



Phylogeny of the South American genus *Baripus* (Coleoptera: Carabidae: Broscini) with the description of new mountain species from the northern Patagonia Biogeographic Province

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ABSTRACT

The genus *Baripus* Dejean is a carabid beetle endemic to southern South America, inhabiting grassland and shrub habitats in mountain and lowland areas. In this work, the phylogeny of the genus is updated and new species restricted to isolated mountains from the Patagonia Biogeographic Province are described. The cladistic analysis showed that the new mountain species comprise a monophyletic clade with five other species. Within this group, the species are arranged in two internal clades. Each clade contains one or two lowland species with a wide distribution range and the remaining species with microendemic distribution on each mountain system. Their distribution pattern suggests that mountain species of *Baripus* could have originated since (by) the end of the Cenozoic when the mountains uplifted and acted as a refuge for populations of lowland species that remained isolated and later became differentiated from one another. Based on morphological and cytochrome *c* oxidase subunit I molecular data, *Baripus* (*Cardiophthalmus*) *palauco*, sp. nov., *Baripus* (*Cardiophthalmus*) *tromen*, sp. nov., *Baripus* (*Cardiophthalmus*) *aucamahuida*, sp. nov. and *Baripus* (*Cardiophthalmus*) *payun*, sp. nov. are described and a key to all currently known species of *Baripus* (*Cardiophthalmus*) is provided.

Keywords: *aucamahuida*, *Baripus*, *Cardiophthalmus*, distribution pattern, *palauco*, *payun*, Payunia volcanoes, phylogeny, *tromen*.

Introduction

Baripus Dejean is a South American genus of the tribe Broscini Hope (Coleoptera: Carabidae), comprising 24 species in three subgenera (Roig-Juñent *et al.* 2008). *Baripus* has been recently revised and phylogeny has also been proposed for its species (Roig-Juñent *et al.* 2008). The three subgenera exhibit allopatric distributions and inhabit different types of grassland or dwarf-shrub vegetation. Among subgenera, *Cardiophthalmus* Curtis, 1839 is the most diverse with 16 species, of which 14 occur exclusively in the Patagonian steppe, from Tierra del Fuego to Mendoza provinces, in Argentina. These species inhabit lowland steppes, which extend from the Atlantic coast to the eastern slope of the Andes Mountains. In contrast, only two of the known species of *Cardiophthalmus*, which encompass the northern distribution of the subgenus, inhabit mountain systems (Roig-Juñent *et al.* 2008). Both mountain species occupy high-altitude grassland of extra-Andean mountains. One of them occurs in the Precordillera, a mountain system that runs for 450 km parallel to the Andes, separated by the longitudinal Uspallata – Calingasta valley (Furque and Cuerda 1979). The other species inhabits the Nevado mountain range, located in the so-called Payunia Biogeographic district (Domínguez *et al.* 2006), in northern Patagonia.

One of the major geomorphological features of Payunia is the presence of more than 800 volcanoes that were formed between the Pliocene and Holocene, some of them

reaching over 3000-m elevation (Ramos and Folguera 2011). Collecting on four unexplored volcanoes from Payunia led us to find new *Cardiophthalmus* species, each one restricted to a volcano.

This study aims to describe four new species of *Baripus* and their habitats, update their phylogeny and discuss their biogeographic distribution patterns.

Materials and methods

Material examined

Most of the specimens examined belong to the entomological collection of the Instituto Argentino de Investigaciones de las Zonas Áridas (IADIZA-CEIT), Mendoza, Argentina. We studied a total of 374 specimens of already described species of *Baripus* and 807 specimens belonging to the new species described in this study. Type material of the new species was deposited in the IADIZA.

Phylogenetic taxon sampling

In total, 28 *Baripus* species were included in the phylogenetic analyses, namely 24 known species and the four new species. The obtained cladograms were rooted following the parsimonious outgroup comparison method proposed by Farris (1982) and reviewed by Nixon and Carpenter (1993). As external groups, we chose the genera *Nothobrosicus* Roig-Juñent & Ball, 1995 (*Nothobrosicus chilensis* Roig-Juñent & Ball, 1995), *Creobius* Guérin-Ménéville, 1838 (*Creobius eydouxii* (Guérin-Ménéville, 1838)), *Cascellius* Curtis, 1839 (*Cascellius gravesii* Curtis, 1839) and *Bembidiomorphum* Champion, 1918 (*Bembidiomorphum convexum* Champion, 1918). The three first genera belong to different subtribes of the tribe Broscini (Roig-Juñent, 2000): *Nothobrosicus* to *Nothobrosicina* Roig-Juñent, 2000; *Creobius* and *Cascellius* to *Creobiina* Jeannel, 1941; and *Bembidiomorphum* to *Barypina* Jeannel, 1941, the same subtribe as that of *Baripus*.

Character sampling

We scored 62 characters derived from external morphology (38), male genitalia (18) and female genitalia (6) (see 'Characters and character states used in the phylogenetic analysis of *Baripus*' in the Supplementary material). The distribution of states among terminal taxa is shown in the data matrix (see 'Data matrix of species of *Baripus* and outgroups' in the Supplementary material) and apomorphic states are presented in the obtained cladograms. All multi-state characters were treated as non-additive. Polymorphic characters are represented within brackets in the data matrix (see 'Data matrix of species of *Baripus* and outgroups' in the Supplementary material). Morphological characters used in this study are illustrated in Fig. 4–40.

Phylogenetic analyses

The dataset was analysed using the parsimony software TNT (Tree Analysis Using New Technology, ver. 1.0, see <https://www.lillo.org.ar/phylogeny/tnt/>; Goloboff *et al.* 2008) applying the implicit enumeration search option, which finds the most parsimonious trees through an exact solution. The dataset was also analysed by heuristic search under the implied transformation costs method (Goloboff 1997) where the cost of character state transformations depends on the number of homoplasious states present in different trees. The cost of transformation depends on a constant (K) and on the number of homoplasious states (H) related in the formula $K \div K + H$ (Goloboff 1993, 1997). The value of $K = 1$ is the maximum value and when K increases, homoplasious transformations are down-weighted. We applied different values of the constant concavity ($K = 3, 6, 10$ and 20). Branch support was measured using two resampling methods with 100 replicates: jackknifing (Farris *et al.* 1996) with $P = 36$ ($P =$ removal probability) and standard bootstrapping (Felsenstein 1985). Bremer support was calculated as an absolute value, with support below 10 applying tree bisection and reconnection in suboptimal trees.

Taxonomic descriptions

The new species of *Baripus* have been diagnosed from external morphology and male genitalia (Roig-Juñent and Cicchino 1989; Roig-Juñent 1992). We also took into account the nucleotide divergence from a barcode DNA region, the cytochrome *c* oxidase subunit 1 (*COI*) gene. For species concept, we followed the phylogenetic species concept (PSC) (i.e. a species constitutes the smallest aggregation of populations diagnosable by a unique combination of character states; Nixon and Wheeler 1990).

Dissection methods and length measurements

Comparisons among new species were based on features of their external morphology and genitalia. To study male and female genitalia, specimens were soaked in NH_3 for 10 min to relax their anatomical structures and then the aedeagus or female genital tract was removed through the pygidium and cleared in boiling 10% KOH for 5 min. The internal sac was everted by injecting 1:1 glycerin with a hypodermic syringe. To study female genitalia, membranes and muscles were removed. All illustrations were made using a camera lucida attached to a Nikon stereomicroscope. The terms used for the aedeagus follow Jeannel (1955) and the terms used for female genitalia follow Deuve (1993) and Liebheer and Will (1998).

Body length was measured from labrum to apex of elytra. Length of pronotum was taken from base to apex and width is the maximum width. Width of tarsomeres was taken at the apex of tarsomere. Length of median lobe apex was taken

from the apical region of ostium to the apical region of apex and width is the maximum width.

Estimation of genetic distance in the new *Baripus* (*Cardiophthalmus*) species

We calculated the number of base differences per site between *COI* barcode sequences from the new species of *Baripus* described in this work. Total genomic DNA was extracted from muscular tissue of legs using the Salting out protocol (Sambrook and Russell 2006). *COI* was amplified and sequenced using the primer pair 'LepF-LepR' (Hebert *et al.* 2003). DNA sequences can be found on GenBank (accession numbers for *B. (C.) aucamahuida*: MZ983801; *B. (C.) payun*: OK428797; *B. (C.) tromen*: MZ519867; *B. (C.) palauco*: MZ519868).

Analyses were conducted in MEGA (ver. 7.0, see <https://www.megasoftware.net>; Kumar *et al.* 2016) using the Kimura 2-parameter model (K2P; Kimura 1980) and the *p*-distance method:

$$p = n_d \div n_t$$

where n_d is the number of different nucleotides between the two sequences and n_t is the total number of nucleotides examined). The rate variation among sites was modelled with a gamma distribution (shape parameter = 0.4) in the K2P analysis. Codon positions included were 1st + 2nd + 3rd + non-coding. All ambiguous positions were removed for each sequence pair. There was a total of 597 positions in the final dataset.

Results and discussion

Phylogeny

Parsimony analyses of the dataset using different concavity *K* values yielded three optimal trees of 155 steps (consistency index (CI) = 0.67, retention index (RI) = 0.86). The three cladograms differ in the relationships of two species, *B. (C.) clivinoides* (Curtis, 1839) and *B. (C.) neuquensis* Roig-Juñent, 1992, resulting in a polytomy in the strict consensus (Fig. 1). *Baripus* subgenera are strongly supported. Within the subgenus *Cardiophthalmus*, all of the new species are grouped in the same monophyletic group.

The four new species are included in two well-supported clades (Fig. 1). Clade A (Fig. 1, 2) includes *B. (C.) aucamahuida*, sp. nov., as sister to *B. (C.) mendozensis* Roig-Juñent & Cicchino, 1989 and *B. (C.) precordillera* Roig-Juñent in Roig-Juñent *et al.* (2008). This clade is supported by two synapomorphies: lateral apical groove of median lobe present, long and curved, starting laterally on the right side of apex and then dorsally (character 44⁽³⁾) and mucro as a conical tooth in the medial-left region of the basal surface of median lobe (48⁽²⁾). These three species also share a synapomorphy within the genus, which is the spatulate

shape of apex of median lobe (51⁽³⁾) (see Fig. 36) but the analysis did not show it as a synapomorphy because the state was ambiguous in the nodes. All species belonging to Clade A occur at altitudes of over 1100 m above sea level (mountain species).

Clade B (Fig. 1, 3) is split into two groups, one comprises *B. (C.) nevado* Roig-Juñent, Agrain, Carrara, Ruiz-Manzanos & Tognelli, 2008 and the new species *B. (C.) payun*, sp. nov., *B. (C.) tromen*, sp. nov. and *B. (C.) palauco*, sp. nov., supported by two synapomorphies: lateral apical groove of median lobe long and straight (44⁽²⁾) and a small mucro in the medial left basal region of median lobe (48⁽¹⁾). The other group includes the sister pair *B. (C.) schajovskoyi* Roig-Juñent, 1992 and *B. (C.) gentilii* Roig-Juñent, 1992, supported by two characters states: elytral setae on interval 3, 5 and 7 (33⁽¹⁾), and internal sac with conical and broad tooth (52⁽¹⁾). Within Clade B, the species *B. (C.) nevado*, *B. (C.) payun*, sp. nov., *B. (C.) tromen*, sp. nov. and *B. (C.) palauco*, sp. nov. occur at high altitudes, from 2100 to 3150 m above sea level (mountain species), whereas *B. (C.) schajovskoyi* and *B. (C.) gentilii* occur at altitudes lower than 1700 m above sea level (lowland species).

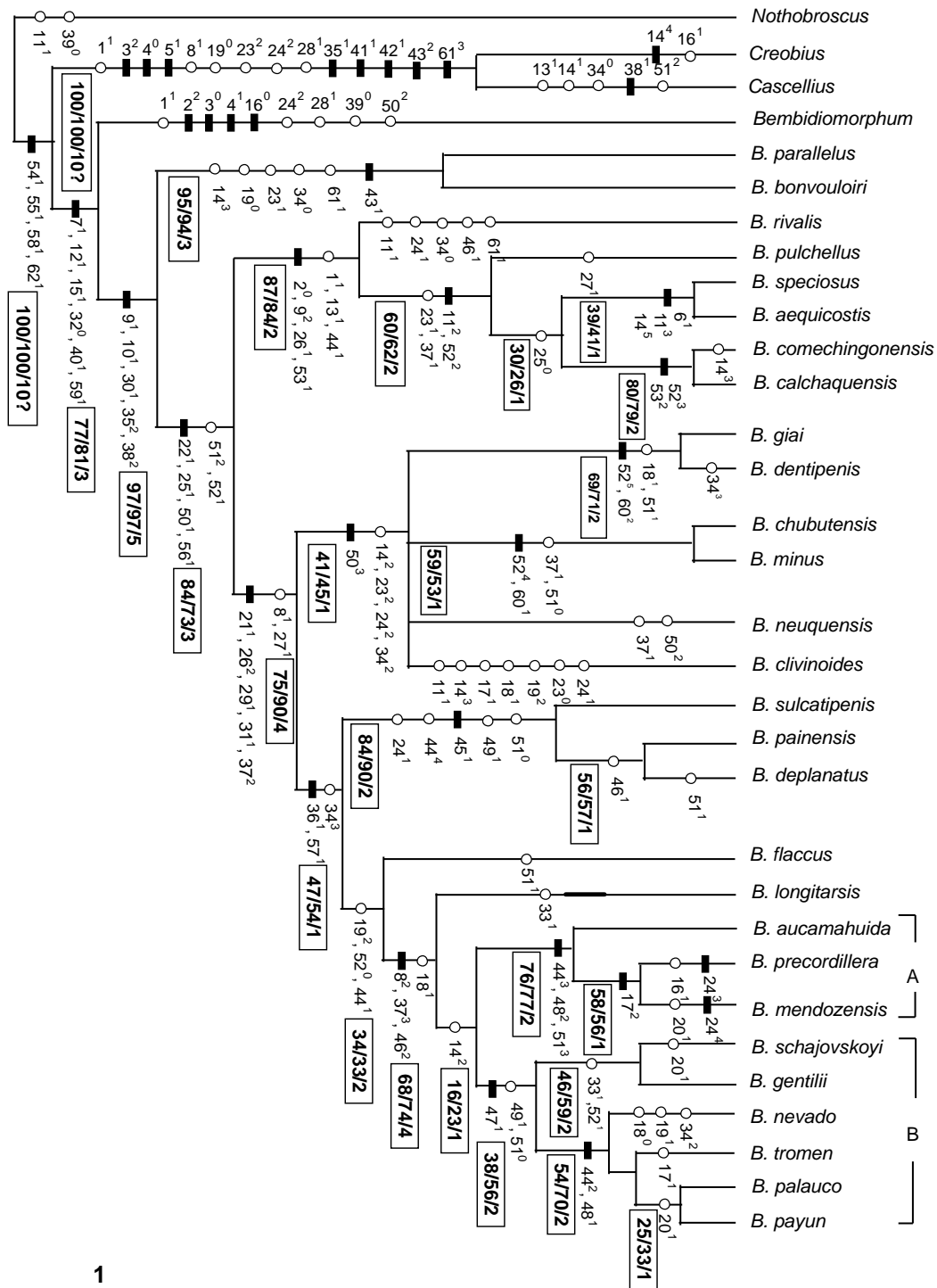
Clades A and B are related to *B. (C.) longitarsis* (Waterhouse, 1841) because of the length of antennomeres (8⁽²⁾), the disposition of anal setae (37⁽³⁾) and the presence of a broad ventral fossa in the median lobe (46⁽²⁾) and to *B. (C.) flaccus* Roig-Juñent & Cicchino, 1989 by the absence of a tooth in the internal sac (54⁽⁰⁾).

Biogeography

The study of regions that have never been explored allowed us to collect new species of the subgenus *Cardiophthalmus*. The species of this subgenus with southern geographic distribution occur in lowland Patagonian steppe habitats, whereas most northern species inhabit montane habitats in Payunia and Precordillera systems (see Fig. 2, 3).

Roig-Juñent *et al.* (2008) called this pattern Southern Lowland plus Northern Mountains (SLNM), which consists of a group of related taxa having high-latitude species inhabiting lowland habitats whereas low-latitude species inhabit mountain habitats. The same pattern of high latitude and lowland and low latitude and high altitude has been reported in the northern hemisphere (Noonan 1992). Noonan (1992) proposed for carabid beetles that mesic refuges in the mountains during periods of drought may have been important centres for species diversification. Roig-Juñent *et al.* (2008) proposed that mountains might have acted as refugia for the northern species of *Cardiophthalmus* and, later on, as areas from which these species evolved.

We found a similar pattern in Clades A and B recognised in our phylogenetic analyses (Fig. 2, 3) from which the four new *Cardiophthalmus* species could have originated. This biogeographic pattern comprises the following. First, at least one species of each clade inhabits the lowland



1

Fig. 1. Strict consensus tree from the three optimal trees obtained with parsimony analysis under implied weighting scheme. Numbers below branches indicate characters and character states (as superscript). Black bars indicate non-homoplasious states; white circles indicate homoplasious character states. The numbers below nodes indicate support values (jackknifing, standard bootstrap, Bremer index respectively) for each node.

grassland steppe, whereas the remaining are mountain species. Second, there is no sympatry between mountain and lowland species. Third, at least one of the lowland species

has an extensive geographic range (such as *B. (C.) mendozensis* in Clade A and *B. (C.) gentilii* in Clade B), whereas mountain species are microendemic.

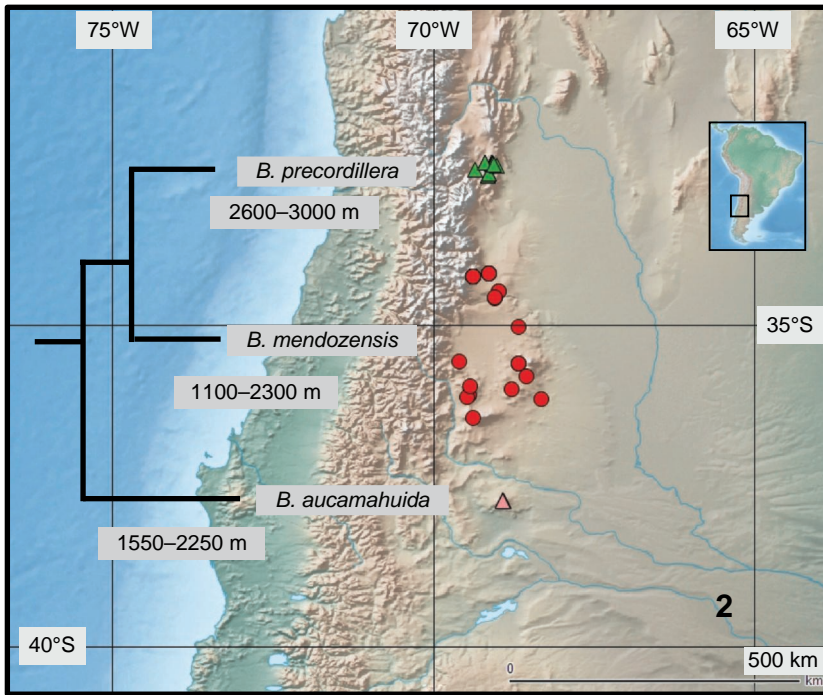


Fig. 2. Geographic distribution and phylogenetic relationships of the species grouped in Clade A: *Baripus (Cardiophthalmus) precordillera*, green triangle; *Baripus (Cardiophthalmus) mendozensis*, red circle; *Baripus (Cardiophthalmus) aucamahuida*, sp. nov., yellow triangle.

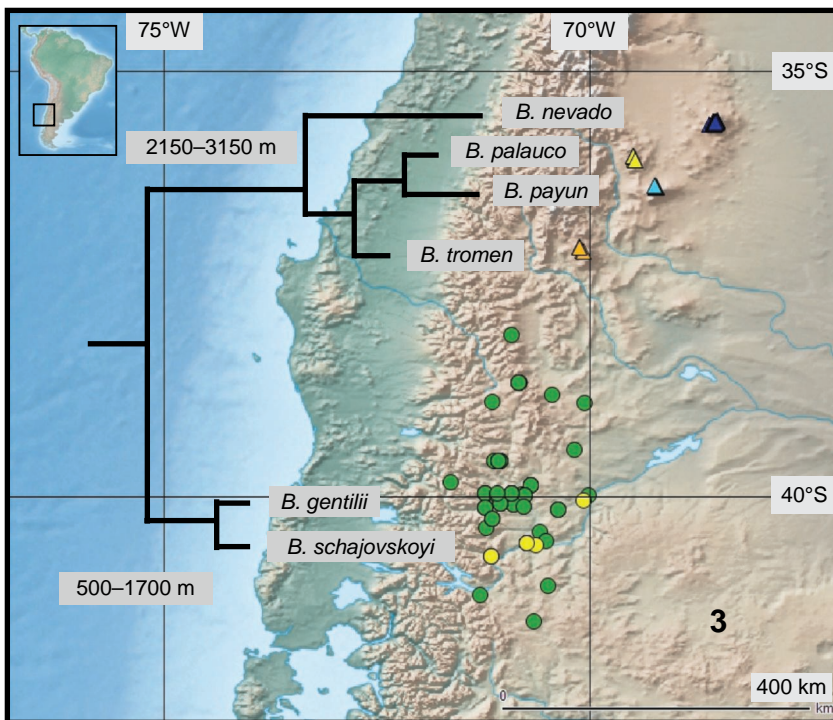


Fig. 3. Geographic distribution and phylogenetic relationships of the species grouped in Clade B: *Baripus (Cardiophthalmus) nevado*, blue triangle; *Baripus (Cardiophthalmus) palauco*, sp. nov., yellow triangle; *Baripus (Cardiophthalmus) payun*, sp. nov., light blue triangle; *Baripus (Cardiophthalmus) tromen*, sp. nov., orange triangle; *Baripus (Cardiophthalmus) gentili*, green circle; *Baripus (Cardiophthalmus) schajovskoyi*, yellow circle.

Being large-bodied and wingless beetles, *Cardiophthalmus* has low dispersal capacity. Therefore, it is possible that fragmentation of the area, resulting from physical or climatic barriers, may have effectively isolated their populations. Their current distribution suggests that *Cardiophthalmus* is a cold-adapted carabid able to disperse across lowlands

during glacial periods but restricted to high altitudes in the volcanoes during interglacial periods. Under this climatic scenario, gene flow between populations is possibly much restricted given the lack of wings and of suitable ecological areas in which to live. It is postulated that it is during warm geological periods when isolated *Baripus* populations may

evolve into new taxa. Thus, Plio-Pleistocene glacial and interglacial alternations may have provided the geographic and climatic scenarios for these events to occur. This hypothesis was already suggested for boreal biota (Noonan 1990, 1992), in which the distribution range decreased to include only the highland regions during interglacial periods (warm and dry periods) and the lowlands acted as an effective barrier (Ball 1970).

The austral Broscini genus *Mecodema* Blanchard shows a similar distribution pattern in New Zealand, as some species tend to form discrete colonies, often restricted by altitude or habitat (Townsend 1965), showing small differences in the shape of male aedeagus. In a recent phylogeographic study of *Mecodema*, the timings inferred indicate radiation of these beetles no earlier than the mid-Miocene with most divergences being younger, dating to the Plio-Pleistocene (Goldberg *et al.* 2014).

In our hypothesis, ancestral lowland species of northern Clades A and B of subgenus *Cardiophthalmus* occupied areas farther north than recent lowland species. A later climate change event, leading to current conditions, resulted in isolation of the populations occupying higher altitudes of extra-Andean mountains and in the southward displacement of other populations. These mountain populations could have evolved through a peripheral isolation process of speciation, resulting in the appearance of the species *B. (C.) precordillera* and *B. (C.) aucamahuida*, sp. nov. in Clade A and *B. (C.) nevado*, *B. (C.) palauco*, sp. nov., *B. (C.) tromen*, sp. nov. and *B. (C.) payun*, sp. nov. in Clade B.

The four new species inhabiting these recently explored volcanoes in Patagonia are very similar in external morphology, showing subtle differences. However, our analysis based on the genetic divergence in *COI* sequences showed that the new species show enough nucleotide divergence to allow their diagnosis. Pairwise genetic distance from *COI* sequences among congeneric animal species is generally over 2% (Hebert *et al.* 2003). In Coleoptera, one of the major insect orders, the mean *COI* sequence divergence between closely related species is ~11% (Hebert *et al.* 2003). Our results indicate that each pairwise percentage divergence between species is close to 11%.

From our molecular data only, we cannot estimate divergence times among the new mountain species, but at least we predict that they are not older than the geological time of the volcanoes in which each one lives. The origin of volcanoes in Payunia dates from the Pliocene and Holocene periods. Payún-Matru Volcano arose between the Pliocene and Holocene (Bermúdez and Delpino 1989), Tromen and Wayle Volcanoes as well as Auca Mahuida plateau could have arisen during the Pleistocene (Tromen: from 1.8 to 1.6 Ma, Galland *et al.* 2007; Auca Mahuida: from 0.8 to 2.03 Ma, Ramos and Folguera 2011).

Under the assumption that our tree shows the true relationships among *Baripus* species (see Fig. 1), the differences found in the percentage divergence among the pairwise

comparisons from the new *Cardiophthalmus* species could suggest devitalisation of the neutral molecular clock. Such differences could be explained by differences in generation times among species or different rates of natural selection across the different microhabitats occupied by these species (Kimura 1987). We expect to test those predictions in future multidisciplinary studies aiming to unravel how the populations of the mountain *Baripus (Cardiophthalmus)* species could have diverged over time.

Taxonomy

Family CARABIDAE

Subfamily BROSCINAE

Supertribe BROSCITAE

Tribe BROSCINI Hope, 1838

Genus *Baripus* Dejean, 1828

Subgenus *Cardiophthalmus* Curtis, 1839

Diagnosis

Baripus is the only genus of Broscini that has a distinctly developed basal keel on the median lobe (Fig. 13) (Roig-Juñent 2000) and a row of posterolateral setae on antennomeres 2–10 (Fig. 6). Other characters of external

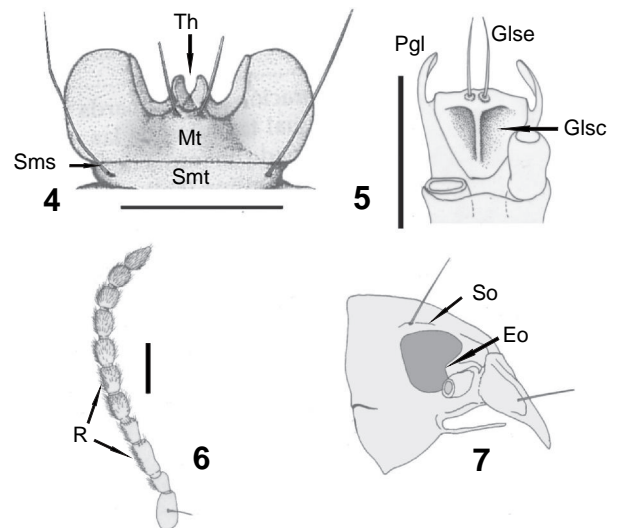


Fig. 4–7. Structures of head: 4, mentum of *Baripus parallelus*; 5, labium of *Baripus gentilii*; 6, antenna of *Baripus pulchellus* Burmeister; 7, lateral view of head of *Baripus pulchellus*. Eo, emargination of eye; Glsc, glossal sclerite; Glss, glossal setae; Mt, mentum; Pgl, paraglossa; Sms, submentum seta; Pgl, paraglossa; R, row of postlateral setae; Smt, submentum; Th, menton tooth. Scale bar: 1 mm.

Table 1. Estimates of cytochrome c oxidase subunit I (COI) sequence divergence between species using the Kimura 2-parameter model (K2P) and p-distance method.

Pairwise comparisons			Mean percentage divergence		
Species 1	Species 2	K2P	s.d.	p-distance	s.d.
<i>Baripus tromen</i>	<i>Baripus payun</i>	3.4	0.9	3.1	0.7
<i>Baripus tromen</i>	<i>Baripus palauco</i>	9.8	1.8	7.6	1.0
<i>Baripus tromen</i>	<i>Baripus aucamahuida</i>	10.3	1.8	8.0	1.1
<i>Baripus payun</i>	<i>Baripus palauco</i>	9.0	1.6	7.2	1.0
<i>Baripus payun</i>	<i>Baripus aucamahuida</i>	10.8	1.8	8.3	1.1
<i>Baripus palauco</i>	<i>Baripus aucamahuida</i>	5.1	1.1	4.4	0.8

Standard error estimates (s.d.) were obtained by bootstrap procedure (1000 replicates).

morphology and genitalia are described in Roig-Juñent (2000). Among the three subgenera of *Baripus*, the subgenus *Cardiophthalmus* is diagnosable by the following combination of characters: dorsal surface without metallic colouration; eyes emarginate (Fig. 7); front without longitudinal grooves; two setae on submentum; 24–51 setae in lateral umbilical series of elytra; prothrochanter with one seta.

The genetic distance found between the new *Baripus* species supports their status as different species. The average sequence divergence between the four new *Baripus* species was 8.1% (K2P distance) – 6.4% (*p*-distance), with pairwise interspecific divergence ranges from 3.4 to 10.8% (K2P) – 3.1% to 8.3% (*p*-distance) (Table 1). The lowest distance was observed between *Baripus* (*C.*) *tromen* and *B.* (*C.*) *payun*, with a: 3.4% (K2P) – 3.1% (*p*-distance) of divergence.

Key to the species of the subgenus *Cardiophthalmus*

- 1 Antennomeres 5–10 from 2.5 to 3× as long as wide; last visible sternite with setae almost covering external margin.....2
- Antennomeres 5–10 2× times as long as wide; last visible sternite with setae on apical half or just with few setae on apex.....11
- 2 Margin of pronotum with three umbilicate setae (Fig. 8, 25–28); median lobe with wide ventral fovea, not divided (Fig. 36)..... 3
- Margin of pronotum with two umbilicate setae; median lobe with ventral fovea divided by a small carina at middle.....
-*B.* (*C.*) *longitarsis* (Waterhouse, 1841)
- 3 Elytral intervals 3, 5, 7 and 9 with setae; male protarsomeres without adhesive setae (as Fig. 9); median lobe without ventral mucro; internal sac with tooth (Fig. 14, 15).....4
- Only elytral interval 9 with setae; male protarsomeres with or without small patch of adhesive setae (as Fig. 10); median lobe with ventral mucro (Fig. 30, 34, 36); internal sac without tooth (Fig. 29, 31, 33, 35).....5
- 4 Margin of pronotum very wide (Fig. 8); ligula 0.75× as long as length of the ostium of median lobe; tooth of internal sac slightly sclerotised.....*B.* (*C.*) *schajovskoyi* Roig-Juñent, 1992
- Margin of pronotum narrow (as Fig. 25); ligula 0.50× as long as length of ostium of median lobe; tooth of internal sac sclerotised.....*B.* (*C.*) *gentilii* Roig-Juñent, 1992

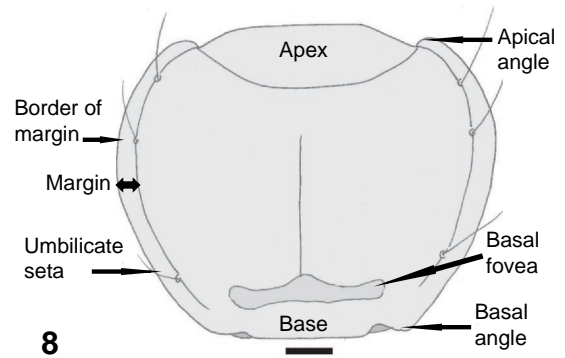


Fig. 8. Pronotum of *Baripus schajovskoyi*. Scale bar: 1 mm.

- 5 Male protarsomeres 1 and 2 without ventral adhesive setae (as Fig. 9).....7
- Male protarsomeres 1 and 2 with ventral adhesive setae on apical region (as Fig. 10).....6
- 6 Margin of pronotum complete from base to apical region; male protarsomeres 1 and 2 with patch of adhesive setae; last visible sternite with 30–41 setae; elytral interval 9 with 30–38 umbilicate setae; first antennomere 0.8× as long as third, second 0.50× as long as third.....
-*B.* (*C.*) *mendozensis* Roig-Juñent & Cicchino, 1989
- Margin of pronotum erased on basal third; male protarsomeres 1 and 2 with few adhesive setae (three or four); last visible sternite with 16–27 setae; elytral interval 9 with 23–28 setae, first antennomere as long as third, second 0.33× as long as third.....
-*B.* (*C.*) *precordillera* Roig-Juñent in Roig-Juñent et al. (2008)
- 7 Apex of median lobe spatulate (Fig. 35, 36); mucro of ventral groove conical, well developed and with apex curved (Fig. 36).....
-*B.* (*C.*) *aucamahuida*, sp. nov.
- Apex of median lobe quadrangular (Fig. 29–34); mucro of ventral groove small, not conical (Fig. 30, 32, 34).....8
- 8 Basal foveae of pronotum deep and connected centrally by a fossa equally wide and deep (Fig. 28); margin wider at basal than at apical region; apical angles protruding, exceeding apical margin; apex of median lobe long (length/width = 1.88) (Fig. 33, 34); lateral apical groove of median lobe straight, with a small curved part, partially visible from right view (Fig. 34).....*B.* (*C.*) *tromen*, sp. nov.

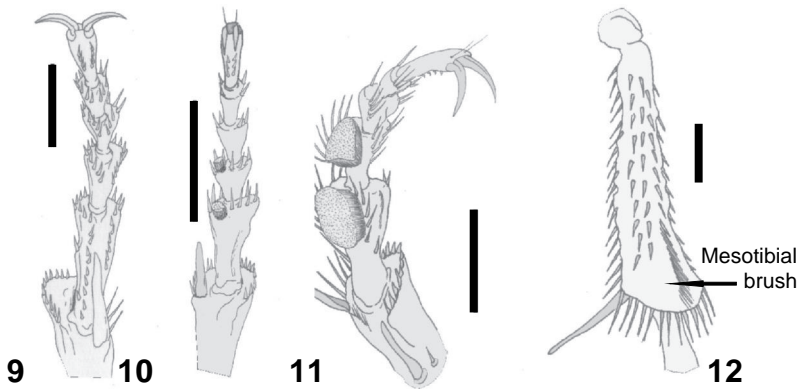


Fig. 9–12. Structures of legs: 9, ventral view of male protarsus of *Baripus schajovskoyi*; 10, idem of *B. sulcatipennis*; 11, idem of *Baripus dentipennis*; 12, mesotibia of *Baripus clivonoides*. Scale bar: 1 mm.

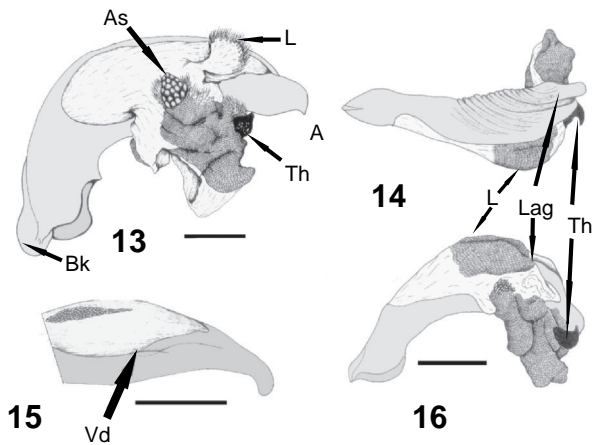


Fig. 13–16. Male median lobe of: 13, *Baripus speciosus* Dejean, lateral left view; 14, idem *Baripus sulcatipennis*; 15, dorsal view *Baripus sulcatipennis*; 16, apex of median lobe of *Baripus deplanatus*. A, apex of median lobe; As, sclerite alfa; Bk, basal keel; L, ligula; Lag, Lateral apical groove; Th, tooth of internal sac; Vd, ventral doubling of ostium. Scale bar: 1 mm.

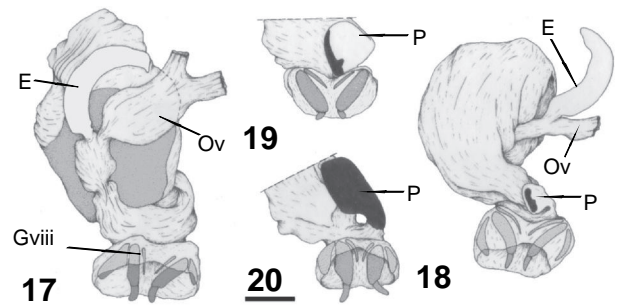


Fig. 17–20. Female genital tract of: 17, *Baripus gentilii*; 18, idem *Baripus minus*; 19, idem *Baripus chubutensis*; 20, idem *Baripus gaii*. E, spermatheca; Gviii, gonopod VIII; OV, oviduct; P, Pocket of apex of bursa copulatrix; Scale bar: 1 mm.

Basal foveae of pronotum shallow, separated centrally (Fig. 33, 34) or, if joined, the depression is thinner and shallower than laterobasal fossae (Fig. 26); margin of pronotum equally wide along its length; anterior angles do not surpass anterior margin; apex of median lobe as long as wide (length/width = 1.16–1.27); lateral apical groove of median lobe straight, but with a more pronounced curved part clearly visible from right view (Fig. 30, 32).....9

9 Border of pronotum margin bordered, with a defined groove, basal foveae faintly marked, not united centrally and separated from the margin by a convex area (Fig. 25).....*B. (C.) nevado* Roig-Juñent, Agrain, Carrara, Ruiz-Manzanos & Tognelli, 2008

Border of pronotum margin not bordered, flat, without groove, basal foveae not separated from margin (Fig. 26, 27) and separated (Fig. 27) or joined by a shallow area thinner than foveae (Fig. 26).....10

10 Basal foveae of pronotum not united centrally (Fig. 27); posterior margin of ventral mucro of median lobe forming a right angle (Fig. 32 – M); apex of median lobe rounded (Fig. 31, 32).....*B. (C.) palauco*, sp. nov.

Basal foveae of pronotum united centrally by a depression thinner and shallower than foveae (Fig. 26); posterior margin of ventral mucro of median lobe not in right angle (Fig. 30 – M); apex of median lobe wide, subquadrangular (Fig. 29, 30).....*B. (C.) payun*, sp. nov.

11 Margin of pronotum with two or four umbilicate setae; male protarsomeres 1 and 2 with or without small patch of adhesive setae on apical area (as in Fig. 9, 10); male protarsomeres triangular; last visible sternite with 10–24 apical setae; apical orifice of median lobe dorsolateral, at least 0.5× as long as length of median lobe.....12

12 Lateral margin of pronotum with three umbilicate setae; male protarsomeres 1 and 2 with adhesive setae covering the entire ventral area (Fig. 11); male protarsomeres subquadrangular; last visible sternite with less than eight setae; apical orifice of median lobe lateral, 0.33× as long as length of median lobe.....16

12 Margin of pronotum with four setae; median lobe with apex short and rounded; apical orifice of median lobe with apical ligula; median oviduct joined to bursa copulatrix apically (as in Fig. 18).....*B. (C.) clivonoides* (Curtis, 1839)

Margin of pronotum with two setae; median lobe with sharpened apex, apical orifice of median lobe with or without ligula; median oviduct joined to bursa copulatrix basally (as in Fig. 17).....13

13 Male protarsomeres without adhesive setae; median lobe thin and long, without ventrolateral grooves; apical orifice of median lobe long, without ligula; internal sac without tooth.....*B. (C.) flaccus* Roig-Juñent & Cicchino, 1989

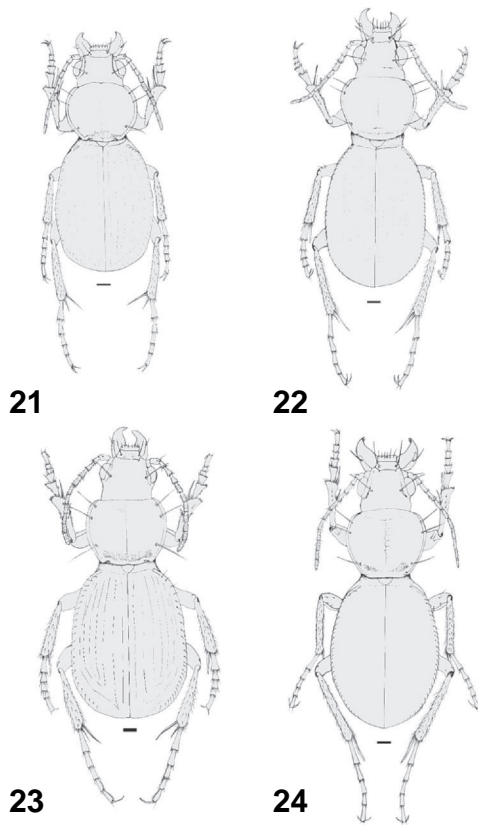


Fig. 21–24. Dorsal habitus of: 21, *Baripus (Cardiophthalmus) payun*, sp. nov.; 22, *B. (Cardiophthalmus) palauco*, sp. nov.; 23, *Baripus (Cardiophthalmus) tromen*, sp. nov.; 24, *Baripus (Cardiophthalmus) aucamahuida*, sp. nov. Scale bar: 1 mm.

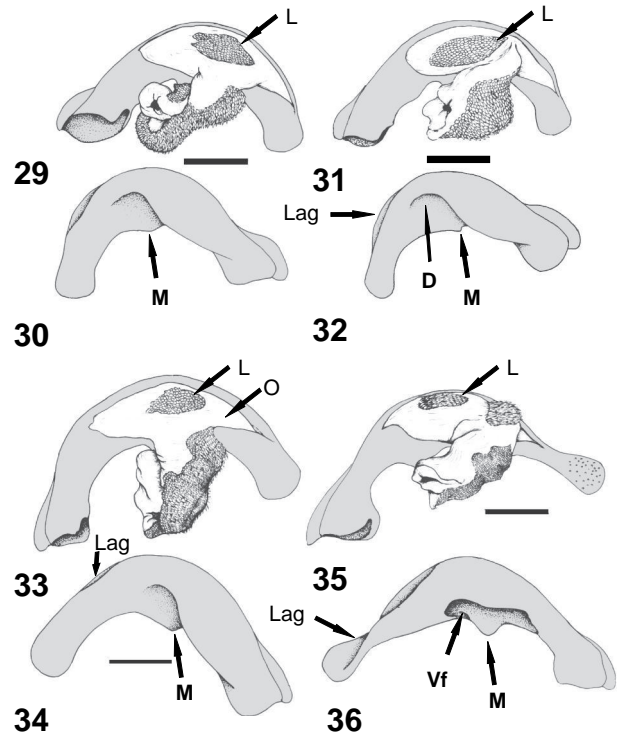


Fig. 29–36. Median lobe of: 29, *Baripus (Cardiophthalmus) payun*, sp. nov. left lateral view; 30, *Baripus (Cardiophthalmus) payun*, sp. nov. right lateral view; 31, *Baripus (Cardiophthalmus) palauco*, sp. nov. left lateral view; 32, *Baripus (Cardiophthalmus) palauco*, sp. nov. right lateral view; 33, *Baripus (Cardiophthalmus) tromen*, sp. nov. left lateral view; 34, *Baripus (Cardiophthalmus) tromen*, sp. nov. right lateral view; 35, *Baripus (Cardiophthalmus) aucamahuida*, sp. nov. left lateral view; 36, *Baripus (Cardiophthalmus) aucamahuida*, sp. nov. right lateral view. L, ligula; Lag, Lateral apical groove; M, ventral mucro; D, ventral doubling of median lobe; O, ostium; Vf, ventral fovea of median lobe. Scale bar: 1 mm.

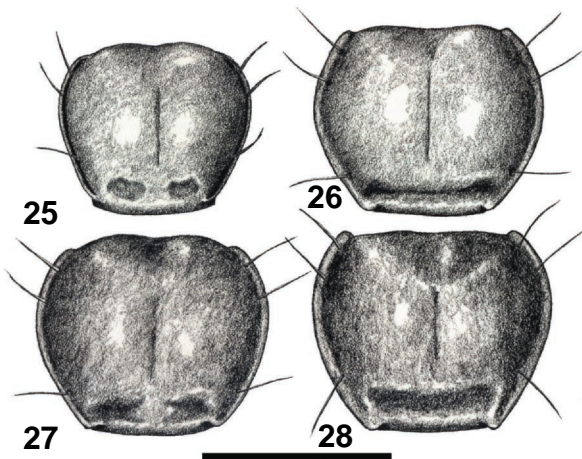


Fig. 25–28. Pronotum of: 25, *Baripus nevado*; 26, *Baripus (Cardiophthalmus) payun*, sp. nov.; 27, *Baripus (Cardiophthalmus) palauco*, sp. nov.; 28, *Baripus (Cardiophthalmus) tromen*, sp. nov. Scale bar: 1 mm.

- 14 Median lobe wide from middle to apex, with deep grooves; apical orifice of median lobe with big and wide ligula (Fig. 14, 16).....
.....*B. (C.) sulcatipenis* Roig-Juñent, 1992
- Median lobe thin throughout its length, grooves present but weak; apical orifice of median lobe with small and thin ligula.....15
- 15 Apex of median lobe thin, extended downwards as a hook
.....*B. (C.) deplanatus* Roig-Juñent & Cicchino, 1989
- Apex rounded, wide.....
.....*B. (C.) painensis* Roig-Juñent & Cicchino, 1989
- 16 Apical orifice of median lobe in dorsoapical position, small, with ligula; median lobe with shorter apex (as long as the base); internal sac with a complex of unfused sclerotised spiculae in same position as tooth; female genital tract without pocket at apex of bursa copulatrix (as in Fig. 17).....
.....*B. (C.) neuquensis* Roig-Juñent, 1992
- Apical orifice of median lobe in lateroapical position, without ligula; median lobe with longer apex (2 or 3× longer than the base); internal sac with tooth; female genital tract with pocket at apex of bursa copulatrix (Fig. 18–20).....17
- 17 Elytral striae weakly impressed; apex of median lobe very long (more than 3× as long as the width at base) and sharpened, apex slender; pocket at apex of bursa copulatrix with narrow base and completely sclerotised (Fig. 20); bursa copulatrix ventrally sclerotised.....18

Male protarsomeres 1 and 2 with adhesive setae; median lobe with ventrolateral grooves (Fig. 14, 16); apical orifice of median lobe with ligula (Fig. 14, 16); internal sac with tooth (Fig. 14, 16).....
.....14

- Elytral striae deep; apex of median lobe long (at least as long as the width at base), with rounded apex; pocket at apex of bursa copulatrix with wide base, with a small part sclerotised (Fig. 18, 19); bursa copulatrix dorsally sclerotised.....19
- 18 Apex of median lobe strongly sharpened; tooth of internal sac very long (3× as long as the width at base).....*B. (C.) dentipenis* Roig-Juñent, 1992
- Apex of median lobe rounded; tooth of internal sac shorter (length less than 3× the width at base).....*B. (C.) giani* Roig-Juñent, 1992
- 19 Last visible sternite with basal setae; tooth of internal sac as long as wide; pocket at apex of bursa copulatrix small (Fig. 18).....*B. (C.) minus* Roig-Juñent, 1992
- Last visible sternite without basal setae; tooth of internal sac longer than wide; pocket at apex of bursa copulatrix bigger (Fig. 19).....*B. (C.) chubutensis* Roig-Juñent, 1992

***Baripus (C.) payun*, Roig-Juñent & Cisterna, sp. nov.**

(Fig. 21, 26, 29, 30, 37)

<http://zoobank.org/urn:lsid:zoobank.org:act:2EA4E270-FCE7-4B85-A7CB-94666B3D3DAB>

Material examined

Holotype. ♂, Argentina, Mendoza, Malargüe: Payunia Provincial Reserve, Payún Matrú Volcano, 2819 m (−36.36469, −69.22065), 13–23.xii.2015, S. Roig, R. Carrara, F. Fernández Campón and S. Lagos col. (IADIZA-CEIT 1012).

Paratypes. 2♂, 3♀, same data as holotype (IADIZA-CEIT 1013–1017); 3♂, 1♀, Payunia Provincial Reserve, Payún Matrú Volcano, 2491 m (36.35232°S, 69.23048°W), same data and collectors as holotype (IADIZA-CEIT 1019–1022); 1♂, Payunia Provincial Reserve, Payún Matrú Volcano, 3037 m (36.7759°S, 69.21978°W), same data and collectors as holotype (IADIZA-CEIT 1018); 2♂, 2♀, Payunia Provincial Reserve, Payún Matrú Volcano, 2957 m (36.37266°S; 69.22328°W), 26.i.2010, E. Scheibler col. (IADIZA-CEIT 1023–1027).

Other material examined. **Argentina:** Mendoza, Malargüe: 11♂, 8♀, Payunia Provincial Reserve, Payún Matrú, 2595 m (36.35709°S, 69.22405°W), 26.i.2010, R. Carrara and E. Scheibler col. (IADIZA); 1♂, Payunia Provincial Reserve, Payún Matrú, 2957 m (36.37266°S, 69.22328°W), 26.i.2010, E. Scheibler col. (IADIZA); 1♂, Payunia Provincial Reserve, Payún Matrú, 2370 m (36.34915°S, 69.24048°W), 26.i.2010, E. Scheibler col. (IADIZA); 1♀, Payunia Provincial Reserve, Payún Matrú, 8.ii.2007, G. Flores col. (IADIZA); 5♂, 5♀, Payunia Provincial Reserve, Payún Matrú, 2491 m (36.35232°S, 69.23048°W), same data and collectors as holotype (IADIZA); 1♂, 3♀, labelled as holotype (IADIZA); 1♂, Payunia Provincial Reserve, Payún Matrú, 3053 m (36.37930°S, 69.22142°W), 5–15.xii.2016, S. Roig, R. Carrara, M. Roig-Cerdeño and G. Zalazar col. (IADIZA); 10♂, 15♀, Payunia Provincial Reserve, Payún Matrú, 2595 m (36.35712°S, 69.22382°W), 5–15.xii.2016, S. Roig, R. Carrara, G. Flores, M. Roig-Cerdeño and G. Zalazar col. (IADIZA).

Diagnosis

Margin of pronotum narrow, of equal width from base to apex; with three umbilicate setae on each side; basal foveae shallow, joined centrally and not separated from margin; elytra with striae indistinct, but with small punctuation, without setae in intervals 3, 5, 7; male protarsomeres 1–2

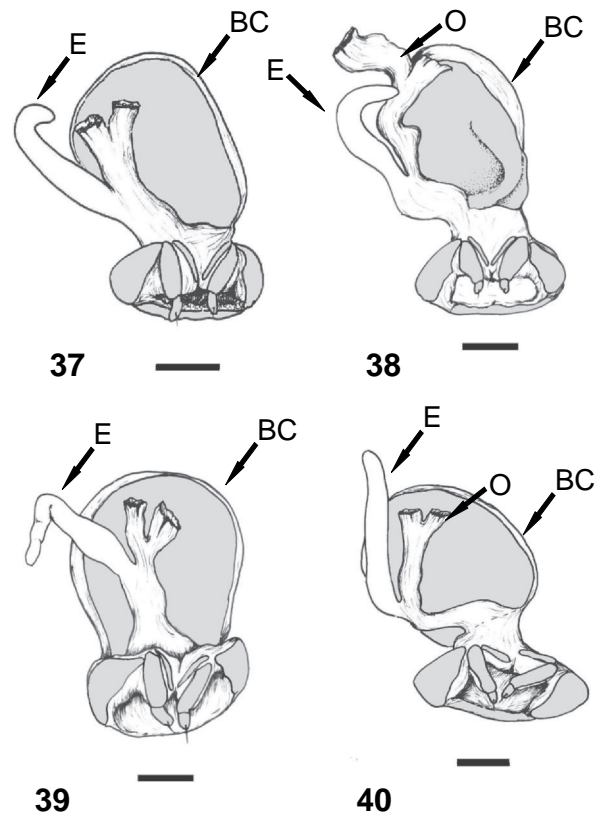


Fig. 37–40. Female genitalia of: 37, *Baripus (Cardiophthalmus) payun*, sp. nov.; 38, *Baripus (Cardiophthalmus) palauco*, sp. nov.; 39, *Baripus (Cardiophthalmus) tromen*, sp. nov.; 40, *Baripus (Cardiophthalmus) aucamahuida*, sp. nov. E, spermatheca; O, oviduct; BC, Bursa copulatrix. Scale bar: 1 mm.

without adhesive setae; median lobe of aedeagus with a wide ventral groove open laterally to the right and a ventral mucro on left side of the groove; apex of median lobe as long as wide; ostium with a large ligula; internal sac without tooth; spermatheca and oviduct joining together at base of oviduct.

Description

Habitus as in Fig. 21.

Length. 18.0–21.1 mm.

Colouration. Black; with mouthparts, antennae and legs testaceous, dark reddish.

Head. Clypeus with two short lateral sulci slightly developed; supraorbital sulcus well defined, complete; antennomeres 5–10 2.5× as long as wide.

Pronotum (Fig. 26). As wide as long (width/length = 1.16–1.18), maximum width at medium; dorsal surface smooth; margin narrow, of equal width along its length; not bordered; with three umbilicate setae on each side, two setae on apical third and one on basal third, in two specimens with four setae on one side and three on the other; umbilicate setae are inserted in a depression, the two anterior ones on lateral margin, the posterior one

displaced internally, not placed on lateral margin (Fig. 26); apical angles not exceeding apical margin; basal foveae slightly impressed, without separation from margin, without convex area; basal foveae joined centrally by a thin depression shallower than foveae; central longitudinal sulcus indistinct; basal angles rounded, inconspicuous.

Elytra. Without humeral angle (Fig. 21); striae with small punctures, weakly impressed, more visible at apex; 28–36 umbilicate setae in ninth interval, without setae on intervals 3, 5 and 7.

Legs. Profemora with three or four teeth ventrally. Protrochanters with one umbilicate seta. Male protarsomere 1 $2 \times$ as long as apex width ($l/aw = 2.20$); first and second protarsomeres of males without adhesive setae; meso- and metatarsomeres long (length of all metatarsomeres/metatibia length = 0.84), meso and metatibial internal spur long, as long as tarsomere 1 and twice as long as external spur.

Abdominal sterna. Visible sterna 3–6 with basal sulcus complete; last visible sternite with 45–56 umbilicate setae along lateral and apical margin, starting near the base and without separation at middle of apical margin.

Male genitalia (Fig. 29, 30). Median lobe from dorsal view, 'S' shaped, wider at central part and abruptly thinner at apical third; apex of median lobe short (length/maximum width = 1.16), quadrangular (Fig. 29, 30), flat on left and right sides; ventral groove wide, starting ventrally near the base and curved to the right side and opening completely at

middle of median lobe; a mucro on the left side of the ventral groove with apex not recurved and both anterior and posterior angles smooth (Fig. 30); ostium of median lobe $0.61 \times$ the length of median lobe, opening on left side of median lobe; ostium with broad ligula; internal sac without tooth (Fig. 29), with free small spicules on apical region.

Female genitalia (Fig. 37). Bursa copulatrix with the whole ventral side sclerotised, dorsal side membranous; spermatheca long, curved at apex, joining the base of bursa copulatrix along with the oviduct; stylomeres short and rounded, with a nematiform seta.

Comparative notes

Baripus (*C.*) *payun*, sp. nov. is very similar to *B.* (*C.*) *nevado* in external and genital morphology. The two species differ as follows: pronotum wider in *B. payun*, sp. nov.; basal foveae of pronotum joined, with the margin not bordered in *B.* (*C.*) *payun*; shape of the apical margin of median lobe apex curved in *B.* (*C.*) *payun*, sp. nov., straight in *B.* (*C.*) *nevado*.

Distribution and habitat

The known distribution of *B.* (*C.*) *payun*, sp. nov. is restricted to the Payún Matrú Volcano (Fig. 41, 42). Payún

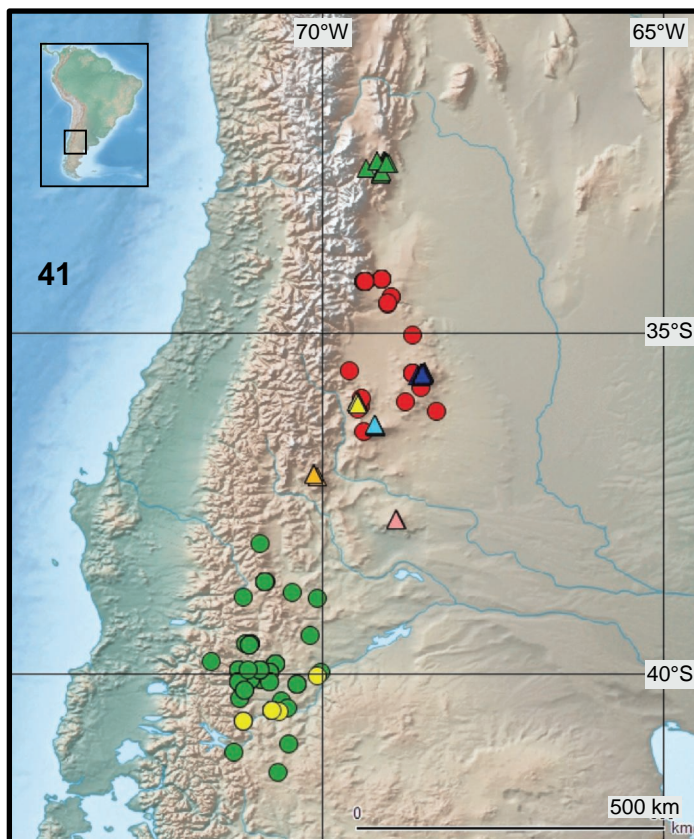


Fig. 41. Distribution of species of Clades A and B. Mountain species represented by triangles: green triangle, *Baripus* (*Cardiophthalmus*) *precordillera*; blue triangle, *Baripus* (*Cardiophthalmus*) *nevado*; yellow triangle, *Baripus* (*Cardiophthalmus*) *palauco*, sp. nov.; light blue triangle, *Baripus* (*Cardiophthalmus*) *payun*, sp. nov.; pink triangle, *Baripus* (*Cardiophthalmus*) *aucamahuida*, sp. nov.; orange triangle, *Baripus* (*Cardiophthalmus*) *tromen*, sp. nov. Lowland species represented by circles: red circle, *Baripus* (*Cardiophthalmus*) *mendozaensis*; green circle, *Baripus* (*Cardiophthalmus*) *gentilii*; yellow circle, *Baripus* (*Cardiophthalmus*) *schajovskoyi*.

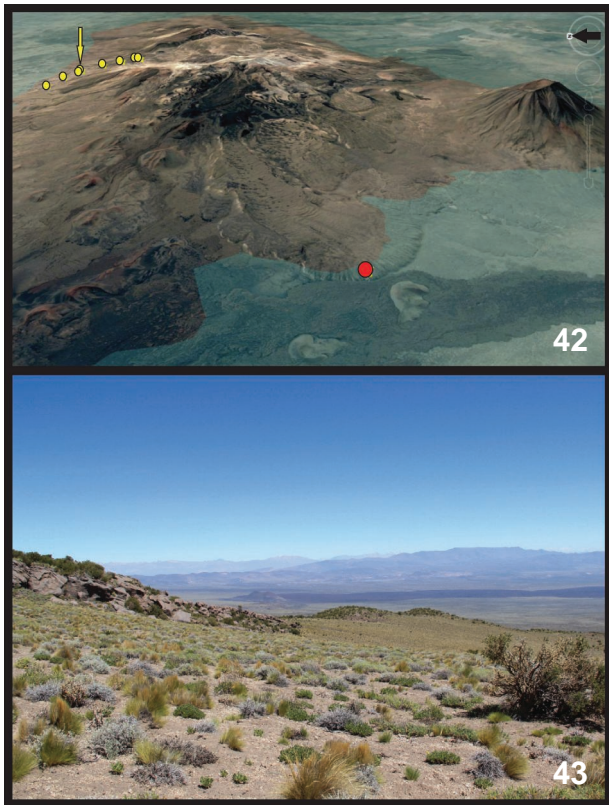


Fig. 42–43. Geographical distribution of *Baripus (Cardiophthalmus) payun*. 42, Aerial view of Payún Matrú Volcano from the west (source Google Earth, Google Inc., Mountain View, CA, USA, see <http://earth.google.com/>, Accessed 30 July 2017): yellow circle, locations of *Baripus (Cardiophthalmus) payun*, sp. nov., red circle, locality of *Baripus (Cardiophthalmus) mendozensis*; the masked area is below 2200-m altitude, the yellow arrow shows location of Fig. 43. 43, Habitat of Payún Matrú Volcano at 2595-m altitude.

Matrú is a volcano located 200 km to the east of the Andes Mountains and increases in height from north to south (Fig. 41), reaching a maximum elevation of 3833 m. This volcano arose between the Pliocene and Holocene (Bermúdez and Delpino 1989). Specimens were collected at different elevations, from 2370 m at the base of the mountain to 3037 m at the top (Fig. 42). This area corresponds to the Payunia district of the Patagonia Biogeographic Province (Domínguez *et al.* 2006).

Baripus (C.) payun, sp. nov. was collected in grassland or shrub-steppe vegetation, two types of vegetation that belong to two different elevations, the lowest habitat comprises grassland vegetation with tall shrubs like *Adesmia pinnifolia* (Fabaceae) and *Anarthrophyllum rigidum* (Fabaceae) (Fig. 43), whereas high-altitude vegetation is scarce, small in size and there is a large proportion of bare soil, with *Pantacantha ameghinoi* (Solanaceae) being predominant (Roig *et al.* 1998). Nevertheless *B. (C.) payun*, sp. nov. is more abundant in the first vegetation belt (Fig. 42, 43) since, using the same number of pitfall traps

(32 pitfall traps for each habitat), we collected 54 specimens at low elevation and only four at high elevation (up to 3000 m).

Etymology

The name of the new species is related to the mountain where it was collected, the Payún Matrú Volcano in Mendoza Province, Argentina.

Baripus (C.) palauco, Roig-Juñent & Cisterna, sp. nov.

(Fig. 22, 27, 31, 32, 38)

<http://zoobank.org/urn:lsid:zoobank.org:act:E1197376-1362-4748-9BFE-316BDC8873B4>

Material examined

Holotype. ♂, Argentina, Mendoza, Malargüe, Sierra de Palauco, 2811 m (36.04557°S, 69.47460°W), 13–23.xii.2015, S. Roig, R. Carrara, F. Fernández Campón and S. Lagos col. (IADIZA-CEIT 969).

Paratypes. 15♂, 11♀, same data as holotype (IADIZA-CEIT 970–996); 1♀, Sierra de Palauco, 3000 m, 6.i.2007, S. Roig col. (IADIZA-CEIT 998); 1♀ Sierra de Palauco, 2730 m (36.05722°S, 69.43505°W), 6.ii.2007, S. Roig col. (IADIZA-CEIT 997).

Other material examined. **Argentina:** Mendoza. Malargüe: 36♂, 30♀, same data as holotype (IADIZA); 4♂, 6♀, Sierra de Palauco, 2997 m (36.00565°S, 69.47225°W), 5–15.xii.2016, S. Roig, R. Carrara, G. Flores, M. Roig-Cerdeño and G. Zalazar col. (IADIZA); 22♂, 18♀, Sierra de Palauco, 2647 m (36.015042°S, 69.47225°W), 5–15.xii.2016, S. Roig, R. Carrara, G. Flores, M. Roig-Cerdeño and G. Zalazar col. (IADIZA).

Diagnosis

Margin of pronotum narrow, of equal width along its length; not bordered; basal foveae shallow, not joined centrally and not separated from margin; elytral interval 9 with 23–38 umbilicate setae; elytra without striae; last abdominal sternite with more than 40 lateral umbilicate setae, starting from base and without separation in central apical part of margin; male without squamosetae on protarsomeres 1 and 2; median lobe of male aedeagus curved, with wide ventral groove open laterally to the right and a mucro on the left lateral side with posterior margin straight; apex of median lobe as long as wide; spermatheca and oviduct joined together at base of bursa copulatrix. Ventral side of bursa copulatrix sclerotised.

Description

Habitus as in Fig. 22.

Length. 16.3–21.4 mm.

Colouration. Black, mouth parts and some regions of legs and antennae dark reddish.

Head. Clypeus with two lateral sulci, supraorbital sulcus erased at base and poorly defined at middle; antennomeres 5–10 $2.5 \times$ longer than wide.

Pronotum (Fig. 27). Slightly wider than long (width/length: 1.16), widest at middle; margin narrow, of equal width along its length, not bordered; apical angles not exceeding apical margin; with three umbilicate setae on each side, two at apical half and one at basal third; umbilicate setae inserted in a depression, the two apical ones on lateral margin, the basal one displaced internally, not placed on lateral margin (Fig. 27); posterior foveae slightly impressed, without separation from margin; without convex area; basal foveae not united centrally by a depression, central longitudinal sulcus indistinct; basal angles rounded, inconspicuous.

Elytra. Without humeral angle (Fig. 22); without or with slightly impressed striae, with small punctures; interval 9 with 23–38 umbilicate setae, without setae on intervals 3, 5 and 7.

Legs. Profemora with three ventral teeth ventrally; pro-trochanters with one umbilicate seta; male protarsomere 1 $2 \times$ as long as apex width ($l/aw = 2.18$), male protarsomeres 1 and 2 without adhesive setae on apical side, meso- and metatarsomeres long (length of all metatarsomeres/metatibia length = 1.16); meso and metatibial internal spur long, as long as tarsomere 1 and twice as long as external spur.

Abdominal sterna. Visible sterna 3–6 with basal sulcus complete; last visible sternite with 45–55 umbilicate setae on lateral margin, starting near the base and without separation at middle of apical margin.

Male genitalia (Fig. 31, 32). Median lobe from dorsal view, 'S' shaped, wider at central part and abruptly thinner at apical third; apex of median lobe short (length/maximum width = 1.16), quadrangular, flat on both sides; ventral groove wide, starting ventrally near the base and curved to the right side and opening completely at middle of median lobe (Fig. 32 – D); a mucro on the left side of the ventral groove with the apex not recurved and with posterior margin straight, in right angle (Fig. 32 – M); ostium of median lobe latero-dorsal, $0.57 \times$ the length of median lobe, with large ligula (Fig. 28); internal sac without tooth, with free small spicules in apical region (Fig. 31).

Female genitalia (Fig. 38). Bursa copulatrix with almost the whole ventral side sclerotised, dorsal side not; spermatheca long, curved at apex; joining the base of bursa copulatrix along with the oviduct; stylomeres short and rounded, with a nematiform seta.

Comparative notes

B. (C.) palauco, sp. nov. is similar in external morphology to *B. (C.) payun*, sp. nov. The two species differ as follow: basal foveae of pronotum deep, joined centrally in *B. (C.) payun*, sp. nov. (Fig. 26) and separated in *B. (C.) palauco*, sp. nov. (Fig. 27); male genitalia differ in shape of apical margin

median lobe apex and in the length of apex (compare Fig. 30, 32); ventral mucro of median lobe with its posterior margin in right angle in *B. (C.) palauco*, sp. nov. (Fig. 32 – M), a unique character state.

Distribution and habitat

Baripus (C.) palauco, sp. nov. occurs in the Sierra de Palauco (Fig. 41, 44), a mountain system that runs in a South–North direction and is isolated from the other mountain systems of the Payunia as the Nevado Hill and Payún Matrú Volcano (Fig. 44). In between these orographic systems, there stretches a 1600–1900-m elevation plateau, characterised by Patagonian steppe vegetation.

The specimens were collected at high altitude, between 2730 and 3000 m (Fig. 44), in grassland and shrub steppe vegetation that occurs at two different elevations. The lowest habitat comprises shrub communities of *Adesmia pinnifolia*, *A. schniderii* and *A. obovata* (Fabaceae), grasses such as *Poa holciformis* (Poaceae) and different species of *Stipa* (Poaceae) (Fig. 45) (Roig et al. 1998). High-altitude vegetation is similar to those on Payún Matrú: scarce, dwarf-shrub

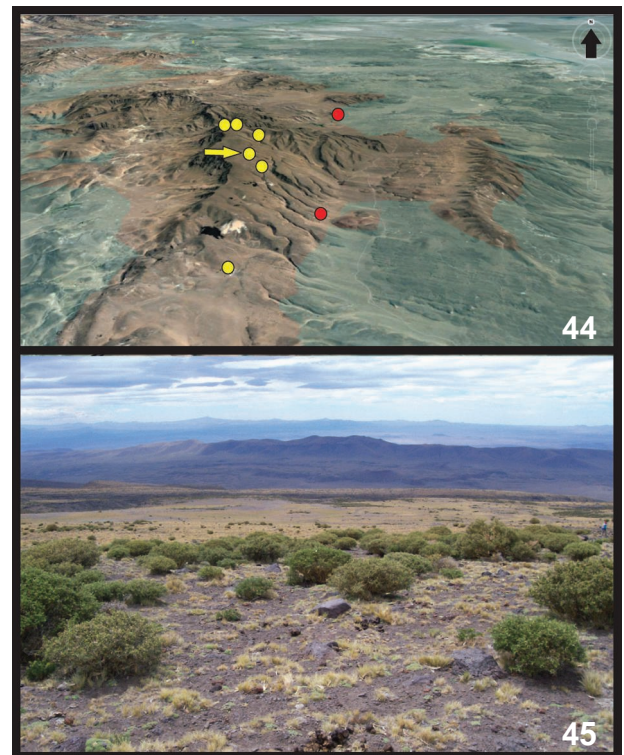


Fig. 44–45. Geographical distribution of *Baripus (Cardiophthalmus) palauco*. 44, Aerial view of Sierra de Palauco from the South (source Google Earth, Google Inc., Mountain View, CA, USA, see <http://earth.google.com/>, accessed 30 July 2017): yellow circle, locations of *Baripus (Cardiophthalmus) palauco*, sp. nov.; red circle, locality of *Baripus (Cardiophthalmus) mendozensis*; the masked area is below 2200-m altitude, the yellow arrow shows location of Fig. 43. 45, Top of Sierra de Palauco at 2700-m altitude.

vegetation and grasses with a high proportion of bare soil and predominance of *Pantacantha ameghinoi* (Solanaceae). *B. (C.) palauco*, sp. nov. occurs in both habitats, but it is more abundant in the first vegetation belt since, using the same number of pitfall traps (32 pitfall traps for each habitat), we collected 164 specimens at low elevation and only 10 at high elevation (~3000 m).

Etymology

The name of the species is related to the mountains, Sierras de Palauco, where the species was discovered.

Baripus tromen, Roig-Juñent & Cisterna, sp. nov.

(Fig. 23, 28, 33, 34, 39)

<http://zoobank.org/urn:lsid:zoobank.org:act:AD042D71-C9C0-47AF-A32B-66248B94423B>

Material examined

Holotype. ♂, Argentina, Neuquén, Chos Malal: Tromen Provincial Reserve, Tromen Volcano, 2610 m (37.11200°S, 70.07203°W), 13–23.xii.2015, S. Roig, R. Carrara, F. Fernández Campón and S. Lagos col. (IADIZA-CEIT 999).

Paratypes. 6♂, 4♀, same data as holotype (IADIZA-CEIT1000–1009); 1♂, 1♀, Tromen Provincial Reserve, Tromen Volcano, 2147 m (37.11039°S, 70.08475°W) 13–23.xii.2015, S. Roig, R. Carrara, F. Fernández Campón and S. Lagos col. (IADIZA-CEIT 1010–1011).

Other material examined. **Argentina**: Neuquén, Chos Malal, 2♀, same data as holotype (IADIZA); 72♂, 70♀, Tromen Provincial Reserve, Wayle Hill, 2559 m (37.06792°S, 70.12266°W), 5–15.xii.2016, S. Roig, R. Carrara, G. Flores, M. Roig-Cerdeño and G. Zalazar (IADIZA); 1♂, 2♀, Tromen Provincial Reserve, park rangers' base, Wayle Hill, 2249 m (37.07855°S, 70.11867°W), S. Roig col. (IADIZA).

Diagnosis

Margin of pronotum narrow, wider in apical third than central region, not bordered; with three umbilicate setae on each side; elytra with striae indistinct, without setae in intervals 3, 5, 7; male protarsomeres 1–2 without adhesive setae; median lobe of aedeagus with a wide ventral groove open laterally to the right and a ventral mucro on left side of the groove; apex of median lobe twice longer than wide; ostium with a large ligula; internal sac without tooth; spermatheca and oviduct joining together at base of oviduct; almost the entire ventral side of bursa copulatrix sclerotised.

Description

Habitus as in Fig. 23.

Length. 18.5–24.0 mm.

Colouration. Black; with mouthparts, antennae and legs testaceous, dark reddish.

Head. Clypeus with two subparallel lateral sulci slightly developed; supraorbital sulcus poorly defined at base; antennomeres 5–10 3× as long as wide.

Pronotum (Fig. 28). As long as wide (width/length = 1.16), maximum width at apical third; dorsal surface smooth. Margin narrow, wider in apical than central region, not bordered; apical angles protruding, exceeding apical margin with three umbilicate setae on each side, two setae on apical third and one on basal third; umbilicate setae are inserted in a depression displaced internally, not placed on margin (Fig. 28); basal foveae deep, separated from margin by a convex area and connected centrally by a fossa of equal width and depth (Fig. 28); central longitudinal sulcus slightly developed, complete; basal angles rounded, inconspicuous.

Elytra. Without humeral angles; striae weakly impressed, more visible at apex, without punctures; ninth interval with 28–38 umbilicate setae, without setae on intervals 3, 5 and 7.

Legs. Profemora with three or four teeth ventrally; pro-trochanter with one umbilicate seta; protarsomere 1 2× as long as apex width ($l/aw = 2.07$); first and second male protarsomeres without adhesive setae; meso and metatarsomeres long (length of all metatarsomeres/metatibia length = 0.84); meso and metatibial internal spur long, as long as metatarsomere 1 and twice as long as external spur.

Abdominal sterna. Visible sterna 3–6 with basal sulcus complete; last visible sternite with 32–45 setae on lateral margin, starting near the base and without separation at middle of apical margin.

Male genitalia (Fig. 33, 34). Median lobe from dorsal view, 'S' shaped, wider at central part and abruptly thinner at apical third; apex long (length/maximum width = 1.88) flat on left and right sides; ventral groove wide, starting ventrally near the base and curved to the right side and opening completely at middle of median lobe (Fig. 34 – M); a mucro on the left side of the ventral groove with apex not recurved and both anterior and posterior angle smooth (Fig. 34); ostium of median lobe 0.55× the length of median lobe, opening on the left side of median lobe; ostium with short but broad ligula; internal sac without tooth (Fig. 33), with free small spicules in apical region.

Female genitalia (Fig. 39). Bursa copulatrix with sclerotised ventral side, dorsal side membranous; spermathecal long, curved in right angle at apical third, with narrow apex, joining the base of bursa copulatrix along with the oviduct; stylomeres short and rounded, with a nemati-form seta.

Comparative notes

Baripus (C.) tromen, sp. nov. is similar in external morphology to *B. (C.) nevado*, *B. (C.) palauco*, sp. nov. and *B. (C.) payun*, sp. nov., but is distinguished from those by following combination of characters: basal foveae deep and connected

centrally by a fossa of equal width and length; margin wider in basal than apical region; apical angles protruding, exceeding apical margin; median lobe apex longer ($l/w = 1.88$) (Fig. 34) than in the other species ($l/w = 0.79\text{--}1.16$) (Fig. 30, 32).

Distribution and habitat

The known distribution of *B. (C.) tromen*, sp. nov. is restricted to the Tromen and Wayle volcanoes in Tromen Provincial Reserve (Fig. 41, 46). Tromen Volcano is 3978 m in altitude (Fig. 46) whereas Wayle Volcano is 3182 m, separated from each other by a small valley at an elevation of 2140–2200 m (Fig. 46). Both volcanoes have a recent origin, c. 1.8 Ma (Galland et al. 2007) and constitute isolated mountains located 80 km east of the Andes Mountains. Specimens were collected at different elevations, from 2147-m altitude at the base of the mountain to 2610-m altitude (Fig. 47). The area where the species was found corresponds to the first Andean vegetation belt present in the Reserve (Chiapella and Ezcurra 1999), which occurs between 2100 and 2600 m. The mountain base supports a

grassland steppe, with *Stipa* species and *Poa* species (Poaceae) being dominant. At 2300-m elevation, there are shrub communities of *Adesmia pinifolia* (Fabaceae), *Nassauvia* species, *Perezia* species (Asteraceae) and *Mulinum* species (Apiaceae). At 2400 m, the grassland vegetation becomes sparser and there are local communities with a herbaceous layer of *Uncinia lechleriana* (Cyperaceae) and *Pratia repens* (Campanulaceae) and shrub communities composed of *Berberis empetrifolia* (Berberidaceae), *Discaria nana* (Rhamnaceae) and *Chilotrachelium rosmarinifolium* (Asteraceae). *Baripus (C.) tromen*, sp. nov. seems to be more abundant at high altitudes, since using the same number of pitfall traps (32 pitfall traps for each habitat), we collected 159 specimens at altitudes between 2500 and 2600 m (Fig. 47), but only one specimen between 2150 and 2250 m.

Etymology

The name of the new species is related to the area where it was collected, Tromen Provincial Reserve in Neuquén Province, Argentina.

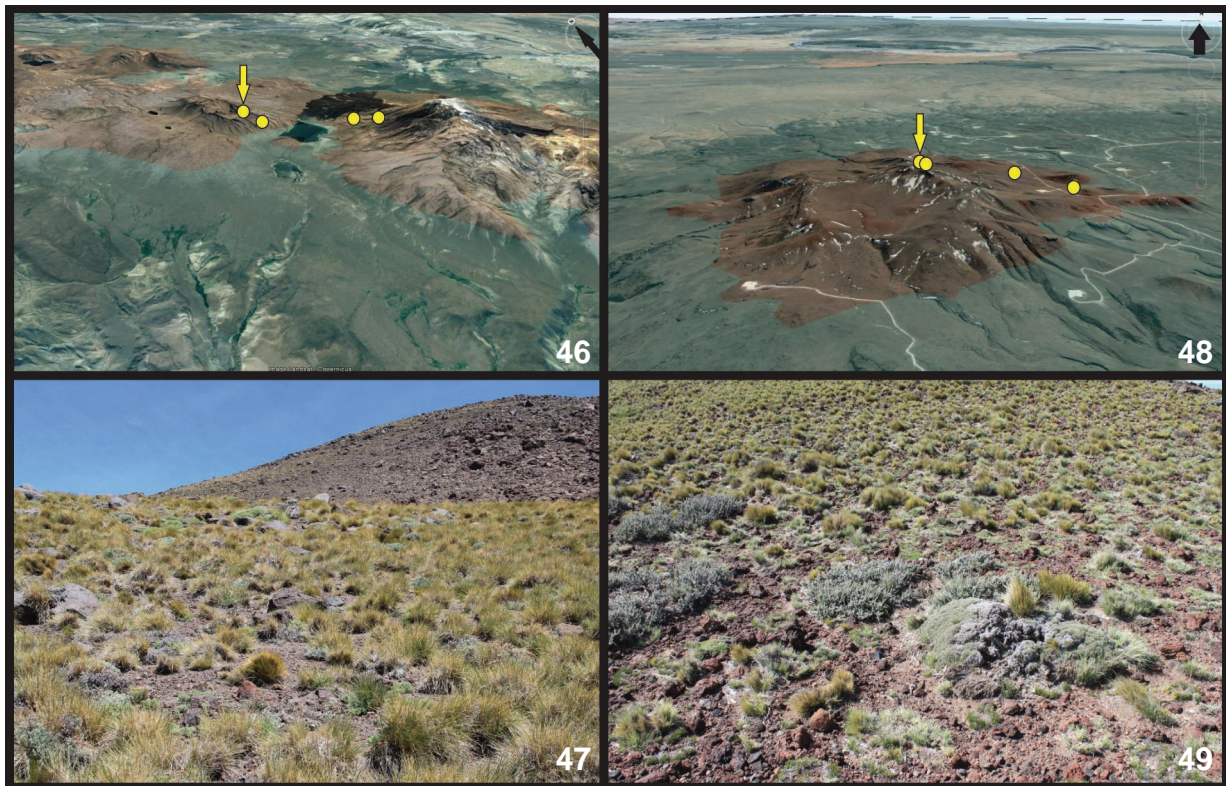


Fig. 46–49. Geographical distribution of *Baripus (Cardiophthalmus) tromen* and *Baripus (Cardiophthalmus) aucamahuida*. 46, Aerial view of Tromen and Wayle Volcanoes from the west (source Google Earth, Google Inc., Mountain View, CA, USA, see <http://earth.google.com/>, Accessed 30 July 2017): yellow circle, locations of *Baripus (Cardiophthalmus) tromen*, sp. nov., the masked area is below 2200-m altitude, the yellow arrow shows location of Fig. 45. 47, Wayle Volcano at 2559-m altitude; 48, aerial view of Auca Mahuida Volcano from the west (source Google Earth): yellow circle: locations of *Baripus (Cardiophthalmus) aucamahuida*, sp. nov.; the masked area is below 1500-m altitude; the yellow arrow shows location of Fig. 49. 49, Top of Auca Mahuida Volcano at 2212-m altitude.

***Baripus aucamahuida*, Roig-Juñent & Cisterna,
sp. nov.**

(Fig. 24, 35, 36, 40)

<http://zoobank.org/urn:lsid:zoobank.org:act:B872D4E9-86AC-468F-8AAD-3492E5BF412D>

Material examined

Holotype. ♂, Argentina, Neuquén, Añelo, Auca Mahuida Provincial Reserve, Auca Mahuida Hill, 2232 m (37.739250°S, 68.922859°W), 12–21.xii.2015, R. Carrara, S. Lagos, F. Fernández Campón and S. Roig col. (IADIZA-CEIT 943).

Paratypes. 6♂, 2♀, labelled as holotype (IADIZA-CEIT 944–951); 1♂, 1♀, Auca Mahuida Provincial Reserve, Auca Mahuida Hill, 1970 m (37.734550°S, 68.909836°W), 13–23.xii.2015, S. Roig, R. Carrara, F. Fernández Campón and S. Lagos col. (IADIZA-CEIT 952–953); 4♂, Auca Mahuida Provincial Reserve, park rangers' base, 1546 m (37.70129°S, 68.85785°W), 3.xii.2016, S. Roig, R. Carrara, G. Flores, M. Roig-Cerdeño and G. Zalazar col. (IADIZA-CEIT 960–963); 4♂, 2♀, Auca Mahuida Provincial Reserve, Auca Mahuida Hill, 2212 m (37.73928°S, 68.92375°W), 3.xii.2016, S. Roig, R. Carrara, G. Flores, M. Roig-Cerdeño and G. Zalazar col. (IADIZA-CEIT 954–959); 4♂, 1♀, Auca Mahuida Provincial Reserve, Auca Mahuida Hill, 1913 m (37.73814°S, 68.90296°W), 3.xii.2016, S. Roig, R. Carrara, G. Flores, M. Roig-Cerdeño and G. Zalazar col. (IADIZA-CEIT 964–968).

Other material examined. **Argentina**: Neuquén, Añelo, 60♂, 58♀, same data as holotype (IADIZA); 72♂, 74♀, Auca Mahuida Provincial Reserve, Auca Mahuida Hill, 2212 m (37.73928°S, 68.92375°W), 3.xii.2016, S. Roig, R. Carrara, G. Flores, M. Roig-Cerdeño and G. Zalazar col. (IADIZA); 43♂, 54♀, Auca Mahuida Provincial Reserve, Auca Mahuida Hill, 1913 m (37.73814°S, 68.90296°W), 3.xii.2016, S. Roig, R. Carrara, G. Flores, M. Roig-Cerdeño and G. Zalazar col. (IADIZA).

Diagnosis

Margin of pronotum narrow, of equal width along its length, bordered, with three umbilicate setae on each side; elytra smooth, with striae indistinct, without setae in intervals 3, 5, 7; male protarsomeres 1–2 without adhesive setae; median lobe of aedeagus with a ventral groove that does not open laterally, and a conical ventral tooth; median lobe straight in dorsal view; apex of median lobe spatulate; internal sac without tooth; spermatheca and oviduct joining together at base of oviduct; bursa copulatrix sclerotised basally.

Description

Habitus as in Fig. 24.

Length. 19.1–22.5 mm.

Colouration. Black; with mouthparts, antennae and legs testaceous, dark reddish.

Head. Clypeus with two subparallel lateral sulci slightly developed; supraorbital sulcus complete, poorly defined; antennomeres 5–10 $3\times$ as long as apical width.

Pronotum. Wider than long (width/length = 1.16), maximum width at apical third; dorsal surface smooth; margin narrow, of equal width along its length; bordered, with a

well-defined channel; apical anterior angles slightly marked; basal foveae faintly impressed, not united centrally and separated from the margin by a convex area; three umbilicate setae on each side, two setae on apical third and one on basal third, all of them on the marginal channel; central longitudinal sulcus slightly developed; basal angles poorly developed, ending before basal margin.

Elytra. Humeral angles rounded; dorsal surface smooth, striae indistinct; ninth interval with 28–36 umbilicate setae.

Legs. Profemora with three or four teeth ventrally; pro-trochanters with one umbilical seta present; male protarsomere 1 $2\times$ as long as apex width ($l/aw = 2.09$); first and second protarsomeres of males without adhesive setae; meso and metatarsomeres long (length of all metatarsomeres/metatibia length = 0.84); male mesotibiae with apical brush of setae.

Abdominal sterna. Visible sterna 3–6 with basal sulcus complete; visible sterna 3–5 with 1–2 central apical setae; last visible sternite with 31–38 lateral umbilicate setae on apical margin.

Male genitalia (Fig. 35, 36). In dorsal view almost straight from base to apex, with apex long and spatulate (Fig. 35, 36) and the lateral apical groove on the right side extended almost the whole length of apex (Fig. 36); median lobe with a deep and wide fovea ventrally, completely closed, not open laterally; left side of ventral groove with a well developed mucro, subtriangular and with its tip not recurved (Fig. 36 – M); apical orifice of median lobe opening on left side, with a small ligula (Fig. 35 – L); internal sac without tooth (Fig. 35), with apical group of free spiculae.

Female genitalia (Fig. 40). Bursa copulatrix with ventral side sclerotised; spermathecal long, slightly curved, with narrow apex, joining the base of bursa copulatrix along with the oviduct; stylomeres short and rounded, with a nematiform seta.

Comparative notes

Baripus (*C.*) *aucamahuida*, sp. nov. is quite similar to *B.* (*C.*) *mendozensis* and *B.* (*C.*) *precordillera* in external morphology and shape of median lobe, but is distinguished from those by having the ventral mucro of median lobe without the tip recurved and by the absence of adhesive setae on male protarsomeres 1 and 2.

Distribution and habitat

The distribution of *B.* (*C.*) *aucamahuida*, sp. nov. is restricted to Auca Mahuida Reserve (Fig. 41, 48). The Reserve lies on a high plateau that starts at 1500-m elevation. In this area there are several volcanic cones, the highest is the Auca Mahuida Volcano, which is 2258 m high (Fig. 49). This plateau is ~170 km east of the Andes Mountains. Ramos and Folguera (2011) considered that this large basaltic shield volcano ranges in age from 0.8 to 2.03 Ma.

The specimens of *B. (C.) aucamahuida*, sp. nov. were collected at different elevations, from 1546-m altitude to the top of the mountain at 2232 m (Fig. 48). These localities correspond to the northern area of the Patagonia Biogeographic Province. The vegetation is typical Patagonian steppe from 1500-m altitude upwards. At the top of the mountains (Fig. 49), there are some high-Andean biotic elements, such as *Calceolaria* sp. (Scrophulariaceae). From 1500 m downwards, there occurs vegetation of the Monte Biogeographic Province. Therefore, Patagonian vegetation is isolated from other Patagonian steppes by Monte vegetation. *Baripus (C.) aucamahuida*, sp. nov. is abundant in the high-altitude habitats of the reserve, since using the same number of pitfall traps (32 pitfall traps for each habitat), we collected 109 specimens between 1920 and 1970 m and 282 at the top of the mountain (up to 2200 m).

Etymology

The name of this new species is related to the area that it inhabits, Auca Mahuida Hill, in Neuquén Province, Argentina.

Supplementary material

Supplementary material is available [online](#).

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Data availability. The data that support this study are available in the article and accompanying online Supplementary material.

Conflicts of interest. The authors declare that they have no conflicts of interest.

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