

Updated catalog of the Chilean wedge-shaped beetles (Coleoptera: Ripiphoridae) with the first records of *Macrosiagon flavipennis* (LeConte) in Chile

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Abstract. The biology and ecology of wedge-shaped beetles (Coleoptera: Ripiphoridae) are scarcely known in the Neotropical realm. Chilean species of this beetle family are currently represented by two genera: *Macrosiagon* Hentz, 1830 and *Ripiphorus* Bosc, 1791, and three species, only known from their type localities. Here, we present an updated catalog of Chilean Ripiphoridae, along with the new distributional and biology records. Also, *Macrosiagon flavipennis* LeConte, 1866 (Ripiphorinae: Macrosiagonini) has been reported for the first time in Chile. We discuss the reasons for the presence of *M. flavipennis* in urban areas, the state of knowledge of the endemic species presents in Chile in relation to their distribution and the opportunity to use opportunistic records to better understand their natural history.

Keywords. *Macrosiagon gayi*, *Macrosiagon vittata*, Macrosiagonini, *Ripiphorus valdivianus*, Ripiphorinae.

INTRODUCTION

The Ripiphoridae is a parasitoid beetle family composed of five subfamilies (Hemirhipidiinae Heller, 1921; Pelecotominae Seidlitz, 1875; Ptilophorinae Gerstaecker, 1855a; Ripidiinae Gerstaecker, 1855a, and Ripiphorinae Gemminger, 1870 in Gemminger & von Harold, 1870), represented by 41 genera and close to 400 species worldwide (excluding Antarctica; Lawrence *et al.*, 2010; Falin & Engel, 2014; Barclay, 2015). Ripiphoridae is phylogenetically near to the Mordellidae beetle family, discarding their relationship with Meloidae (Batelka *et al.*, 2016). Adults are frequently found feeding on flowers of different families (Ulysséa & Albertoni, 2020), whereas larvae are characterized by parasitizing (both as ectoparasitoids and endoparasitoids) different hosts, such as beetles (Pelecotominae and Hemirhipidiinae) or cockroaches (some Ripidiinae species), although Ripiphorinae larvae develop in

Hymenoptera nests (Auko *et al.*, 2014; Ulysséa & Albertoni, 2020).

Ripiphoridae beetles are scarcely collected in Neotropical Region and most of the information on their biology remains unknown. The Neotropical Region only contains twelve genera (*Ancholaemus* Gerstaecker, 1855b; *Elytroxystrotus* Manfrini de Brewer, 1963; *Ivierhipidius* Barclay, 2015; *Macrosiagon* Hentz, 1830; *Micholaemus* Viana, 1971; *Neorrhypidius* Viana, 1958; *Pirhidius* Besuchet, 1956; *Quasiriphidius* Zaragoza-Caballero, 1991; *Quasiriphidius* Zaragoza-Caballero, 1991; *Ripiphorus* Bosc, 1791; *Trigonodera* Dejean, 1834, and *Zaragozapirhidius* Vega-Badillo *et al.*, 2022) and one-third of the extant species approximately (Costa, 2000; Barclay, 2015; Batelka & Chaboo, 2015). Some countries such as Peru or Brazil have recently published updated catalogs, incorporated new records, summed new species and new information on their biology (Barclay, 2015; Batelka & Chaboo, 2015; González

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& Juárez, 2016; Ulysséa & Albertoni, 2020). Ripiphoridae in Chile has been scarcely collected and so far, represented by two genera and three species: *Macrosiagon gayi* (Gerstaecker, 1855b); *Macrosiagon vittata* (Erichson, 1847), and *Ripiphorus valdivianus* (Philippi, 1861) (Elgueta & Arriagada, 1989; Elgueta, 2000; Falin, 2004). As in other countries of the region, the biology of these beetles is virtually unknown (Elgueta & Arriagada, 1989). Here, we present an updated catalog of the Chilean species with new distribution and biology records as well as a key to Chilean Ripiphoridae species. We have also reported for the first time the presence of *Macrosiagon flavipennis* (LeConte, 1866) in Chile.

MATERIAL AND METHODS

Study sites and collect

Individuals of *M. flavipennis* were collected by hand and photographed in Arica city (18°28'42"S, 70°19'16"O), which is the greater urban area located at the coast of Northern Chile, near the border with Peru. The ecosystem is found within the subtropical climate with scarce vegetation such as cacti, and seasonal native herbs like *Nolana* L. ex L.F., *Tetragonia* L., *Cistanthe* Spach, or *Solanum* L. (González & Molina, 2017). Inside the city, parks and gardens are composed mainly of exotic flora, which attracts many native flower-visitors as carpenter bees, oil-collecting bees, or native wasps and exotic Hymenoptera (Aguilera, 1968; Barrera-Medina & Sepúlveda-Osorio, 2014; R. Barahona-Segovia pers. obs.). Ripiphorid individuals also were photographed with a Samsung Galaxy smartphone S21+.

Similarly, new records of *R. valdivianus* individuals were collected by hand and photographed with a Nikon D7500 camera equipped with Tamron 90 mm f/2.8G and with Nikon 40 D7500 camera also equipped with Raynox DCR 150 mm lens. Finally, *M. gayi* individuals were captured from several localities, always by hand or using entomological net, stored in 90% alcohol and then, pinned.

To ensure morphological identification of the collected individuals and photos, we follow the description according to Philippi (1861) for *R. valdivianus*, Solier (1851) for *M. gayi*, and key species and description of Rivnay (1929) and Vaurie (1955) for *M. flavipennis*.

Structure of the catalog

Subfamilies, genera and species are listed alphabetically. After the name of each species, old denominations are also provided. The material type subsection presents as follows: type kind when is available (e.g., holotype, allotype), type-specimen sex, repository collection of the type, and type locality. New Records in Chile were mainly based on examined material from different collections and were presented by geopolitical regions from North to South. The dataset includes specific location + georeferencing + collector (Leg.) and the acronym of the museum or collection where the specimen is deposited in brackets. Citizen science occurrences of *M. flavipennis*, *M. gayi* and *R. valdivianus* were obtained from a social media group (Facebook) devoted to recording Chilean arthropod biodiversity (<https://web.facebook.com/groups/1566907606922926>). Photos provided by citizen scientist were included as photographic collection and indicated the acronym [CSO]. For this work, we created the section 'bibliography', which contains all pertinent literature per genera, species, their synonyms, or new combinations reported for Chile (for example, "*Macrosiagon gayi* AND Chile" or "*Macrosiagon* AND Neotropics"), which was reviewed on the ISI web of Science, SciELO, as well as Google Scholar. 'Distribution' section shows the geopolitical occurrence of the Chilean Ripiphoridae. Maps were produced with ArcGIS v.10.4.1 (ESRI, 2019). We include the 'Diagnosis' section to highlight the principal morphological characteristics and because the original description for some species is old and poor. The color of individuals was treated and identified with a Munsell table. Finally, we add new interaction records with flowers and natural history in the section 'Biology'.

We used the following acronyms for Ripiphoridae species catalog: males (♂), females (♀), catalog = cat.; description = desc., distribution = dist., and synonyms = syn. All material collected has been stored in: **MCZ** – Museum of Comparative Zoology, New York, USA; **MNHN** – Muséum National d'Histoire Naturelle, Paris, Francia; **MNHNCL** – Museo Nacional de Historia Natural de Santiago de Chile, Chile; **PCFAR** – personal collection of Francisco Ramírez, Las Condes, Chile; **PCVVM** – personal collection of Vicente Villablanca, La Serena, Chile.

RESULTS

Key to Chilean Ripiphoridae species

1. Body length exceeds 1 cm (Figs. 1-2); pronotum entirely black with medial protuberance distally acuminate at posterior margin; elytra black with a transverse yellow stripe at anterior third (Figs. 1-4)
..... *Macrosiagon flavipennis* LeConte
- Total body length, less than 1 cm; pronotum brownish-reddish with black marks, without medial protuberance in the posterior margin; elytra generally reddish or brownish-red with some species with dark areas on humeral and apical parts of elytra..... 2
2. Frons and vertex strongly crenulate; vertex mostly pilose; elytra short, covering 1/3 of the total length of abdomen, most part of wings not completely covered by elytra; fore and middle legs completely brownish-red (Figs. 11-12)..... *Ripiphorus valdivianus* (Philippi)
- Frons and vertex scarcely crenulate or smooth; vertex scarcely pilose or glabrous; abdomen and wings almost entirely covered by elytra; fore and middle legs mostly black..... 3
3. Elytra uniformly brownish-red except humeral part; basal part of metatibiae and first tarsomere of metatarsus generally brownish-red (Figs. 7-9)..... *Macrosiagon gayi* (Gerstaecker)
- Elytra mostly brownish-red, with individuals ranging from black markings on apical and basal area to completely yellow-orange; legs mostly brownish *Macrosiagon vittata* (Erichson)

Catalog of Chilean Ripiphoridae

Superfamily Tenebrionoidea Latreille, 1802

Family Ripiphoridae Laporte, 1840

Subfamily Ripiphorinae Laporte, 1840

Tribe Macrosiagonini Heyden, 1908

Genus *Macrosiagon* Hentz, 1830

Macrosiagon Hentz, 1830: 462. Type species by original designation *Ripiphorus dimidiatus* Fabricius, 1792.

= *Emenadia* Laporte, 1840: 261. Type species by subsequent designation *Mordella flabellata* Fabricius, 1781.

Macrosiagon flavipennis LeConte, 1866, (Figs. 1-4, 6), **new record from Chile**

Rhipiphorus flavipennis LeConte, 1866: 153.

Rhipiphorus abdominalis LeConte, 1866: 154.

Emenadia flavipennis Champion, 1891: 354.

Macrosiagon flavipennis Barber, 1915: 187.

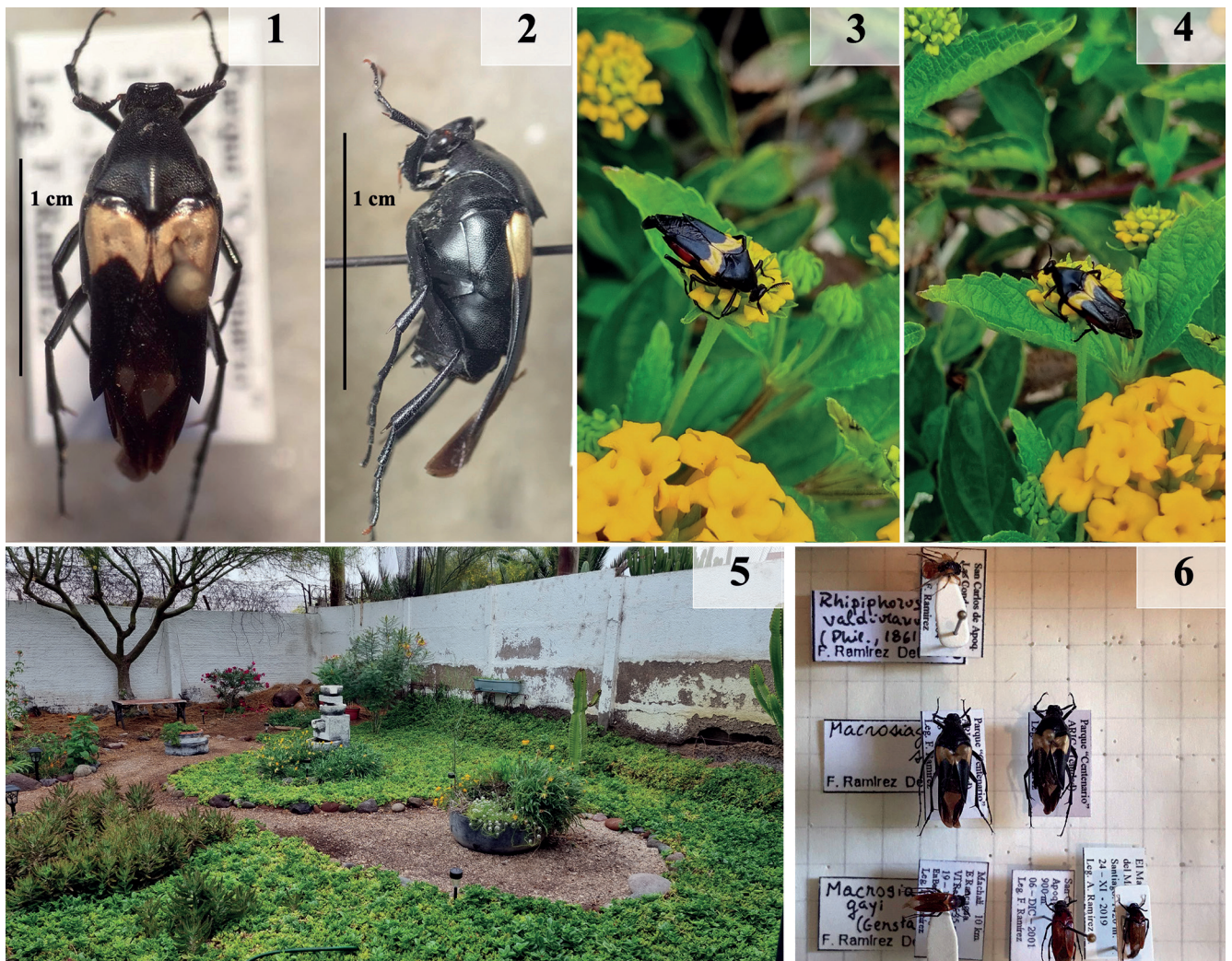
Type material: Male, Holotype at the MCZ. Type locality: Missouri, New York, USA.

New records: Chile: Arica y Parinacota: 1♂ Parque Centenario, Arica, 55 m., 29.xi.1996, Leg. F. Ramírez [MNHNC]; 1♂, Parque Centenario, Arica, 55 m., 29.xi.1996, Leg. F. Ramírez [CFRF]; 1♂, Parque Centenario, Arica, 55 m., 28.iii.1997, Leg. F. Ramírez [CFRF]; 1♀, Rotonda alcalde Manuel Castillo Ibaceta, Arica, 11.xii.2021, Leg. Andrés Puigross [CSO] (<https://www.inaturalist.org/observations/102898136>).

Bibliography: LeConte, 1866: 153 (desc.); LeConte, 1866: 154 (desc. as *R. abdominalis*); Horn, 1874: 121-122 (key, desc.); Champion, 1891: 354 (desc.); Barber, 1915: 187 (parasitizing *Bembix* (= *Bembex*), Fabricius, 1775); Blackwelder, 1945: 480 (cat.); Vaurie, 1955: 6 (key, dist., natural history); Graham et al., 2012: 294 (floral hosts).

Distribution: From the USA to Argentina (Vaurie, 1955) and Northern Chile (present work, Fig. 13).

Diagnosis: *M. flavipennis* is specific by black head and pronotum; concave vertex and a medial protuberance distally acuminate on the posterior margin of the pro-



Figures 1-6. *Macrosiagon flavipennis* (LeConte, 1866): (1) dorsal habitus, male; (2) lateral habitus, male; (3-4) visiting *Lantana* sp., female; (5) urban garden where the female was found in Arica city and (6) individuals collected of *Ripiphorus valdivianus* (Philippi, 1861), *M. flavipennis* and *Macrosiagon gayi* (Gerstaecker, 1855b). Photos by Andrés Puigross and Andrés Ramírez-Cuadros.

notum (Figs. 1-4). Legs entirely black with claws brownish-red. Males of *M. flavipennis* have black abdomen (Figs. 1-2) and females have a brownish-red with dark terminal tergites (Figs. 3-4). The anterior part of elytra usually has a narrow transverse yellow stripe, where the posterior margin is semicircular; the posterior part of elytra is black. Black wings, not covered completely by elytra. Males without hairy pads on the fore protarsi.

Biology: Males were collected in a public park, whereas the female was photographed feeding on *Lantana* (Verbenaceae) and *Gazania* (Asteraceae) (Fig. 5). *Macrosiagon flavipennis* has been recorded parasitizing the cocoon of wasps (Barber, 1915) and visiting plants of the family Lamiaceae (Graham et al., 2012).

Macrosiagon gayi (Gerstaecker, 1855b); Figs. 7-10.

Rhipiphorus gayi Gerstaecker, 1855b: 27.

Rhipiphorus rufipennis Solier, 1851: 275.

Type material: Female, Zoologisches Museum in Berlin, Germany. Type locality: Coquimbo, Chile.

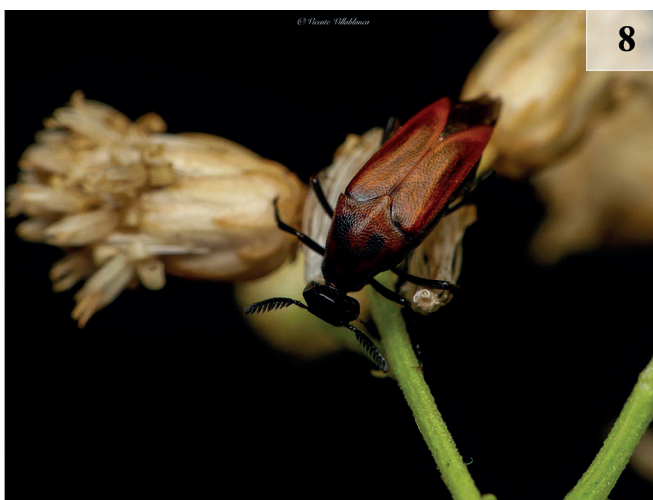
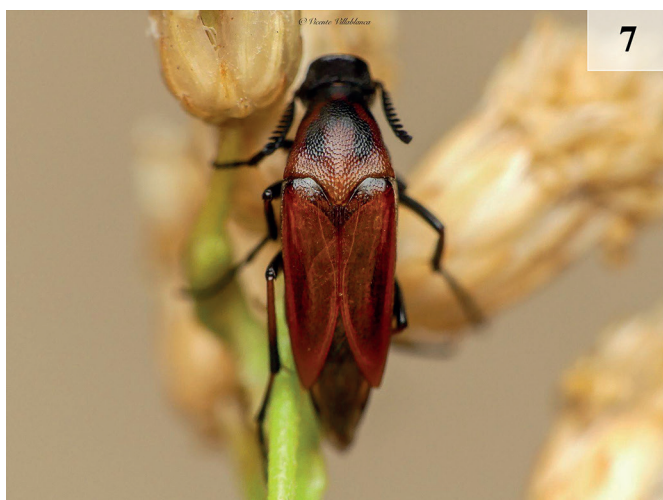
New records: Chile: *Coquimbo:* Pisco Elqui, 16.i.2022, Leg. Vicente Villablanca [CPVVM]; *Metropolitana:* San

Carlos de Apoquindo, Stgo. 900 m, 06.xii.2001, Leg. F. Ramírez [CFRF]; El Manzano, Cajón del Maipo, 1,420 m, 24.xi.2019, Leg. A. Ramírez C. [CFRF]; *O'Higgins:* Machalí, 10 km E. Rancagua, 635 m, 19.xi.2000, Leg. F. Ramírez [CFRF]; Buin, -33.7189°S, -70.7490°W, 11.iii.2022, Leg. José Ignacio C. Martínez [CSO].

Bibliography: Solier, 1851: 275 (desc.), lam. 21, fig. 9; Gerstaecker, 1855b: 27 (desc.); Blackwelder, 1945: 480 (cat.); Elgueta & Arriagada, 1989: 36 (cat.); Rojas & Camousseight, 2010: xlix (cat.); Solervicens, 2015: 283 (cat.); Barreda & Ayala Landa, 2020: 192 (mentioned as possible synonym of *M. multinotata* Pic, 1906).

Distribution: From Coquimbo to O'Higgins (Fig. 12).

Diagnosis: Body is black with deep punctuation (Figs. 7-9). Pronotum with variable colors. Some individuals with anterior margin of pronotum black, with an inverted black 'U' in the middle (Figs. 6-8, 9), the rest of the pronotum is brownish-red. Some specimens present lateral margins and middle of pronotum brownish-red, the black portion of pronotum covering all anterior margin, and posterior part of pronotum brownish-red (Fig. 9). Elytra is entirely brownish-red (Figs. 7-8), except



Figures 7-10. *Macrosiagon gayi* (Gerstaecker, 1855) *in situ*: (7-8) dorsal habitus, (9) male and (10) female in lateral habitus. Photos 7-8 and 10 by Vicente Villablanca; photo 9 by José Ignacio Cabezas Martínez.

the humeral part in some individuals, which is darker (Fig. 9). Wings with anterior parts brownish-red, posterior parts hyaline (Fig. 9). Basal part of metatibia and basal

metatarsomere rufous (Figs. 9-10). The tibial spurs and claws brownish-red (Figs. 9-10). Posterior sternites partly brownish-rufous.



Figures 11-12. *Ripiphorus valdivianus* (Philippi, 1861): (11) frontal view and (12) lateral habitus. Photos by Vicente Valdés-Guzmán and Ricardo Varela-Varela, respectively.

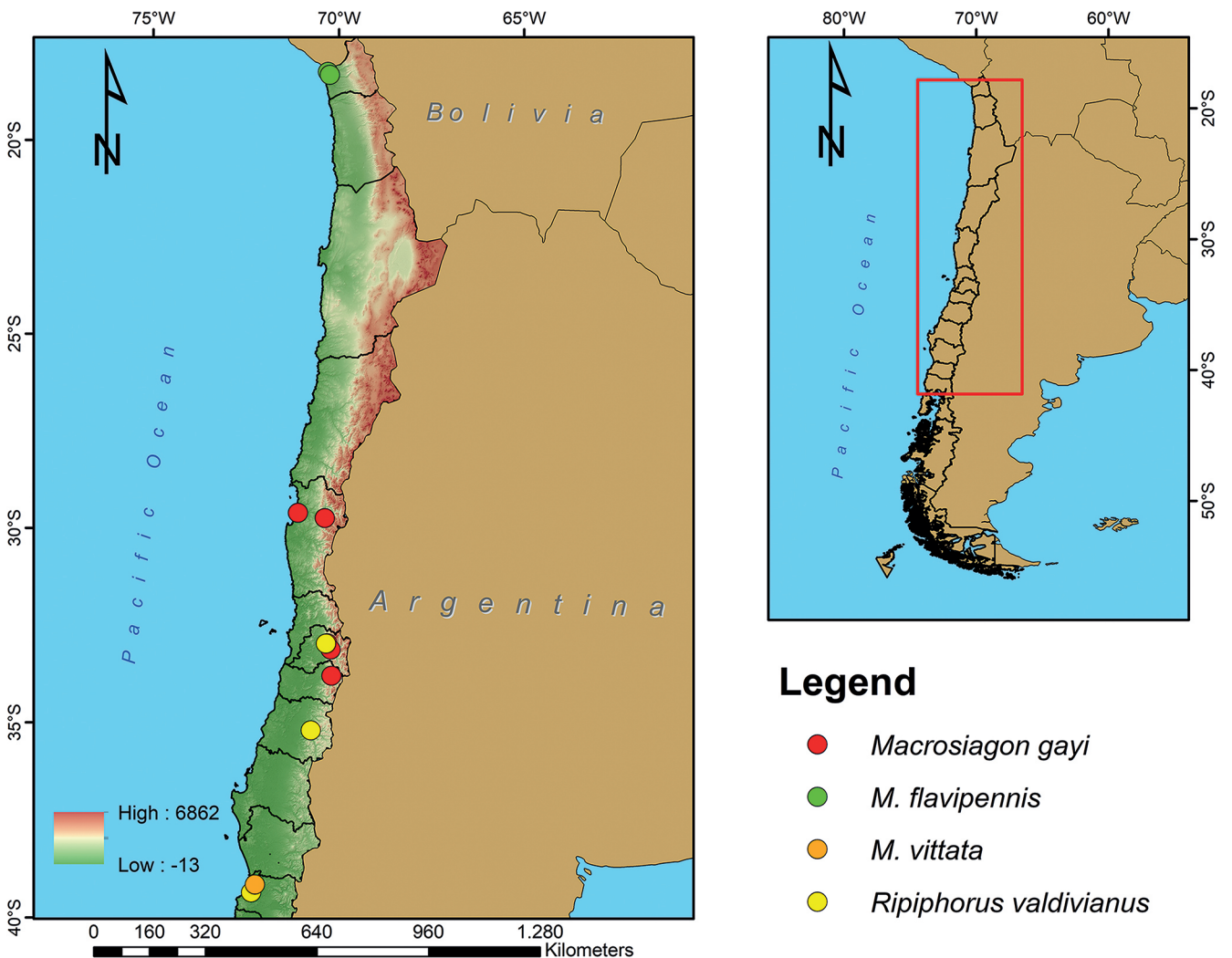


Figure 13. Distribution map of Chilean Ripiphoridae species.

Biology: *Macrosiagon gayi* is endemic to Chile. Individuals described here were collected mainly in Mediterranean ecosystems at different altitudes and they are apparently associated with various plants such as *Baccharis linearis* (Ruiz & Pav.) Pers. or *B. salicifolia* (Ruiz & Pav.) Pers. as well as *Quillaja saponaria* Molina. The hosts remain unknown for this species.

Macrosiagon vittata (Erichson, 1847).
Rhipiphorus vittatus Erichson, 1847: 123.
Rhipiphorus discicollis Gerstaecker, 1855b: 32.
Macrosiagon brasiliensis Pic, 1906: 176.
Macrosiagon vittatus var. *biinterruptus* Pic, 1913: 18.
Macrosiagon vittatus var. *bahiensis* Pic, 1913: 19.
Macrosiagon pectorale Pic, 1923: 15.
Macrosiagon vittatum var. *lateluteum* Pic, 1939: 250.

Type material: Male, cat the MNHN in Paris, France. Type locality: Valdivia, Chile.

Bibliography: Erichson, 1847: 123 (desc. as *Rhipiphorus vittatus*); Gerstaecker, 1855b: 32 (desc. as *Rhipiphorus discicollis*); Lacordaire, 1859: 628 (desc. as *Emenadia vittatus*); Gemminger & von Harold, 1870: 2122 (cat. as *Emenadia vittata*); Pic, 1906: 176 (desc. as *Macrosiagon brasiliensis*); Pic, 1913: 18 (desc. as *Macrosiagon vittatus* var. *biinterruptus*); Pic, 1913: 19 (desc. as *Macrosiagon vittatus* var. *bahiensis*); Csiki, 1913: 17 (cat. as *Macrosiagon vittatum*); Pic, 1923: 15 (desc.); Rivnay, 1929: 39 (desc. as *Macrosiagon discicollis*); Pic, 1939: 250 (desc. as *Macrosiagon vittatum* var. *lateluteum*); Blackwelder, 1945: 480-481 (cat.; mentioned as *M. pectorale*, *M. vittatum* and other syn.); Vaurie, 1955: 15 (desc. as *Macrosiagon discicollis*); Elgueta & Arriagada, 1989: 36 (cat.); Falin, 2004: 13, 15 (mentioned as *M. pectoralis* and syn. of *M. vittata*), fig. 6 (frons, anterior view).

Distribution: From Mexico to Argentina (Falin, 2004). In Chile, only known to Valdivia, Los Ríos region (Fig. 13).

Diagnosis: According to Falin (2004), *M. vittata* resembles *M. mutilata*, except the frontoclypeal margin, which is straight or slightly emarginate, whereas the frontoclypeal margin of *M. mutilata* is strongly notched. Male antennae are bilabellated, whereas those of female are single flabellate. The presence of tibial spurs, the second metatarsomere short and dorsally flattened separate *M. vittata* from other species of the genus (Falin, 2004), except *M. mutilata*. Additionally, *M. vittata* has a wide range of coloration, which caused confusion in entomologists, who described several species from the different variations (Falin, 2004). *Macrosiagon vittata* presents brownish-red to yellow-orange color in pronotum and elytra. Pronotum mostly black with posterior margin yellow-orange. Elytra can have a uniformly brownish-red color or present black maculae in humeral as well as apical margins of the elytra. Legs are entirely brownish.

Biology: *Macrosiagon vittata* is a native species that is widely distributed in the Neotropics. The biology of this

species is scarce. Rozen (1997) identified adults of *M. vittata* parasitizing on *Exomalopsis bruesi* Cockerell, in Peru. There are no new records available.

Taxonomic notes: Falin (2004) concluded that the type specimens of *M. brasiliense* and *M. pectoralis* stored in MNHN, represent color variations of *M. vittata* and therefore, those were synonymized under *M. vittata*.

Tribe Myoditini Gerstaecker, 1855a

Genus *Ripiphorus* Bosc, 1791

Ripiphorus Bosc, 1791: 327. Type species by original designation *Ripiphorus subdipterus* Fabricius, 1792.
= *Myodites* Latreille, 1819: 302.
= *Dorthesia* Say, 1824: 274.

Ripiphorus valdivianus (Philippi, 1861); Figs. 11-12.
Myodites valdivianus Philippi, 1861: 741.
Myodites chilensis Fairmaire & Germain, 1863: 258.

Type material: Allotype at the MNHNCL. Type locality: Valdivia.

New records: Chile: *Metropolitana:* San Carlos de Apoquindo, Las Condes, Santiago, 900 m, 08.xi.2004, Leg. F. Ramírez [CFRF]; *Maule:* Parque Natural Tricahue, Armerillos, Maule, -35.7004°S, -71.1027°W, 27.xi.2021, photos: Ricardo Varela and Vicente Valdés [CSO].

Bibliography: Philippi, 1861: 742 (desc. as *Myodites valdivianus*); Fairmaire & Germain, 1863: 258 (mentioned as *Myodites chilensis*); Blackwelder, 1945: 481 (cat.); Camousseight, 1980: 18 (cat.); Elgueta & Arriagada, 1989: 36 (cat.).

Distribution: From Metropolitan to Los Ríos (Fig. 13).

Diagnosis: Black body with abundant and short brownish pilosity on the head and oral parts. Head with a short projection densely pilose on the vertex (Fig. 11). Frons concave and strongly crenulate (Fig. 11). Flabellate antenna longer than the total height of the head. Elytra very short, brownish-red; metathoracic wings with a wide, transverse, black median band (Fig. 12). Fore and middle legs completely orange reddish with abundant brown pilosity. Posterior legs black, except the dorso-anterior part of the femora, which is orange reddish. Abdomen brownish with some parts darker.

Biology: *Ripiphorus valdivianus* is endemic to Chile. This species was recorded by Philippi (1861) visiting *Eryngium paniculatum* Cav. & Dombey ex F. Delaroché. It has been recently recorded from shrublands dominated by *Fabiana imbricata* Ruiz & Pav. and *Baccharis* surrounded by temperate trees such as *Nothofagus glauca* (Phil.) Krasser and *N. obliqua* (Mirb.) Oerst. (V. Valdés and R. Varela pers. comm.).

DISCUSSION

The genus *Macrosiagon* is the richest genus of wedge-shaped beetles and is widely distributed worldwide (Falin, 2004). Species of *Macrosiagon* have several hosts recorded from aculeate wasps (Crabronidae, Pompilidae, Scoliidae, Sphecidae, Tiphidae, Thynnidae, Vespidae) to solitary bees like Apidae, Halictidae and Megachilidae (Ulysséa & Albertoni, 2020). Here, we report the presence of *M. flavipennis* in northern Chile, a species otherwise commonly found in the southern USA, Mexico and Caribbean Islands, and previously recorded from Argentina (*sensu* Vaurie, 1955). *Macrosiagon flavipennis* is found inhabiting the urban area, feeding on ornamental flowers and could parasitize native or exotic Hymenoptera species. Our records demonstrate that the Chilean population of *M. flavipennis* has been established for many years, but its abundance is considered low compared with other beetle families that visit flowers. Further studies could reveal the biology of this parasitoid (host species and flower visited) as well as its abundance, distribution and environmental data that influence these ecological parameters.

Natural history of the Chilean Ripiphoridae remains unknown (Elgueta & Arriagada, 1989). Although other countries have recently generated important contributions on the hosts of some *Macrosiagon* species (Barreda & Ayala Landa, 2020; Ulysséa & Albertoni, 2020), further fieldwork is needed to better understand the biology of these elusive beetles. Recently, Cid-Arcos & Ramírez-Cuadros (2022) described the biology of *Nemognatha nigrotarsata* (Fairmaire & Germain, 1861), including the first record of triungulin of this species parasitizing primarily on *Diadasia* sp. (Apidae: Emphorini) as the primary vector. On the other hand, *R. valdivianus* belongs to a genus with many species that parasitize Halictidae bees and Apidae (Batelka & Straka, 2011). Some of these bee genera are represented in Chile. They are widely distributed across various ecosystems (Montalva & Ruz, 2010). Therefore, there is a great chance to supplement the presently known distribution and fill the distributional gaps in the Chilean wedge-shaped beetles. Finally, in part, our work presented new distribution information generated by opportunistic records by naturalists and macrophotography. These records are valuable given that they provide other sources of evidence, high-resolution images of the individuals in their natural environment and contribute significantly to the natural history of species from which there is not much information available.

AUTHORS' CONTRIBUTIONS: **RMBS:** conceived the idea, collected the data, and wrote the first draft. **AP, VVG, RVV, ARC:** provided the individuals, photos, dataset, natural history information, and corrections. **LPM:** generates the map and suggestions. All authors contributed equally to the revision of the manuscript and approved their publication.

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