the lower part (80 m thick), and alternations of dark siltstones and whitish quartzitic sandstones toward the top (López Gamundi, 1980). The contact between these formations was variably interpreted as an angular unconformity (Cucchi, 1980), erosive (González Bonorino and González Bonorino, 1988) or paraconformable and slightly erosive (herein; Fig. 5). Fossils from the Valle Chico Formation suggest a late Tournaisian age (Taboada *et al.*, 2018), whereas SHRIMP U/Pb data on detrital zircons yielded  $372 \pm 9$  My for the base of the unit (Hervé *et al.*, 2005), indicating a maximum late Devonian-Tournaisian age. Consequently, these last ages could be also considered as the minimum age for the Esquel Formation, although discarding a significant hiatus in between (but probably longer than 1 My, as estimated by González Bonorino and González Bonorino, 1988).



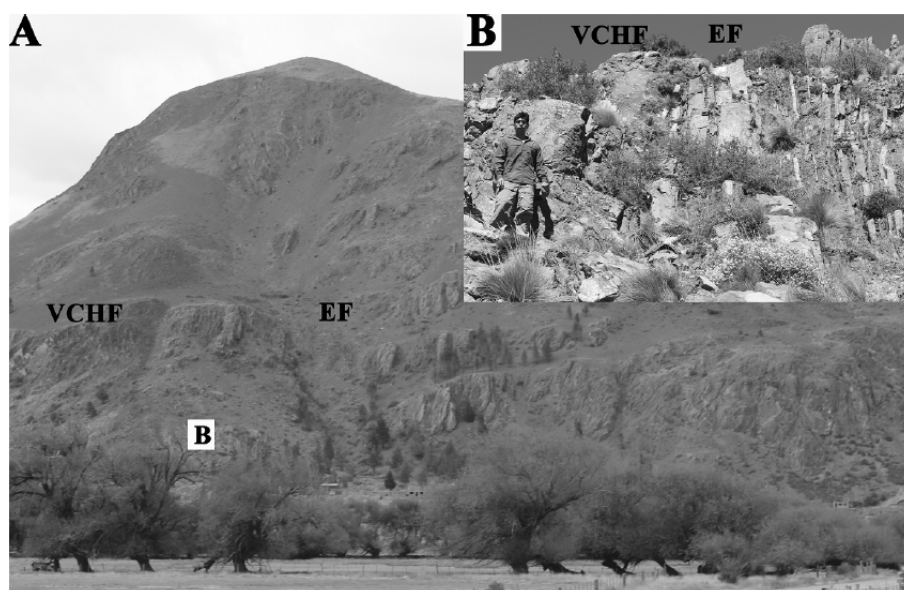


FIG. 5

A. Northeast face of the Cerro Excursión showing outcrops of the Valle Chico (VCHF) and Esquel (EF) formations. B. detail of the paraconformable contact between the uppermost sandstone-shales rhythmites of the Esquel Formation and the basal diamictite of the Valle Chico Formation.

### 4.3. Stratigraphic correlations

The study section at the northern tip of Sierra de Tecka (Quebrada de Güera-Peña) bears a conspicuous fauna which allows to extend further north the *Languigneotus laevicaudatum* Subzone; a stratigraphic unit that has previously been reported from the Pampa de Tepuel Formation at Sierra de Tepuel, Puesto La Carlota and Sierra de Languineo near Colan Conhue Town (Simanaukas and Sabattini, 1997; Taboada, 2008; Pagani and Taboada, 2010).

In addition, recent field work at Estancia Ap-Iwan allowed us to check the stratigraphic schemes proposed by González *et al.* (1995) and Vizán *et al.* (1996) for this area. According to our observations, the glacial-related section that crops out there is partially equivalent to the Pampa de Tepuel Formation only from interval D upwards (see description in González *et al.*, 1995), whereas the intervals A, B and C represent the lower Jurassic conglomeradic beds indicated by Vizán *et al.* (1996). Based mainly on the occurrence of the ostracod *Graphyadactilloides*, levels from the Pampa de Tepuel Formation at Estancia Ap-Iwan (Arroyo Pescado area) are older than those of Quebrada Güera Peña.

Additionally, Vizán *et al.* (1996) regarded the Arroyo Pescado Formation at Estancia Ap-Iwan as equivalent to the Pampa de Tepuel Formation. However, this correlation has not been supported by metamorphic chronology studies. The Rb/Sr age of  $349 \pm 29$  My determined by Linares *et al.* (2001) in the Arroyo Pescado Formation accords roughly with the detrital zircon ages obtained at the base of the Valle Chico Formation (Hervé *et al.*, 2005), supporting correlation between the Esquel and Arroyo Pescado formations by its common low grade of metamorphism, as previously suggested by Cucchi (1980). Furthermore, both these units would be, at least in part, equivalents to the southern Río Lácteo/Bahía de la Lancha formations and equivalents (Giacosa and Márquez, 2002 and references therein). Recently, the Llanquihue basement Complex (Hervé *et al.*, 2016) in the subsurface of Los Muermos (Chile, close to  $41^\circ$  S) was considered to be contemporaneous with the Esquel and Arroyo Pescado formations, all of them forming an hypothetical late Devonian-early Carboniferous marine basin in the extra-Andean Chubut and southern Chile (Marcos *et al.*, 2017) (Fig. 4).

Correlation of the Esquel Formation with the Arroyo Pescado Formation implies that the former unit should be segregated from the Tepuel Group. Both formations can be regarded as the basement of the glaciomarine column of the Tepuel-Genoa Basin. The overlying Valle Chico Formation represents the basal unit of the Tepuel Group as well as the oldest record of the Late Paleozoic Ice Age in Gondwana.

## 5. SUMMARY AND CONCLUSIONS

The black shales of the Pampa de Tepuel Formation at northern Sierra de Tecka (Quebrada de Güera-Peña) contain diverse fossil assemblages previously listed as belonging to the “*Levipustula*” fauna. The studied material comprises gastropods [*Glabrocingulum* ] *Glabrocingulum. poperimense* (Maxwell), *G. .Stenozone. argentinum* (Reed), *G. .Stenozone* sp., *Peruvispira teckaensis* sp. nov., *Ananias riccardii* Pinilla], bivalves [*Nuculopsis* (*Nuculopsis*) *patagoniensis* González, *Phestia tepuelensis* González, *Streblochondria sueroi* González, *Streblopteria* sp.], conulariids [*Paraconularia* cf. *ugartei* Cúneo and Sabattini], brachiopods [*Amosia sueroi* Simanaukas, *Languigneotus laevicaudatum* (Amos), *Beecheria patagonica* Amos], trilobites [*Australosutura argentinensis* Hahn and Hahn], cephalopods [Pseudoorthoceratidae Flower and Caster, *Sueroceras?* sp., *Mitorthoceras?* sp.], and rugose corals [?Lophophyllidiidae Moore and Jeffords].

In addition, the key brachiopods *Languigneotus dammanorum* gen. et sp. nov. and *Tuberculatella waterhousei* sp. nov., from the top of the Pampa de Tepuel Formation and the upper part of the Mojón de Hierro Formation, respectively, are proposed herein.

The *Languigneotus laevicaudatum* and *Languigneotus-Verchojania* subzones (late Pennsylvanian) replace the former *Tuberculatella* Zone. The *L. laevicaudatum* Subzone would be no older than late Kasimovian?-Ghzelian in age, while the younger *Languigneotus-Verchojania* Subzone would be no younger than Asselian.

The fauna from northern Sierra de Tecka allows expand further north the *Languigneotus laevicaudatum* Subzone, a stratigraphic unit that has previously been reported from the Pampa de Tepuel Formation at Sierra de Tepuel, Puesto La Carlota and Sierra de Languiño near Colan Conhue Town.

A stratigraphic section cropping out at Estancia Ap Iwan, which was entirely assigned to the Carboniferous by González *et al.* (1995), includes conglomeradic beds (intervals A-C of González *et al.*, 1995) that are reinterpreted herein as early Jurassic in age, and glaciomarine levels (intervals D-H) that are partially equivalent to the Pampa de Tepuel Formation but older than those of Quebrada de Güera-Peña.

On the other hand, a correlation of the Esquel Formation with the Arroyo Pescado Formation and other contemporaneous units (Devonian- Carboniferous?) on the paleopacific margin such as the Bahía de la Lancha and Río Lacteo formations, as well as the metamorphic Llanquihue Complex, is assessed (Fig. 4), implying that the Esquel Formation should be segregated from the Tepuel Group. The Esquel and Arroyo Pescado formations can be regarded as the basement of the glaciomarine column of the Tepuel-Genoa Basin.

## 6. PALEONTOLOGICAL MATERIAL AND METHODS

The material studied herein is housed in the Invertebrate Paleontology collections of the Museo Paleontológico Egidio Feruglio, Trelew, Chubut (MPEF-PI); the Laboratorio de Investigaciones en Evolución y Biodiversidad, Esquel, Chubut (LIEB- PI); and the Instituto de Paleontología, Fundación Miguel Lillo, San Miguel de Tucumán (FML-IP). The fossil material was prepared according to standard paleontological procedures (Feldmann *et al.*, 1989). The samples were examined with a stereomicroscope and photographed with a digital camera. The material was coated with magnesium oxide vapors before photographing. Linear measurements were made with Vernier calipers to an accuracy of 0.1 mm.



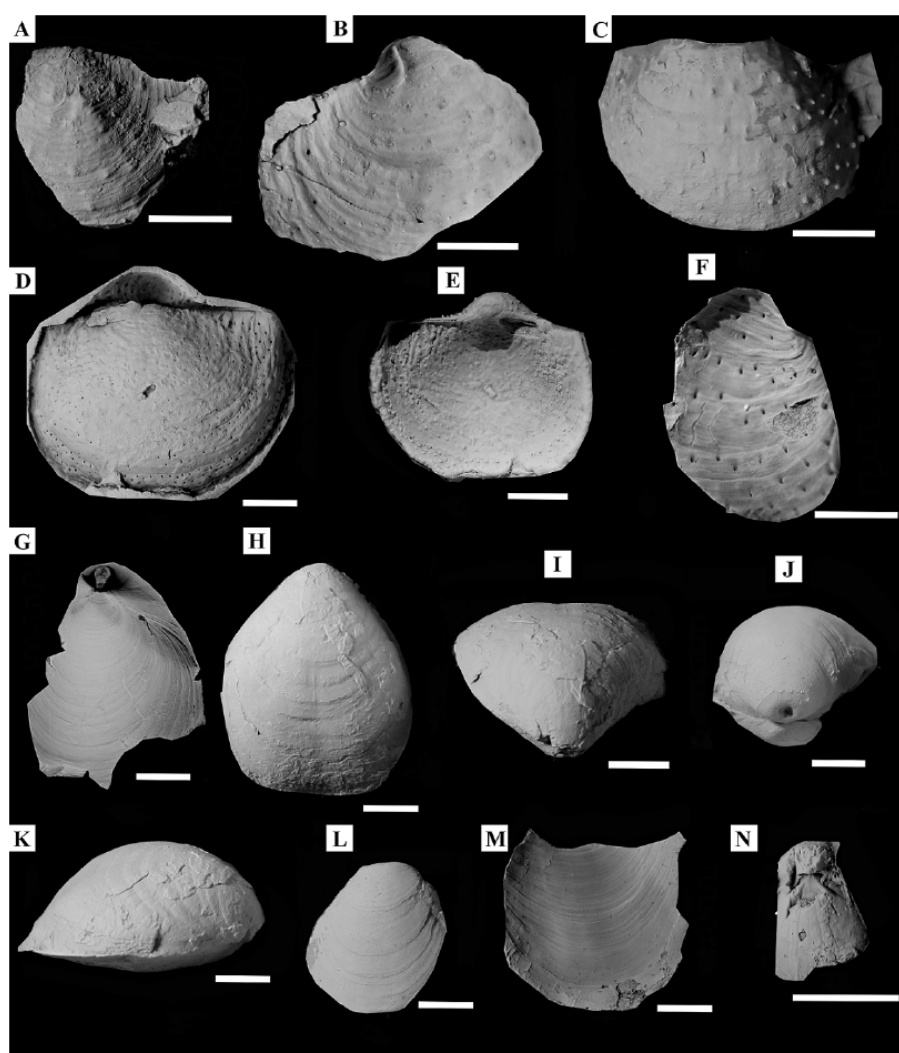


FIG. 6

A-F. *Amosia sueroi* Simanauskas, 1996. A. Ventral valve internal mold showing diductor scars and a weak and short median septum, LIEB-PI 431; B. Ventral valve external mold, LIEB-PI 433; C. polyvinilxyloxane ventral valve external cast exhibiting halteroid spines on right ear, LIEB-PI 434; D-E. external mold of a fragmentary articulate specimen in ventral view and its polyvinilxyloxane cast in dorsal view, LIEB-PI 436; F. ventral valve external mold, LIEB-PI 438; G-N. *Beecheria patagonica* Amos, 1958; G. External mold of fragmentary articulate specimen, MEF-PI 6252; H-I, K. Ventral valve in ventral, posterior and lateral views, MEF-PI 6254; J, L. Polyvinilxyloxane external cast of a fragmentary articulate specimen in postero-ventral and ventral views, MEF 6256; M. External mold of a fragmentary ventral valve, MEF-PI 6259; N. Internal mold of a juvenile specimen in posterior view, MEF-PI 6258. Scale bar: 5 mm.

Several aspects of the suprageneric classification adopted here were discussed by Fortey (1997, 2001) for trilobites (MFT); Van Iten *et al.* (2006) and Leme *et al.* (2008) for conulariids (CAT); Bouchet and Rocroi (2010) and Carter *et al.* (2011) for bivalves; Sweet (1964) and Shevyrev (2006) for nautiloids; Hill (1981) for rugose corals (MAP); Bouchet and Rocroi (2005) for gastropods (MKP); and Lee *et al.* (2007) and Waterhouse (2013) for brachiopod terebratulids and productids, respectively (ACT). Synonymy lists follow the recommendations of Matthews (1973).

## 7. SYSTEMATIC PALEONTOLOGY

Phylum Brachiopoda Duméril, 1806

Order Productida Sarycheva and Sokolskaya, 1959

Suborder Productidina Waagen, 1883

Superfamily Echinoconchoidea Stehli, 1954

Family Sentosiidae McKellar, 1970

Subfamily Tubersulculinae Waterhouse, 1971 (in Bamber and Waterhouse, 1971)

Tribe Lethamiini Waterhouse, 2001

Genus *Amosia* Simanauskas, 1996

Type species. *Amosia sueroi* Simanauskas, 1996, from shales north 260° of “Casa Roelse” (currently main house of Estancia Entresierras) of Pampa de Tepuel Formation, Sierra de Languiño (upper section of the lower part of the “Tepuel System” of Suero, 1948) (late Pennsylvanian), by original designation.

**Remarks:** *Amosia* Simanauskas (1996) was originally placed in the Family Overtoniidae and Subfamily Overtoniinae Muir-Wood and Cooper, 1960. However, Overtoniidae was not used in Brunton *et al.* (2000), and the genus was relocated in the Tribe Lethamiini Waterhouse, 2001 by Brunton (2007). *Amosia* was also included in Lethamiini by Waterhouse (2013), although Waterhouse’s supratribal hierarchy differs from that used in Brunton (2007). Lethamiini was interpreted as having echinoconchid affinities by the possession of numerous and evenly spaced spines on both valves, and by lacking a special hinge row and a high postero-lateral internal dorsal ridge (Waterhouse, 2013); a criterion that is followed herein.

*Amosia sueroi* Simanauskas, 1996

Figure 6, A-F

v1960 *Productella* aff. *bifaria* (Stainbrock), Amos, p. 91-92, Pl. II, Figs. 7, 8a and 8b

1979 *Productella* aff. *bifaria* (Stainbrock), Amos, p. 75-76 (copy from Amos, 1960, Figs. 7 and 8a)

v\*1996 *Amosia sueroi* Simanauskas, p. 378-380, Figs. 1, 2A-2H

v.2013 *Amosia sueroi* Simanauskas; Waterhouse, p. 193, Figs. 6.16 A-D

**Material:** Twelve samples, one dorsal valve internal mold, two dorsal valve external molds, one ventral valve internal mold, four ventral valve external molds and four fragmentary articulate specimens.

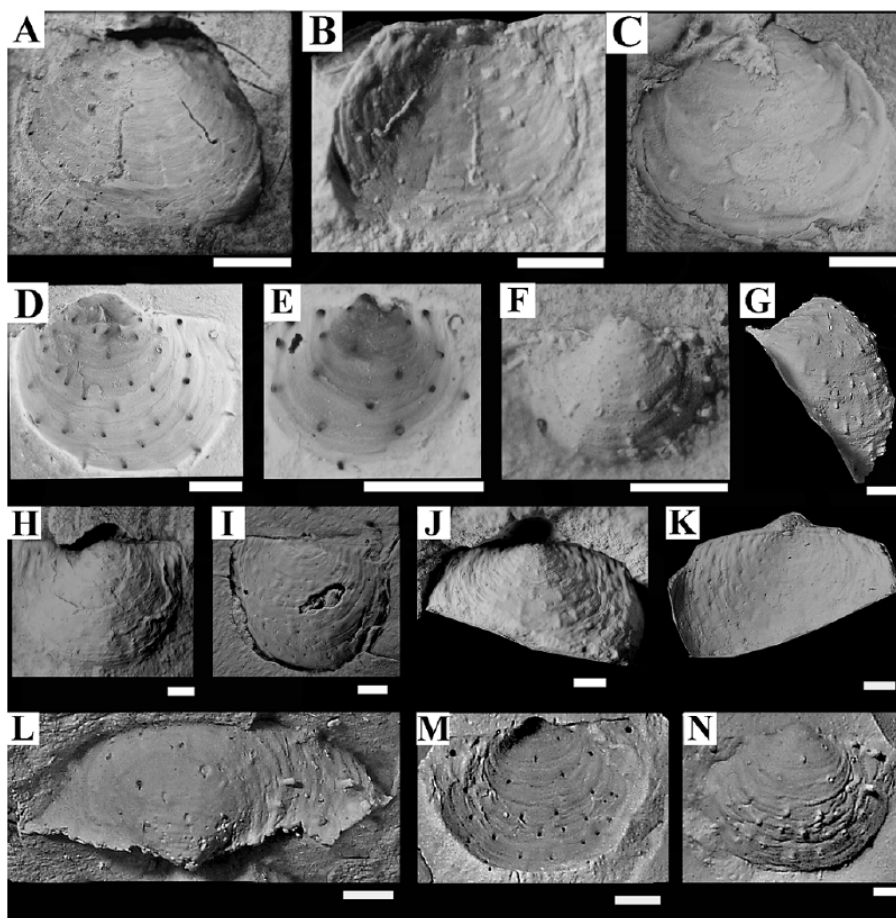


FIG 7

A-N. *Languineotus laevicaudatum* (Amos, 1960); A-F. Specimens from Quebrada de Güera-Peña. A-B. Dorsal valve external mold and its polyvinilxyloxane cast, MEF-PI 6324; C. Ventral valve exterior, MEF-PI6372; D. External mold of ventral valve, MEF-PI 2299; E-F. External mold of ventral valve and its polyvinilxyloxane cast, MEF-PI 6371; G-N. Specimens from La Carlota; G. Polyvinilxyloxane external ventral valve cast, LIEB-PI 23a; H. Dorsal valve external mold, LIEB-PI24; I. Dorsal valve external mold, LIEB-PI 26; J-K. External mold of fragmentary articulate specimen showing geniculate dorsal valve and ventral umbonal region, and its polyvinilxyloxane mold, LIEB-PI 23b; L. Polyvinilxyloxane external ventral valve cast, LIEB-PI 27; M-N. Ventral valve external mold and its polyvinilxyloxane cast, LIEB-PI 133. Scale bar: 5mm.

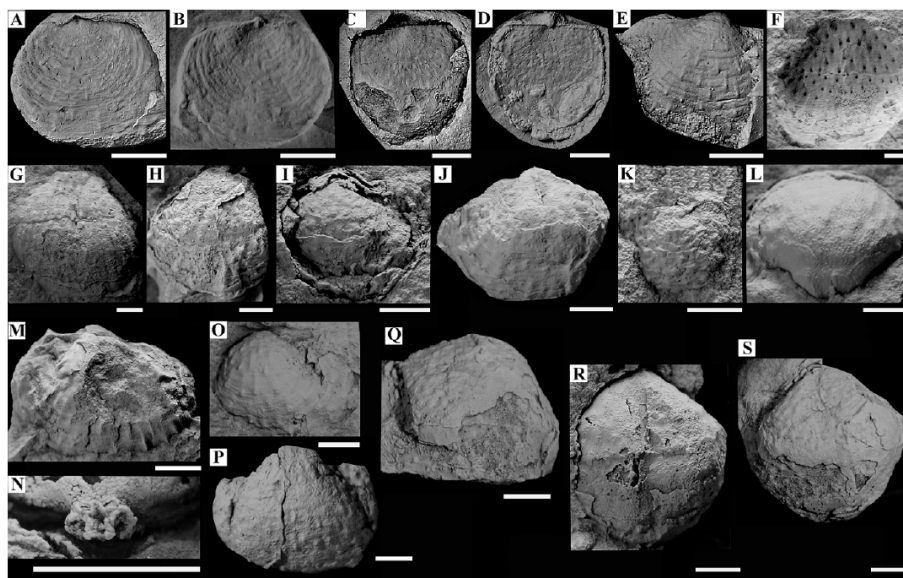


FIG 8

A-E. *Languigneotus dammanorum* sp. nov.; A-B. Dorsal valve external mold and its polyvinylxyloxane cast, FML-IPI 3877; C-D. Dorsal valve external mold and its polyvinylxyloxane cast, FML-IPI 3879; E. Polyvinylxyloxane external ventral valve cast, FML-IPI 3880; F-S. *Tuberculatella waterhousei* sp. nov.; F-G. Ventral valve external mold, LIEB-PI 302a; H. Dorsal valve external mold, LIEB-PI 305; I, N. Dorsal valve external mold and detail of cardinal process, LIEB-PI 307; J. Dorsal valve external mold, LIEB-PI 306; K. Dorsal valve external mold, LIEB-PI 308; L. Ventral valve internal mold in postero-ventral view, LIEB-PI 309; M. Ventral valve external mold, LIEB-PI 304; O. Polyvinylxyloxane external ventral valve cast, LIEB-PI 312; P. Polyvinylxyloxane external ventral valve cast, LIEB-PI 302b; Q, S. Dorsal valve external mold in lateral and ventral view, LIEB-PI 303; R. Ventral valve internal mold, LIEB-PI 310. Scale bar: 5mm, except for figure N: = 2mm.

**Geographic and stratigraphic provenance:** Specimens LIEB-PI 431-435, from fossil-site 1; MPEF-PI 6194, 6326 from fossil-site 2; LIEB-PI 436-437; LIEB-PI 438-440, from fossil-site 3; LIEB-PI 441-443 from fossil-site 4; MPEF-PI 6351 from fossil-site 5. All fossil-sites located upstream at right bank of Quebrada de los puestos Güera-Peña, northern Sierra de Tecka (Figs. 2, 4). Pampa de Tepuel Formation, *Languigneotus laevicaudatum* Subzone. **Description:** Shell with strongly concave-convex profile, transverse subelliptical outline and average-size for the genus. Maximum width up 24 mm, maximum length up 17 mm, with a 1.42 W/L ratio and a hinge line that is equal or slightly shorter than the maximum shell width. Ventral valve strongly convex, with well differentiated ears and margins at right angles. Ornamentation of fine growth lines which are usually sinuous, broad lamellae toward antero-lateral margins and weak rugae on ears. Small slightly prostrate spines irregularly arranged over the whole valve (4-5/5 mm on the venter) although less densely grouped anteriorly of two concentric rows in a single lamellae close to a short geniculation (Figs. 6D-E). Ears exhibit 2-3 halteroid spines (nearly twice in diameter than venter spines) up 2 mm length or somewhat longer (Fig. 6C). Ventral valve interior of a juvenile specimen (LIEB-PI 431) with a weak and short median septum laterally bounded at each side by slightly raised diductor scars of drop shape and one third of valve length. Adductor scars un conspicuous. Dorsal valve strongly concave, ornamented with concentric growth lines and weak lamellae anteriorly. Spines are smaller and erected when compared to those of the ventral valve. Few or no spines on the disk, increasing in density (4-7/5 mm) toward anterior and lateral margins with concentric arrangement up two rows in a single lamellae close to the genicule.

**Discussion:** The profile, outline, dimensions, ornamentation and ventral valve internal features of the studied material collectively indicate affinities with *Amosia sueroi* Simanaukas, 1996; a species previously



described from the Pampa de Tepuel Formation at Sierra de Languiño (Simanauskas, 1996) and Sierra de Tepuel (Amos, 1960; Waterhouse, 2013).

Dorsal spine density in the specimens from northern Sierra de Tecka is a little higher than that observed by Simanauskas (1996) in specimens from Sierra de Languiño (4-5 spines/5 mm). Likewise, the length/width ratio is comparable to that observed in the material from Puesto La Carlota (northern Sierra de Tepuel) by Amos (1960), although higher than the average obtained by Simanauskas (1996) in specimens from Sierra de Languiño. Anyway, these values are within the range of variability of the species.

Superfamily Overtonioidea Muir-Wood and Cooper, 1960

Family Overtoniidae Muir-Wood and Cooper, 1960

Subfamily Overtoniinae Muir-Wood and Cooper, 1960

Genus *Languigneotus* gen. nov.

Type species. *Geniculifera laevicaudata* Amos, 1960, from the upper half of Pampa de Tepuel

Formation at Cerro Mina (late Pennsylvanian), Sierra de Languiño, southwest of Colan

Conhué town, by original designation.

**Etymology:** Combined word derived from the latinized Languiño Department, Chubut province, Argentina, and *Productus*.

**Diagnosis:** Small to medium-sized shell with a concave-convex profile and a subcircular to subelliptical transverse outline. Hinge line shorter than maximum width of shell. Umbo slightly incurved. Ornamentation of weak irregular concentric rugae, fine growth lines and spines with subcircular slightly swollen bases (2- 5/2 mm), roughly in quincunx arrangement. Dorsal valve with short abrupt geniculation. Ornamentation of concentric irregular rugae stronger than those of ventral valve, fine growth lines, minute subprostrate spines (4-5/2 mm) and subcircular and short elongate dimples. Geniculation with faint growth lines, without spines or constrictions. Cardinal process bilobed externally. Ventral interior with smooth elongate adductors and large diductors striated posteriorly. Dorsal interior with short median septum, smooth adductors and two orders of endospines.

**Discussion:** The type species of *Languigneotus* gen. nov. was originally placed in *Geniculifera* Muir-Wood and Cooper, 1960, based mainly on shell shape and dimensions (Amos, 1960). Nevertheless, doubts on this generic assignment were consigned by Amos (1960), who noted that the type species *G. laevicaudata* lacks irregular ribs on the geniculation and exhibits dorsal spines. Roberts *et al.* (1976) indicated that *G. laevicaudata* may belong to *Bulabdelia* Roberts, 1976 (in Roberts *et al.*, 1976) by having a comparable shape, quincuncially arranged spine bases on the venter of the ventral valve and corresponding dimples on the dorsal valve, and a dorsal valve which is anteriorly geniculate and possesses a similar style of median septum and lateral ridges. Major differences are the smaller ears, the presence of 4 to 5 large erect spines on the auricles, and the apparent absence of rows of suberect spines on the lamellae at the front of both valves of *G. laevicaudata* (Roberts *et al.*, 1976). Later, Amos (1979) accepted the reassignment of *G. laevicaudata* to *Bulabdelia*. Finally, Simanauskas (1996) provided a complementary description of the Patagonian species and agreed that *G. laevicaudata* should be excluded from *Geniculifera* by the presence of dorsal spines and a smooth geniculation, but rejected its assignment to *Bulabdelia* by the absence of lamination, and differences in the arrangement of spines and the shell shape. Simanauskas (1996) reassigned *G. laevicaudata* to *Tuberculatella* Waterhouse, 1982, though *G. laevicaudata* slightly differs from the type species *T. tubertella* Waterhouse, 1982 in shell-size and spine bases, and is clearly distinguished by lacking sinus and having a higher width/length ratio (Simanauskas, 1996). Besides these differences, others of generic significance are related to the geniculation. The material studied herein exhibits a short abrupt geniculation ornamented with just faint concentric lines, and the dorsal valve has an external bifid cardinal process. Because *Tuberculatella* possesses an external trifid cardinal process, and is ornamented with uneven concentric growth lines disrupted by longitudinal constrictions as anterior ridge-like projections and erect spines on swollen bases, a generic distinction is sustained. The particular combination of characters of the

Patagonian material allows propose *Languigneotus*, a new endemic genus just recorded in the Tepuel- Genoa Basin. The diagnosis of *Languigneotus* gen. nov. includes internal characters described for the type species by Simanauskas (1996).

*Languigneotus laevicaudatum* (Amos, 1960)

Figure 7, A-N

v \*1960 *Geniculifera laevicaudata* Amos, pp. 92- 94, pl. 2, figs. 1-6

1979 *Bulabdelia laevicaudata* (Amos), Amos, p. 78, figs. a-c (copy Amos, 1960, figs. 3, 5-6)

v.1996 *Tuberculatella laevicaudata* (Amos), Simanauskas, pp. 381-383, figs. 3a-g

**Material:** Fourteen specimens, four dorsal valve external molds, five ventral valve external molds, one exterior of ventral valve and fragmentary samples.

**Geographic and stratigraphic provenance:** Specimens MPEF-PI 6372 from fossil site-1; MPEF- PI 2299 from fossil site-2; MPEF-PI 6324, 6371, from fossil site-3; located upstream at right bank of Quebrada de los puestos Güera-Peña, northern Sierra de Tecka. Specimens LIEB-PI 23a, 23b, 24, 26-27, 29, 132-133, 314, 316, from fossil-site 7, located in a concretionary fossiliferous horizon (= level 4 of Suero, 1948) at 900 m ENE of Puesto La Carlota, upper half of Pampa de Tepuel Formation (late Pennsylvanian) (Figs. 2, 4). Pampa de Tepuel Formation, *Languigneotus laevicaudatum* Subzone.

**Description:** Shell of concave-convex and subcircular to slightly transverse subelliptical outline with its maximum width at the posterior third length. Maximum width up to 14.5 mm and maximum length up to 10.5 mm with W/L ratio varying between 1.18-1.28. Ventral valve moderately convex with maximum convexity in the posterior third of the valve. Auricles flattened and well differentiated from flanks. Umbo slightly incurved over hinge line. Ornamentation of weak irregular concentric rugae, fine growth lines and spines with subcircular slightly swollen bases. Spines (3-5/2 mm) erect to suberect on auricles and postero-lateral flanks, subprostrate anteriorly, roughly in quincunx arrangement, more abundant toward the anterior half of the valve. With two hinge spines on each side of the umbo (up to 4 mm length) and other two larger ones on the auricles. Dorsal valve weak to moderately concave with short geniculation at ~90°. Ornamentation of concentric irregular rugae stronger than those of ventral valve, fine growth lines, minute spines and subcircular to short elongate dimples. Spines (4-5/2 mm) located between dimples in a roughly concentric pattern, subprostrate to prostrate anteriorly. Geniculation with faint growth lines, without spines or constrictions. Cardinal process bilobed, externally bifid. Internal characters unknown.

**Discussion:** Specimens from Quebrada de Güera- Peña and Puesto La Carlota collectively show all the diagnostic characters first described by Amos (1960) for *L. laevicaudatum* (Amos) and later reviewed by Simanauskas (1996). They share a concave-convex and subcircular to slightly transversely subelliptical outline with its maximum width at the posterior third of the shell, and strong geniculation. The ventral valve exhibits ornamentation of weak irregular concentric rugae, as well as fine growth lines and spines with subcircular slightly swollen bases, roughly in quincunx arrangement. The dorsal valve is ornamented with concentric irregular rugae that are stronger than those of the ventral valve, fine growth lines, minute spines and subcircular to short elongate dimples.

Some specimens from Quebrada de Güera- Peña exhibit more concave dorsal valves which are attributed to intraspecific variations. Simanauskas (1996) reported material of *L. laevicaudatum* from Puesto La Carlota locality but it was not described nor figured.

*Languigneotus dammanorum* gen. et sp. nov.

Figure 8, A-E

**Material:** Three specimens, two dorsal valve external molds and one ventral valve external mold.

**Holotype:** FML-IPI 3879

**Paratypes:** FML-IPI 3877, 3880



**Geographic and stratigraphic provenance:** Specimens FML-IPI 3877, 3879 and 3880 from fossil-site 9, located in a pebbly sandstone bed overlying glaciomarine deposits of the upper part of Pampa de Tepuel Formation at El Molle area, 1 km to the east of Puesto Lefiú (Fig. 2). Pampa de Tepuel Formation, *Languigneotus-Verchojania* Subzone (early? Asselian).

**Etymology:** Combined three first letters of the last names of the outstanding paleontologists Professors Susana Damborenea and Miguel Manceñido (University of La Plata, Argentina).

**Diagnosis:** Medium-sized shell of weakly concave-convex profile and slightly elongate subcircular outline. Hinge line shorter than maximum width of shell. Umbo incurved over hinge line. Ornamentation of concentric rugae, fine growth lines, subprostrate to prostrate spines (2-3/2 mm) and dimples on dorsal valve.

**Description:** Shell of weakly concave-convex profile and slightly elongate subcircular outline. Maximum width up 15mm and maximum length up 14 mm with W/L ratio between 1.07-1.16. Hinge line of  $\frac{3}{4}$  of maximum width which is located at mid-length of the shell. Umbo incurved over hinge line. Ventral valve moderately convex with maximum convexity at the posterior third of the valve. Ornamentation of regular concentric rugae, fine growth lines, subprostrate spines of flanks and auricles and prostrate spines anteriorly. Spines on slightly swollen elongate bases (2-3/2 mm) arranged in a roughly quincuncial pattern. Dorsal valve weakly concave, flattened toward auricles and laterally, with obtuse cardinal angles and short geniculation at  $\sim 80^\circ$  (Figs. 8C-D). Ornamentation of weak concentric rugae on auricles and laterally (almost imperceptible on disc), fine growth lines, minute subprostrate spines and elongate dimples. Spines with a roughly quincuncial arrangement located between dimples, with a density of 2-3/2 mm.

**Discussion:** *Languigneotus dammanorum* gen. et sp. nov. is close to *L. laevicaudatum* (Amos), but the shell of the former exhibits a less transverse shape, a shorter hinge line, a weakly concave to flattened dorsal valve, an umbo which is located above the hinge line, and a lower spine density. Taboada (2008) and Pagani and Taboada (2010) mentioned the presence of "*Tuberculatella?*" *laevicaudata* (Amos), here classified as *Languigneotus dammanorum* sp. nov., in association with *Verchojania archboldi* characterizing the top of the "*Tuberculatella*" Biozone, here the *Languigneotus-Verchojania* Subzone.

Family Avoniidae Sarytcheva, 1960

Subfamily Avoniinae Sarytcheva, 1960

Genus *Tuberculatella* Waterhouse, 1982

Type species: *Tuberculatella tubertella*

Waterhouse, 1982, from Luak Formation (Moscovian), Huai Bun Nak, Loei, north Thailand, by original designation.

*Tuberculatella waterhousei* sp. nov.

Figure 8, F-S

**Material:** Thirteen specimens, four ventral valve external molds, seven dorsal valve external molds and two ventral valve internal molds.

**Holotype:** LIEB-PI 302a

**Paratypes:** LIEB-PI 302b, 307, 309

**Additional material:** LIEB-PI 303-306, 308, 310-312

**Geographic and stratigraphic provenance:** Specimens LIEB-PI 302-312, from fossil-site 8, located 4 km to the east of Puesto Tres Lagunas, Sierra de Tepuel, upper part of Mojón de Hierro Formation (level 6 of Taboada, 2001) (Fig. 2), *Cimmeriella-Costaumulus* Zone (late Sakmarian).

**Etymology:** In honor of the New Zealand Professor Bruce Waterhouse, outstanding paleontologist and expert on biostratigraphy.

**Diagnosis:** Average to large-sized shell of strong concave-convex profile and subelliptical transverse outline. Ventral valve with long trail. Hinge line shorter than maximum width of shell. Ornamentation of concentric growth lines, suberect spines on swollen oval bases on venter and flanks, and erect spines on auricles and trail. Dorsal valve gently concave in the visceral disc, with relatively long geniculation.

Ornamentation of weak concentric rugae, uneven growth lines, deep dimples, and among them, small erect spines over the whole valve. Concentric uneven growth lines disrupted by longitudinal constrictions on trail. Cardinal process bilobed, externally trifold.

**Description:** Average to large-sized shell for the genus, with maximum width and length exceeding 29 mm and 26 mm, respectively. Shell of strong concave-convex profile and subelliptical transverse outline, with a W/L ratio average of 1.25. Ventral valve of moderate convexity on venter, with long trail near the geniculation ( $\sim 60^\circ$ ). Hinge line shorter than maximum width which is located at valve mid-length. Umbonal angle close to  $90^\circ$ , auricles slightly convex and well differentiated from flanks. Median sinus variably developed, narrow, shallow anteriorly, not reaching the commissure. Ornamentation of concentric growth lines (less regular anteriorly), suberect spines on swollen oval bases on venter and flanks, and erect spines on auricles and trail. Spines in quincuncial arrangement, in number of 4-5/5 mm on venter increasing to 5-6/5 mm on trail. Maximum diameter average of spine bases near 1 mm on venter, decreasing to half on trail. Irregular growth constrictions on trail rise as ridge-like longitudinal projections disrupting well-marked concentric ornamentation. Ventral interior with smooth oval adductors (4 mm length and 2.5 mm width) separated by a thin myophragm. Diductor scars (5.5 mm length) drop-shaped, weakly radially grooved, reaching 2/5 of valve length. Rest of valve surface with small, radially aligned pustules. Dorsal valve gently concave on the disc, with a relatively long geniculation at  $\sim 60^\circ$ . Dorsal fold variably developed, shallow or absent. Ornamentation of weak concentric rugae, uneven growth lines, deep dimples, and among them, small erect spines over the whole valve ( $\sim 15/5$  mm) in roughly quincuncial arrangement. Concentric uneven growth lines disrupted by longitudinal constrictions on trail. Cardinal process bilobed, externally trifold.

**Discussion:** Some specimens described herein were preliminary assigned to *Tuberculatella* by Dr. B. Waterhouse during an international workshop in Patagonia in 2009 (see Taboada *et al.*, 2009). The shell shape and diagnostic ornamentation of this genus are herein confirmed, while the dimensions, shell outline, geniculation, and density and characteristics of the spines, allow us to propose a new species. Although the type species, *T. tubertella* was originally described as having a bifid cardinal process (Waterhouse, 1982), this character, like in the Patagonian species, seems to be trifold, as shown in the illustrations of the holotype (Waterhouse, 1982, 2013; Brunton, 2007). *T. waterhousei* sp. nov. also resembles *T. tubertella* in sharing a transverse shell outline, a similar spine pattern, and irregular longitudinal ridge-like projections anteriorly, but the former species is differentiated mainly by the presence of more elongate spine bases on the ventral valve and more numerous spines on both valves.

*Avonia karpinskiana* (Yanischevsky) (Sarytcheva, 1968), from the middle to late Carboniferous of the Urals, Verchojan (Russia) and Kazhakstan regions, was included in *Tuberculatella* by Waterhouse (1982). The Russian species exhibits a hinge line that is coincident with the maximum width of the shell, and prominent ventral spine bases, unlike *T. waterhousei* sp. nov. Another species assigned to *Tuberculatella* by Waterhouse (2013) is *Maemia archboldi* Martínez Chacón and Winkler Prins (2008) from the Valdejeta Formation (Bashkirian) of Asturias, northern Spain. Nevertheless, the presence of a slightly elongate shell profile, ribs which are weak and restricted to the anterior part of the trail or absent, short spine bases, lamellose irregular rugae on both valves, and an externally bifid cardinal process, prevent an assignment to *Tuberculatella*.

Specimens from central-western Argentina (Uspallata-Iglesia Basin) were ascribed to *Tuberculatella* by Simanaukas and Cisterna (2001). These authors referred *Productus (Marginifera) spinulo-costatus* Abich var. *peregrina* Reed (1927), from the Pituil Formation (=Esquina Gris Formation, in part, Taboada, 1997), to *Tuberculatella*, together with specimens from the lower fossil-bearing interval of the El Paso Formation (Simanaukas and Cisterna, 2001). Furthermore, Simanaukas and Cisterna (2001) included *Bulabdelia* cf. *B. myallensis* Roberts of Taboada (1989; see also Taboada *et al.*, 2009; Taboada, 2010) in the synonymy of "*Tuberculatella peregrina* (Reed, 1927)". Although this concept of "*Tuberculatella peregrina* (Reed, 1927)" was followed until recently by Cisterna and Sterren (2016) and Cisterna *et al.* (2017), a different taxonomic

viewpoint was suggested by Taboada (1997, 2006). Material of *P. (M.) spinulo-costatus* var. *peregrina* from the Pituil Formation has a ventral valve that is moderately convex, transversely subelliptical in outline with a hinge line equal or nearly equal to the maximum width, without geniculation. It is ornamented with concentric growth lines and weak, low, rounded ribs which are somewhat discontinuous mainly due to the presence of regular radially elongate recumbent stout spines arranged in a roughly quincunx style. Auricles bear 2-3 spines and other 3-5 aligned at the junction of the auricles and the flanks (Reed, 1927). All these characters indicate that this material is conspecific with *Maemia tenuiscostata* (formerly *Geniculifera tenuiscostata* of Taboada, 1997; see also Taboada *et al.*, 2009; Taboada, 2006, 2010).

On the other hand, specimens from the El Paso Formation ascribed to "*Tuberculatella peregrina*" by Simanaukas and Cisterna (2001) exhibit a smooth geniculation in both valves or faint growth lines (Cisterna *et al.*, 2017). This character contrasts with Reed's var. *peregrina* which lacks ventral geniculation, as well as with *Tuberculatella* which shows irregular longitudinal constrictions on dorsal and ventral genicule, and with *B. cf. B. myallensis* which has a spinose tuberculate trail. The general morphology of the El Paso's specimens is comparable to that of *Languigneotus* gen. nov., but the presence of strong irregular lamellose rugae and a conspicuous geniculation on both valves, coupled with robust grooved diductors and dorsal raised adductors, may justify the erection of a new genus.

**Order Terebratulida Waagen, 1883**

**Suborder Terebratulidina Waagen, 1883**

**Superfamily Dielasmatoidea Schuchert, 1913**

**Family Beecheridae Smirnova, 2004**

**Genus Beecheria Hall and Clarke, 1893**

**Type species.** *Beecheria davidsoni* Hall and Clarke, 1893, from the Viséan Windsor Group, Nova Scotia, Canada.

*Beecheria patagonica* Amos, 1958

Figure 6, G-N

\*1958 *Beecheria patagonica* Amos, pp. 104-106, fig. 2, 1-8

1979 *Beecheria patagonica* Amos; Amos, p. 95, figs. a-c (copy Amos, 1958, only Figs. 6-7).

2016 *Beecheria patagonica* Amos; Cisterna and Sterren, figs. 5, R-S

2017 *Beecheria patagonica* Amos; Cisterna, Sterren, López Gamundi and Vergel, pp.

15-16, figs. 5, D-F (copy Cisterna and Sterren, 2016, Figs. 5, only R-S)

**Material:** Twelve samples, one articulate specimen, two external molds of articulate specimens, four external molds of ventral valves and fragmentary remains.

**Geographic and stratigraphic provenance:** Specimens MPEF-PI 3064, 3067, 6221, 6250, 6252, 6254, 6257, 6259, 6312, 6352 from fossil-site 2; MPEF-PI 6182, 6256, 6258, 6317, 6319, 6323, 6325 from fossil-site 3. All fossil-sites located upstream at right bank of Quebrada de los puestos Güera-Peña, northern Sierra de Tecka. (Figs. 2, 4). Pampa de Tepuel Formation, *Languigneotus laevicaudatum* Subzone (late Pennsylvanian).

**Description:** Medium-size shell up 22 mm in length, 19.5 mm in width and 11 mm in thickness. Shell unequally biconvex with a slightly elongate subelliptical outline and maximum width at valve mid-length. Ventral valve more convex than dorsal valve, umbo nearly straight to suberect and umbonal angle near 95°. Ventral valve with a weak shallow depression on anterior half. Commissure rectimarginate. Shell smooth with concentric growth lines and lamellae. Foramen subpermesothyrid. Dental plates slightly divergent, anterior- and ventrally. Punctae densely and regularly arranged.

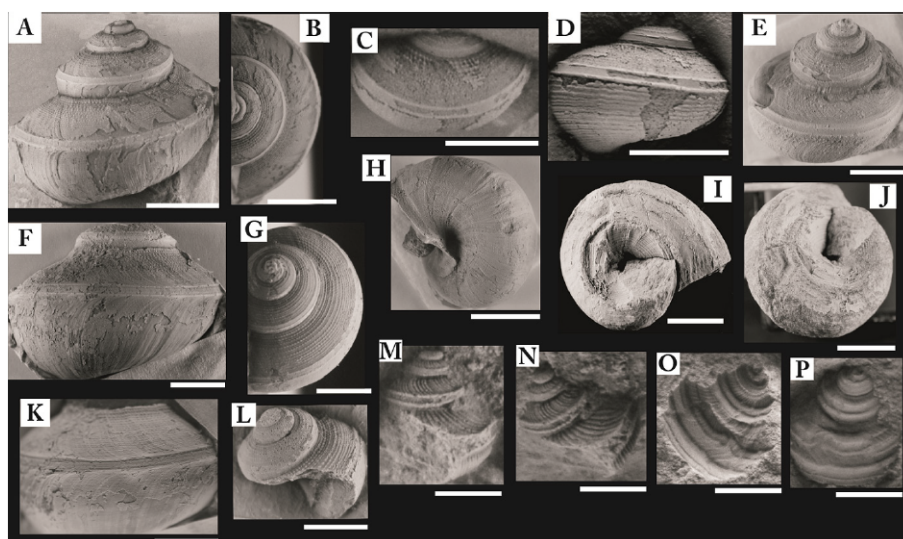


FIG 9

**A-B, E.** *Glabrocingulum* (*Glabrocingulum*) *poperimense* (Maxwell); **A.** MEF 1859, latex mould of shell showing four whorls and nodose spiral ornamentation; **B.** MEF 1859, latex mould, apical view; detail of well-marked nodose spiral lirae on upper whorl face; **E.** MEF 1866(b), latex mould, lateral view of five whorls; detail of the closely spaced nodose spiral lirae and selenizone. **C-D, G, L.** *Glabrocingulum* (*Stenozone*) *argentinum* (Reed); **C.** MEF 1769, latex mould, last whorl in apical view showing ornamentation and selenizone; **D.** MEF 1769, latex mould in lateral view showing the selenizone bounded by two spiral cords, and spiral threads on outer whorl face; **G.** MEF 1871, latex mould, apical view of five whorls with details of the upper whorl surface and nodose spiral lirae; **L.** MEF 1755, external latex mould of four whorls; apical view showing nodose spiral threads on the upper whorl surface, and a concave, peripheric selenizone. **F, H, K.** *Ananias riccardii* Pinilla; **F.** MEF 1834, latex mould, lateral view of last two whorls with details of the spiral lirae on the upper whorl face, the selenizone, and growth lines on the outer surface; **H.** MEF 1872, latex mould of phaneronphalous shell base showing spiral and collabral treads; **K.** MEF 1834, external latex mould of last whorl in lateral view; detail of the selenizone. **I-J.** *Glabrocingulum* (*Stenozone*) sp. 1; **I.** MEF 1792, external mould in apical view; detail of the upper whorl surface and nodose spiral ornamentation; **J.** MEF 1792, lateral view of outer whorl surface. **M-P.** *Peruvispira teckaensis* sp. nov.; **M.** MEF 1796, external latex mould in lateral view; detail of the last whorl showing a concave selenizone, faint alveozone, anonphalous shell base and collabral ornament; **N.** MEF 1796, holotype, external latex mould in lateral view; detail of collabral lirae on the upper whorl face; **O.** MEF 1847, paratype, fragmentary external mould showing a detail of the collabral ornamentation; **P.** MEF-1847, external latex mould showing shell surface and closely spaced collabral lirae. Scale bars: 10 mm (Figures A-B, E-K) and 5 mm (Figures C-D, L-P).

**Discussion:** According to the above description, the specimens studied are confidently assigned to *Beecheria patagonica* Amos, 1958. This species was originally described from the *Languigneotus laevicaudatus* Subzone of the Pampa de Tepuel Formation at Languiño and Tepuel hills (Amos, 1958). *Beecheria patagonica* was also reported from several localities of central-western Argentina (Uspallata-Iglesia Basin) (Amos, 1958, 1979 and references therein) and eastern Australia (Yarrol Basin) (*Beecheria* aff. *patagonica* of Campbell and McKellar, 1969), but was only discussed and illustrated from the El Paso Formation (Cisterna and Sterren, 2016; Cisterna *et al.*, 2017). *Beecheria* sp. from the Hoyada Verde Formation (Uspallata-Iglesia Basin) (Cisterna and Sterren, 2016), as well as *Beecheria boranelensis* and *Beecheria subrotundatus* Peou and Engel, 1979, from the Faulkland Formation, New South Wales, Australia, have a well- developed dorsal median septum, unlike *Beecheria patagonica* Amos.



**Class Gastropoda Cuvier, 1795****Clade Vetigastropoda Salvini-Plawen, 1980****Superfamily Eotomarioidea Wenz, 1938****Family Eotomariidae Wenz, 1938****Subfamily Eotomariinae Wenz, 1938****Tribe Glabrocingulini Gordon and Yochelson, 1987****Genus *Glabrocingulum* Thomas, 1940****Subgenus *Glabrocingulum* (*Glabrocingulum*) Thomas, 1940****Type species. *Glabrocingulum beggi* Thomas, 1940, from the Viséan of Scotland, by original designation.**

**Remarks:** The genus *Glabrocingulum* was originally described by Thomas (1940) and has a total stratigraphic range from the Carboniferous to the Permian. It is known from Europe, North America, South America, Australia and Asia. Sloan (1955) divided the genus and regarded the subgenus *G. (Glabrocingulum)* as an eotomariid having a turbinate shell; a straight upper surface; a convex outer lower face; a concave peripheric selenizone; and spiral and transverse lines on upper and lower surfaces, with small nodes or pustules at the intersections of both systems of lines. The pleural angle varies from 70° to 120°, and the base is convex and phaneronphalous.

*Glabrocingulum* (*Glabrocingulum*) *poperimense* (Maxwell, 1964)**Figure 9, A-B, E****\*1964 *Pseudobaylea poperimensis* sp. nov.****Maxwell, p. 21-22, Pl. 4, figs. 12-17****v1969 *Mourlonia* (*Pseudobaylea*) *poperimensis* Maxwell; Sabbattini and Noirat, p. 101-102, Pl. 1, figs. 3-4**

**Material:** Twenty-one fragmentary external and internal molds in concretionary samples.

**Geographic and stratigraphic provenance:** MPEF-PI 6261, 6263, 6265, 6266, 6268 and 6269 from fossil site-2; MPEF-PI 6286-6288, 6272, 6274, 6277, 6290, 6291, 6297, 6298, 6301, 6303, 6304 and 6315 from fossil site-3; MPEF-PI 6308, 6311, 6333, 6360-6362, 6366-6367 and 6369 from fossil site-5. All fossil-sites located upstream at right bank of Quebrada de los puestos Güera-Peña, northern Sierra de Tecka (Figs. 2, 4), Pampa de Tepuel Formation, *Languigneotus laevicaudatum* Subzone (late Pennsylvanian).

**Description:** The specimens examined are characterized by having a turbiniform shell with a pleural angle of 93° to 100°, and an inclined and flat upper whorl surface. The selenizone is concave in profile, narrow (0.3- 1.0 mm width), and has a peripheric position; it is bounded by two spiral cords, and shows numerous, fine lunulae. The outer whorl face is convex. The ornamentation consists of spiral and transverse elements bearing small nodes at crossing points. The spiral lirae are well marked, with 11 to 16 nodose elements on the upper whorl face. The outer face below the selenizone, and the base have 20 spiral elements. The base is convex and phaneronphalous, and spiral nodose elements rise over the growth lines.

**Discussion:** These specimens fit with material from the Tepuel-Genoa Basin (La Carlota, Tres Lagunas, El Molle, Quebrada Honda, Salar de Ferrarotti and Languiño Hills) that was previously assigned to *Mourlonia .Pseudobaylea. poperimensis* by Sabbattini and Noirat (1969). Based mainly on the presence of a turbiniform shell, a transverse and revolving ornamentation, and a concave, narrow and peripheric selenizone, this species is reassigned herein to *G. (Glabrocingulum)*.

*G. (G.) poperimense* closely resembles two North American species, *G. (G.) granulosum* Gordon and Yochelson (1987) and *G. (G.) quadrignatum* Sadlick and Nielsen (Gordon and Yochelson, 1987) from the Mississippian of Utah, USA. However, *G. (G.) granulosum* differs by having spiral nodose lirae of two sizes on the body whorl, whereas *G. (G.) quadrignatum* exhibits 5-7 spiral nodose elements on the upper whorl surface (*versus* 11-16).

*G. (G.) poperimense* also shows similarities with *G. (G.) amotapense* Thomas (Newell *et al.*, 1953), from the middle Pennsylvanian of the Tarma Group, Peru, which possesses a similar pleural angle, a flat upper whorl face, and a convex outer whorl face. The Peruvian species hardly differs by having a smaller number of spiral cords on the body whorl.

*G. (Glabrocingulum) poperimense* and *G. (G.) hosei* Gordon and Yochelson (1987), from the late Mississippian (*Paracravenoceras barnettense* Zone and *Cravenoceras hesperium* Zone) of Utah, USA, share a similar prominence of the spiral sculpture and a concave, peripheral selenizone; however, *G. (G.) hosei* differs by having a pleural angle of 88° (*versus* 93°-100°) and an anophalous shell base.

**Subgenus *Glabrocingulum* (Stenozone) Batten, 1972**

**Type species:** *Glabrocingulum (Stenozone) nodosuturala* Batten, 1972, from the lower Permian of Malaysia, by original designation.

*Glabrocingulum (Stenozone) argentinum* (Reed, 1927)

Figure 9, C-D, G, L

\*1927 *Pleurotomaria argentina* Reed (in Du Toit, p. 144, pl. 15, figs. 3 a-c)

1955 *Glabrocingulum argentinus* (Reed), Sloan, p. 278

v1969 *Glabrocingulum argentinus* (Reed), Sabbattini and Noirat, p. 102-112, pl. 1, fig. 5

1972 *Glabrocingulum (Stenozone) argentinus* (Reed), Batten, p. 21

1978 *Glabrocingulum (Stenozone) argentinus* (Reed), Sabbattini, p. 49-51

1979 *Glabrocingulum (Stenozone) argentinus* (Reed), Amos, p. 149, fig. 1 (copy Sabbattini and Noirat, 1969, pl. 1, fig. 5)

1980 *Glabrocingulum (Stenozone) argentinus* (Reed), Sabbattini, p. 112

1987 *Glabrocingulum (Stenozone) argentinus* (Reed), Cúneo and Sabbattini, p. 292

**Material:** Three external molds.

**Geographic and stratigraphic provenance:** MPEF- PI 6260, 6267 from fossil site-1; MPEF-PI 6299 from fossil site-4; all fossil-sites located upstream at right bank of Quebrada de los puestos Güera-Peña, northern Sierra de Tecka (Figs. 2, 4), Pampa de Tepuel Formation, *Languigneotus laevicaudatum* Subzone (late Pennsylvanian).

**Description:** The specimens studied show a turbiniform shell with five whorls, a pleural angle of 91°-120°, and an inclined and flat upper whorl surface. The ornamentation consists of 11-13 well- marked spiral nodose elements which are intersected by prosocline growth lines. The selenizone is narrow (0.4-0.8 mm width) and concave, peripheral in position. The outer whorl face is gently convex and the base is rounded, phaneronphalous, with prominent spiral nodose elements and faint growth lines.

**Remarks:** According to the revision of Sabbattini and Noirat (1969), these specimens are assignable to *Glabrocingulum .Stenozone. argentinum* (Reed, 1927); a species known from classic localities from the Tepuel-Genoa Basin (Tres Lagunas, El Molle, Quebrada Honda, Languiño Hills and La Carlota), as well as from the Calingasta-Uspallata Basin, western Argentina (Sabbattini, 1980).

*G. (S.) argentinum* (Reed, 1927) strongly resembles *G. (S.) elegans* Swart (1998), from the Kungurian of the Carnarvon Basin, West Australia, by sharing spiral lirae intersecting collabral growth lines making a characteristic pattern of nodes, and a pleural angle of 124°; however, the Australian species bears a selenizone which is not bounded by spiral elements, so it is perceptible only by the deflection of growth lines.

*Glabrocingulum (Stenozone) sp. 1*

Figure 9, I-J

**Material:** Six fragmentary external molds.

**Geographic and stratigraphic provenance:** MPEF-PI 6309 from fossil site-1; MPEF-PI 6264, 6270 from fossil site-2; MPEF-PI 6273, 6278, 6289 from fossil site-3. All fossil-sites located upstream at right bank of Quebrada de los puestos Güera-Peña, northern Sierra de Tecka (Figs. 2, 4), Pampa de Tepuel Formation, *Languigneotus laevicaudatum* Subzone (late Pennsylvanian).

**Description:** External molds of the shell with five whorls; upper whorl surface flattened, inclined, bearing nodose spiral lirae; selenizone peripheral, narrow (0.7- 0.9 mm width) and concave, bounded by two spiral treads; outer whorl face with opistocline growth lines below selenizone; base convex, phaneronphalous.

**Discussion:** The material described above closely resembles *Glabrocingulum .Stenozone. brennensis* Reed (Batten, 1972), from the early Permian of Malaysia, in sharing nodose spiral elements on the upper whorl



surface, but the Patagonian specimens differ by having a pleural angle of  $100^\circ$  (*versus*  $85^\circ$ ). *G. (Stenozone) argentinum* Reed (Sabattini and Noirat, 1969), from the Tepuel-Genoa and Calingasta-Uspallata basins, shows a similar nodose spiral pattern on the upper whorl face, but it is distinguished by having a pleural angle of  $100^\circ$  (*versus*  $120^\circ$ ), and only growth lines on the outer whorl surface.

This material may represent a new species; however, because it consists only of fragmentary external molds, it is provisionally left in open nomenclature.

**Genus *Ananias* Knight, 1945**

**Type species:** *Phanerotrema? welleri* Newell, 1935, from the upper Pennsylvanian of USA, by original designation.  
*Ananias riccardii* Pinilla, 2012

**Figure 9, F, H, K**

v.1978 *Glabrocingulum (Ananias)* sp. Sabattini, p. 48-49, pl. 2, fig. 15

\*2012 *Ananias riccardii* Pinilla, p. 360-363, figs. 5 a-b, 6 a-b

**Material:** Twenty-three external molds in concretionary samples.

**Geographic and stratigraphic provenance:** MPEF-PI 6305-6307, 6310 from fossil site-1; MPEF-PI 2298, 3063, 3068, 3069, 6262 from fossil site-2; MPEF-PI 6271, 6276, 6279-6284; 6292-6296, 6300, 6322, 6327, 6329, 6334 from fossil site-3; MPEF-PI 6356-6359; 6363-6365 and 6370 from fossil site-5. All fossil-sites located upstream at right bank of Quebrada de los puestos Güera-Peña, northern Sierra de Tecka (Figs. 2, 4), Pampa de Tepuel Formation, *Languigneotus laevicaudatum* Subzone (late Pennsylvanian).

**Description:** The specimens studied have faint spiral lirae on the selenizone. In addition, external molds of the last whorl show a well-developed turbinate shell. The upper whorl surface is inclined and flat, with 17-20 faint nodose spiral lirae by intersection with growth lines. The pleural angle ranges from  $83^\circ$  to  $89^\circ$ . The outer whorl profile is convex and exhibits delicate spiral lirae and growth lines. The selenizone is narrow, 0.6-1 mm in width, slightly concave, with faint lunulae and 5 spiral lirae. The base is convex, rounded and phaneronphalous, with numerous closely spaced nodose spiral elements.

**Discussion:** The presence of faint spiral lirae on the selenizone is a distinctive feature of *Ananias*. Following the diagnosis of Pinilla (2012), the material is assigned to *A. riccardii*, which was originally described from the classic locality of Cerro Mina (Sierra de Languiño, Tepuel-Genoa Basin).

*Ananias riccardii* is closely similar to the type species, *A. welleri* Newell, 1935, from the Moskovian of USA (Newell, 1935; Hoare, 1961), in having a similar pleural angle ( $85^\circ$  *versus*  $83^\circ$ ), 10-14 spiral lirae on the upper whorl surface (*versus* 17-20), and a convex, phaneronphalous base. However, the North American species differs by having a vertical outer whorl face.

**Subfamily Neilsoniinae Knight, 1956**

**Genus *Peruvispira* Chronic, 1949**

**Type species:** *Peruvispira delicata* Chronic, 1949, from the upper Pennsylvanian-lower Permian of Peru, by original designation.

*Peruvispira teckaensis* sp. nov. Figure 9, M-P

**Material:** Two external molds preserved in concretionary samples.

**Etymology:** Refers to the Sierra de Tecka, Chubut Province, Argentina.

**Holotype:** MPEF-PI 6275

**Paratype:** MPEF-PI 6285

**Geographic and stratigraphic provenance:** MPEF-PI 6275 and 6285 from fossil site-3. Fossil-site located upstream at right bank of Quebrada de los puestos Güera-Peña, northern Sierra de Tecka (Figs. 2, 4), Pampa de Tepuel Formation, *Languigneotus laevicaudatum* Subzone (late Pennsylvanian).

**Diagnosis:** Shell small, turbiniform, with four whorls; pleural angle of  $58^\circ$ ; upper whorl surface straight; outer whorl surface slightly concave, with a narrow selenizone bounded by two spiral cords; alveozone concave above a peripheric peribasal carina; ornamentation consisting of collabral lirae; base convex, anophalous.

**Description:** Shell small and gradate, with four whorls and a height of 5.5 mm. Pleural angle of  $58^\circ$ . Upper whorl surface inclined and flattened. Ornamentation consisting of closely spaced (8 per mm) collabral threads. The outer whorl surface bears a concave selenizone (width=0.4 mm) which is bounded by two spiral cords that occupy about one-third of the surface. Below the selenizone, a concave alveozone precedes a faint peribasal carina. This carina limits the base of the shell, which is convex and anonphalous. **Discussion:** *Peruvispira teckaensis* sp. nov. mostly resembles the type species, *P. delicata* Chronic, 1949, from the Bashkirian-Moskovichian of the Parana Basin, Brasil (Rocha Campos, 1966), in having a similar pleural angle ( $56^\circ$  versus  $58^\circ$ ) and ornamentation pattern (collabral lirae 7 per mm versus 8), but differs by showing a broad selenizone with well-marked lunulae, and a slightly convex upper whorl surface. *Peruvispira sueroi* Sabattini and Noirat (1969), from the Bashkirian-Artinskian of the Tepuel-Genoa Basin, has similar dimensions (5 mm in height) and collabral threads (8 per mm), but differs by having a higher pleural angle ( $70^\circ$ - $76^\circ$  versus  $58^\circ$ ).



FIG 10

A-D. *Nuculopsis* (*Nuculopsis*) *patagoniensis* González, 1969; A. Left valve internal mold in lateral view, MPEF-PI 6189; B. Right valve internal mold in lateral view, MPEF-PI 6335; C-D. Detail of dentition; C. MPEF-PI 6186; D. MPEF-PI 6185; E-F. *Phestia tepuelensis* González, 1969; E. Right valve external mold in lateral view, MPEF-PI 6187b; F. Left valve external mold in lateral view, MPEF-PI 6187a; G. *Streblopteria* sp., right valve internal mold in lateral view, MPEF-PI 6255; H. *Streblochondria sueroi* González, 1969 right valve internal mold in lateral view, MPEF-PI 6218; I-J. *Suerocheras?* sp. MPEF-PI 6354; K. *Mitorthoceras?* sp., external mold, MPEF-PI 6355b. L. *Pseudortoceratidae* gen. et sp. indet, internal mold, MPEF-PI 6353. Scale bar: 5 mm.

*Peruvispira canningensis* Taboada *et al.*, 2015, from the Sakmarian of the Canning Basin, Western Australia, possesses a similar number of collabral elements (10 *versus* 8), but differs from *Peruvispira teckaensis* sp. nov. by having a pleural angle of 40° (*versus* 58°). *Peruvispira kuttungensis* Campbell, 1961, from the Bashkirian-Moskavian of New South Wales, is distinguished by having a flat to convex upper whorl surface, and a rounded to convex outer surface.

Class Bivalvia Linnaeus, 1758

Clade Eubivalvia Carter *et al.*, 2011

Subclass Protobranchia Pelseneer, 1889

Superorder Nuculiformii Dall, 1889

Order Nuculida Dall, 1889

Superfamily Nuculoidea Gray, 1854

Family Nuculidae Gray, 1854

Subfamily Nuculinae Gray, 1854

Genus *Nuculopsis* Girty, 1911

Type species: *Nucula ventricosa* Hall, 1858 from the Upper Carboniferous of Iowa, USA, by original designation.

Subgenus *Nuculopsis* (*Nuculopsis*) Dickins, 1963

*Nuculopsis* (*Nuculopsis*) *patagoniensis* González, 1969

Figure 10, A-D

v\*1969 *Nuculopsis* (*Nuculopsis*) *patagoniensis* nov. sp., González, pp. 237-238, pl. I, figs. 1-5.

1979 *Nuculopsis* (*Nuculopsis*) *patagoniensis* González, Amos, p. 104 (copy González, 1969, Fig. 5)

**Material:** Nineteen internal and external molds.

**Geographic and stratigraphic provenance:** MPEF-PI 6330, 6331, 6335, 6336 from fossil site-1; MPEF-PI6247-6249, 6251, 6332 from fossil site-2; MPEF-PI 6183-6186, 6188, 6189, 6200 and 6318 from fossil site-3. All fossil-sites located upstream at right bank of Quebrada de los puestos Güera- Peña, northern Sierra de Tecka (Figs. 2, 4), Pampa de Tepuel Formation, *Languigneotus laevicaudatum* Subzone (late Pennsylvanian).

**Description:** Nuculiform, medium- to large-sized suboval shell, inequilateral slightly extended toward anteroventral margin, valves inflated, longer than high. Umbos incurved above dorsal margin toward the back of the shell, opisthogyrate, placed posteriorly to mid-length, at about 1/3 of total length from posterior end. Margins are convex and continuous, without angles. No distinct lunule or escutcheon. Hinge gradidentate with convexodont teeth. Anterior part of hinge longer than posterior part, with chevron-shaped teeth and sockets decreasing in size toward umbo. Posterior teeth also decreasing in size toward umbo. Anterior and posterior teeth narrow, tall and triangular. Muscle scars weakly impressed. External surface ornamented with regular concentric ridges. Inner margin smooth.

**Discussion:** *N. (Nuculopsis) darlingensis* Dickins, 1963, from the Lower Permian of Western Australia, is closely related to *N. (Nuculopsis) patagoniensis* González, but the Australian species differs by having a more conspicuous umbo in a less posterior position. Pagani (2004) described two other species of *Nuculopsis* (*Nuculopsis*) from the Carboniferous- Permian of Patagonia. *Nuculopsis* (*N.*) *teckaensis* Pagani is suboval to subtriangular in outline, has a medially positioned umbo, and exhibits teeth of different shape and size; whereas *Nuculopsis* (*Nuculopsis*) sp. has a truncate posterior margin, the umbo is in a medial position, and the anterior faces of the teeth are weakly striate.

Superorder Nuculaniformii Carter, Campbell and Campbell, 2000

Order Nuculanida Carter, Campbell and Campbell, 2000

Superfamily Nuculanoidea Adams and Adams, 1858

Family Polidevciidae Kumpner, et al., 1960

Genus *Phestia* Chernyshev, 1951

Type species: *Leda inflatiformis* Chernyshev, 1939 from the Carboniferous of Russia, by original designation.

*Phestia tepuelensis* González, 1969

Figure 10, E-F

v\*1969 *Phestia tepuelensis* González, pp. 239- 243, pl. I, figs. 6-9.

v1977 *Phestia tepuelensis* González, González, p. 114, pl. I, fig. 8.

1979 *Phestia tepuelensis* González, Amos, p. 106 (copy González, 1969, pl. I, fig. 6)

v1987 *Phestia* sp., Cúneo and Sabattini, p. 293, pl. I, fig. 18.

2002 *Phestia tepuelensis* González, Pagani, p. 37-43, pl. 5, figs. a-k, pl. 6, figs. a-j.

2004 *Phestia tepuelensis* González, Pagani, p. 276-280, pl. 7, figs. A-L.

2010 *Waterhouseus tepuelensis* (González, 1969); González, p. 67-69, pl. 5, figs. A-B.

**Material:** One external mold of both valves and one fragmentary external mold.

**Geographic and stratigraphic provenance:** MPEF- PI 6314; 6187 from fossil site-3. Fossil site located upstream at right bank of Quebrada de los puestos Güera-Peña, northern Sierra de Tecka (Figs. 2, 4), Pampa de Tepuel Formation, *Languigneotus laevicaudatum* Subzone (late Pennsylvanian).

**Description:** Shell inequilateral, with a long posterior rostrum. Anterior, antero-ventral and postero-ventral margins regularly rounded. Umbo placed anteriorly, opisthogyrous, moderately projected dorsally. Shell densely covered with thin comarginal ribs and finer radial riblets, which conform a cancellate ornamentation. With small nodules at intersection of comarginal and radial ribs.

**Discussion:** The ornament pattern of the studied material is diagnostic of *Phestia tepuelensis* González, 1969. González (2010) proposed the new genus *Waterhouseus* to include this species, but the diagnosis of *Waterhouseus* is not accurate and the differences with *Phestia* and other close taxa such as *Polidevcia* are not properly discussed. Thus we provisionally keep the original generic name for the Patagonian species. A revision of these genera is necessary, but it exceeds the scope of this paper and will be the subject of future research.

Subclass Autobranchia Grobben, 1894

Superorder Pteriomorphia Beurlen, 1944

Order Pectinida Gray, 1854

Superfamily Chaenocardioidae Miller, 1889

Family Streblochondriidae Newell, 1938

Subfamily Streblochondriinae Newell, 1938

Genus *Streblochondria* Newell, 1938

Type species: *Aviculopecten sculptilis* Miller, 1891 from the Upper Carboniferous of Missouri, USA, by original designation.

*Streblochondria sueroi* González, 1969, Figure 10, H

v\*1969 *Streblochondria sueroi* González, p. 245-246, pl. I, figs. 10-15.

1979 *Streblochondria sueroi* González, Amos, p. 108 (copy González, 1969, pl. I, Fig. 15).

v2002 *Streblochondria sueroi* González, Pagani, pp. 123-127, pl. 17, figs. a-k.

v2005 *Streblochondria sueroi* González, Pagani, pp. 591-593, pl. 5, figs. A-H.

**Material:** Three external molds.

**Geographic and stratigraphic provenance:** MPEF- PI 2300 from fossil site-2; MPEF-PI 6218 and 6328 from fossil site-3. All fossil sites located upstream at right bank of Quebrada de los puestos Güera-Peña, northern Sierra de Tecka (Figs. 2, 4), Pampa de Tepuel Formation, *Languigneotus laevicaudatum* Subzone (late Pennsylvanian).

**Description:** Right valve with cardinal line shorter than total shell width. Anterior auricle long, rounded, trigonal, with a marked bysal sinus. Posterior auricle small, triangular. Umbo orthogyrous. Apical angle of 90°. Shell ornamented with wavy radial ribs crossed by regular concentric ribs to produce a cancellate pattern, with small nodes at intersection points.

**Remarks:** This species has previously been reported from many Carboniferous-Permian localities of the Tepuel-Genoa Basin. *Streblochondria sueroi* closely resembles *Streblochondria sculptilis* (Miller), from the Upper Paleozoic of USA (Newell and Boyd, 1995), but the latter shows stronger nodes or scales at the intersections of the concentric and radial ribs. For a complete comparison see Pagani (2005).

Subfamily Streblopteriinae Waterhouse, 2008

Genus *Streblopteria* McCoy, 1851

Type species: *Meleagrina laevigata* McCoy, 1844 from Carboniferous of Ireland, by subsequent designation of Meek and Worthen, 1866.

*Streblopteria* sp. Figure 10, G

**Material:** One external mold and three internal molds, left valves.



**Geographic and stratigraphic provenance:** MPEF- PI 6220, 6253, 6255 from fossil site-2. Fossil site located upstream at right bank of Quebrada de los puestos Güera-Peña, northern Sierra de Tecka (Figs. 2, 4), Pampa de Tepuel Formation, *Languigneotus laevicaudatum* Subzone (late Pennsylvanian).

**Description:** Shell orbicular, acline. Anterior, ventral and posterior margins of disc regularly rounded. Cardinal margin straight, shorter than maximum width of shell. Umbo orthocline. Beak slightly projected above hinge margin. Anterior auricle slightly larger than posterior one. Left anterior auricle flat and subquadrate; posterior auricle triangular. Ligament area triangular, elongate, without a distinct chondrophore. External surface with inconspicuous comarginal growth-lines.

**Remarks:** *Streblopteria* sp. closely resembles *Streblopteria lagunensis* Pagani, 2006, from other localities of the Tepuel-Genoa Basin. However, because the specimens from Güera-Peña are fragmentary, they are provisionally left under open nomenclature.

Class Cephalopoda Leach, 1817

Subclass Nautiloidea Agassiz, 1847

Order Orthocerida Kuhn, 1940

Family Pseudortoceratidae Flower and Caster, 1935 Gen. et sp. indet Figure 10, L

**Material:** One fragmentary internal mold.

**Geographic and stratigraphic provenance:** MPEF-PI 6353 from fossil site 3, located upstream at right bank of Quebrada de los puestos Güera- Peña, northern Sierra de Tecka (Figs. 2, 4), Pampa de Tepuel Formation, *Languigneotus laevicaudatum* Subzone (late Pennsylvanian).

**Description:** Phragmacone orthoconic, 47.8 mm long; cross section subcircular, 29.6 mm in diameter. Sutures straight. Siphuncule with a central position and a diameter of 4.3 mm.

Genus *Sueroceras* Riccardi and Sabattini, 1975

Type species: *Sueroceras irregulare* Riccardi and Sabattini, 1975, p. 124; original designation.

*Sueroceras?* sp. Figure 10, I-J

**Material:** One fragmentary internal mold and shell preserved.

**Geographic and stratigraphic provenance:** MPEF- PI 6354, 6368 from fossil site-5. Located upstream at right bank of Quebrada de los puestos Güera-Peña, northern Sierra de Tecka (Figs. 2, 4), Pampa de Tepuel Formation, *Languigneotus laevicaudatum* Subzone (late Pennsylvanian).

**Description:** Phragmacone orthoconic, 84.7 mm long; cross section subcircular, with a diameter of 51.1 mm. Sutures straight. Exoskeletal surface ornamented with transverse and longitudinal lirae forming a reticulate pattern.

Genus *Mitorthoceras* Gordon, 1960

Type specie: *Mitorthoceras perfilosum* Gordon, 1960 by original designation.

*Mitorthoceras?* sp. Figure 10, K

**Material:** Two fragmentary external molds.

**Geographic and stratigraphic provenance:** MPEF-PI3065 from fossil site-2; MPEF-PI 6355 from fossil site-4. All fossil site located upstream at right bank of Quebrada de los puestos Güera-Peña, northern Sierra de Tecka (Figs. 2, 4), Pampa de Tepuel Formation, *Languigneotus laevicaudatum* Subzone (late Pennsylvanian).

**Description:** Phragmacone orthoconic, 51 mm long; cross section circular, with a diameter of 51.1 m. Exoskeletal surface ornamented with fine, transverse ribs averaging 3 per mm.

Phylum Cnidaria Hatschek, 1888

Subphylum Medusozoa Petersen, 1979

Class Scyphozoa Götte, 1887

Subclass Conulata Moore and Harrington 1956

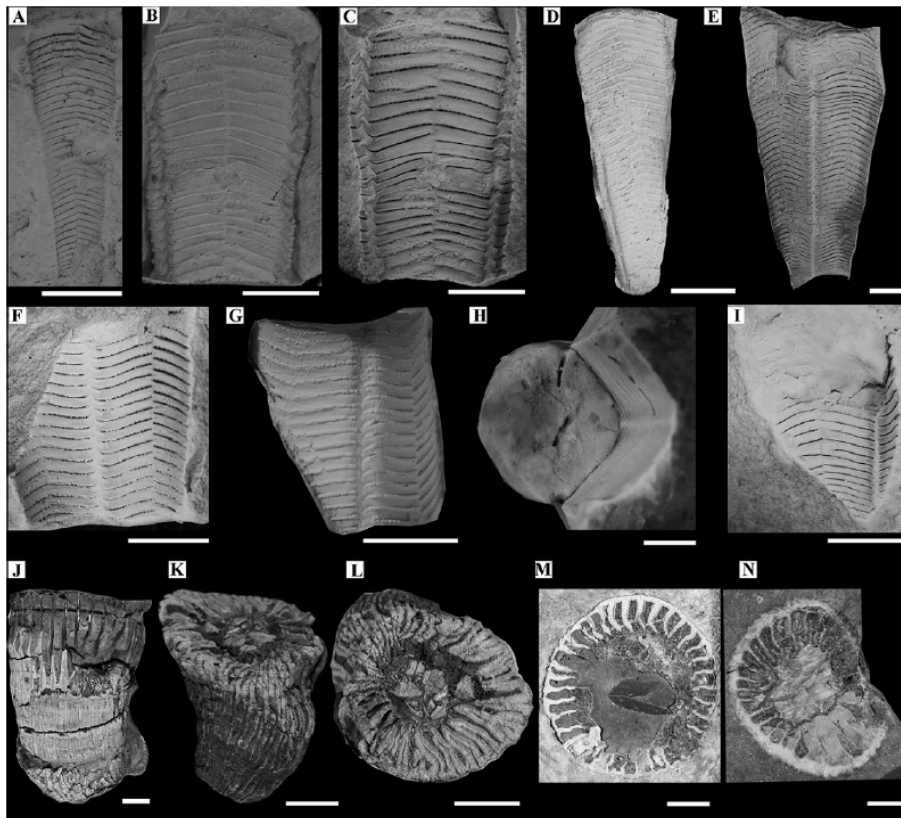
Order Conulariida Miller and Gurley, 1896

Family Conulariidae Walcott, 1886



**Genus *Paraconularia* Sinclair, 1940****Type species.** *Conularia inaequicostata* Koninck, 1883, from the Tournaisian of Belgium, by original designation.

**Discussion:** *Paraconularia* Sinclair, 1940 hardly differs from *Calloconularia* Sinclair, 1952 because the latter has a smaller-sized shell, crowding transverse ribs and well-marked longitudinal bars in the interspaces (Campbell, 1962); characters that may lack generic significance (Leme, 2006; Leme *et al.*, 2008; this paper). *Adesmoconularia* Driscoll, 1963 was also regarded as a junior synonym of *Paraconularia* by Babcock and Feldman (1986a, b), although this affirmation was questioned by Sendino (2007).

**FIG 11**

A-I. *Paraconularia* cf. *P. ugartei* Cúneo and Sabbattini, 1987; A. Lateral view, MPEF-PI 6195; B-C. MPEF-PI 6190; B. Polyvinilxyloxane cast external view; C. External mold in lateral view; D. External lateral view, MPEF-PI 6197; E. External mold frontal view, MPEF-PI 6209; F-G. Frontal view, MPEF-PI 6198; F. External mold; G. Polyvinilxyloxane cast; H. External and internal mold showing the cross section, MPEF-PI 6223; I. Fragmentary external mold, MPEF-PI 6201; J-N. ?Family Lophophyllidiidae Moore and Jeffords, 1945; J-L. MPEF-PI 6343; J. Lateral view; K. Lateral view apical fragment; L. Transverse view apical fragment; M. Transverse section, MPEF-PI 6345; N. Transverse section, MPEF-PI 6342. Scale bar: 5mm.

In Patagonia, five species of conulariids were described by Mariñelarena (1970) and Cúneo and Sabbattini (1987) mainly on the basis of biometric characters. However, because some of these features could be of taphonomic origin (Feldman and Babcock, 1986; Simões *et al.*, 2003), a comprehensive systematic revision is necessary and will be the subject of a future paper.

*Paraconularia* cf. *P. ugartei* Cúneo and Sabbattini, 1987

Figure 11, A-I

\*1987 *Paraconularia ugartei* Cúneo and Sabbattini, pp. 289-290, pl. I, figs. 1-3. p.2004 *Paraconularia ugartei* Cúneo and Sabbattini; Sabbattini and Hlevszevitsch, pp. 400-401, figs. 1, A-F; figs. 2, A-E.

**Material:** Fifty-one external molds and six internal molds.

**Geographic and stratigraphic provenance:** MPEF-PI 3066, 3070-3072, 3281, 6190- 6193, 6195, 6215, 6216 from fossil-site 2; MPEF-PI 6196, 6197, 6198, 6201-6214, 6217; 6222-6246 from fossil-site 3; MPEF-PI 6337-6339 from fossil-site 5. All fossil-sites located upstream at right bank of Quebrada de los puestos Güera-Peña, northern Sierra de Tecka (Figs. 2, 4). Pampa de Tepuel Formation, *Languigneotus laevicaudatum* Subzone (late Pennsylvanian).

**Description:** Medium size shell, straight, tapering, subquadrate in cross section, with faces that are approximately equal in width. Maximum shell length of 35 mm and width of 11 mm. Apical angle between 10° and 15°. Periderm ornamented with trochoidal transverse ribs which are straight adapically to slightly curved adaperturally, in a number of 2-3/mm. In the mid facial line, ribs are alternate, opposite or continuous, always inflected adaperturally. Ribs exhibit numerous subcircular tubercles, 4-6/mm in average, reaching up to 9/ mm toward the adapical region in some specimens. Tubercles, as well as ribs, are more numerous toward the adapical region of the shell. Corner grooves transversely angulate, with the ends of the ribs from one face alternating with the ends of the ribs from the other face and showing an adapertural flexion. Interspaces concave, two or three times wider than ribs, usually smooth, although oblique bars close to the facial edges or the facial mid lines are present in some specimens. Facial mid-lines defined by an inflection, interruption and/or alternation of the ribs. Ridge articulation (= connection of Sendino, 2007) of both gothic arch style and inflected gothic style, can be present in the same specimen. Some specimens exhibit an internal septum on the inner side of the mid-line region.

**Discussion:** The specimens studied resemble *P. ugartei* Cúneo and Sabbattini (1987) by sharing a similar number of ribs and tubercles per millimeter, although the latter shows a wider apical angle (14°- 22°). *Paraconularia pulcheria* Mariñelarena, 1970 has a similar size and a similar number of transverse ribs, but the ridges are sinuous adapically, the corner grooves are rounded and the apical angle is wider (22°). *P. acuminata* Mariñelarena, 1970 exhibits a similar ornamentation and a narrow apical angle (15°); nevertheless, its shell is bigger than that of *P. cf. ugartei*, and has an adapertural furrow on the mid-facial line.

*Paraconularia tuberculata* (Fletcher, 1938) (see also Campbell, 1962), from the middle Carboniferous of New South Wales, Australia, differs from *P. cf. P. ugartei* by having sinuous ribs, conspicuous longitudinal grooves, and a rectangular cross section. *Paraconularia nefarious* Campbell, 1962, from the Pennsylvanian of Australia, is distinguished because it has interspaces ornamented with longitudinal bars which correspond exactly in position with the rows of pustules. *P. cf. P. ugartei* and *Calloconularia minima* Campbell, 1961, from the Booral Formation (Pennsylvanian) of Australia, have similar ridge articulations and numbers of ribs per millimeter, but the latter exhibits a wider apical angle (20°-26°) and a distinct longitudinal ridge across the midline of each face.

Subphylum Anthozoa Petersen, 1979

Class Anthozoa Ehrenberg, 1831

Subclass Rugosa Milne-Edwards and Haime, 1850

Order Stauriida Verrill, 1865

?Family Lophophyllidiidae Moore and Jeffords, 1945

Figure 11, J-N

**Material:** Six specimens preserved as internal molds and transverse sections.

**Geographic and stratigraphic provenance:** MPEF- PI 6345 from fossil-site 4; MPEF-PI 6341-6344 from fossil-site 5. All fossil-sites located upstream at right bank of Quebrada de los puestos Güera- Peña, northern Sierra de Tecka (Figs. 2, 4). Pampa de Tepuel Formation, *Languigneotus laevicaudatum* Subzone (late Pennsylvanian).

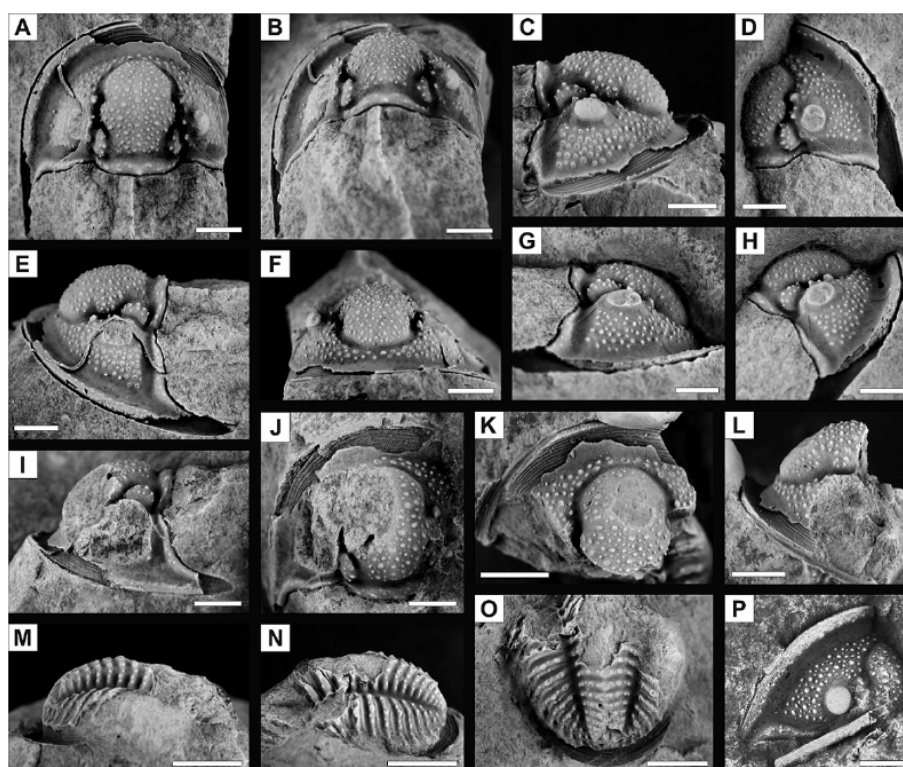


FIG. 12

A-P. *Australosutura argentinensis* Hahn and Hahn, 1969; A-C, E-F. Cephalon in dorsal, postero-dorsal, lateral and anterior views, FML 4007A; D, G-H. Cephalon in dorsal, lateral and oblique views, FML 4008; I-J. Cephalon in lateral and dorsal views, MEF6375; K-L. Fragmentary cephalon in dorsal and lateral views, MPEF-PI 6373a; M-O. Pygidium in lateral and dorsal views, MEF 6373; P. Cephalon in dorsal view, latex mold, MPEF-PId 6373b. Scale bar: 3 mm.

**Discussion:** The specimens are fragmented and poorly preserved. They consist of solitary medium-sized, curved corals of conical to conical-cylindrical shape. In transverse section, the corallia are circular and the wall is proportionately thin. Septa are arranged radially; tabulae and dissepimentarium are not observed. The external surface of the wall is marked by wrinkles and fine growth lines, with longitudinal furrows matching the internal septa.

#### Phylum Arthropoda

Class Trilobita Walch, 1771

Order Proetida Fortey and Owens, 1975

Family Brachymetopidae Prantl and Přibyl, 1950

Genus *Australosutura* Campbell and Goldring in Amos et al., 1960

Type species: *Cordania gardneri* Mitchell, 1922, from the Upper Carboniferous of Australia, by original designation.

*Australosutura argentinensis* Hahn and Hahn, 1969

Figure 12, A-P

v1960 *Australosutura gardneri* (Mitchell), Amos, Campbell and Goldring, p. 231-234, Pl. 39, Figs. 1-11 (only)

1960 *Australosutura gardneri* (Mitchell), Amos, p. 99

1964 *Australosutura gardneri* (Mitchell), Amos, p. 62

1969 *Australosutura argentinensis* Hahn and Hahn, p. 14-15

1973 *Australosutura gardneri* (Mitchell), Amos et al., p. 7

1978 *Australosutura gardneri* (Mitchell), Polanski, pl. 2, Fig. 1

1980 *Australosutura gardneri* (Mitchell), Archangelsky et al., p. 267

1986 *Australosutura gardneri* (Mitchell), Andreis et al., p. 176, 177

1997 *Australosutura argentinensis* Hahn and Hahn, Simanauskas and Sabattini, p. 54



**Material:** Five cephalo, two pygidia and two exoskeletal fragments.

**Geographic and stratigraphic provenance:** FML 4007a-b, 4008; MPEF-PI 3073, 6375 from fossil site-2; MPEF-PI 6373, 6374 from fossil site-3. All fossil-sites located upstream at right bank of Quebrada de los puestos Güera-Peña, northern Sierra de Tecka (Figs. 2, 4), Pampa de Tepuel Formation, *Languigneotus laevicaudatum* Subzone (late Pennsylvanian).

**Description:** Exoskeletal surface with numerous tubercles of different sizes. Cephalon semicircular in outline, strongly convex. Anterior margin of cranidium well rounded; glabella large, strongly inflated, surrounded by well defined axial furrows, subparallel-sided to subconical in outline and broadly rounded anteriorly, occupying 74-78% of the total cranidial length; with one to two pairs of glabellar furrows, of which the S1 is deepest and isolating subtriangular L1; occipital furrow straight to slightly bowed backwards, marked throughout, delimiting a short (sag.) and convex occipital ring. Preglabellar field very short (sag.); cephalic border furrow broad and concave; anterior border convex; anterior branches of facial sutures divergent forward; palpebral lobe prominent, elevated above surface of fixed cheek, situated close to the glabella and opposite S1; posterior branches oblique backwards; free cheek with a moderately long genal spine; cephalic doublure carrying 10-12 terrace lines. Pygidium semielliptical in outline, strongly convex; pygidial axis well defined, inflated, very long, tapered backwards, with 15 rings and a terminal piece; pleural fields large, with conspicuous pleural furrows and longitudinally arranged rows of tubercles of variable size.

**Discussion:** Suero (1948, 1953, 1958, 1961) first cited the occurrence of trilobites in the upper Paleozoic of the Tepuel-Genoa Basin and pointed out its biostratigraphic value. The trilobites collected by Suero were described in great detail by Amos *et al.* (1960) and assigned to *Australosutura gardneri* (Mitchell, 1922); a brachymetopid previously reported from the Westphalian (middle Pennsylvanian) of eastern Australia (Mitchell, 1922, 1924; Amos *et al.*, 1960). However, the presence of slight differences between the morphology of the Australian and the Argentinean specimens (see Amos *et al.*, 1960; Campbell and Engel, 1963; Ormiston, 1966) led Hahn and Hahn (1969) to erect the new species *A. argentinensis*. The latter differs from *A. gardneri* mainly in having a more inflated glabella, distinctive tubercles on the cephalic borders and the occipital ring, and a strongly arched pygidium with pleural fields that occupy, in side view, more than half of the total pygidial height (cf. Amos *et al.*, 1960; Hahn and Hahn, 1969). *Australosutura argentinensis* is a rare member of the cold-water *Lanipustula* and *Languigneotus* faunas, which characterize the upper part of the Pampa de Tepuel Formation (e.g., Amos, 1960, 1964; Amos *et al.*, 1973; Archangelsky *et al.*, 1980; Andreis *et al.*, 1986; Simanaukas and Sabattini, 1997; Pagani and Taboada, 2011; Taboada and Shi, 2011).

Trilobites from Sierra de Tecka are reported herein for the first time. The specimens studied represent an *Australosutura* species with coarse, widely-distributed tubercles on the exoskeleton, a subcylindrical, very inflated glabella, a short preglabellar field, an elongate (sag.), strongly arched pygidium, and large pleural fields, so they are confidently assigned to *A. argentinensis* Hahn and Hahn. The fixed-cheeks exhibit a pair of conspicuous tubercles opposite S2 (e.g., Fig. 12A, E), and the cephalic border furrow is either smooth (Fig. 12A, B, D, E, H, K) or pitted (Fig. 12P). In order to complement the systematic descriptions furnished by Amos *et al.* (1960) and Hahn and Hahn (1969), updated comparisons of *A. argentinensis* with other species of *Australosutura* are provided below.

*Australosutura georgiana* Rich, from the Osagean of the Appalachians, USA (Rich, 1966; Brezinski, 2009), differs from *A. argentinensis* mainly by having a longer (sag.) preglabellar field. *Australosutura strattonporterae* (Rowley), from the Louisiana Limestone (lowest Carboniferous) of Missouri, USA (Rowley, 1908; Williams, 1943; Hahn and Hahn, 1969) has, in addition, a shorter and somewhat conical glabella, with a more expanded (tr.) glabellar lobe L1. Similarly, *Australosutura lodiensis* (Meek, 1875), from the Lower Mississippian of western USA (Brezinski, 2009), is distinguished from *A. argentinensis* by its forward tapering glabella.

*Australosutura argentinensis* and *A. llanoensis* Brezinski, from the Tournaisian of the southern United States (Brezinski, 1998), share a cranidium with a cylindrical glabella. However, the glabella of *A. llanoensis*



is less inflated, whereas the pygidium is clearly distinguished from that of *A. argentinensis* by its low profile and its less prominent tubercles (Brezinski, 1998). *Australosutura asiatica* Yuan and Xiang, from the lowest Carboniferous of China (Yuan and Xiang, 1998), differs by having coarser tubercles on the librigenae.

*Australosutura campbelli* Engel and Morris, from the Lower Carboniferous of eastern Australia (Engel and Morris, 1992), is distinguished from *A. argentinensis* by having more delicate nodes on the cephalon, a less convex glabella, a much longer (sag.) frontal area, and a much shorter (sag.) cephalic border furrow. *Australosutura* aff. *A. gardneri*, from the Mississippian (Viséan) of Oklahoma, USA (Ormiston, 1966), differs by its less inflated cephalon and its longer (sag.) preglabellar field (cf. Ormiston, 1966). As stated by Campbell and Engel (1963), *Australosutura* sp. from the Viséan of New South Wales, Australia (Campbell and Engel, 1963), differs from *A. argentinensis* mainly by the relatively greater width/length ratio of the pygidium.

*Australosutura osagensis* Brezinski, from the Mississippian (Osagean) of Missouri and New Mexico, USA, was described only on the basis of pygidia (Brezinski, 2000, 2007). It differs from *A. argentinensis* by having a wider (tr.) axis, as well as a smaller number of axial rings. *Australosutura elegans* (Girty), from the Lower Mississippian of Arkansas, USA (Girty, 1915), is easily differentiated by its strongly tapered posterior pygidial axis, its straight pleural furrows, and its distinctive postaxial region.

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