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THE MOST ANCIENT PLATYPERLIDAE (INSECTA, PERLIDA= PLECOPTERA) FROM EARLY LATE TRIASSIC DEPOSITS IN SOUTHERN SOUTH AMERICA

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Abstract. The new insect species *Platyperla marquati* sp. nov. described herein is represented by a nymphal stage and belongs to the Order Perlida (= Plecoptera) Latreille (stoneflies). It comes from the uppermost section of the Potrerillos Formation, which crops out south of Cerro Cacheuta, at the southernmost end of the Precordillera (Mendoza Province, Argentina). The early Late Triassic Potrerillos/Cacheuta sedimentary succession in this area includes fluvial, deltaic and lacustrine facies that reflect deposition in the border of the Cacheuta depocenter of the Cuyo Basin. This is the second complete insect and the first autochthonous aquatic insect from Triassic beds in Argentina, and also the first record of the family Platyperlidae in Gondwana. This finding demonstrates the similarity of aquatic insect faunas in Mesozoic deposits all over the world, at least of the morpho-ecological types of the aquatic stages. The lacustrine insect fauna began evolving during the Triassic and became diverse during the Jurassic and Early Cretaceous. Detailed geological studies revealed that levels equivalent to the middle Triassic lower units of the Uspallata Group (Río Mendoza and Cerro de Las Cabras formations) lie exposed on the southeastern flank of Cerro Cacheuta. Therefore, a new geological map and interpretation for this area are also presented.

Key words. Insecta. Perlida. Plecoptera. Upper Triassic. Potrerillos Formation. Paleoenvironment. Paleoecology.

Resumen. EL MÁS ANTIGUO PLATYPERLIDAE (INSECTA, PERLIDA= PLECOPTERA) EN DEPÓSITOS DEL TRIÁSICO SUPERIOR TEMPRANO DEL SUR DE SUDAMÉRICA. El nuevo insecto aquí descripto, *Platyperla marquati* sp. nov., está representado por un estadio ninfal y pertenece al Orden Perlida (=Plecoptera) Latreille. Este ejemplar proviene de la sección superior de la Formación Potrerillos, que aflora en el sur del Cerro Cacheuta, en el extremo sur de la Precordillera (Provincia de Mendoza, Argentina). La secuencia sedimentaria Potrerillos/Cacheuta en esta área de edad Triásico Tardío temprano, comprende facies depositadas en ambientes fluvial, deltaico y lacustre en un borde del depocentro Cacheuta de la Cuenca Cuyana. Este es el segundo insecto completo y el primero típicamente acuático hallado en los niveles del Triásico de la Argentina y también el primer registro de la Familia Platyperlidae en Gondwana. El hallazgo demuestra las semejanzas de la fauna de insectos acuáticos durante el Mesozoico a nivel mundial, por lo menos con respecto a los tipos morfo-ecológicos de los sistemas acuáticos pasados. En el Triásico, la fauna de insectos lacustres comienza su evolución llegando a tener un mayor desarrollo durante el Jurásico y Cretácico Inferior. Estudios geológicos detallados han revelado que niveles equivalentes a las unidades inferiores del Grupo Uspallata (formaciones Río Mendoza y Cerro de Las Cabras) afloran en el flanco sureste del Cerro Cacheuta. Por lo tanto se presenta un nuevo mapa e interpretación geológica para esta área.

Palabras clave. Insecta. Perlida. Plecoptera. Triásico Superior. Formación Potrerillos. Paleoambiente. Paleoecología.

THE Triassic insect fauna of Gondwana has been well known since the Nineteenth Century. Knowledge of the fauna from southern South America has increased markedly during the last few years. This led to the recognition of considerable insect diversity in the continental Triassic basins of Argentina and to the relationships of the Gondwanan Triassic insect biota.

The history of research and the previously described Triassic insect species from southern South America have been respectively discussed and reported by Gallego (1997), Gallego and Martins-Neto (1999), Gallego *et al.* (2005), Martins-Neto and Gallego (1999, 2001, 2006, 2009) and Martins-Neto *et al.* (2003, 2005, 2006a,b, 2007, 2008). The insects come mainly from beds lying within the Ischichuca and Los Rastros formations (Bermejo Basin, Argentina; Fig. 1), the Potrerillos and Cacheuta formations (Cuyo Basin, Argentina; Fig. 1), the Santa Maria Formation (Santa Maria Basin, Brazil) and the Santa Juana Upper Triassic levels (Bío-Bío Region, Chile).

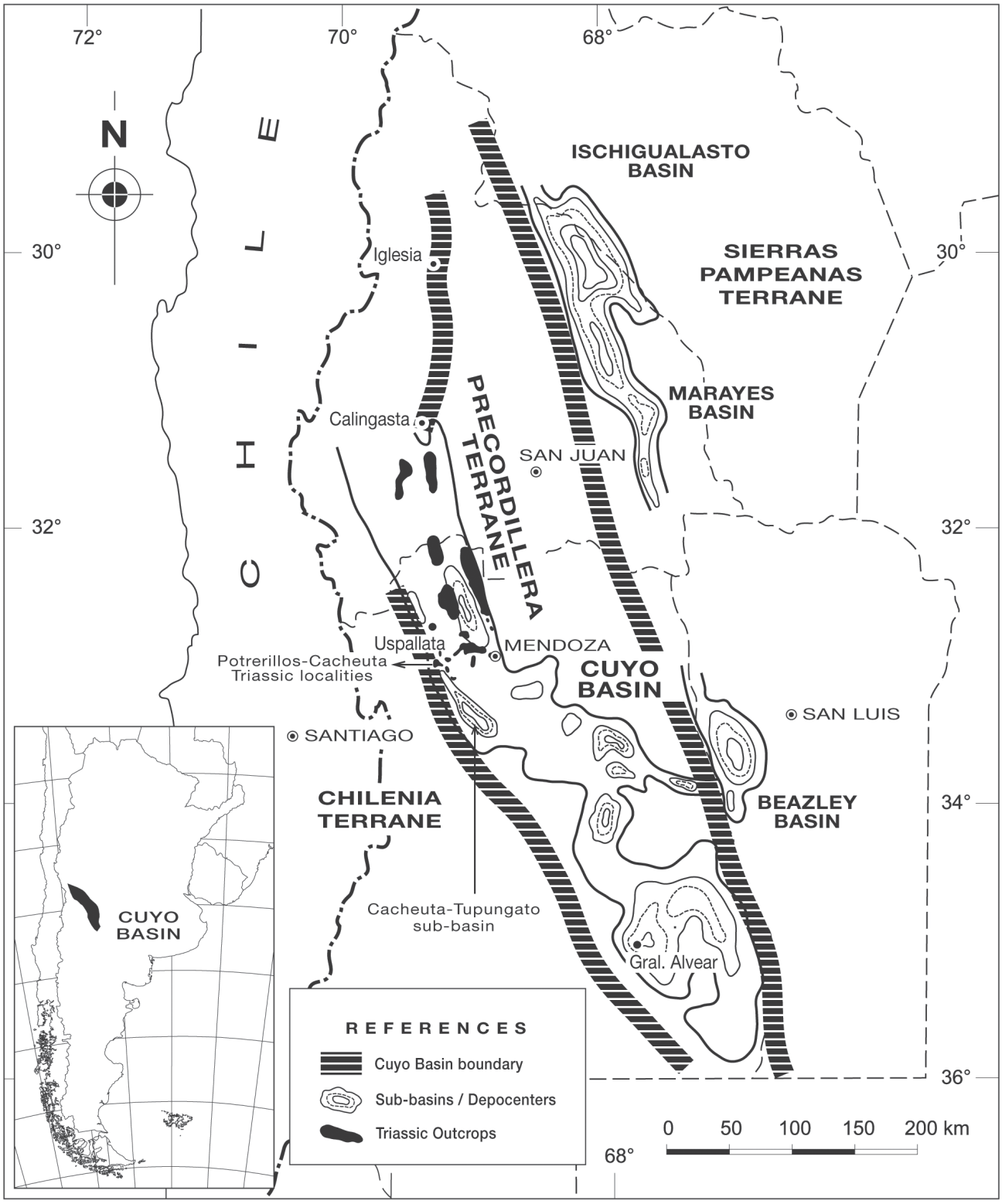


Figure 1. Generalized reconstruction of the Triassic basins of central-western Argentina, showing the location and extent of the Cuyo Basin. Filled black areas show Triassic outcrops and concentric (complete and dashed) lines show the locations of the sub-basins of the Cuyo Basin (modified from Kokogian *et al.,* 1993)/ *Reconstrucción generalizada de las cuencas triásicas del centro-oeste de Argentina mostrando la ubicación y extensión de la Cuenca Cuyana. Las áreas en negro muestran los afloramientos y las áreas de líneas concéntricas (enteras y rayas) la ubicación de las subcuencas de la Cuenca Cuyana (modificado de Kokogian* et al.*, 1993).*

In this contribution we describe the second complete insect and the first autochthonous aquatic insect from Triassic deposits in Argentina. This new specimen is a nymphal stage and belongs to the Order Perlida (=Plecoptera) Latreille, 1810 (stoneflies). It is also the first record of the family Platyperlidae in Gondwana. It was collected from the upper part of the Potrerillos Formation (Fig. 2), in outcrops near the locality known in the literature as Puesto Miguez or Minas de Petróleo, south of Cerro Cacheuta at the southern end of the Precordillera in Mendoza Province, Argentina (Figs. 3, 4, 5). The other complete insect (probably a semi-aquatic nymphal stage) was also recorded from the upper part of the Potrerillos Formation in the southern exposures of Cerro Cacheuta, at the Puesto Agua de las Avispas section, which is approximately 0.5 km southwest of the Puesto Miguez area (Fig. 4). It was described by Marquat (1991) –as *Palaeomantis acostai* (Marquat, 1991)– who included it in the Order Miomoptera. Subsequently, Gallego (1997) transferred it to the genus *Delopterum* Sellards, 1909, and later Storozhenko (1997) re-studied it and ascribed it to the genus *Triasseuryptilon* Storozhenko, 1997, of the Order Grylloblattida, a combination now considered valid.

Eleven fossil insects have been recorded from the upper section of the Potrerillos Formation in the Cuyo Basin. They were published in papers by Cabrera (1928), Carpenter (1960), Pinto and Purper (1978), Marquat (1991), Martins-Neto and Gallego (1999) and Martins-Neto *et al.* (2008). Specimens were assigned to the orders Ensifera (*Notopamphagopsis bolivari* Cabrera, 1928, and *Notopamphagopsis* sp. 1), Odonatoptera (*Triassothemis mendozensis* Carpenter, 1960), Plecoptera (*Gondwanoperlidium argentinarum* Pinto and Purper, 1978, and *G. mendozensis* Pinto and Purper, 1978), Grylloblattida (*Triasseuryptilon acostai* ([Marquat] Storozhenko, 1997), Coleoptera (*Argentinosyne duraznoensis* Martins-Neto and Gallego, in Martins-Neto *et al.*, 2008), and Hemiptera (*Cacheutacicada kurtzae* Martins-Neto and Gallego, 2008). Martins-Neto *et al.* (2007) also described new fossil insects of the orders Blattida (*Anablatta compacta* Martins-Neto and Gallego, 2007, *Potrerilloblatta stipanicici* Martins-Neto and Gallego, 2007, *Delpuenteblatta dangeloi* Martins-Neto and Gallego, 2007, and *Lariojablatta neiffi* Martins-Neto and Gallego) and Coleoptera (*Delpuentesyne menendezi* Martins-Neto and Gallego, 2007). This last insect record came from the upper part of the Potrerillos Formation at Quebrada del Puente (Cerro Bayo, Potrerillos).

MATERIAL AND METHODS

The insects described in this paper were collected by P. Dicindio and L.O. Rébori in 1978 –when they were studying the geology of this area for their Master's theses– and originally reported by Rébori (1979, unpublished). The specimens are housed in the Palaeoinvertebrate Collection (**MCNAM–PI**) of the Museo de Ciencias Naturales y Antropológicas "Juan Cornelio Moyano", Mendoza city. The morphological terminology adopted here is mainly that of Sinitshenkova (1982) and Carpenter (1992).

GEOLOGICAL SETTING

The Cuyo Basin (also known as "Cuyana Basin") is the largest Triassic rift basin of central-western Argentina. It is a narrow, fault-bounded, asymmetric half-graben trough. Like the other narrow, NW–SE-trending basins along the western margin of southern South America, it was formed by extensional faulting at the end of the Paleozoic and in the Triassic, during the final stages of the break-up of Gondwana (Uliana and Biddle, 1988). Ramos and Kay (1991) stated that the initial infilling of the Cuyo Basin during the Triassic post-dated the climax of magmatic and volcanic early Permian–Early Triassic activity represented by the Choiyoi Group. Thus, sedimentation in the Cuyo Basin began around the Middle Triassic (López Gamundí and Astini, 2004). The infilling of this basin was associated with rifting and minor mafic volcanism during the later stages of the magmatic Choiyoi event (Ramos and Kay, 1991). Continental Triassic exposures of this basin run in a NNW–SSE direction along Mendoza and San Juan provinces and include several depocenters or sub-basins (Fig. 1). The basement of the basin is constituted by Paleozoic rocks and by the magmatic and effusive rocks of the Choiyoi complex (Figs. 2, 4). The Cacheuta Sub-basin (which includes the classical Cacheuta and Potrerillos areas) is one of the most important Triassic depocenters of the Cuyo Basin, especially because of its hydrocarbon resources (Chebli *et al.*, 2001) and its diverse fossil assemblages (Stipanicic, 1983; Stipanicic and Zavattieri, 2002). The continental Triassic succession of this sub-basin in the northwestern part of Mendoza Province is represented by the Uspallata Group (Stipanicic and Zavattieri, 2002) (Fig. 2), which is considered a complete fluvial system. It begins with thick basal fanglomeratic facies corresponding to alluvial fan deposits of the Río Mendoza Formation. This facies is gradually replaced upwards by conglomerates, sandstones, tuffaceous siltstones and mudstones that suggest proximal braided river systems, ephemeral streams, un-channelized flows (sheet floods), playa lake deposits and shallow

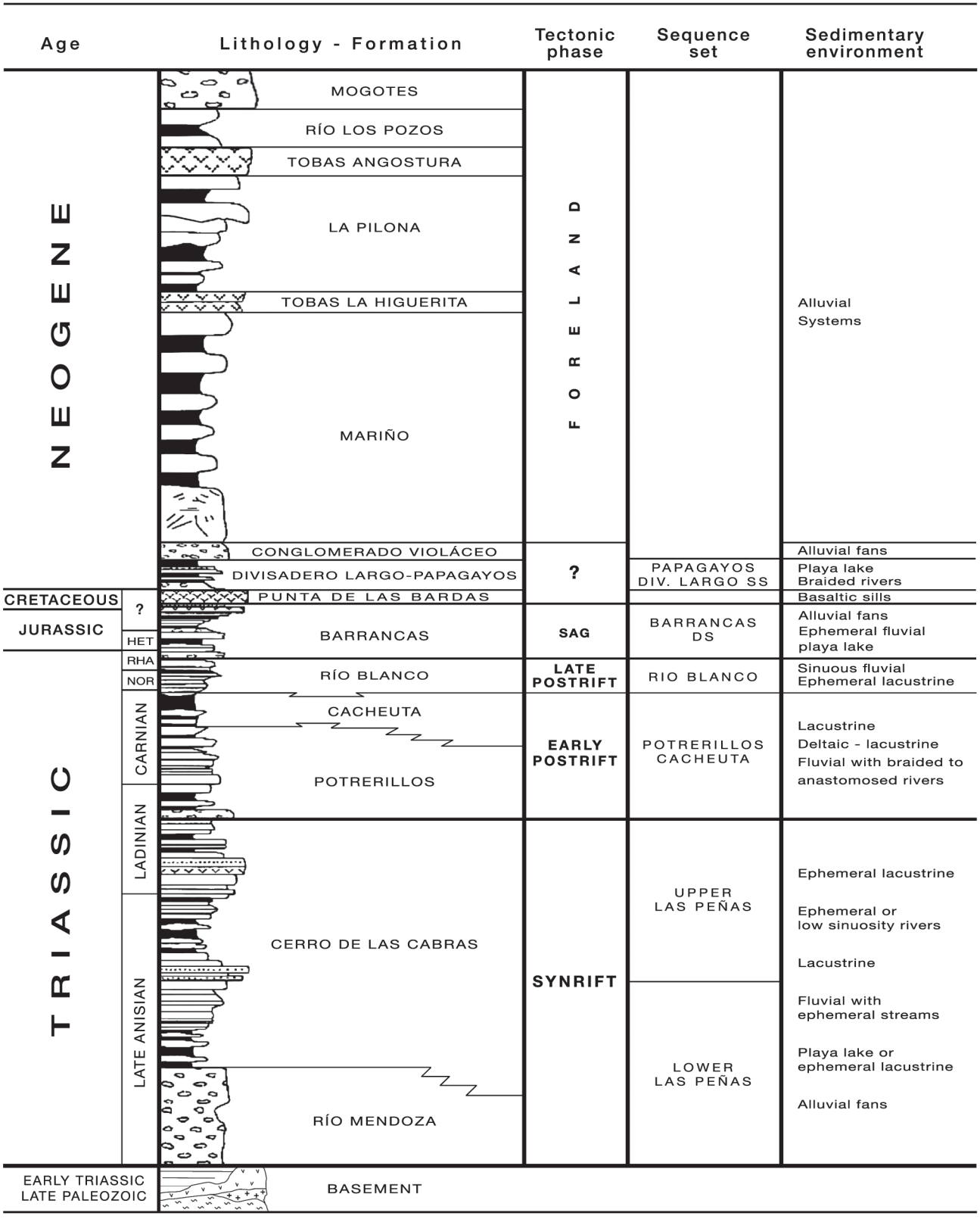


Figure 2. Generalized stratigraphic column of the Cacheuta Sub-basin (also named in the oil industry as Cacheuta-Tupungato Sub-basin or depocenter), Cuyo Basin, northern Mendoza Province and the corresponding interpretation of tectonic evolutionary phases (modified from Boggetti *et al*., 2002)/ *Columna estratigráfica generalizada de la sub-cuenca Cacheuta (también llamada en la industria petrolera como subcuenca ó depocentro Cacheuta-Tupungato), Cuenca Cuyana, norte de la Provincia de Mendoza y la correspondiente interpretación de la evolución de las fases tectónicas (modificado de Boggetti* et al*., 2002*).

lacustrine facies (with stromatolitic limestones) of the Cerro de Las Cabras Formation. Basalt, rhyolite and andesite sills and conspicuous volcaniclastic deposits (tuffites) interbedded in this unit are evidence of profuse volcanic activity during the Middle Triassic synrift phase (Ramos and Kay, 1991) (Fig. 2). Unconformably overlying this succession is the Potrerillos Formation. This unit consists of thick initial, coarse conglomerates that grade upward into coarse–medium sandstones, tuffaceous mudstones (bentonites), bituminous shales and tuffs interpreted as a braided and meandering fluvial system developed on a flood plain. On top lie the deposits of lacustrine deltas and widespread organic rich accumulations of the Cacheuta Formation. Finally, fluvial red-beds of the Río Blanco Formation represent a second sedimentary depositional sequence in the basin. Kokogian and Boggetti (1986), Kokogian and Mancilla (1989) and Kokogian *et al.* (1989, 1993) gave full details of the depositional sequence analysis and tectonic evolution of the sedimentary Triassic infilling of the Cuyo Basin. Boggetti *et al.* (2002) re-analyzed the tectonic evolution of the basin using new 3D seismic surveys and identified the following phases: (1) a Synrift I Sequence Set (Río Mendoza and Cerro de Las Cabras formations, Middle Triassic); (2) an Early Post-rift Sequence Set (Potrerillos and Cacheuta formations, latest Middle- to early Late Triassic); (3) a Late Post-rift Set (Río Blanco Formation, late Late Triassic); and (4) a Sag set (Barrancas Formation, late Late Triassic to Early Jurassic) (see Fig. 2).

The Cuyo Basin is well-known for the floras (megafossils and palynofloras) and faunas that have been recorded from most of its units (Stipanicic, 1983). Triassic plant megafossils of the Argentinian basins belong to the widespread Gondwanan "*Dicroidium* Flora" and to the equivalent diverse *Falcisporites/Alisporites* Ipswich Microflora (Zavattieri and Batten, 1996; Stipanicic and Zavattieri, 2002; Zavattieri and Prámparo, 2006).

THE SECTION SOUTH OF CERRO CACHEUTA

At the southern end of the Precordillera in Mendoza Province, approximately 35 km to the southwest of Mendoza city, the Triassic units of the Uspallata Group are exposed in the Potrerillos and Cacheuta areas of the Cacheuta Sub-basin. These continental rocks are exposed continuously at different sections of the Uspallata Group along the southern and western flanks of Cerro Cacheuta. The Río Mendoza Formation is exposed in this area as thin, conspicuous outcrops located in Quebrada San Agustín, less than 1000 m away in an E-NE direction from Puesto Miguez (Figs. 3, 4). Here, fanglomerates containing clasts derived from the Devonian Villavicencio Formation are exposed. These non-classical deposits of the Río Mendoza Formation were locally named "Unidad Conglom-

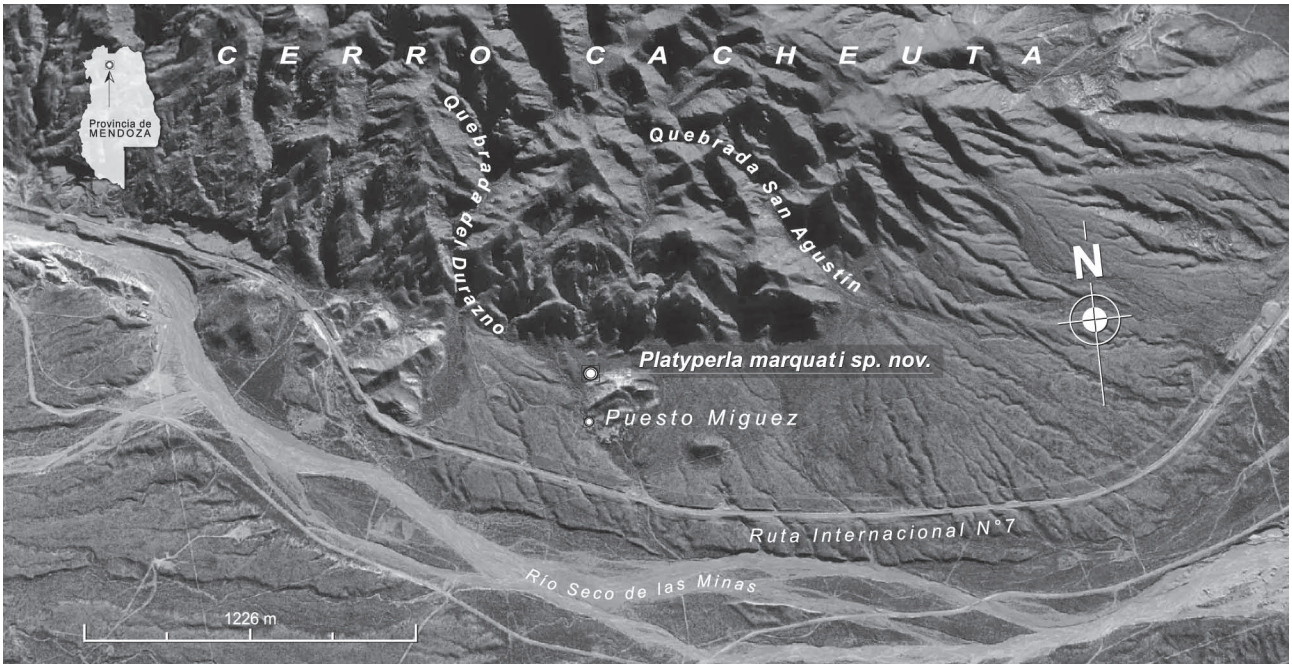


Figure 3. Aerial view of the southern flank of the cerro Cacheuta, southern tip of Precordillera, Mendoza Province showing the Puesto Miguez (or Minas de Petróleo) locality. The *Platyperla marquati* sp. nov.-bearing level is indicated. Image taken from Google Earth-Internet (2009)*/ Vista aérea del flanco sur del Cerro Cacheuta, extremo sur de la Precordillera, Provincia de Mendoza mostrando la localidad de Puesto Miguez (o Minas de Petróleo). Se indica la ubicación del nivel con* Platyperla marquati *sp. nov.. Imagen tomada de (2009) Google Earth-Internet.*

erado Pircas" by Rébori (1979, unpublished) (Fig. 4). Over these deposits there are variably thick lithoclastic tuffs; the maximum recorded was 70 m and this unit was named "Unidad Quebrada San Agustín" by Rébori (1979, *op. cit.*). Now it is easy to correlate these rocks with the informal member "Tobas de Cristales", a subsurface level known in the oil industry and equivalent to the lower section of the Cerro de Las Cabras Formation. Overlying this unit are rhyolitic and andesitic sill deposits and tuffs. Rébori (1979, *op. cit.*) named these rocks "Unidad Puesto Miguez". Their thickness varies from 30 m at Quebrada de San Agustín to 100 m at Quebrada del Durazno. The "Unidad Puesto Miguez" can be correlated to the part of the Cerro de Las Cabras Formation known in the oil industry as "Brecha Verde Member". The deposits of the Potrerillos Formation overlap the effusive rocks of the "Unidad Puesto Miguez". Sandstones suggesting meandering rivers and siltstones and shales interpreted as deltaic environments are the main facies of the unit in this area.

The fossil insect described herein was found in yellowish shales near the base of the section of the Potrerillos Formation exposed at the studied locality (see Figs. 3, 4). The total thickness of this unit at the Puesto Miguez section is 155 m (Fig. 5). It is important to mention that all of these Triassic rocks include large quantities of ash, reflecting frequent episodic volcanic activity during this period. The tuffaceous sandstone beds of the Potrerillos Formation are transitionally overlain by the black lacustrine shales of the Cacheuta Formation, which is the main source-rock of the oil trapped in the Cuyo Basin. At Puesto Miguez the thickness of this last unit is nearly 74 m, but in the deepest part of the basin it measures over 425 m (Ingrassia, 1977). The deposits of the Río Blanco Formation transitionally overlie the Cacheuta Formation, but in the southern area of Cerro Cacheuta there are only scattered exposures of this part of the succession. The lower member of the Río Blanco Formation consists of dark grey siltstones and shales on the right side of the Quebrada del Durazno (Figs. 2, 3). The middle member of this unit is missing in this region. Red deposits of the upper member of the Río Blanco Formation are recognized south of the Agua de las Avispas section and also in a hill located 340 m E-SE from Puesto Miguez. Outcrops of the Barrancas and Punta de Las Bardas formations were not recognized in this region (Fig. 2). Foreland Cenozoic deposits are well developed southwards. They unconformably overlie the Triassic succession; the fanglomerates of the Pliocene Mogotes Formation have been affected by neotectonic processes where Quaternary pediments are overlying those coarse sediments (Figs. 2, 4).

The insect-bearing level is located about 200 m north of Puesto Miguez (33°04′0.6″S–69°06′33.6″W and at 1.386 m a.s.l.), also known in the literature as Cerro Cacheuta or Minas de Petróleo (*cf.* Jain, 1968; Stipanicic *et al.*, 1996, p. 133), in the uppermost part of the exposure of the Potrerillos Formation (Fig. 5). This section is characterized by finely alternating, parallel-laminated sandstones in tabular strata interbedded with yellowish, dark grey and brownish silty layers (in which the insect specimen described herein was found), carbonaceous clays and coals (with plant remains, cuticles, scarce spinicaudatan "conchostracans", and fish scales). The insect bed also yielded well-preserved plant remains belonging to the *Dicroidium* Flora, described originally by Zuber (1889), Szajnocha (1889), Kurtz (1921), du Toit (1927), Frenguelli (1948), Jain and Delevoyras (1967), Morel (1991, 1994) and most recently by Morel *et al.* (2010). The exposures represent braided streams, low sinuosity fluvial channels and overbank deposits developed on a floodplain that passes upward into interdistributary bay-facies of lacustrine deltas and lacustrine basin deposits of the Cacheuta Formation (Zavattieri and Prámparo, 2006).

SYSTEMATIC PALEONTOLOGY

Superclass Hexapoda Latreille, 1825

Class Insecta Linnaeus, 1758

Order Perlida Latreille, 1810

Suborder Perlina Latreille, 1802

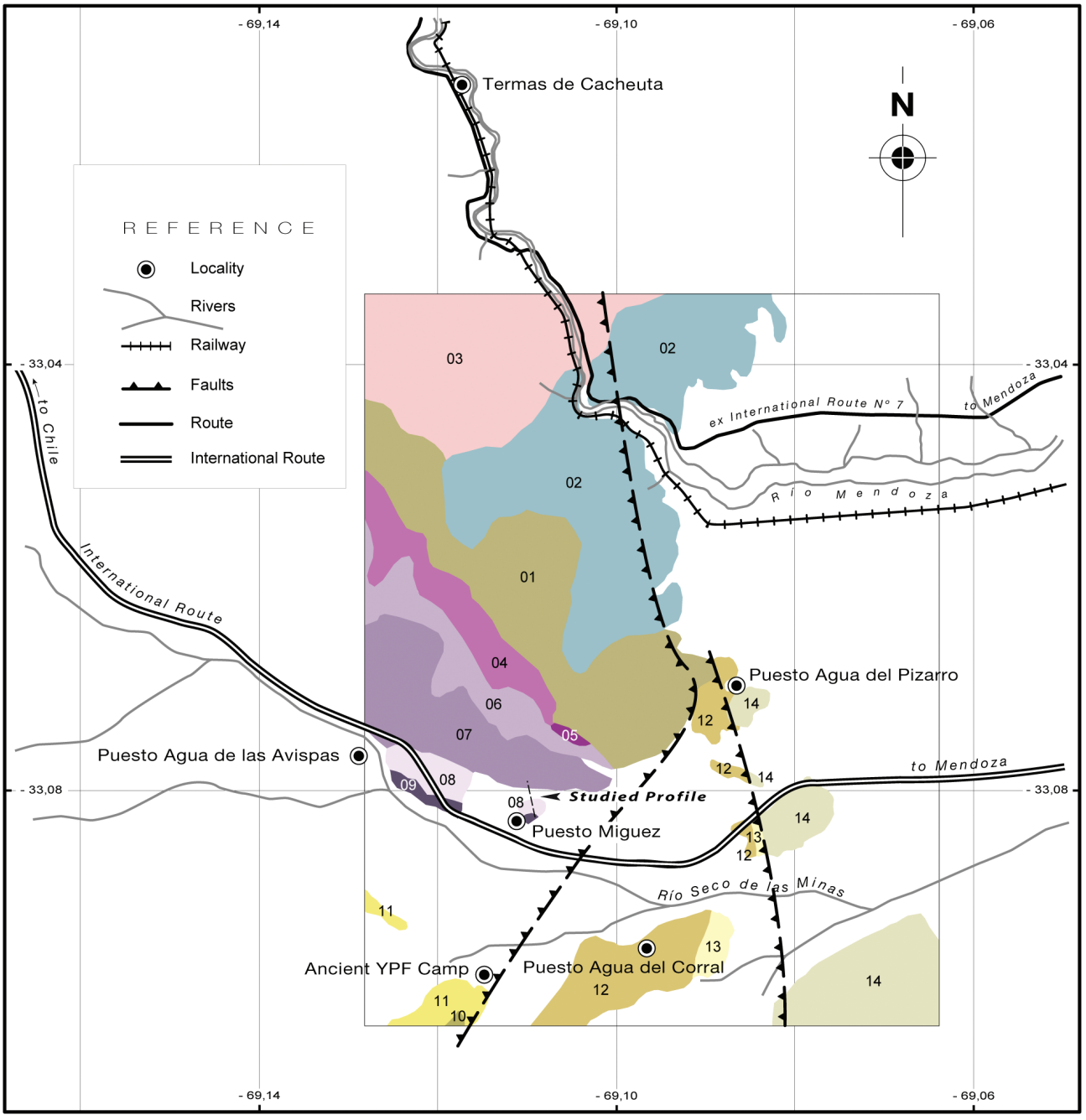
Infraorder Perlomorpha Latreille, 1802

Family Platyperlidae Sinitshenkova, 1982

Genus ***Platyperla*** Brauer, Redtenbacher and Ganglbauer, 1889

Type species. *Platyperla platypoda* Brauer, Redtenbacher and Ganglbauer, 1889, from the Abashevo, Osinovskiy and Cheremkhovo

Figure 4. Geologic map of the south-eastern flank of the cerro Cacheuta, south of the Precordillera of Mendoza. Note that the lower units of the Uspallata Group (Río Mendoza and Cerro de Las Cabras formations) crop out in this area as was first described by Rébori (1979). Age known of the mapped units: **01**: Devonian; **02**: ?early–?late Carboniferous; **03**: middle to late Permian; **04**: late Permian to Early Triassic; **05 – 07**: late Middle Triassic; **08-09**: early Late Triassic; **10-12**: middle Miocene; **13**: ?middle Pliocene; **14**; ?late Pliocene (Series/Epoch according to ISC 2010)/ *Mapa geológico del flanco sudeste del Cerro Cacheuta, sur de la Precordillera de Mendoza. Notar que las unidades inferiores del Grupo Uspallata (formaciones Río Mendoza y Cerro de Las Cabras) afloran en esta área como fue primeramente descripto por Rébori (1979). Edad conocida de las unidades mapeadas:* ***01****: Devónico;* ***02****: Carbonífero ?temprano-?tardío;* ***03****: Pérmico medio a tardío;* ***04****: Pérmico tardío a Triásico Temprano;* ***05 – 07****: Triásico Medio tardío;* ***08-09****: Triásico Tardío temprano;* ***10-12****: Mioceno medio;* ***13****: ?Plioceno medio;* ***14****: ?Plioceno tardío (Series/Epocas según el ISC 2010).*



GEOLOGICAL REFERENCE

- 07 Puesto Miguez Unit (Vulcanites) Cerro de Las Cabras Fm
- 06 Quebrada de San Agustín Unit (Tuffites) Cerro de Las Cabras Fm
- 05 Rio Mendoza Fm
- 04 Choiyoi Group
- 03 Cacheuta Stock Granitic
- 02 Boca de Río Granodioritic Stock
- 01 Villavicencio Fm
- 14 Mogotes Fm
- 13 Tobas Angostura Fm
- 12 Upper Member (Estratos de Mariño) Mariño Fm
- 11 Middle Member (Areniscas Entrecruzadas) Mariño Fm
- 10 Lower Member (Conglomerado Violáceo) Mariño Fm
- 09 Cacheuta Fm
- 08 Potrerillos Fm

formations, Lower Jurassic of South Cisbaikalia, Russia, original designation.

Other species. *Platyperla kingi* Ping, 1935, Shuysigou Series, Lower to Middle Jurassic, North-West China; *P. caudiculata* Sinitshenkova, 1985, Osinovskiy Formation, Lower to Middle Jurassic, Kuznetsk Basin; *P. conferta* Sinitshenkova, 1985, Itat Formation, Middle Jurassic, West Siberia; *P. rigida* Sinitshenkova, 1987, Kushmurun Formation, Lower to Middle Jurassic, West Kazakhstan; *P. propera* Sinitshenkova, 1987, Bakhar Formation, Lower to Middle Jurassic, Central Mongolia; *P. admissa* Sinitshenkova, 1987, Khamarkhuburga Formation, Lower to Middle Jurassic, East Mongolia; *P. mendosa* Sinitshenkova, 1995, Shar Teg beds, Upper Jurassic, South-West Mongolia; *P. parricidalis* Sinitshenkova, 1990, Ust'Kara Formation, Lower Cretaceous, East Transbaikalia.

Remarks. The new species belongs to the genus *Platyperla* Brauer, Redtenbacher, Ganglbauer, 1889, according to the original diagnosis (Carpenter, 1992) based on the morphology of its legs with short and wide femur and tibiae.

Platyperla marquati Gallego, Sinitshenkova, Martins-Neto and Lara sp. nov.

Figures 6, 7, 8

Derivation of name. Dedicated to Prof. Fernando J. Marquat (1932–1989), a renowned Argentinean naturalist from Mendoza**.**

Diagnosis. Large nymph with short thorax only 2.1 times shorter than abdomen. Head as long as wide. Antennae shorter than body length, stipitus large, twice as wide as long**.** Fore-wing pads long and narrow; hind-wing pads shorter and foliaceous (leaf-like).

Holotype. MCNAM-PI 24312 (Fig. 7).

Type locality. Puesto Miguez (or Minas de Petróleo), southern flank of Cerro Cacheuta, southern end of the Precordillera, Cuyo Basin, Mendoza Province, Argentina.

Type stratum. Uppermost part of the Potrerillos Formation.

Age. Early Late Triassic.

Material. MCNAM-PI 24312, partially complete and well-preserved specimen.

Description. Nymphal stage. Body stout and elongate, brown and lightly sclerotized, without setae and external gills apparently absent. Head almost as long as wide, posterior margin markedly convex. Antennae shorter than body length, stipitus (scapus) large, wider than long (1.75:1). Epicranial suture evident, with both methopic or coronal and frontal stems. Vertex narrow and fronts smooth. Labrum transverse, partially evident and sclerotized. Labium partly and barely evident in ventral view. Fore-wing pads long and narrow with almost parallel external margins, hind-wing pads shorter and leaf-like. Pro- meso- and metathorax distinctive, with a mid-dorsal suture. Legs with robust femora probably slightly longer and broader than tibia (partially covered). Abdomen almost twice long as thorax, with ten segments. Abdomen segments twice as wide as long; the last segment with small protrusion in the middle; two lateral paraprocts are evident. Cerci long, shorter than body length, with 25 segments.

Measurements. Body length: 17 mm; head length: 1.7 mm; head width: 1.6 mm.

Comparison. *Platyperla marquati* resembles the type species *P. platypoda* in its elongated slender body and the proportions of the thorax and abdomen, but differs by having narrow forewing pads. It is similar to *P. caudiculata* Sinitshenkova in having stretched long and narrow fore-wing pads with almost parallel external margins and small protrusion on the middle part of the 11th abdominal segment. However, it differs by its comparatively short thorax which is only 2.1 times shorter than the abdomen (in *P. caudiculata* this proportion is 2.6) and by its much larger size (the body length of *P. caudiculata* is 9.7 mm).

DISCUSSION

Platyperlidae belong to the morpho-ecological type of swimming pelophilous Perlida (=Plecoptera), which are lacking among the recent stoneflies (Sinitshenkova, 1982). They are characterized by a slender body with short, widened and flattened femora, and tibia with two very short first tarsus joints. The mouth-parts of *Platyperla* are similar to those of living perlomorphous stoneflies, which are often non-specific predators feeding on zooplankton, small larvae of chironomids, mayflies, caddisflies, dipterans, and less often on other stoneflies and small crustaceans. No doubt, *Platyperla* nymphs were also predators. Moreover, microscopic investigation of the intestine contents of *P. platypoda* revealed the presence of a dark dense substance (probably chitin particles) and a non-structural mass, but no fragments of plant cuticles were found (Sinitshenkova, 1987). The widened legs might have served for catching the prey by swimming, which is not characteristic for living stoneflies at all. Such unusual stoneflies as the Platyperlidae occur among assemblages of highly oxyphilous aquatic insects (stoneflies, mayflies, some damselflies) found in small lenses within coal-bearing fluvial sequences in large river valleys (Sinitshenkova and Zherikhin, 1996).

These environments from the Jurassic of Siberia, interpreted and reconstructed as shallow oxbow lakes by Zherikhin and Kalugina (1985), were dominated by detritivorous stonefly and mayfly nymphs and carnivorous stonefly and damselfly nymphs. It was suggested that microbial activity was strongly reduced by the antibiotic effect of certain plants like Ginkgoales and Czekanowskiales (Kalugina, 1980). This type of ecosystem –with no analogue among the modern models– was named "hypotrophic" by Kalugina (1980).

The morphology of *P. marquati* sp. nov. resembles that of Recent nymphs of the Family Perlodidae, suggesting that they had similar life habits. Perlodidae nymphs include stoneflies that are similar to Perlidae in general appearance. However, most lack any gill vestiges, and long bristles are absent from the front femora. Recent Perlodidae inhabit high-energy lotic environments (flowing water) that are cold and well oxygenated; they are also sometimes found along the edges of cold lakes (lentic environments). They are most commonly found under stones, inside immersed trunks and hidden in compressed leaves under stones. They are generally clingers. Commonly they are engulfer predators and occasionally scrapers, collector-gatherers and sprawlers. Their prey includes chironomids, simulids, mayflies, caddisflies and other stoneflies (Stewart and Harper, 1996; Bouchard, 2004).

Platyperla marquati sp. nov. is the first representative of the family Platyperlidae in Gondwana. This family includes only one genus (*Platyperla*). The genus includes –apart from *P. marquati* sp. nov.– nine species from the Jurassic and Lower Cretaceous in Laurasia (Siberia, Mongolia, China). The occurrence of *P. marquati* sp. nov. in the Triassic deposits of Argentina is the most ancient record of this family and genus. Its occurrence in Argentina demonstrates the similarity of aquatic insect faunas in the Mesozoic all over the world, at least of the morpho-ecological types of the aquatic stages.

The evolution and the ecologic significance of the assemblages of aquatic insects were not important during the Carboniferous, and their importance probably began increasing during the Permian. In the late Permian some groups of insects colonized lacustrine environments, but their fossil record is still poor. During the Triassic the lacustrine insect faunas started evolving, and they have been recorded in all continents. At some Triassic localities, the fossil nymphs are more frequent than adult forms. This is characteristic for the Mesozoic records and has not been observed in the Paleozoic. Aquatic insect assemblages were more diverse in the Triassic, and their taxonomic composition indicates the presence of a type of community different from that of the Jurassic. During this period, the plecopteran family Platyperlidae occurred together with the Mesoleuctridae. During the Jurassic and Early Cretaceous, when the faunas of lacustrine insects were diversifying, both families included the typical representatives of the fauna of shallow oxbow-type lakes in the great fluvial valleys (Sinitshenkova, 2007a).

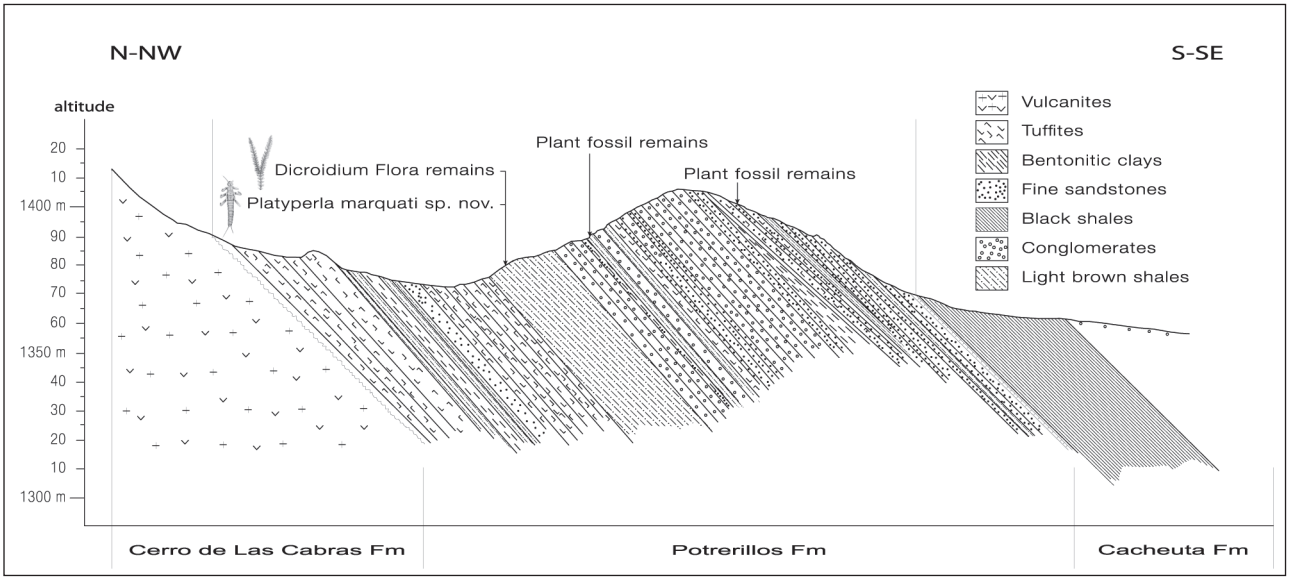


Figure 5. Detailed stratigraphic and sedimentologic profile of the northern section of the Puesto Miguez locality; the *Platyperla marquati* sp. nov. bearing level in association with *Dicroidium* plant fossils is in the uppermost part of the Potrerillos Formation/ *Perfil estratigráfico y sedimentológico de detalle de la sección norte de la localidad de Puesto Miguez; el nivel con* Platyperla marquati *sp. nov. asociada a la Flora de* Dicroidium *se indica en la sección superior de la Formación Potrerillos.*

PLECOPTERAN FOSSIL RECORD

The world record of Triassic plecopterans is scarce and consists mainly of adult forms, with most species belonging to four families (Euxenoperlidae, Siberioperlidae, Mesoleuctridae and Perlariopseidae). Fossil perlomorphs consist of larval stages of uncertain systematic position, mainly recorded from localities in Ukranie (Garazhovka), east Kazakhstan (Kenderlyk) and southern China (Yunnan). Siberioperlidae larval stages are also known in the Northern Hemisphere from Ukranie (Garazhovka) and east Kazakhstan (Kenderlyk) in Central Asia. The Fergana locality (Madygen Formation) has yielded a larval stage of the Family Mesoleuctridae and a

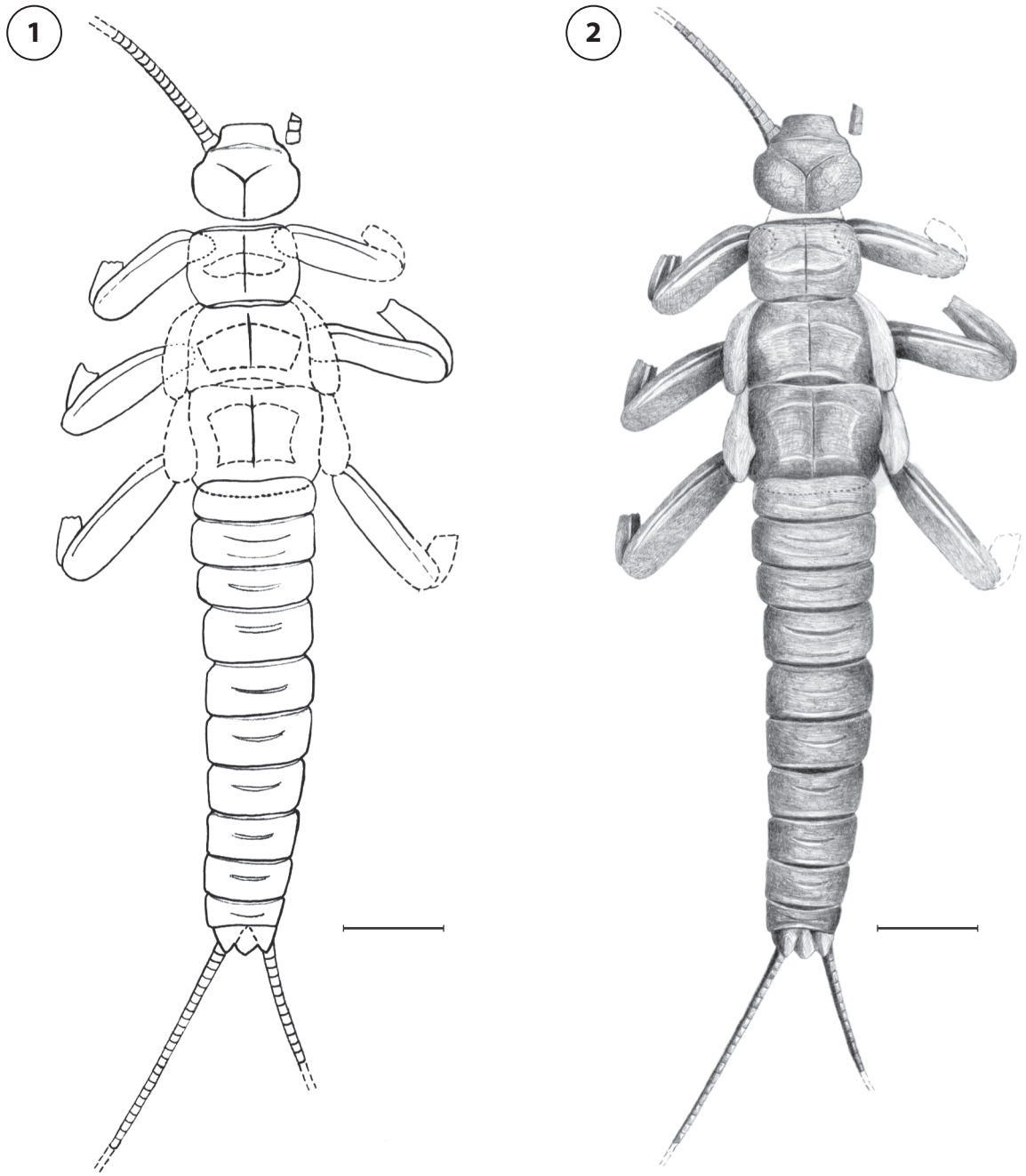


Figure 6. *Platyperla marquati* sp. nov. **1,** Line drawing of the body/ *dibujo lineal del cuerpo*. **2,** Restored line drawing showing some morphological structures / *dibujo lineal de la reconstrucción mostrando algunas estructuras morfológicas*. Scale bar/ escala gráfica=2 mm.

large record of the fairly diverse Family Perlariopseidae. Perlomorphs (Perlina) are in general less common than Nemourina and presently –as in the fossil record– they are found only in the Northern Hemisphere. Gripopterygomorpha have been already found in the Northern Hemisphere, but not in Triassic rocks. One species of Gripopterygidae has been described from Late Jurassic – Early Cretaceous of Yakutia. Recently, a member of Eustheniidae was discovered in the Late Permian of the European part of Russia (unpublished). Contrarily, in the Southern Hemisphere the record of the Gripopterygomorphs includes adult forms of the Euxenoperlidae from the Molteno Formation (South Africa), Ipswich Series (Australia) and Potrerillos Formation (*Gondwanoperlidium argentinarum* Pinto and Purper, 1978, *G. mendozensis* Pinto and Purper, 1978) (Argentina) (Sinitshenkova, 2007b).

FOSSIL RECORDS AS INDICATORS OF DEPOSITIONAL ENVIRONMENTS AND PALAEOECOLOGY

Sedimentary facies and palynofacies of the Triassic Puesto Miguez and Agua de las Avispas sections that are exposed south of Cerro Cacheuta were described in detail by Zavattieri and Prámparo (2006). They discussed environmental interpretations based on lithofacies descriptions, palynofacies analysis and palynofloral assemblages (terrestrial spores and pollen grains associated with diverse chlorophycean freshwater algae) recorded from both sections. At Puesto Miguez, rich and diverse terrestrial floras (plant remains and mainly associated miospore assemblages) allow the reconstruction of the habitats in which the insect described herein was found. Morel (1994) and Zavattieri and Prámparo

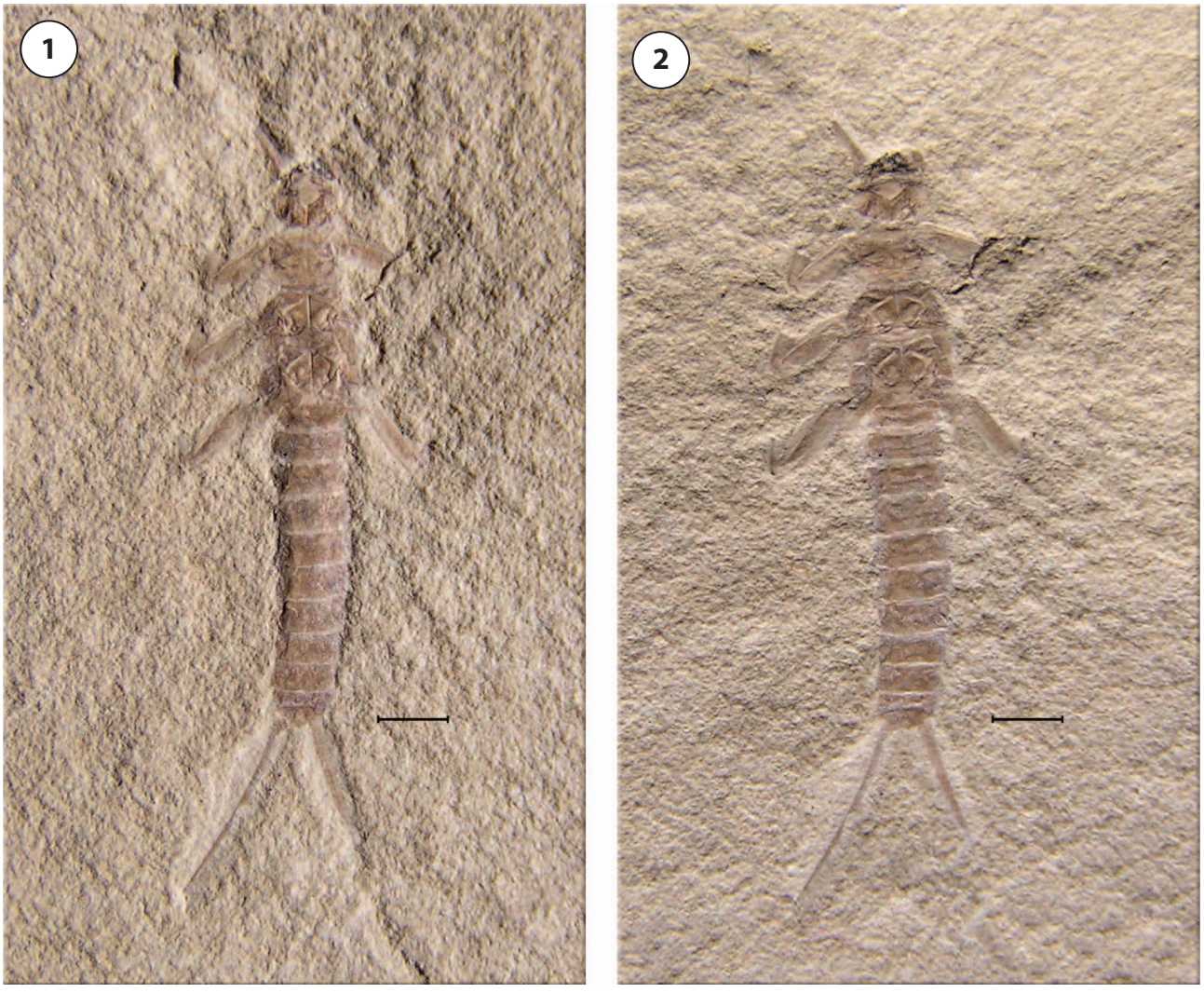


Figure 7. 1-2, *Platyperla marquati* sp. nov. MCNAM-PI 24312, holotypes, photographs of the specimen taken with two natural light directions showing different morphological structures/ *fotografías del ejemplar tomadas con luz natural desde dos direcciones para mostrar diferentes estructuras morfológicas*. Scale bar/ escala gráfica=2 mm.

Figure 8. *Platyperla marquati* sp. nov., reconstruction in life of the plecopteran nymph over a *Dicroidium* leaf under the water surface (drawn by Carsten Brauckmann and Elke Gröening, 2009)/ *reconstrucción en vida de la ninfa de plecoptera sobre una hoja de* Dicroidium *bajo la superficie del agua (dibujos de Carsten Brauckmann y Elke Gröening, 2009).*

(2006) interpreted the upper part of the Potrerillos Formation exposed at this section as deposits belonging to tractive flows (fluvial channels) alternating with episodes of flooding where stagnant bodies of water, swamp and/or pond sub-environments, and overbank deposits (crevasse splays) were developed within the floodplain. These facies consist of alternating parallel-laminated yellowish white sandstones in tabular strata inter-bedded with light yellow, banded brown to greenish grey silty layers, finely laminated dark grey carbonaceous clays and some coal levels altogether with plant remains (megafossils and diverse palynofloras including chlorococcalean algae) and very scarce spinicaudatans (conchostracans) and fish scales. *Platyperla marquati* sp. nov. was recovered from these facies. As documented by Morel (1994), Morel *et al*. (2010), Rojo and Zavattieri (2005) and Zavattieri and Rojo (2005), these environments were vegetated by a diverse community of bryophytes, pteridophytes (ferns), lycopods and sphenopsids growing near the depositional sites. Gymnosperms were mainly represented by the "seed fern" corystosperms (*Dicroidium*) and Caytoniales (including peltasperms), cycads, ginkgoaleans, and voltzialeans and other conifers that probably grew in upland areas close to the depositional sites. A relative increase in the number of freshwater algae in the upper part of the unit suggested a gradual change from a flood-plain environments dominated by fluvial systems to delta-plain conditions in which coal swamps and stagnant water bodies developed (Zavattieri and Prámparo, 2006). Overall, the abundant, highly diverse terrestrial floras (miospores and megafloral assemblages) indicate a moist temperate, highly seasonal climate typical of Gondwanan Triassic realms.

CONCLUSIONS

Contrary to previous interpretations, the lower units of the Uspallata Group (Río Mendoza and Cerro de Las Cabras formations) are recognized on the southern flank of Cerro Cacheuta. The mid-lower part of the Potrerillos Formation is not exposed at this locality because, this region was a "high" in the basin, but those deposits were found in the wells drilled in the southern part of this region.

The insect-bearing beds of the Potrerillos Formation are associated with plant remains of the "*Dicroidium* Flora" and the corresponding palynoflora described previously from this locality as "Minas de Petróleo Beds". Thus, *Platyperla marquati* sp. nov. is the most ancient record (early Late Triassic) of the Family Platyperlidae and the first specimen of this family from the Southern Hemisphere. In the Jurassic, species of Platyperlidae often occur together with Mesoleuctridae. They were the typical fauna of shallow water bodies in large river valleys. In Triassic times the lacustrine insect fauna started evolving; it became diverse in the Jurassic and Early Cretaceous (Sinitshenkova, 2007a).

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REFERENCES

Boggetti, D., Scolari, J.C. and Regazzoni, C. 2002. Cuenca Cuyana: Marco Geológico y Reseña Histórica de la Actividad Petrolera. In: M. Schiuma, G. Hinterwimmer y G. Vergani (Eds.), Rocas Reservorio de las Cuencas Productivas de la Argentina, *5º Congreso de Exploración y Desarrollo de Hidrocarburos, Instituto Argentino del Petróleo y Gas* (Mar del Plata), *Actas*: 585–607.

Bouchard, R.W. 2004. *Guide to aquatic macroinvertebrates of the Upper Midwest*. Water Resources Center - University of Minnesota, Saint Paul, 208 p.

Brauer, F., Redtenbacher, J. and Ganglbauer, L. 1889. Fossile Insekten aus der Juraformation Ost Sibiriens. *Memoires de l'Academie Imperiale des Sciences de St. Petersbourg, Serie 7*, 15: 1–22.

Cabrera, A. 1928. Un segundo ortóptero del Triásico argentino. *E.O.S. Revista Española de Entomología* 4: 371–373.

Carpenter, F.M. 1960. A Triassic odonate from Argentina. *Psyche* 67: 71–75.

Carpenter, F.M. 1992. Hexapoda. In: R.L. Kaesler, (Ed.*), Treatise on Invertebrate Paleontology.* Geological Society of America and University of Kansas, Part R. Arthropoda 4, Boulder, 655 p.

Chebli G.A, Ploszkiewicz, J.V. and Azpiroz, G.M. 2001. El Sistema Triásico y los hidrocarburos. In: A.E. Artabe, E.M. Morel and A.B. Zamuner, (Eds.), *El Sistema Triásico en la Argentina.* Fundación Museo de La Plata "Francisco Pascasio Moreno", La Plata, p. 283–315.

du Toit, A.L. 1927. The Fossil Flora of the Upper Karroo beds. *Annals of the South African Museum* 22: 289–418.

Frenguelli, J. 1948. Estratigrafía y edad del llamado Rético en la Argentina. *Anales de la Sociedad Argentina de Estudios Geográficos*, *GAEA* 8: 159–309.

Gallego, O.F. 1997. Hallazgos de Insectos Triásicos en la Argentina. *Ameghiniana* 34: 511–516.

Gallego, O.F. and Martins-Neto, R.G. 1999. La entomofauna mesozoica

de la Argentina: Estado actual del conocimiento. *Revista de la Sociedad Entomológica Argentina* 58: 86–94.

Gallego, O.F., Martins-Neto, R.G. and Nielsen, S. 2005. Conchostracans and insects from the Upper Triassic Santa Juana Formation from southern central Chile. *Revista Geológica de Chile* 32: 301–319.

Ingrassia, V.S. 1977. [*Consideraciones geológicas de la cuenca Cuyana*. Yacimientos Petrolíferos Fiscales, Buenos Aires. Unpublished report.].

Jain, R.K. 1968. Middle Triassic pollen grains and spores from "Minas de Petroleo Beds" of Cacheuta Formation (Upper Gondwana), Argentina. *Palaeontographica*, *Abteilung B* 122: 1–47.

Jain, R.K. and Delevoryas, T. 1967. A Middle Triassic Flora from the Cacheuta Formation, Minas de Petroleo, Argentina. *Palaeontology* 10: 564–589.

Kalugina, N.S. 1980. Insects in fresh water ecosystems of the past. *Trudy Paleontologicheskogo Instituta, Akademiya Nauk SSSR* 175: 224–240 (in Russian).

Kokogian, D.A. and Boggetti, D.A. 1986. Estratigrafía y ambientes de sedimentación de los depósitos triásicos en la localidad de Potrerillos en la provincia de Mendoza. *1ª Reunión Argentina de Sedimentología* (La Plata)*, Resúmenes expandidos*, p. 161–164.

Kokogian, D.A. and Mancilla, O. 1989. Análisis estratigráfico secuencial de la Cuenca Cuyana. In: G.A. Chebli and L.A. Spalletti (Eds.), Cuencas sedimentarias argentinas, *Serie de Correlación Geológica (INSUGEO)* 6: 169–201.

Kokogian, D., Fernandez Seveso, F. and Mosquera, A. 1993. Las secuencias sedimentarias triásicas. *12º Congreso Geológico Argentino y 2º Congreso de Exploración de Hidrocarburos* (Mendoza)*, Relatorio Geología y Recursos Naturales de Mendoza*, *Actas* 1: 65–78.

Kokogian, D.A., Boggetti, D.A. and Rebay, G.A. 1989. Cuenca Cuyana. El análisis estratigráfico secuencial en la identificación de entrampamientos estratigráficos sutiles. *1er Congreso Nacional de Exploración de Hidrocarburos* (Mar del Plata), *Actas* 2: 649–674.

Kurtz, F. 1921. Atlas de plantas fósiles de la República Argentina. *Actas de la Academia Nacional de Ciencias* 7: 129–153.

Latreille, P.A. 1802. *Historie naturelle générale et particulière des Crustacés et des Insectes*. *Tome 3. Familles naturelles des genres*. F. Dufart, Paris, 467 p.

Latreille, P.A. 1810. *Considérations générales sur l´ordre natural des animaux composant les classes des crustacés, des arachnides et des insectes; avec un tableau méthodique de leurs genres disposés en familles*. F. Schoell, Paris, 444 p.

Latreille, P.A. 1825. *Familles naturelles du règne animal, exposées succinctment et dans un ordre analytique, avec l´designation de leurs genres*. J.B. Baillière, Paris, 570 p.

Linnaeus, C. 1758. *Systema Naturae per regna tria naturae, secundum Classes, Ordines, Genera, Especies, cum characteribus, differentiis, synonimis, locis*. Tomus I. Editio Decima, Reformata. Salvius, Stockholm, 823 p.

López Gamundí, O.R. and Astini, R.A. 2004. Alluvial fan-lacustrine association in the fault tip end of a half-graben, northern Triassic Cuyo basin, western Argentina. *Journal of South American Earth Sciences* 17: 253–265.

Marquat, F.J. 1991. Ninfa de miomóptero (Insecta) del Triásico de Mendoza, República Argentina. *Revista del Museo de Historia Natural de San Rafael* 11: 3–13.

Martins-Neto, R.G. and Gallego, O.F. 1999. The Triassic Insect Fauna from Argentina. I. Auchenorrhyncha, Miomoptera and Ensifera. *Revista Española de Paleontología* 14: 191–202.

Martins-Neto, R.G. and Gallego, O.F. 2001. The Triassic Insect Fauna from Argentina. IV. Glosselytrodea and complements on Auchenorrhyncha. *Acta Geologica Leopoldensia* 24: 105–114.

Martins-Neto, R.G. and Gallego, O.F. 2006. Review of Dysmorphoptilidae Handlirsch (Hemiptera: Cicadomorpha) from the Argentinean Triassic, with description of a new subfamily, and a new species. *Polish Journal of Entomology* 75: 185–197.

Martins Neto, R.G. and Gallego, O.F. 2009. The Triassic Insect Fauna from Argentina. Blattoptera and Coleoptera from Ischichuca Formation (Bermejo Basin) La Rioja province. *Ameghiniana* 46: 361–372.

Martins-Neto, R.G., Gallego, O.F. and Mancuso, A.C. 2006a. The Triassic Insect Fauna from Argentina. Coleoptera from Los Rastros Formation (Bermejo Basin), La Rioja Province. *Ameghiniana* 43: 591–609.

Martins-Neto, R.G., Gallego, O.F. and Melchor, R.N. 2003. The Triassic insect fauna from South America (Brazil, Argentina and Chile): a checklist (except Blattoptera and Coleoptera) and descriptions of new taxa. *Acta Zoologica Cracoviensia* 46: 229–256.

Martins-Neto, R.G., Gallego, O.F. and Zavattieri, A.M. 2007. A new Triassic insect fauna from Cerro Bayo, Potrerillos (Mendoza Province, Argentina): with descriptions of new taxa (Insecta: Blattoptera and Coleoptera). *Alcheringa* 31: 199–213.

Martins Neto, R.G., Gallego, O.F. and Zavattieri, A.M. 2008. The Triassic insect fauna from Argentina: Coleoptera, Hemiptera and Orthoptera from the Potrerillos Formation, south of Cerro Cacheuta, Cuyana Basin. *Alavesia* 2: 47–58.

Martins-Neto, R.G., Mancuso, A.C. and Gallego, O.F. 2005. The Triassic Insect Fauna from Argentina. Blattoptera from Los Rastros Formation (Bermejo Basin), La Rioja Province. *Ameghiniana* 42: 705–723.

Martins-Neto, R.G., Brauckmann, C., Gallego, O.F. and Carmona, M.J. 2006b. The Triassic insect fauna from Argentina. Blattoptera, Glosselytrodea, Miomoptera, Auchenorrhyncha, and Coleoptera from the Los Rastros Formation (Bermejo Basin), Los Chañares locality (La Rioja Province). *Clausthaler Geowissenschaften* 5: 1–9.

Morel, E.M. 1991. [*Estudio paleoflorístico y paleoambiental de la secuencia triásica en el área de Cacheuta (provincia de Mendoza)*. Doctoral Thesis, Universidad Nacional de la Plata, Facultad de Ciencias Naturales y Museo, La Plata, 368 p. Unpublished].

Morel, E.M. 1994. El Triásico del Cerro Cacheuta, Mendoza (Argentina). Parte I: Geología, contenido paleoflorístico y cronoestratigrafía. *Ameghiniana* 31: 161-176.

Morel, E.M., Artabe, A.E., Ganuza, D.G. and Zúñiga, A. 2010. La paleoflora triásica del cerro Cacheuta, provincia de Mendoza, Argentina. Bryopsida, Lycopsida, Sphenopsida, Filicopsida y Gymnospermopsida (Corystospermales y Peltaspermales). *Ameghiniana* 47: 3–23.

Ping, C. 1935. On four fossil insects from Sinkiang. *Chinese Journal of Zoology* 1: 107–115.

Pinto, I.D. and Purper, I. 1978. A new genus and two species of Plecopteran Insects from the Triassic of Argentina. *Pesquisas* 10: 77–86.

Ramos, V.A. and Kay, S.M. 1991. Triassic rifting and associated basalts in the Cuyo basin, central Argentina. In: R.S. Harmon and C.W. Rapela, (Eds.), Andean Magmatism and its tectonic setting, *Geological Society of America, Special Paper* 265: 79–91.

Rébori, L.O. 1979. [*Contribución al conocimiento geológico del extremo sur de la Precordillera Mendocina, Sector Agua del Pizarro, Cacheuta, Mendoza*. Magister Thesis, Facultad de Ciencias Geológicas, Universidad Nacional de San Juan, 123 p. Unpublished.].

Rojo, L.D. and Zavattieri, A.M. 2005. Estudio microflorístico de las formaciones Potrerillos y Cacheuta (Triásico) en el sur del cerro Cacheuta, Mendoza, Argentina. Parte 1. *Ameghiniana* 42: 3–20.

Sellards, E.H. 1909. Types of Permian insects. Part 3. Megasecoptera, Oryctoblattinidae and Protorthoptera. *American Journal of Science, series* 4 27: 151–173.

Sinitshenkova, N.D. 1982. Systematic position of the Jurassic stoneflies *Mesoleuctra gracilis* Br., Redtb., Gangl. and *Platyperla platypoda* Br., Redtb., Gangl. and their stratigraphic distribution. *Byulleten 'Moskovskogo Obshchestva Ispytateley Prirody, Otdel Geologicheskiy* 57: 112–124 (in Russian).

Sinitshenkova, N.D. 1985. The Jurassic stoneflies of South Siberia and ad-

joining territories (Perlida =Plecoptera). In: A.P. Rasnitsyn, (Ed.), The Jurassic Insects of Siberia and Mongolia. *Trudy Paleontologicheskogo Instituta, Akademiya Nauka SSSR* 211: 148–171 (in Russian).

Sinitshenkova, N.D. 1987. Historical development of the Stoneflies. *Trudy Paleontologicheskogo Instituta, Akademiya Nauk SSSR* 221: 1–144 (in Russian).

Sinitshenkova, N.D. 1990. The stoneflies. Perlida. In: A.P. Rasnitsyn, (Ed.), The Late Mesozoic insects from Eastern Transbaikalia. *Trudy Paleontologicheskogo Instituta, Akademiya Nauka SSSR* 239: 207–210 (in Russian).

Sinichenkova [Sinitshenkova], N.D. 1995. New Late Mesozoic stoneflies from Shara-Teeg, Mongolia (Insecta: Perlida =Plecoptera). *Paleontological Journal* 29: 93–104.

Sinitshenkova, N.D. 2007a. Ecological history of aquatic insects. In: A.P. Rasnitsyn and D.L.J Quicke, (Eds.), *History of Insects*; Kluwer Academic Publishers, Dordrecht, p. 388–426.

Sinitshenkova, N.D. 2007b. Order Perlida. In: A.P. Rasnitsyn and D.L.J Quicke (Eds.), *History of Insects*; Kluwer Academic Publishers, Dordrecht, p. 281–287.

Sinitshenkova, N.D. and Zherikhin, V.V. 1996. Mesozoic lacustrine biota: extinction and persistence of communities. *Paleontological Journal* 30: 710–715.

Stewart, K.W. and Harper, P.P. 1996. Plecoptera. In: R.W. Merrit and K.W. Cummins (Eds.), *An introduction to the aquatic insects of North America*, Third Edition, Kendall /Hunt, New York, p. 217–266.

Stipanicic, P.N. 1983. The Triassic of Argentina and Chile. In: M. Moullade and A.E.M. Nairm (Eds.), *The Phanerozoic geology of the World 2, The Mesozoic, B 7*. Elsevier, Amsterdam, p. 181-199.

Stipanicic, P.N. and Zavattieri, A.M. 2002. Grupo Uspallata. In: P.N. Stipanicic and C.A. Marsicano (Eds.), Léxico Estratigráfico de la Argentina. Volumen VIII. Triásico; *Asociación Geológica Argentina, Serie "B" (Didáctica y Complementaria)* 26: 290–294.

Stipanicic, P.N., Herbst, R. and Bonetti, M.I.R. 1996. Floras triásicas. *Actas de la Academia Nacional de Ciencias* 11: 127–184.

Storozhenko, S.Yu. 1997. A new Triassic Genus of the Family Atactophlebiidae (Grylloblattida). *Far Eastern Entomologist* 40: 1-8.

Szajnocha, L. 1889. Uber fossile Pflanzenreste aus Cacheuta in der Argentinischen Republik. *Sitzungsberischte der kaiserlichen Akademie der Wissenschaft, Mathematisch-Naturwissenschafiliche Classe* 97: 219–246.

Uliana, M.A. and Biddle, K.T. 1988. Mesozoic-Cenozoic extension and geodynamic evolution of southern South America. *Revista Brasileira de Geociencias* 18: 172–190.

Zavattieri, A.M. and Batten, D.J. 1996. Chapter 20B. Miospores from Argentinian Triassic deposits and their potential for intercontinental correlation. In: J. Jansonius and D.C. McGregor (Eds.), *Palynology: principles and applications, volume 2.* American Association of Stratigraphic Palynologists Foundation, Dallas, p.767–778.

Zavattieri, A.M. and Prámparo, M.B. 2006. Freshwater algae from the Upper Triassic Cuyana Basin of Argentina: palaeoenvironmental implications. *Palaeontology* 49: 1185–1209.

Zavattieri, A.M. and Rojo, L.D. 2005. Estudio microflorístico de las formaciones Potrerillos y Cacheuta (Triásico) en el sur del cerro Cacheuta, Mendoza, Argentina. Parte 2. *Ameghiniana* 42: 513–534.

Zherikhin, V.V. and Kalugina, N.S. 1985. Landscapes and communities. In: A.P. Rasnitsyn (Ed.), Jurassic non-marine biocoenoses of South Siberia and adjacent territories. *Trudy Paleontologicheskogo Instituta, Akademiya Nauk SSSR* 213: 137–183 (in Russian).

Zuber, R. 1889. Estudio geológico del cerro Cacheuta y sus contornos. *Boletín de la Academia Nacional de Ciencias* (*Córdoba*) 10: 448–472.

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