

Conchostracans and insects from the Upper Triassic of the Biobío river ('Santa Juana Formation'), south-central Chile

Oscar F. Gallego

Paleontología (Facultad de Ciencias Exactas y Naturales y Agrimensura
Universidad Nacional del Nordeste) y Área Paleontología
(Centro de Ecología Aplicada del Litoral - CONICET),
Casilla de Correo 128, 3400 Corrientes-Argentina
ofgallego@hotmail.com

Rafael G. Martins-Neto

Programa de Pós Graduação em Ciências Biológicas, Comportamento e Biologia Animal,
Universidade Federal de Juiz de Fora, UFJF, Sociedade Brasileira de Paleontropodologia,
Campus Universitário- Martelos, 36036-900- Juiz de Fora, Minas, Brasil
martinsneto@terra.com.br

Sven N. Nielsen

Institut für Geologische Wissenschaften, Fachrichtung Paläontologie, Freie
Universität Berlin, Malteserstrasse 74-100, D-12249 Berlin, Germany
nielsen@zedat.fu-berlin.de

ABSTRACT

Fossil arthropods from Upper Triassic outcrops along the Biobío river, south-central Chile, are reported in this paper. Two species of the order Coleoptera, *Ademosyne* sp., and *Ischichucasyne santajuanaensis* gen. et sp. nov. (Permosynidae) are described for the first time for the Triassic of Chile. The conchostracans *Menucoestheria terneraensis* Gallego and *Polygrapta troncosoi* (Gallego) comb. nov., are re-examined based on newly collected specimens and scanning electron microscope photographs. A close relation between *M. terneraensis* and Argentinean and Antarctic species is postulated, with the possibility that *Menucoestheria* evolved from *Euestheria* Depéret y Mazerán. *Menucoestheria* could be the origin of all other Gondwanic eostheriids. The use of *Menucoestheria* and *Polygrapta* as fossil guides for continental levels of the Upper Triassic of Argentina and Chile is tentatively proposed. The reported entomofauna, which exhibits close affinities with the Argentinean entomofauna, sharing, for example, the genera *Ademosyne* and *Ischichucasyne*, broadens our knowledge of South American arthropod diversity during the Triassic. The presence of the homopteran dysmorphoptiliid *Bandelnielsenia* Martins-Neto and Gallego, the most plesiomorphic of the South American forms, seems fundamental for an understanding of the phylogeny of this important Triassic group.

Key words: Conchostraca, Insects, Upper Triassic, Chile.

RESUMEN

Conchóstracos e insetos del Triásico Superior del río Biobío ('Formación Santa Juana'), Chile centro sur. En este trabajo se da a conocer el hallazgo de artrópodos del Triásico Superior, en estratos que afloran a lo largo del río Biobío, en el centro sur de Chile. Se describen, por primera vez, para el Triásico de Chile, representantes del orden Coleoptera: *Ischichucasyne santajuanaensis* gen. et sp. nov. y *Ademosyne* sp. (Permosynidae). Sobre la base de nuevos materiales recolectados y fotografías de detalle con microscopía electrónica de barrido, se reestudiaron los

conchóstracos *Menucoestheria terneraensis* Gallego y *Polygrapta troncosoi* (Gallego) comb. nov. Se destaca la estrecha relación entre *M. terneraensis* Gallego y otras especies de Argentina y Antártica. Se menciona la posibilidad de que este género haya evolucionado a partir de especies de *Euestheria* Depéret y Mazerán, y que a su vez *Menucoestheria* Gallego haya dado origen a todos los eosetherideos gondwánicos. Se propone, tentativamente, el empleo de *Menucoestheria* y *Polygrapta* como fósiles guías para los niveles continentales del Triásico Superior de Argentina y Chile. La entomofauna registrada muestra estrechas afinidades con las faunas argentinas, con las que comparte los géneros *Ademosyne* e *Ischichucasyne*, y amplía el conocimiento sobre la diversidad de artrópodos durante el Triásico en Sudamérica. La presencia del homóptero dysmorphoptilideo *Bandelnielsenia* Martins-Neto y Gallego, la más plesiomórfica de las formas sudamericanas, resulta fundamental para comprender la filogenia de este importante grupo triásico.

Palabras claves: Conchóstracos, Insectos, Triásico Superior, Chile.

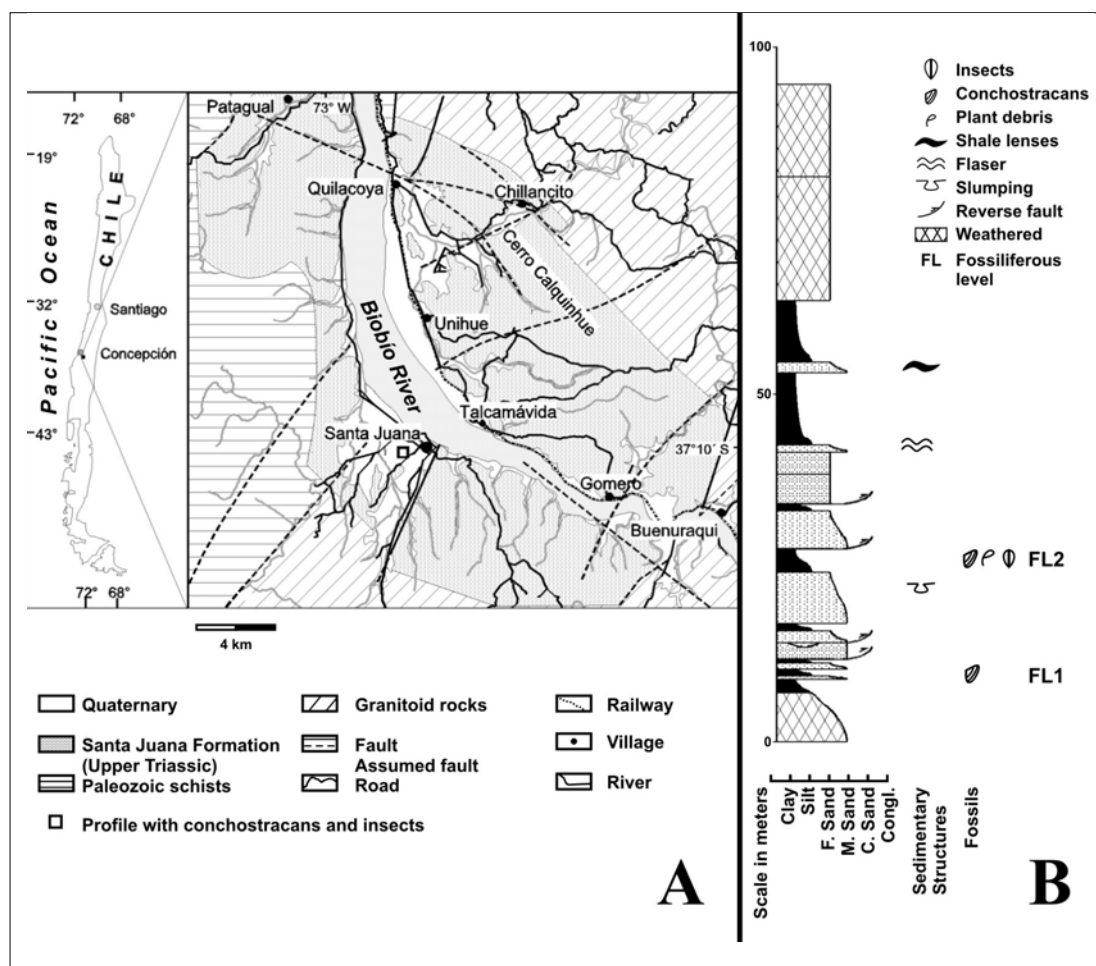
INTRODUCTION

The record of fossil conchostracans and insects from Triassic sedimentary rocks of Chile is poorly known. Recently it was summarized by Gallego and Covacevich (1998) and Martins-Neto *et al.* (2003). Previous records mainly consisted of brief mentions with geographical and stratigraphical sources. Gallego and Covacevich (1998) cited only two references (Fuenzalida, 1937; Cecioni and Westermann, 1968) mentioning fossil insects in the Triassic of the Punta Puquén and Los Molles areas. Martins-Neto *et al.* (2003) described the first Triassic insect (homopteran, commonly called bugs or planthoppers) from Chile, *Bandelnielsenia chilena* Martins-Neto and Gallego, 2003 (*in* Martins-Neto *et al.*, 2003) (Auchenorrhyncha, Dysmorphoptilidae, Gallegomorphoptilinae), from the Upper Triassic of the Biobío river, near Concepción (south-central Chile) (text-Fig. 2.D; Pl. 3, Fig. 8).

Gallego and Covacevich (1998) described three new species of Triassic conchostracans: *Menucoestheria terneraensis* Gallego (*in* Gallego and Covacevich, 1998), from the La Ternera Formation (Upper Triassic) and the La Coipa Beds (?Lower Triassic *sensu* Hutter *in* Suárez *et al.*, 1995, based on a palynomorph assemblage; or Upper Triassic, *sensu* R. Herbst, oral communication, 1997, based on the a plant assemblage, and M. Suárez, oral communication, 2004, see also Gallego and Covacevich, 1998, p. 129); *Menucoestheria*

puquenensis Gallego (*in* Gallego and Covacevich, 1998), from the Pichidanguí? and Profeta? formations (Upper Triassic); and *Liograptia troncosoi* Gallego (*in* Gallego and Covacevich, 1998), from the La Coipa Beds (for age assignation see above).

In recent fieldwork, one of the authors (SNN) and Klaus Bandel (University of Hamburg, Germany) recovered several samples with an abundant conchostracan fauna and insect remains from a road-cut outcrop near the village of Santa Juana, near Concepción (southern-central Chile) (text-Fig. 1B). This material comes from the Upper Triassic sediments of the Biobío river. In the present work, the authors identify the record of *Menucoestheria terneraensis* Gallego (*in* Gallego and Covacevich, 1998) and *Polygrapta troncosoi* (Gallego *in* Gallego and Covacevich, 1998) comb. nov. among the conchostracan fauna. This new material and its differing stratigraphical and geographical source permit a more detailed study of these previously known conchostracan taxa. Scanning electron microscope (SEM) studies and new available characters allow us to offer an extended diagnosis of both taxa. Two insect taxa, *Ademosyne* sp. and *Ischichucasyne santajuanaensis* gen. et sp. nov. (Order Coleoptera), are identified and comments on the paleogeographic distribution, dispersal paths and relationships of the described insects and conchostracans are given.



Text FIG. 1. A Geological map with the location of the fossiliferous locality. B Geological column of the studied locality (both from Nielsen, in press).

GEOLOGICAL SETTING

The Upper Triassic sediments from the Biobío river were deposited in a basin surrounded by Paleozoic metamorphic and granitoid rocks (González-Bonorino and Aguirre, 1970; text-Fig. 1A, B). The name Santa Juana Formation was introduced by Ferraris (1981) for Triassic sedimentary rocks along the Biobío river, near Santa Juana. Ferraris (1981) did not clearly define this formation. Accordingly, the term Santa Juana Formation is interpreted in this work as including all Triassic sedimentary rocks exposed in the mentioned area, the extent of which is indicated on text-Fig. 1A. While this is not satisfying, it is not

within the scope of this paper to give a clearer definition of the Santa Juana Formation. Comprehensive accounts on the sedimentology and paleontology have been conducted by Felsch (1910), Steinmann (1921), Tavera (1960), Hervé *et al.* (1976), Charrier (1979), Leppe and Moisan (2003), Pérez-Barría (2004) and, more recently, by Nielsen (in press).

The exclusively clastic sedimentary rocks of the Upper Triassic from the Biobío river have been interpreted as the deposits of rivers, lakes, playas and alluvial fans (Nielsen, in press). Material described in this article comes from black mudstones

exposed by a road-cut just outside the village of Santa Juana (text-Fig. 1A, B) at S37°10.270'/W 072°57.406' (GPS data). These mudstones have been interpreted 'as the product of settling from suspension in relatively deep water' of lakes (Nielsen, in press). However, some of the black shales may have been deposited in abandoned channels or lakes leading to still conditions preferred by conchostracans (Nielsen, in press). The lower fossiliferous level (FL 1, text-Fig. 1B) consists of a dark grey silty mudstone with abundant conchostracans, *M. terneraensis* Gallego and *P. troncosoi* (Gallego), while the upper fossiliferous level (FL 2, text-Fig. 1B) consists of a finer black mudstone yielding abundant conchostracans, *M. terneraensis* Gallego and *P. troncosoi* (Gallego), rare insect remains (*Bandelnielsenia chilena* Martins-Neto and Gallego, *Ischichucasyne santajuanaensis* gen. et sp. nov. and *Ademosyne* sp.), and plant fragments.

The Upper Triassic age of the sequence was

established by Steinmann (1921) based on the fossil flora (see Hervé *et al.*, 1976; Leppe and Moisan, 2003). Steinmann (1921) also reported the presence of fresh water invertebrates, including *Esthena Mengolinesis* (sic. in Hervé *et al.*, 1976, probably '*Estheria*' *mangaliensis* Jones) and *Unio* sp. Tavera (1960) gave a Carnian to Rhaetian age for all of these Triassic series (see Hervé *et al.*, 1976) based on the fossil flora and marine mollusk fauna (*Arcestes*, *Myophoria* and *Palaeoneilo*). Leppe and Moisan (2003) gave an Upper Carnian to Lower Rhaetian age based on the paleoflora, while Pérez-Barría (2004) proposed an Upper Carnian to Lower Norian age based on an abundant marine mollusk fauna (Clydonautilidae, Nuculidae, Malletidae, Nuculanidae, Halobiidae, Limidae and Kalenteridae).

Here, the Carnian age proposed by Nielsen (in press) is used, which is based on known stratigraphic ranges of the paleoflora.

MATERIAL AND METHODS

The material studied was collected by Sven N. Nielsen and Klaus Bandel during field trips in 1997 and 2000 near Concepción, south-central Chile. The samples are kept in the Paleontology Section of the Museo Nacional de Historia Natural, Santiago (Chile), with sample numbers prefixed by SGO.PI.

Supplementary material of the conchostracans are kept in the Paleozoological Collection of the Facultad de Ciencias Exactas y Naturales y Agrimensura (Universidad Nacional de Nordeste, Corrientes, Argentina) under the collection number CTES-PZ.

Well-preserved specimens of conchostracans were described and measured. The morphometric parameters used were those of Defretin-LeFranc (*in* Tasch, 1987; Gallego and Covacevich, 1998): L: valve length; H: valve height; Ch: hingeline length; Cr: distance from beak to anterior end of the valve; Av: distance from anterior end of the dorsal margin

to the anterior end of the valve; Arr: distance from the posterior end of the dorsal margin to the posterior end of the valve; a: distance from maximum anterior bulge to dorsal margin; b: distance from maximum posterior bulge to dorsal margin; c: distance from maximum ventral bulge to the anterior end of the valve. All measurements are given in mm.

SEM (JEOL JSM-5800LV Scanning Microscope, SECyT-UNNE, Corrientes, Argentina) photographs provide more detailed microscopic evidence on the morphologic characteristics of the conchostracan species described here.

The terminology adopted in this paper for the insects conforms mainly to that of Ponomarenko (1969).

Chen and Shen's (1985) conchostracan systematic scheme is followed for the infraordinal level, because it is the best adapted to South American Triassic conchostracan faunas.

CONCHOSTRACAN FAUNA

The genus *Menucoestheria* was erected by Gallego (*in* Gallego and Covacevich, 1998) for two new species of the family Eosestheriidae from northern Chile, *M. terneraensis* Gallego from La Ternera Formation (Upper Triassic) and La Coipa Beds (Lower Triassic, see above) and *M. puquenensis* Gallego from the Pichidanguí ? and Profeta ? formations (Upper Triassic). Gallego (1999) recognized for the first time the family Eosestheriidae in the Triassic of Argentina. The name of the genus comes from its first record in the Vera Formation,

which is part of the Los Menucos Group (early Late Triassic age, previously known as Los Menucos Formation) in the area of Los Menucos (Río Negro Province, Argentina). The fauna recovered from the Upper Triassic of the Biobío river, also includes *Polygrapta troncosoi* (Gallego) comb. nov. This species was described by Gallego and Covacevich (1998), belonging to the genus *Liograpta*, from La Coipa Beds (Lower Triassic, see above) from northern Chile.

SYSTEMATIC DESCRIPTIONS

Order Conchostraca Sars, 1867

Suborder Spinicaudata Linder, 1945

Superfamily Eosestherioidea (Zhang and Chen, 1976) Chen and Shen, 1985

Family Eosestheriidae? Zhang and Chen, 1976

Genus *Menucoestheria* Gallego *in* Gallego and Covacevich, 1998

Type species: *Menucoestheria terneraensis* Gallego *in* Gallego and Covacevich, 1998, Upper Triassic, Chile.

Diagnosis (emend.): carapace valve small to moderate in size; subovate, elongated ovate, elliptical to subcircular in outline. Posterior margin strongly convex, elongated posteriorly. Growth lines 14 to 45. Narrow growth bands ornamented with rounded areolar reticulation near anterior and medium part of valve, thin radial striae near ventral and postero-ventral sides. Meshes with 0.01 to 0.05 mm diameter and 30 to 80 radial striae per millimeter.

Remarks: Shen (oral communication, 2004) suggested the possibility that *Menucoestheria* ... 'should belong to the family Polygraptidae rather than Eosestheriidae based on sculpture and size of the valves' and concludes that '*Menucoestheria* is very similar to *Polygrapta* Novojilov, 1946'. According to comparisons made between both forms and their original diagnoses, the authors concluded that *Menucoestheria* belongs to the family Eosestheriidae due to its ornamentation, which differs from that of Polygraptidae (radial striae with cross bars, constituted by the alignment of small reticulate

sculpture, see Pl. 3, Figs. 3-5) because it has **rounded areolar reticulation near the anterior and medium part of the valve, changed into thin radial striae near the ventral and postero-ventral sides** (Pl. 2, Figs. 2, 4). With respect to the carapace size, *Menucoestheria* varies from 3 to 8 mm in length, and therefore overlaps with the dimensions of many species referred to *Polygrapta* by Novojilov (1958). Also, it shares this size range with the eosestheriid *Carapacestheria* Shen, 1994 (Early to Middle Jurassic, Antarctica). Considering Shen's different opinion in this paper, the authors included a question mark at the family level, waiting to resolve this nomenclatural problem with new material.

Menucoestheria differs markedly from all other genera of the family Eosestheriidae (see Gallego and Covacevich, 1998, Table 2). *Carapacestheria* (Early to Middle Jurassic, Antarctica) is the most similar genus, but differs slightly in the smaller dimensions of the carapace, polygonal reticulation with 0.02 to 0.036 mm in diameter and about 40 radial striae per millimeter, and with minute punctae filling in meshes and between striae which are

lacking in *Menucoestheria* (Pl. 3, Figs. 1-2). Due to their close similarities in carapace size, outline and mainly in the type of ornamentation, both genera are regarded as phylogenetically closely related.

***Menucoestheria terneraensis* Gallego in Gallego and Covacevich, 1998**

Pl. 1, Figs 1-5; Pl. 2, Figs. 1-7; Pl. 3, Fig. 1

'*Estheria*' Steinmann in Solms-Laubach and Steinmann, 1899, p. 590.

Estheria mangaliensis Jones, 1862; Steinmann, 1921, p. 352.

Estheria forbesii Jones, 1862; Tavera, 1960, p. 343.

Menucoestheria terneraensis Gallego in Gallego and Covacevich, 1998 p. 120-122, text-Fig. 2B, Pl. 1, Figs. 1-9.

Dimensions: (in mm)

L	H	H/L	Ch	Cr	Arr	Av	A	b	c
3.6-8.4	2.8-5.4	0.54-0.8	2.2-4.6	1.1-2.5	0.92-2.2	0.3-1.8	1.1-2.5	1.1-2.7	1.8-4.5

Material: 77 specimens.

Type locality: 'Quebrada del Carbón' (Cerro La Ternera), Atacama Region, Chile. La Ternera Formation, Upper Triassic.

Other localities: La Coipa mine (La Coipa area), Atacama Region, Chile; La Coipa Beds, ?Lower Triassic (probably Upper Triassic, see Introduction). Santa Juana, Biobío Region, Chile; Upper Triassic from the Biobío river.

Type material: holotype SGO.PI. 5715 (L: 4.7, H: 3.3), paratypes SGO.PI. 5716-5719, 5723-5732.

Additional material: CTES-PZ 7289 (MEB-3), 7294 (MEB-4), 7325 and SGO.PI. 6126, 6128-6133, 6137, 6138 (from Upper Triassic levels from the Biobío river). CTES-PZ: 7269, 7289 (MEB-3) (from La Ternera Formation), 7270 (from La Coipa Beds).

Diagnosis (emended): carapace valve moderate in size, subovate, elongated ovate to subcircular in outline. Straight to slightly convex dorsal margin.

Posterior margin strongly convex and elongated posteriorly. Growth lines 14 to 42. Growth bands ornamented with rounded areolar reticulation near anterior and medium part of valve, and thin radial striae near antero-ventral and postero-ventral sides. Meshes with 0.01 to 0.05 mm diameter and 30 to 75 radial striae per millimeter. Transitional area of two types of ornamentation in last growth bands.

Description: carapace valve moderate in size, between 3.6-8.4 mm length and 2.8-5.4 mm height, subovate, elongated ovate to regularly rounded subcircular in outline. Dorsal margin straight or slightly convex, postero-dorsal angle marked or slightly joined. Posterior margin more convex and larger than anterior one in subovate forms. Elongated ovate forms with subparallel antero-ventral to postero-dorsal margins. Ventral margin slightly convex. Highest at anterior region. Umbonal region located subcentrally to subterminally, raised above dorsal margin. Growth lines 14 to 42. Growth bands ornamented with rounded areolar reticulation distributed nearly on the whole valve surface, and thin radial striae in last five growth bands near antero-ventral and postero-ventral sides. Iso-diametrical meshes with 0.01 to 0.05 mm diameter and 30 to 75 radial striae per millimeter. Antero-ventral area with 30 radial striae and medium-ventral and postero-ventral region with 50 to 75 radial lines. Transitional area of two types of ornamentation in last growth bands. Radial striae bifurcated upward and anastomosed forming small meshes in dorsal area of each growth band.

Remarks: both populations of *Menucoestheria terneraensis* Gallego recovered from the La Ternera Formation and the Upper Triassic levels from the Biobío river, differ in having a slightly larger size and more elongated ovate outline of the last mentioned specimens. The eosestheriid from Vera Formation (Río Negro, Argentina) (see this paper, p. 4) differs from *M. terneraensis* in having smaller dimensions and smaller size of the areolar meshes and larger spaces between radial striae (Pl. 3, Figs. 1-2).

Family Polygraptidae Novojilov, 1954
Genus *Polygrapta* Novojilov, 1946

Type species: *Polygrapta chatangensis* Novojilov, 1946, Upper Permian-Tatarian, Khatanga, Russia.

***Polygrapta troncosoi* (Gallego in Gallego and Covacevich, 1998) comb. nov.**

Pl. 1, Figs. 6-8; Pl. 3, Figs. 3-5

Liograptia troncosoi Gallego in Gallego and Covacevich, 1998, p. 124-126, text-Fig. 2D, Pl. 3, Figs. 1-5.

Dimensions: (in mm)

L	H	H/L	Ch	Cr	Arr	Av	a	b	c
4.3-7.3	3.2-5.3	0.66-0.83	2.4-5.0	1.4-2.3	0.92-1.8	0.5-1.2	0.92-2.8	1.6-2.7	2.1-3.5

Material: 33 specimens.

Type locality: 'Quebrada La Pelada' (La Coipa area), Atacama Region, Chile; La Coipa Beds, ?Lower Triassic (probably Upper Triassic, see Introduction).

Other localities: Santa Juana, Biobío Region, Chile; Upper Triassic levels from the Biobío river.

Type material: holotype SGO.PI. 5720 (L: 5.9, H: 4.9), paratypes SGO.PI. 5721, 5722, 5733 - 5741

Additional material: CTES-PZ 7268, 7287 (MEB-1), 7289 (MEB-3), (from La Coipa Beds); SGO.PI 6127, 6128, 6134-6136; CTES-PZ 7289 (MEB-3), 7324 (from Upper Triassic beds from the Biobío river).

Diagnosis (emend.): carapace valves ovate to subcircular in outline. Dorsal margin straight and strongly joined with posterior margin, forming an angle of 140° in subcircular specimens. Posterior margin longer and more convex than anterior one. Ventral margin regularly convex. Umbo sets subterminal and not risen above dorsal margin. Maximum height in medial region of valve. Growth lines 14 to 40. Ornamented with radial lines, separated by 0.005 to 0.01 mm interspaces and with cross bars in between. Number of radial striae around 80 per mm.

Description: conchostracans with ovate to subcircular outline. Straight dorsal margin, projecting before umbonal region, strongly joined with posterior margin forming angle of 140° in subcircular

specimens. Posterior margin longer and more convex than anterior one. Anterior margin slightly convex and perpendicular, abruptly joined with dorsal one. Ventral margin regularly convex. Umbo sets subterminal and not risen above dorsal margin. Maximum height in medial region of valve. Ovate specimens with maximum height in anterior region of valve, posterior margin more convex and shorter than anterior margin. Growth lines 14 to 40. Ornamented with radial lines separated by 0.005 to 0.01 mm interspaces and with cross bars in between. Number of radial striae around 80 per mm. It resembles areolar ornamentation in middle growth bands of valve.

Remarks: the conchostracans from La Coipa Beds and the Upper Triassic beds of the Biobío river belong to the same species. Here, both are reassigned to the family Polygraptidae and to the genus *Polygrapta* based upon new micro-morphological evidence provided by SEM microphotographs, namely, that the ornamentation in the growth bands is constituted by radial striae with cross bars between them. This ornamentation is characteristic of the genus *Polygrapta*, rather than *Liograptia* Novojilov, 1954, the genus to which this material was assigned previously by Gallego and Covacevich (1998), and in which the ornamentation is constituted by dendritic striae (*sensu* Shen, oral communication, 2003).

Polygrapta was described from the Upper Permian (Tatarian) from the Gulf of Khatanga in the Laptev Sea (Russia). This taxon also includes species from the Upper Permian of China and Russia (Siberia).

Polygrapta troncosoi shares some characteristics of the carapace with many species of the genus (*P. chatangensis*, *P. sibirica*, *P. evenkorum*, *P. necta*, *P. laptevi* and *P. multinstita*; Novojilov, 1958, Figs. 4-10) described by Novojilov (1946, 1958) from the type locality of the genus. These characteristics are: straight dorsal margin, strongly joined with the posterior margin forming a notorious angle, and subcircular to ovate outline. But *P. troncosoi* differs in many other characteristics, such as an umbo rising above the dorsal margin (only in five of the mentioned species) and a dorsal margin

projecting downward to the umbonal region (only in three of the mentioned species). The radial ornamentation of *P. troncosoi* resembles the ornamentation present in *P. sibirica* in length and width of the striae (Novojilov, 1958, Pl. 1, Fig. 1e), but differs markedly from that of *P. chatangensis*, which has narrower striae (Novojilov, 1958, Pl. 1, Figs. 1a-c). *Polygrapta hongluoxianensis* Shen (in Shen and Li, 1986) from the Late Permian from Liaoning (China), has an ornamentation similar in length and width of the striae to *P. troncosoi*, but the

former differs in its generally ovate carapace outline, and the rounded dorsal margin.

Another probable South American member of the genus, is an unnamed species described by Gallego (1999) from the Cerro Bayo locality (Mendoza province, Argentina) of the Cerro de Las Cabras Formation (late Middle Triassic). Both forms differ slightly in the angles of the postero-dorsal and antero-dorsal areas and have more convex dorsal margin and stronger radial striae than the Argentinean species.

INSECT FAUNA

Previous to this paper, the record of Triassic insect fauna from Chile was poorly known (see Introduction of this paper). In this contribution we report the presence of the genus *Ademosyne* that was erected by Handlirsch (1906) from the Upper Triassic of Australia. Currently, there are more than twenty species of this genus described from Triassic levels of the Southern Hemisphere. Recently, Martins-Neto *et al.* (in press) defined four new

species from the early Upper Triassic (Los Rastros Formation) from the Bermejo Basin (La Rioja Province, Argentina). *Ademosyne* is the most common genus registered in the Argentinian Triassic. The new genus *Ischichucasyne* is also known from the late Middle Triassic (Ischichuca Formation) from Argentina, but this material is unpublished. The insect assemblage also includes a hemipteran immature stage, still under study.

Order Coleoptera Linnaeus, 1758

Family Permosynidae Tillyard, 1924 (includes *Ademosynidae* Ponomarenko, 1969)

Genus *Ademosyne* Handlirsch, 1906

Type species: *Ademosyne major* Handlirsch, 1906, p. 402, Pl. 39, Fig. 14, Upper Triassic, Australia.

Ademosyne sp.

(text Figs. 2A, B; Pl. 3, Fig. 6)

Material: SGO.PI.6139 (2A), and (2B), 2 specimens.

Dimensions (in mm): L 2.08-2.8; W 0.83-1.16; L/W 2.4-2.5.

Locality: Santa Juana, Biobío Region, Chile; Upper Triassic levels from the Biobío river.

Description: material (Fig. 2A), elytron 2.08 mm long as preserved and 0.83 mm wide (relation L/W: 2.5), with narrow lateral border. Six smooth costae, not convergent. Space between costae constituted by small granules homogeneously distributed in the whole elytron surface. Material (Fig. 2B): elytra 2.80 mm long as preserved and 1.16 mm wide (relation

L/W: 2.4), with narrow lateral border. Six punctate costae, not convergent. Space between costae constituted by striae homogeneously distributed on the whole elytron surface.

Remarks: these specimens are very similar in all observed morphological aspects to a new species that occurs at the Río Gualo locality (Los Rastros Formation, early Late Triassic) from La Rioja Province (Argentina), described in Martins-Neto *et al.* (in press).

Genus *Ischichucasyne* Martins-Neto and Gallego gen. nov.

Type species: *Ischichucasyne santajuanaensis* sp. nov., designated here; Santa Juana, Biobío Region, Chile; Upper Triassic beds from the Biobío river.

Etymology: alludes to Quebrada de Ischichuca

Chica, locality where the Argentinian material comes from, and *syne*, common suffix for Ademosynidae.

Diagnosis: *Ademosyne*-like elytron shape with 9–11 well-defined smooth costae. The costae closer to the posterolateral margin are multibranched at the proximal part, all of them convergent to the anterolateral margin. Space between costae striated. Elytron relation L/W around 3.5.

Discussion: the morphological variability of *Ischichucasyne* gen. nov. is closer to *Argentinosyne* Martins-Neto and Gallego, reported from the Los Rastros and Cacheuta formations. Some *Ademosyne* species occasionally have one or more dichotomous costae, but no specimens were reported with the peculiar multibranching pattern present in *Ischichucasyne* as proposed herein. *Ischichucasyne*

gen. nov. differs from *Argentinosyne* by having well-defined costae (weakly marked in *Argentinosyne*) and striated ornamentation between costae (constituted by granules in *Ademosyne* as well as *Argentinosyne*).

***Ischichucasyne santajuanaensis* Martins-Neto and Gallego sp. nov.**

(text Fig. 2C; Pl. 3, Fig. 7)

Derivatio nominis: alludes to Santa Juana locality (south central Chile), from where the material comes.

Holotype: SGO.PI. 6140

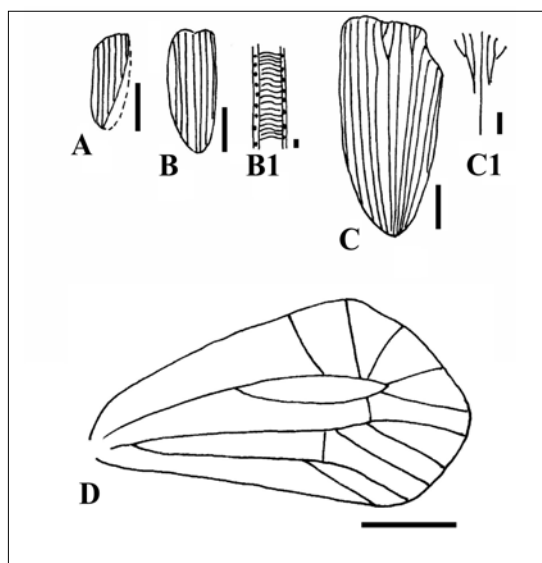
Dimensions (in mm): L 5.08; W 1.25; L/W 4.0.

Locality: Santa Juana, Biobío Region, Chile; Upper Triassic beds from the Biobío river.

Diagnosis: elytron around 5.08 mm long and 1.25 mm wide. Relation L/W 4.0 Six smooth costae, converging to distal border. Costae closer to the posterolateral margin are trichotomous at the proximal part, convergent to the anterolateral margin. Space between costae constituted by small granules homogeneously distributed by the elytron surface.

Description (Holotype SGO.PI. 6140, text. Fig. 2C): elytron 5.08 mm long and 1.25 wide (relation L/W 4.0), with narrow lateral border. Six smooth, divergent costae, proximally multibranched. Space between costae constituted by small granules, homogeneously distributed in the whole elytron surface.

Discussion: the new species belongs to *Ischichucasyne*, because the proximal part of the costae is multibranched. *Ischichucasyne santajuanaensis* gen. et sp. nov. differs from undescribed specimens from the Ischichuca Formation (late Middle Triassic, Argentina) by having an elytron four times longer than wide (three and one-half in the Argentinean specimens), and six costae (nine to eleven in the Argentinean specimens).



Text FIG. 2A,B- *Ademosyne* sp. Martins-Neto and Gallego, drawn from the material SGO.PI.6139 (A), and (B), respectively; B1- ornamentation detail.; 2C- *Ischichucasyne santajuanaensis* Martins-Neto and Gallego sp. nov., drawn from holotype SGO.PI.6140; C1, costae detail, scale bar 1 mm; 2D- *Bandelnielsenia chilena* Martins -Neto and Gallego, drawn from the holotype SGO.PI.5989.

PALEOBIOLOGICAL, BIOSTRATIGRAPHICAL AND PYLOGENETICAL COMMENTS

This study permits to offer some tentative comments with regard to the paleobiology of fossil conchostracans. The assemblage of *Menucoes-theria terneraensis* Gallego in the Upper Triassic horizons of the Biobío river (south central Chile)

shows a ratio of about 4:1 of adults to juveniles. This would indicate a certain stability in the environmental conditions and relative duration of the water body they inhabited which permitted to complete its biological cycle. This is supported by the presence

of regularly spaced growth lines that do not reflect stressful environmental conditions (evidenced by numerous and thin growth bands, which are here only observed on the margins of the valves). On the other hand, the presence of morphological differences among adult specimens suggests the existence of male and female in this population. This would indicate that the environmental conditions had become unfavorable for this species towards the end of its time of inhabitation (narrow bands, see above). The presence of males (in parthenogenic species) in some recent conchostracans populations are due to the establishing of unfavorable environmental conditions in the ecosystem. In this moment, the parthenogenic females produce eggs that only give rise to males. Then, resistant eggs will be formed through sexual reproduction that are able to survive conditions of total dessication of the water body for a long time (up to 15 years). Later, these are able to hatch normally with the return of normal conditions (Webb, 1979). The number of growth lines and their spacing is able to provide additional information about the duration of the biological cycle (from 5 to 240 days in modern forms) and their occupation of a water body, as well as information about the environmental conditions (Tasch, 1961, 1977; Gallego *et al.*, 2004). The calculation of the approximate time of occupation of the said lake by the conchostracans can have a high probability of error (Webb, 1979) and a very wide range of variation (because among other factors we may be dealing with more than one generation). The fossiliferous level (FL) 1 (text-Fig. 1B) from the Upper Triassic of the Biobío river, where *M. terneraensis* Gallego is considered an autochthonous element (by the presence of specimens in life position), one can calculate that this life cycle lasted approximately 30 to 460 days (with average values between 56 and 310 days). Data taken by Gallego and Covacevich (1998, p. 128) for *M. terneraensis* Gallego from the La Ternera Formation and the La Coipa beds show similar parameters (number and spacing in the growth lines) for both localities. One can estimate that the inhabiting lasted between 28 and 365 days (with an average of 46 to 266 days). These relatively minor values of occupation of the water body coincides with interpretations of the environment of Bell and Suárez (1994) and Suárez *et al.* (1995), who suggested a distal flood plain environment with

vegetated banks and lakes (for the La Ternera Formation) and suspension deposits in deep water and dilute turbidity currents (for the La Coipa beds).

Gallego *et al.* (2004) concluded for *Euestheria martinsnetoi* Gallego a shallow and ephemeral lacustrine environment with a hot and humid climate for the Río Mendoza Formation (Cuyana Basin) with a life cycle of 37 to 409 days (mean 50 to 300 days). Of course, these values are relative and much influenced by diverse factors, showing that in the most stable settings (environmentally and temporally) the life cycle, or better, the occupation is prolonged a little more.

From the biostratigraphic point of view, *M. terneraensis* Gallego and *Polygrapta troncosoi* (Gallego), from the La Coipa beds and the Upper Triassic of the Biobío river are present in monospecific assemblages. In the La Coipa beds they were recorded in different localities and probably came from distinct stratigraphic levels, according to lithologic evidence (see Suárez *et al.*, 1995). In the Upper Triassic of the Biobío river, both species coexist in the same stratigraphic intervals (FL1, 2), but *P. troncosoi* (Gallego) occurs in fewer numbers than the other species. In the case of the La Coipa beds, it is possible that this distribution is due to different environmental preferences by each of the species. *M. terneraensis* Gallego always has been recorded in black shales, an indicator of lakes with abundant organic matter, deep, and with long durations. However, in this case the specimens present in the black shale are para-autochthonous (for other authors, allochthonous), being transported from marginal (oxygenated) areas of the lake to deep and anoxic facies. In the case of the *P. troncosoi* (Gallego) data are not so conclusive. They probably preferred environments different than that of *M. terneraensis* Gallego (in Gallego and Covacevich, 1998, p. 128). Due to their short stratigraphic range, both genera and species could be used tentatively as 'local fossil guides' to correlate chronologically the continental Upper Triassic sediments from Chile and Argentina.

Due to their close similarities in the carapace size, outline and type of ornamentation, *Carapacestheria* Shen probably evolved from *Menucoestheria* Gallego or from other related species from the Jurassic of Patagonia, such as *Cyzicus* (*Euestheria*) *taschi* Vallati, 1986 (and other Argentinean forms) that probably belongs to the

family Eosestheriidae. *Menucoestheria* was probably the genus from which all of the Gondwanian members of the family Eosestheriidae originated. If this is the case, the Jurassic forms subsequently migrated across Patagonia through the Antarctic continent to Asia and Europe (see Martins-Neto *et al.*, 2003).

The presence of *Menucoestheria terneraensis* Gallego in Upper Triassic sediments of the Biobío river shows that the family Eosestheriidae had a wide distribution in southern South America during the Triassic, and in Argentinean Patagonia (? *Yanjiestheria* sp. and other related forms are still under study) and Antarctica (*Carapacestheria disgregaris* (Tasch) Shen, 1994 and *C. balli* Shen, 1994) during the Jurassic. A possible record in Brazil can not be discarded, because in the abundant Jurassic and Cretaceous faunas it is likely that these forms have been interpreted as euestherid or fushunograptid ('lioestherid') conchostracans.

Until this record (Gallego and Covacevich, 1998, and this paper) the family Eosestheriidae had a biochron from the late Early Jurassic to the Early Cretaceous (Chen and Shen, 1985; Shen, 1994). Its record is here extended with certainty back to the Upper Triassic. Moreover, these findings show its Gondwanian or South American origin and their

probable ancestral relationship with other members of the family Euestheriidae, due to the fact that the genus *Euestheria* Depéret and Mazerán, 1912 is the best represented in the South American Triassic record.

With respect to the paleoentomofauna, the new taxa described here, as well as *Bandelnielsenia chilena* Martins-Neto and Gallego, 2003 (*in* Martins-Neto *et al.*, 2003), represent the first records for the Chilean territory. Although these records are only a start when compared with other known findings, they are important in extending the paleogeographic distribution of typical Triassic groups represented by *Ademosynes* spp., which was described for several Argentinean localities. The genus *Ischichucasyne* now has one undescribed species from the Ischichuca Formation (Argentina) and another (described here) from the Upper Triassic of the Biobío river (south central Chile), also extending its paleogeographical distribution. Of particular interest for the phylogeny of the group is *Bandelnielsenia* (Dysmorphoptilidae), which until now was the most plesiomorphic of the known genera. Judging from this first collecting effort, the potential of the Chilean paleoentomofauna is considerable and fundamental toward our knowledge of the real insect diversity during Triassic times in South America.

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PLATE 1

Figures 1 - 5 *Menucoestheria terneraensis* Gallego in Gallego and Covacevich, 1998.

- 1 SGO.PI. 6126, ovate right valve, Santa Juana (Biobío Region), scale bar 1mm.
- 2 SGO.PI. 6131, ovate left valve, Santa Juana (Biobío Region), scale bar 1mm.
- 3 SGO.PI. 6129, ovate right valve, Santa Juana (Biobío Region), scale bar 1mm.
- 4 SGO.PI. 6130, ovate left valve, Santa Juana (Biobío Region), scale bar 1mm.
- 5 SGO.PI. 6129, subcircular right valve, Santa Juana (Biobío Region), scale bar 1mm.

Figures 6 - 8 *Polygrapta troncosoi* (Gallego in Gallego and Covacevich, 1998) comb. nov.

- 6 CTES-PZ 7324, ovate left valve, Santa Juana (Biobío Region), scale bar 1mm.
- 7 SGO. PI. 6128, subcircular right valve, Santa Juana (Biobío Region), scale bar 1mm.
- 8 SGO. PI. 6127, subcircular left valve, Santa Juana (Biobío Region), scale bar 1mm.

PLATE 1

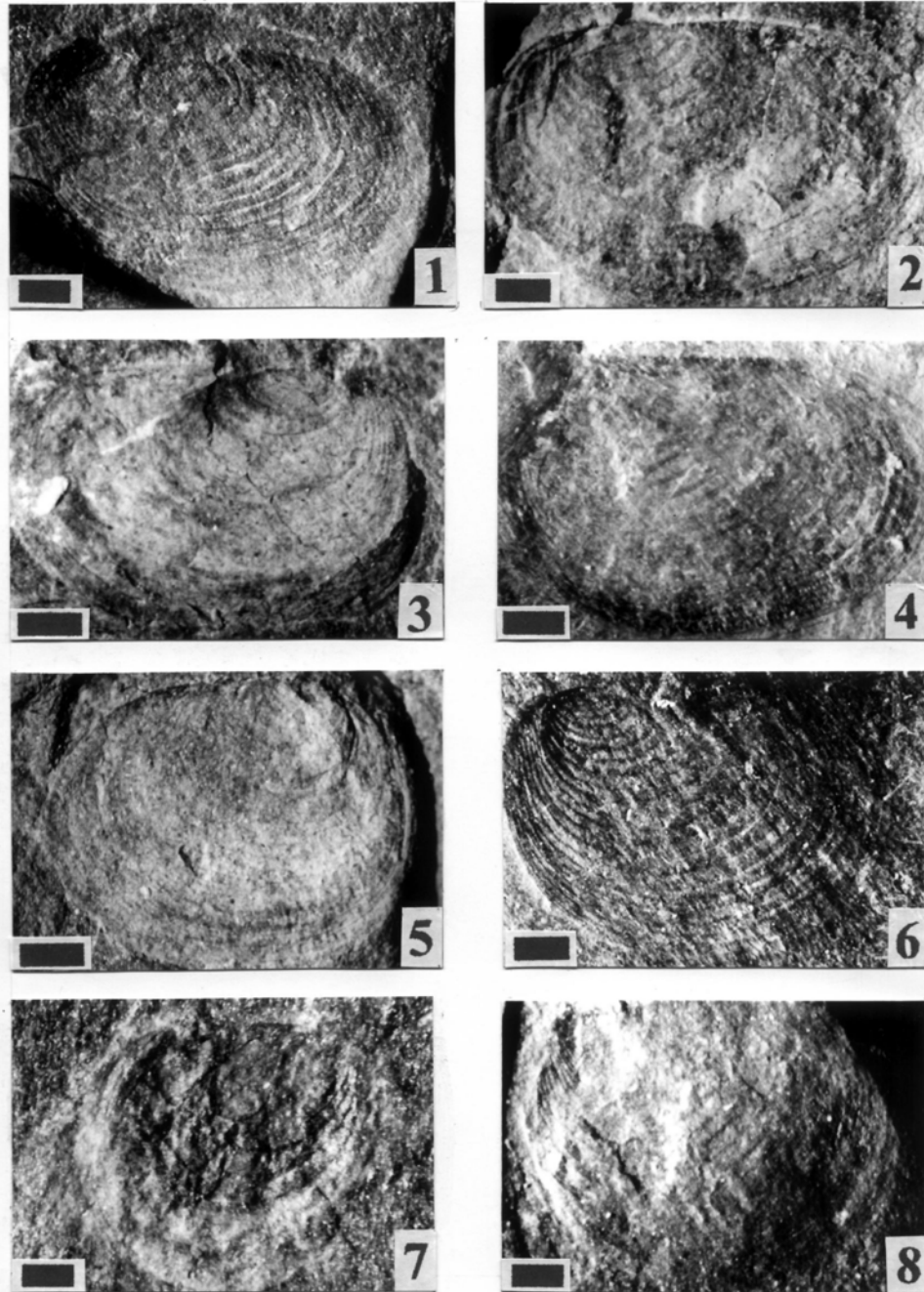


PLATE 2

Figures 1 - 7. *Menucoestheria terneraensis* Gallego in Gallego and Covacevich, 1998.

- 1 CTES-PZ 7289, posterior detail with radial ornamentation, Santa Juana (Biobío Region), scale bar 0.1mm.
- 2 CTES-PZ 7294, middle detail with areolar ornamentation, Santa Juana (Biobío Region), scale bar 0.1mm.
- 3 CTES-PZ 7289, middle posterior detail with transition between areolar to striated ornamentation, Quebrada del Carbón (Cerro La Ternera-Atacama), scale bar 0.1 mm.
- 4 CTES-PZ 7289, middle anterior detail with transition between areolar to striated ornamentation, Quebrada del Carbón (Cerro La Ternera-Atacama), scale bar 0.1 mm.
- 5 CTES-PZ 7289, middle detail with areolar ornamentation, Quebrada del Carbón (Cerro La Ternera-Atacama), scale bar 0.1 mm.
- 6 CTES-PZ 7289, antero-ventral detail with areolar ornamentation, Quebrada del Carbón (Cerro La Ternera-Atacama), scale bar 0.1 mm.
- 7 CTES-PZ 7289, posterior detail with transition between areolar to striated ornamentation, Quebrada del Carbón (Cerro La Ternera-Atacama), scale bar 0.1 mm.

PLATE 2

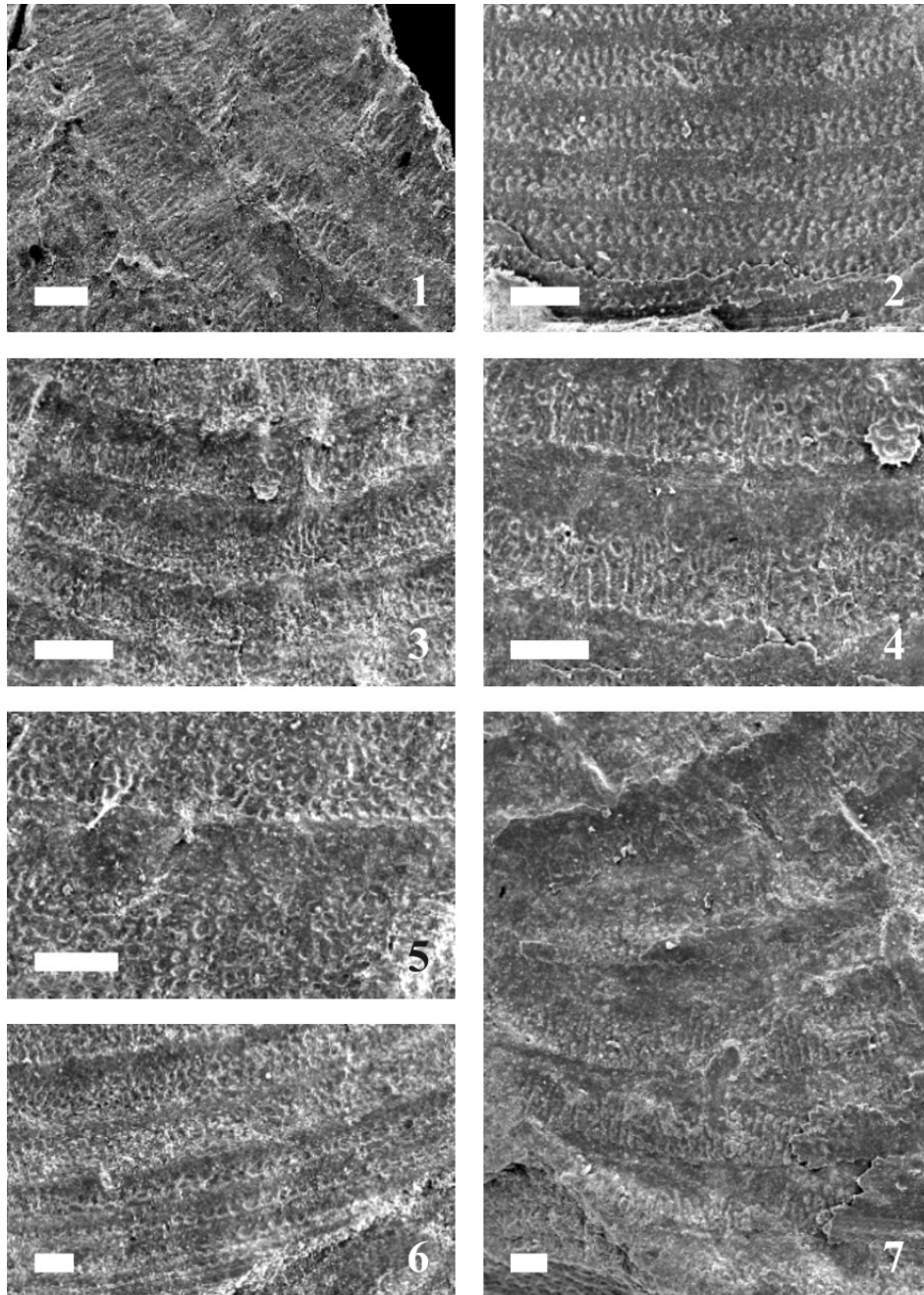


PLATE 3

Figures

- 1 *Menucoestheria terneraensis* Gallego *in* Gallego and Covacevich, 1998, CTES-PZ 7289, middle detail with areola and lacking punctuate ornamentation, Quebrada del Carbón (Cerro La Ternera-Atacama), scale bar 0.05 mm.
- 2 *Menucoestheria* sp. Gallego, 1999, CTES-PZ 7289, middle-ventral detail with striae and lacking punctuate ornamentation, Bajo de Caltrauna (Río Negro, Argentina), scale bar 0.05 mm.
- 3 - 5 *Polygrapta troncosoi* (Gallego *in* Gallego and Covacevich, 1998) comb. nov.
 - 3 CTES-PZ 7289, ventral detail with striae showing cross bars between them, Quebrada La Pelada (Area La Coipa-Atacama), scale bar 0.1 mm.
 - 4 CTES-PZ 7289, middle detail with striae showing cross bars between them, Santa Juana (Biobío Region), scale bar 0.1mm.
 - 5 CTES-PZ 7287, ventral detail with striae showing cross bars between them, Quebrada La Pelada (Area La Coipa-Atacama), scale bar 0.1 mm.
- 6 *Ademosyne* sp. Martins-Neto and Gallego, SGO.PI 6139, Santa Juana (Biobío Region), scale bar 1 mm.
- 7 *Ischichucasyne santajuanaensis* Martins-Neto and Gallego sp. nov., holotype SGO.PI 6140, Santa Juana (Biobío Region), scale bar 1 mm.
- 8 *Bandelnielsenia chilena* Martins-Neto and Gallego, holotype SGO.PI 5989, Santa Juana (Biobío Region), scale bar 1 mm.

PLATE 3

