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An update on the knowledge and general understanding of the Chilean Diptera diversity

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Abstract

Chilean flies play an important role in many aspects of phylogeny and evolution of Diptera given their uniqueness and direct link with the Gondwanan insect fauna. Many dipterists have considered the order to be one of the most diverse in Chile, but there are still many gaps of information to fill. This study updates the families, genera, and species known from Chile and addresses the evolutionary origin of most dipteran families—indicating which biogeographical layers they belong to. The taxonomic literature was thoroughly reviewed from 1967 until May 2024. Our investigation revealed a total of 97 families, 930 genera and 4,108 valid species, placing Diptera as one of the most specious insect orders in Chile. The diversity of the Lower Diptera (suborders Tipulomorpha, Psychodomorpha, Culicomorpha, Perissommatomorpha and Bibionomorpha) increased to 111 genera (93.27%) and 1,019 species (136.22%), whereas Brachycera increased to 229 genera (48.61%) and 703 species (50.72%). Specifically, the number of genera and species in the division Aschiza increased by 117.14% and 114.28% respectively, while Acalyptratae increased by 62.24% genera and 63.82% species to date. Finally, the number of genera and species in the Calyptratae increased by 31.05% and 50%, respectively. The family Neriidae is newly recorded for Chile and the species *Telostylinus lineolatus* (Wiedemann) is reported from Easter Island. We present age hypotheses of clades in Chile belonging to 60 families—of which 16 correspond to Cretaceous- and 46 to Cenozoic-, and a small number to Jurassic-elements. Finally, we address three major gaps for a more robust development of Diptera systematics in Chile: (1) lack of long-term systematic sampling, (2) taxonomic, spatial, and temporal biases for Diptera diversity and (3) poor understanding of biological and ecological processes related to Diptera facing advances in anthropogenic impacts across the country.

Key words: Acalyptratae, Biodiversity, Brachycera, Calyptratae, citizen science, Lower Diptera, Orthorrhapha, Schizophora

Resumen

Los Diptera de Chile son clave para muchos aspectos de la filogenia y evolución del orden, principalmente debido a su singularidad y vínculo directo con especies de origen Gondwánico. Diversos dipterólogos consideran que este orden es uno de los más diversos de Chile, pero aún quedan muchos vacíos por llenar. Este estudio actualiza las familias, géneros y especies conocidas en Chile y aborda el origen evolutivo de la mayoría de las familias de dípteros, indicando a qué capas biogeográficas pertenecen. La literatura taxonómica fue revisada minuciosamente desde 1967—cuando se comenzó a publicar el "Catalogue of the Diptera of the Americas South of the United States"—hasta mayo de 2024. Desde 1967 a la fecha, se encontraron un total de 97 familias, 930 géneros y 4.108 especies válidas, lo que ubica a los Diptera como uno de los órdenes de insectos con mayor riqueza de especies en Chile. La diversidad de los Dípteros Inferiores (subórdenes Tipulomorpha, Psychodomorpha, Culicomorpha, Perissommatomorpha y Bibionomorpha) aumentó en 111 géneros (93,27%) y 1.019 especies (136,22%), mientras que Brachycera aumentó en 229 géneros (48,61%) y 703 especies (50,72%). En concreto, la división Aschiza aumentó sus géneros y especies en un 117,14% y un 114,28% respectivamente, mientras que Acalyptratae aumentó en un 67,24% los géneros y en un 63,82% las especies. Finalmente, Calyptratae aumentó sus géneros y especies en un 31,05% y 50%, respectivamente. La familia Neriidae es un nuevo registro para Chile y se reporta la especie *Telostylinus lineolatus* (Wiedemann) para Isla de Pascua. Presentamos la hipótesis de la edad de clados en Chile perteneciente a 60 familias, de los cuales 16 corresponden claramente a elementos faunísticos originados en el Cretácico y 46 corresponden a elementos del Cenozoico, con un pequeño número de elementos jurásicos. Después de discutir las implicaciones taxonómicas de nuestra revisión, seguimos tres brechas principales para un desarrollo más sólido de la sistemática de Diptera en Chile: (1) falta de muestreo sistemático a largo plazo, (2) sesgos taxonómicos, espaciales y temporales para la diversidad de Diptera y (3) escasa comprensión de los procesos biológicos y ecológicos relacionados con los dípteros frente a los avances en los impactos antropogénicos en todo el país.

Palabras claves: Acalyptratae, Biodiversidad, Brachycera, Calyptratae, ciencia ciudadana, Diptera inferiores, Orthorrhapha, Schizophora

Introduction

Diptera is one of the four largest and most dominant orders of holometabolous insects. It has been suggested that they may represent 10–15% of all known living animal species (Yeates & Wiegmann 2005; Yeates *et al.* 2007), but a more recent inference by Hebert *et al.* (2016) projects an ever-greater participation of Diptera diversity among megadiverse insect orders. Diptera are distributed in all zoogeographical regions of the planet (Yeates & Wiegmann

2005; Pape & Thompson 2022; Evenhuis & Pape 2024), including Antarctica, where specialized chironomids such as *Belgica antarctica* Jacobs and *Parochlus steinenii* (Gerke), have been found (Convey & Block 1996; Kelley *et al.* 2014). Flies are morphologically and functionally diverse, and include species that have colonized terrestrial, freshwater, and marine ecosystems (except open ocean and abyssal zone). They consume a wide variety of available resources, such as plant tissues, decaying organic matter, and predating or parasitizing other animals (Courtney *et al.* 2017), thus playing key roles in diverse ecosystems (Raguso 2020).

There are over 160,000 described species of Diptera grouped, depending on the classification, in 8–10 infraorders, 22–32 superfamilies, 150–180 families, and more than 10,000 genera to which, must be added some 4,000 fossil species (Pape *et al.* 2011; Courtney *et al.* 2017). Traditional classifications divided the order into two suborders, the "Nematocera" (knowingly paraphyletic) and Brachycera. However, a classification considering the phylogenetic system recognizes six major groups with suborder ranks: Tipulomorpha, Psychodomorpha, Bibionomorpha, Perissommatomorpha, Culicomorpha, and Brachycera (Amorim & Yeates 2006). Moreover, the diversity of Diptera is expected to be greater as cryptic groups and obscure taxa become better known (Marshall 2012).

One of the most essential taxonomic tools to categorize biodiversity are catalogs of families or orders, which provide the pertinent information to assess each name. The most complete catalogs include information such as year of description of the genera and species, location of primary types, synonyms, published illustrations, distribution, and references to keys and to additional publications for each of the species included.

The Neotropical realm includes more than 31,000 described species of Diptera grouped into over 3,600 genera (Brown *et al.* 2009); however, these numbers are not updated and the real number of species are at least five times the number known today (Amorim 2009a). The "Catalogue of the Diptera of the Americas South of the United States" (CDASUS) was a global effort to compile Neotropical Diptera information, building upon the early work by Hunter (1900–1901). The CDASUS followed the structure proposed in "A Catalog of the Diptera of America North of Mexico" (Stone *et al.*1965). The CDASUS was coordinated by Dr. Nelson Papavero (Brazil), with the participation of different specialists, who updated their knowledge on Neotropical Diptera between 1966 and 1984. Since then, the information of the Neotropical fauna of Diptera has been partially updated by country-wide (Wolff *et al.* 2016) and world catalogs (Mathis & Suyeoshi 2011; Evenhuis 2015; Gagné & Jaschhof 2021; Oosterbroek 2023), as well as assessments of various families (Amorim 1992; Amorim 2009b; Coscarón & Papavero 2009a, b; Mello & Pereira-Colavite 2018),

The diversity of Diptera in Chile was addressed by Reed (1888), which included 41 families and 716 species, and by Stuardo (1946), which included 68 families and 2,143 species. Subsequently, the series of fascicles published by the British Museum of Natural History between 1929 and 1948 under the title "Diptera of Patagonia and South Chile", are not formally a catalog and corresponds to an overview of the fauna of southern Chile and Argentina. The fascicles of CDASUS validated the presence of 86 families, 752 genera, and almost 3,000 species reported in Chile (González 1995, 2008). For the Chilean fauna of flies, there are examples of catalogs for some families, such as Tabanidae in Kröber (1934), and Culicidae in Stone *et al.* (1959), Acroceridae, Hybotidae, Brachystomatidae and Pyrgotidae in González *et al.* (2018, 2020, 2021a, b) and Syrphidae in Barahona-Segovia *et al.* (2021b).

This paper aims to provide an update to the knowledge of the Diptera of Chile since the publishing of the CDASUS. This update consists of a checklist of all fly families presented in Chile and following the scheme of Brown *et al.* (2009) (see details in materials and methods). The update also incorporates a brief description per family, with the main contributions to Chilean Dipterofauna by different authors as well as an update of the valid genera and fly species to date. We also summarize the information available on zoogeographical patterns for the fly fauna (families and some genera as examples) regarding the geological layers where these fly groups originated. Summary tables and plates of the fly species present in Chile are also provided.

Material and Methods

Information search

To update the knowledge about the diversity of the Diptera of Chile, we used CDASUS as a baseline by family, mostly following the classification scheme based on Stone *et al.* (1965). Our search extended from the year of publication of the first CDASUS fascicle until May 2024. Additionally, we revised the information in CDASUS by analyzing the works of Philippi (1865), Reed (1888), Hunter (1900–1901), Kertész (1902–1910), and Stuardo

(1946), as well as the fascicles of "*Diptera of Patagonia and South Chile*". To provide an up-to-date synopsis of each family with information on genera and species, we used regular database search engines (e.g., Web of Science, Google Scholar, and Scielo) combining keywords such as "family name AND Chile" (e.g., Rangomaramidae AND Chile) or "genus AND Chile OR author name + year of publication" (e.g., *Stibadocerina* AND Chile OR Ribeiro 2009). This provided synonymies, references and potential new families or species reported for Chile. When some species were synonymized, changed genus or family over time, we turned to Systema Dipterorum to validate these changes (Pape & Thompson 2020; www.diptera.org).

Structure of the review

We follow the taxonomic ordering scheme proposed by Brown *et al*. (2009) to make a comparison with the classification used in CDASUS. For suborder, infraorder, or family level, phylogenetic studies that modified the initial systematic position were searched (*i.e*., Wiegmann *et al.* 2011) using keywords such as "family AND phylogeny". For each taxon above the family rank, we included the number of genera and species present in Chile, highlighting taxonomic and phylogenetic contributions or catalogs involving Chilean species. A discussion of the biogeographical composition of the Diptera fauna in Chile is addressed herein.

Results

Chilean Diptera are taxonomically arranged into six suborders, three infraorders, four sections (Homeodactyla, Heterodactyla, Eremoneura and Cyclorrhapha), 17 superfamilies, and three divisions (Aschiza, Schizophora—Acalyptratae, and Schizophora—Calyptratae), summing up a total of 97 families, 930 genera and 4,108 species until May 2024 (Tables 1–5).

TABLE 1. Number of genera and species of the suborders Tipulomorpha, Psychodomorpha, Culicomorpha, Perissommatomorpha and Bibionomorpha treated as suborder Nematocera in CDASUS and to date in Chile, follows Amorim & Yeates (2006) and Brown *et al*. (2009). For each fly family, the percentage increase (+) or decrease (–) in the number of genera and species is shown. A symbol (-) is presented when the family was added, no new genera or species were described, and it was synonymized or removed for the Dipterofauna of Chile after the publication of CDASUS.

Family	N° genera CDASUS	N° species CDASUS	N° genera 2024	N° species 2024	genera (%)	species (%)
Tipulidae *s.l.*[a]	30	397	44	507	+46.66	+27.70
Trichoceridae	-	-	4	9	-	-
Blephariceridae	2	8	2	8	-	-
Psychodidae	4	16	13	41	+225	+156.25
Tanyderidae	2	2	3	4	+50	+100
Ceratopogonidae	9	31	17	63	+88.88	+103.22
Chironomidae	-	-	52	181	-	-
Culicidae	-	-	3	12	-	-
Dixidae	1	4	1	4	-	-
Perissommatidae	1	1	1	1	-	-
Simuliidae	4	25	8	46	+100	+84
Thaumaleidae	1	4	2	16	+100	+200
Anisopodidae	3	5	3	5	-	-
Bibionidae	8	31	2	33	–25	+6.45
Canthyloscelidae	-	-	1	2	-	-
Cecidomyiidae	17	20	17	30	-	+50
Ditomyiidae	-	-	2	10	-	-
Keroplatidae	4	20	5	25	+25	+25

......*continued on the next page*

TABLE 1. (Continued)

Family	N° genera CDASUS	N° species CDASUS	N° genera 2024	N° species 2024	genera (%)	species (%)
Mycetophilidae	26	169	35	739	+34.61	+337.27
Hyperoscelidae[b]	1	3	-	-	-	-
Rangomaramidae	-	-	3	13	-	-
Scatopsidae	5	9	8	8	+60	–11.1
Sciaridae	-	-	4	10	-	-
Diadocidiidae[c]	3	3	-	-	-	-
Total	**119**	**748**	**230**	**1767**	**+93.27**	**+136.22**

[a]Tipulidae *s.l.* + Limoniidae + Cylindrotomidae + Pediciidae; [b]Now in Canthyloscelidae; [c]Currently the genus *Heterotrichia* Loew under Sciaroidea and *Pterogymnus* Freeman under Bibionomorpha (Pape & Thompson 2020).

1. Suborder Tipulomorpha

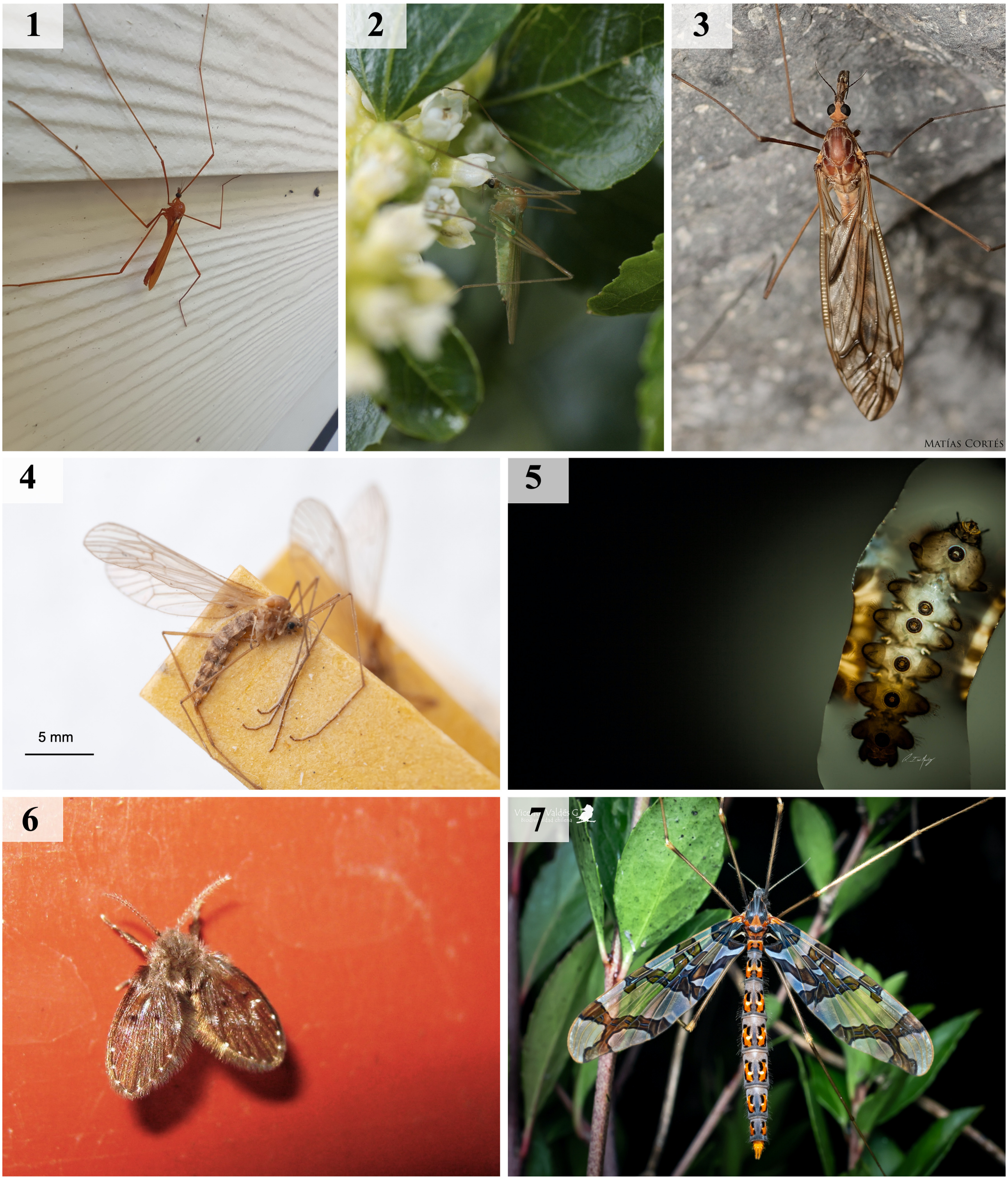
The monophyly of this suborder is supported by the presence of a V-shaped transverse suture on the scutum, vein A_2 very short and submarginal vein no longer than A_1 (Lukashevic & Ribeiro 2019). Although some studies support this suborder as being composed of Cylindrotomidae, Limoniidae, Pediciidae, Tipulidae, and Trichoceridae (Kang *et al.* 2017; Lukashevic & Ribeiro 2019), we follow schematic proposition according to Brown *et al.* (2009).

Tipulidae *sensu lato* (Figs. 1–3)
The family comprises more than 15,246 species in four subfamilies and 212 genera worldwide (Oosterbroek 2023). Much of the knowledge on the Tipulidae of Chile is due to Charles P. Alexander who published several works on Chilean species (e.g., 1928, 1945, 1968). For Cylindrotominae, Ribeiro (2009) redescribed the only species cited for the country, *Stibadocerina chilensis* Alexander, while that for Pediciinae is described one genus: *Tryciphona* with eight species. For Limoniinae, some works have been conducted by Santos & Ribeiro (2018) and Santos *et al.* (2019), and currently 400 species into 36 genera are known for the family in Chile (Oosterbroek 2023). For the Tipulinae, Ribeiro (2007) and de Jong (1989) contributed to the knowledge of the subfamily. 98 species in six genera have been cited for Chile (two of them are monotypic): *Elnoretta* Alexander, *Euvaldiviana* (Alexander), *Ischnotoma* Skuse, *Leptotarsus* Guérin-Méneville, *Tipula* Linnaeus and *Valdiviana* Alexander (Oosterbroek 2023).

Trichoceridae (Fig. 4)
The family comprises more than 160 extant species worldwide, grouped into two subfamilies and six genera (Krzemińska 2021). Studies by Krzemińska & Young (1992) have contributed to the knowledge of this family in Chile with eight species grouped into the genera *Nothotrichocera* Krzemińska, *Trichocera* Meigen and *Zedura* Krzemińska. Recently, *T. maculipennis* has been reported for the first time in Navarino Island and Punta Arenas city, adding a new invasive species for the Chilean territory (Contador *et al.*, 2024).

2. Suborder Psychodomorpha

Bertone *et al.* (2008) and Wiegmann *et al.* (2011) recovered this suborder composed of Blephariceridae, Psychodidae, and Tanyderidae using molecular and morphological analysis to estimate relationships among families. Brown *et al.* (2009) follow Wood & Borkent (1989) and include Psychodidae, Trichoceridae, Perissommatidae, Anisopodidae, Scatopsidae, and Canthyloscelidae, based on larval features (head capsule and mouthparts, mandibular movement, maxillary palps, for example). This arrangement differs from that proposed by Hennig (1973), which was based on the shared coalescence of meron with katepimeron.



FIGURES 1–7. Tipulomorpha and Psychodomorpha of Chile: (1) *Sigmatodera maiae* (Alexander) (Limoniidae, photo by Ignacio Torres); (2) cf. *Geranomyia valida* (Loew) (Limoniidae, Photo by Claudio Arancibia); (3) *Ischnotoma* (*Ischnotoma*) *decorata* (Philippi) (Tipulidae; Photo by Matías Cortés); (4) *Nothotrichocera* cf. *chiloe* Krzeminska & Young (Trichoceridae; Photo by Ricardo Varela); (5) larvae of *Edwardsina* sp. (Blephariceridae, photo by R. I. Madriz); (6) *Clogmia albipunctata* (Williston) (photo by Ani Mari), and (7) *Tanyderus pictus* Philippi (Tanyderidae, photo by Vicente Valdés).

Blephariceridae (Fig. 5)
The family comprises 330 species, grouped into two subfamilies and 30 genera (Courtney *et al.* 2017), the Edwardsininae being restricted to the southern hemisphere (Marshall 2012). Hogue (1971) made the only contribution to knowledge of this family in Chile. Eight species into two genera, *Paltostoma* Schiner and *Edwardsina* Meigen (Hogue 1971), are referred to for Chile.

Psychodidae (Fig. 6)
The global fauna of Psychodidae comprises over 2,500 species, divided among 144 extant genera and grouped into six subfamilies (Wagner & Ibáñez-Bernal 2009; Kvifte & Wagner 2017). In Chile, 41 extant species are recognized in 13 genera from five subfamilies (Elgueta & Jezek 2014).

Tanyderidae (Fig. 7)
The family comprises 39 species assigned to 10 genera worldwide (Madriz *et al.* 2018). In Chile, the diversity of this group is composed of four species divided among three genera: *Araucoderus gloriosus* (Alexander), *Neoderus patagonicus* (Alexander), *N. chonos* Madriz, and *Tanyderus pictus* Philippi. Biological notes and ecology for *A. gloriosus, N. chonos*, and *T. pictus* were provided by Lukashevich & Shcherbakov (2016), Madriz & Courtney (2016), Madriz *et al.* (2018), and Barahona-Segovia *et al.* (2023b).

3. Suborder Culicomorpha

Culicomorpha is a monophyletic group based on the following synapomorphies: metathoracic leg sheath bent in an S-shape, male pedicel enlarged and globular, antennal flagellum of male plumose, and aedeagus membranous (Lambkin *et al*. 2013). The Culicomorpha includes eight extant families that includes most species of blood-sucking lower flies and many other important vectors of pathogens (Zhang *et al.* 2019). Ceratopogonidae, Thaumaleidae and Simuliidae are considered sister group of other Culicomorpha families, with Dixidae at the base of the remaining four Culicomorpha families (Zhang *et al.* 2019). Six families (Ceratopogonidae, Chironomidae, Culicidae, Dixidae, Simuliidae and Thaumaleidae) are present in Chile.

Ceratopogonidae (Fig. 8)
This family comprises 6,206 species, grouped into three subfamilies and 112 genera (Borkent & Dominiak 2020). Several studies (Ronderos & Spinelli 1993; Spinelli & Ronderos 2001; Marino & Spinelli 2001, 2003; Spinelli & Grogan 2001, 2003; Spinelli *et al.* 2010, 2013, 2015; Díaz *et al.* 2011; Cazorla & Spinelli 2012, 2014) contributed new faunistic records of biting midges and descriptions of new species for Chile. Currently, 63 species grouped into 17 genera are cited for Chile (Borkent & Dominiak 2020).

Chironomidae (Fig. 9)
The family comprises more than 6,000 species, grouped into 11 subfamilies and 540 extant genera (Spies *et al.* 2009; Ekrem *et al.* 2017), of which, 10 subfamilies have been recorded in the Neotropical Region. The family was not published in the series of the CDASUS. The subfamily Chilenomyiinae is known only from the *Nothofag*us forest of southern Chile with only one species, *Chilenomyia paradoxa* Brundin. The genera *Dicrotendipes* Kieffer and *Nandeva* Wiedenbrug, Reiss *et* Fittkau were cited by Contreras-Lichtenberg (1994) and Wiedenbrug *et al.* (1998) to Chile for the first time, respectively. In addition, these latter genera and the species *Macropelopia* (*Bethbilbeckia*) *chilensis* Andersen (Andersen 2018) were not included in the world catalog of chironomids by Ashe & O'Connor (2009, 2012a, b, c). Other studies of chironomids in Chile were developed by various specialists, e.g., Andersen (1996) described new *Monodiamesia* Kieffer species from southern Chile; Andersen *et al*. (2011) described *Nandeva digitifer* Andersen, Saether *et* Contreras-Ramos, while Wiedenbrug *et al*. (2013) described two new species of *Thienemaniella* Kieffer: *T. biobio* Wiedenbrug Wiedenbrug, Lamas *et* Trivinho-Strixino and *T. manihuales* Wiedenbrug, Lamas *et* Trivinho-Strixino. Cranston & Krosch (2015) added the subgenera *Araucanopsis* and described the new species *Podonomopsis* (*Araucanopsis*) *avelasse* Cranston & Krosch. The genus *Apelidium* and the species *A. griseistriatum* Edwards were added by Donato *et al.* (2015). The revision of the genus *Pentaneura* Phillipi was conducted by da Silva & Ferrington (2018) with the revalidation of *P. cinerea* (Philippi). Finally,

Andersen *et al.* (2024) added a new species of *Riethia* to the Chilean fauna. A total of 185 (morpho)species in 57 genera are currently known from Chile (Andersen *et al*. 2011; Ashe & O'Connor 2009, 2012a, b, c; Wiedenbrug *et al*. 2013; Cranston & Krosch 2015; Donato *et al.* 2015; da Silva & Ferrington Jr. 2018; Andersen *et al.* 2024).

FIGURES 8–13. Culicomorpha and Perissommatomorpha of Chile: (8) *Forcipomyia* sp. (Ceratopogonidae, Photo by Matías Gargiulo); (9) Chironomidae (photo by Matías Gargiulo); (10) *Aedes* (*Ochlerotatus*) *albifasciatus* (Macquart) (Culicidae, photo by Claudio Maureira); (11) *Cnesia* sp. (Simuliidae, photo by Claudio Maureira); (12) *Gigantodax brophyi* (Edwards) (Simuliidae, photo by Claudio Maureira), and (13) *Perissoma* cf. *congrua* (Perissommatidae, photo by Claudio Maureira).

Culicidae (Fig. 10)
Worldwide, the family comprises more than 3,580 species, grouped into two subfamilies and 113 genera (Harbach 2022). The taxonomy of the family has remained relatively stable although several changes have been made in the subfamily Anophelinae based on molecular data (Foster *et al.* 2017). Different works, such as González & Sallum (2010) and González *et al.* (2015, 2017a, 2023b), have contributed to the knowledge of the family in Chile, for which three genera (*Aedes* Meigen, *Anopheles* Meigen, and *Culex* Linnaeus) and 12 species are cited (González *et al.* 2016).

Dixidae
The family comprises 180 extant species, grouped into three subfamilies and eight genera (Borkent 2009). For Chile, only the genus, *Nothodixa* Edwards and four species: *N. atrovittata* (Edwards), *N. chilensis* (Alexander), *N. ensifera* (Edwards), and *N. nitida* (Edwards) are cited. There are no recent taxonomic studies on the family.

Simuliidae (Figs 11–12)
This family comprises 2,384 extant species in 31 genera and 48 subgenera (Adler 2022) into two subfamilies, Parasimuliinae and Simuliinae (de Moor 2017). Knab (1914) and Silva (1917) made the first contributions to the study of Simuliidae fauna from Chile. Subsequently, Coscarón (1976a), Coscarón & Matta (1982), Coscarón (1985), and Coscarón & Wygodzinsky (1989) studied simuliids in the north and south of the country, describing genera and species. For Chile, 46 species in eight genera are mentioned (Adler 2022), with no more recent taxonomic treatments on the family.

Thaumaleidae
The family comprises 200 extant species in seven genera (Pivar *et al.* 2020, 2021; Sinclair *et al.* 2022). It is represented in Chile by 16 species in two genera: *Austrothaumalea* Tonnoir, with a species recently described, *A. fredericki* Pivar (Pivar *et al.* 2020) and *Niphta* Theischinger with nine species recently described from southern Chile (Pivar *et al.* 2021).

4. Suborder Perissommatomorpha

There is quite a controversy about the position of the Perissommatidae. It has been placed in a small clade with Axymyiidae and Pachyneuridae (Hennig 1973), in the Psychodomorpha (Wood & Borkent 1989), in a "Psychodomorpha grade" connected to the Brachycera (Oosterbroek & Courtney 1995), left as "*incertae sedis*" in Bertone *et al.* (2008), or placed as sister to all Neodiptera (Wiegmann *et al.* 2011). We use here Pape *et al.*'s (2011) classification, with this family in a separate suborder (together to the fossil family Boholdoyidae Kovalev).

Perissommatidae (Fig. 13)
This small family contains only five extant species of the genus *Perissomma* Colless (Colless 1962, 1969). Only *Perissomma congrua* Colless has been reported for Chile and there are no more recent taxonomic studies on the family.

5. Suborder Bibionomorpha

According to Hennig (1973), two synapomorphies support the monophyly of the Bibionomorpha: conspicuous enlargement of the second latero-tergite, and an undivided postphragma of the thorax. Fitzgerald (2004) considered the presence of dorsal sclerite and ventrolateral apodemes as synapomorphies for this suborder. The family composition of Bibionomorpha remains controversial. Wood & Borkent (1989) disagreed with Hennig (1973) and removed the Scatopsoidea from the group based on larval features, and placed it in the Psychodomorpha. This was supported by Amorim (1994, 2000), and Amorim & Grimaldi (2006) based on thoracic pleural features. More recently, Bertone *et al*. (2008) and Wiegmann *et al*. (2011), based on molecular data, and Lambkin *et al.* (2013), based on morphological data, moved the Scatopsoidea back to the Bibionomorpha. There are also problems with the position of Axymyiidae placed as the sister group to Bibionomorpha *s.str.* or in a clade with Pachyneuridae and Perissommatidae (Amorim 1993) or grouped with Culicomorpha (Ševčík *et al.* 2016). Both these families have the plesiomorphic forked R_{2+3}, which is not forked in Anisopodidae and Cramptonomyiidae (with R_{2+3} entirely lost in all remaining Bibionomorpha families).

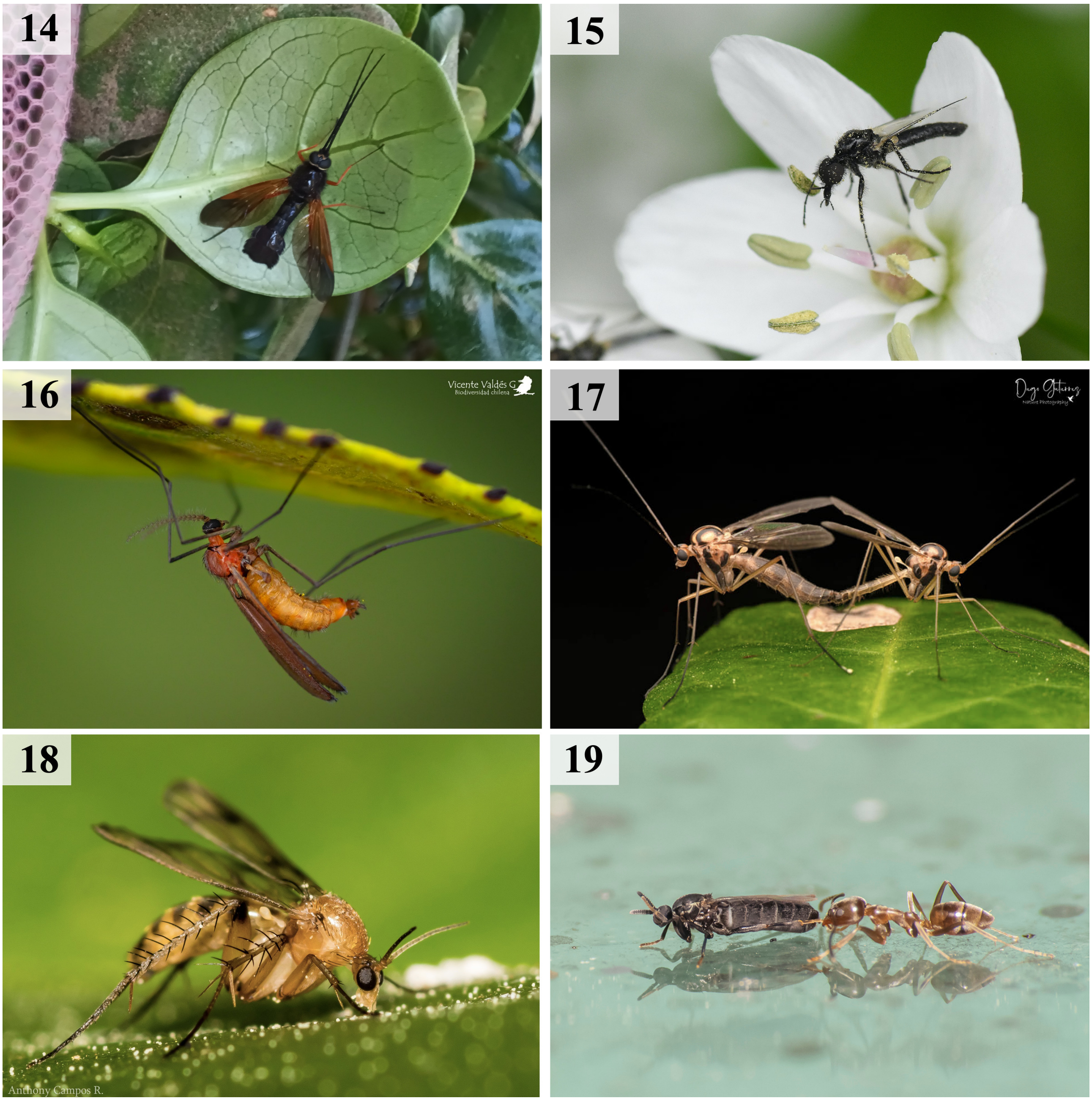
Anisopodidae (Fig. 14)
The family comprises more than 120 extant species, grouped into two subfamilies and six genera (Hancock 2017). Some studies support the current phylogenetic position of the family as the sister taxon of the remaining Bibionomorpha (e.g., Amorim & Tozoni 1994). For Chile, five species are known in three genera: *Lobogaster* Philippi, *Sylvicola* Harris (Anisopodinae), and *Mycetobia* Meigen (Mycetobiinae) (González *et al.* 2019a). *Sylvicola* and *Mycetobia* are widely distributed worldwide; however, *Lobogaster* is known only from Chile, whereas its sister genus, *Carreraia* Corrêa, is restricted to southern Brazil (Amorim & Tozoni 1994).

Bibionidae (Fig. 15)
The family comprises more than 1,000 extant species, grouped into two subfamilies and seven genera (Skartveit 2017). Pinto & Amorim (2000) and Fitzgerald *et al.* (2020) have studied the phylogeny and classification of this family. For Chile, 33 species are known belonging to the genera *Plecia* Wiedemann and *Dilophus* Meigen (Fitzgerald *et al.* 2020).

Canthyloscelidae
This is a very small family comprising 12 extant species and four genera (Hutson 1977), sister to Scatopsidae. Amorim (2000) confirmed the precedence of the name of the family-group Canthyloscelidae and included genera previously referred to as belonging to Synneuridae and Hyperoscelididae. For Chile, there are records of only one genus, *Canthyloscelis* Edwards, with two species described, *C.* (*Araucoscelis*) *pectinata* Edwards and *C.* (*Araucoscelis*) *pictipennis* Edwards (Hutson 1977). *Canthyloscelis* (*Araucoscelis*) has as its sister clade the subgenus *Canthyloscelis* (*Canthyloscelis*), known only from New Zealand. There are no recent taxonomic studies on the family for Chile.

Cecidomyiidae (Fig. 16)
This family comprises 6,203 extant species, grouped into six subfamilies and 736 genera (Jaschhof & Jaschhof 2013; Gagné & Jaschhof 2021). There is molecular evidence that this may be the most species-rich family of insects (Hebert *et al*. 2016). Several recent papers, such as, Maia & Villagra (2017) and Gagné & Whaley (2020), have contributed to the knowledge of the family in Chile. A total of 30 species in 17 genera are now recognized in the country (Gagné & Jaschhof 2021).

Ditomyiidae
The Ditomyiidae comprises over 100 extant species, grouped into two subfamilies and eight genera (Falaschi & Amorim 2009). Munroe (1974) published a large monograph covering the Holarctic genus *Symmerus* and the austral genus *Australosymmerus* Freeman, which is a later genus with eight subgenera. Papavero (1977) published a catalog for the family in the Neotropical Region but unfortunately missed Munroe's (1974) paper. In Chile there are ten species divided among two genera: *Nervijuncta* Marshall and *Australosymmerus* Freeman. *Nervijuncta* species are found in New Zealand, Chile, and southern Brazil. The Chilean species *Nervijuncta conjuncta* (Freeman) was redescribed by Falaschi & Amorim (2009). The subgenera *Australosymmerus* (*Australosymmerus*) Freeman and *A.* (*Crionisca*) Colless are shared between Chile and Australia, while the subgenera *A.* (*Areostylus*) Munroe, *A.* (*Tantrus*) Munroe, *A.* (*Melosymmerus*) Munroe and *A.* (*Calosymmerus*) Munroe are known only from South America. Of these subgenera, *A.* (*Areostylus*) Munroe and *A.* (*Tantrus*) Munroe are known from Chile, whereas the other subgenera are known from the northern areas of South America. Nine of the ditomyiid species of *Australosymmerus* occur in Chile, assigned to the following subgenera: one in *A.* (*Australosymmerus*), one in *A.* (*Crionisca*), four in *A.* (*Areostylus*), and three in *A.* (*Velliocauda*).



FIGURES 14–19. Bibionomorpha of Chile: (14) *Lobogaster paradoxus* Philippi, 1865 (Anisopodidae, photo by Cristóbal Ponce); (15) *Dilophus* sp. (Bibionidae; photo by Patrick Vyvyan); (16) Cecidomyiidae (photo by Vicente Valdés); (17) Keroplatidae (photo by Diego Gutiérrez); (18) *Mycetophila lacuna* Freeman (Mycetophilidae, photo by Anthony Campos); (19) cf. *Coboldia* sp. (Scaptopsidae, photo by Claudio Maureira).

Keroplatidae (Fig. 17)
The family comprises 912 extant species, grouped into four subfamilies and 86 genera (Falaschi 2020), or separated into three subfamilies (Matile 1990; Evenhuis 2006). For Chile, 25 species in five genera are known (Evenhuis 2006). There are no recent taxonomic studies on the family. A considerably large number of undescribed species of the family are expected to be present in the Chilean fauna.

Mycetophilidae (Fig. 18)
The family Mycetophilidae comprises more than 4,000 extant species, grouped into six subfamilies and 150 genera (Oliveira & Amorim 2021). Oliveira & Amorim (2014) provided an updated catalog of the types of many Neotropical

Mycetophilidae, and Amorim & Oliveira (2013) made comments and acquired images of types of the Neotropical species at the Natural History Museum, London. There are records of 739 species divided among 35 genera for Chile, with representatives from all six subfamilies (Oliveira & Amorim 2014). The largest mycetophilid genus in Chile is *Mycetophila* Meigen with 336 species, followed by *Epicypta* Winnertz (63 species), *Tetragoneura* Winnertz (49), *Echinopodium* Freeman (33) and *Mycomya* Rondani (30). Mycetophilids are largely humidity dependent; therefore, they are much more abundant in temperate rainforests than in other areas of Chile. Mycetophilidae are possibly the most species-rich family of flies in Chile, with a large number of undescribed species.

Rangomaramidae

The family Rangomaramidae comprises over 30 described species, grouped into four subfamilies and 11 extant genera (Amorim & Rindal 2007). There are 13 species recorded for the Chilean fauna: *Chiletricha* Chandler, *Colonomyia* Colless and *Ohakunea* Edwards (Amorim & Falaschi 2012). *Chiletricha* belongs to Chiletrichinae, a subfamily with several genera and relict distributions in different parts of the world, and seven species in Chile (some are also present in Argentina) and one species in southern Brazil. The Ohakuneinae genus *Colonomyia* (also present in Australia, Papua New Guinea, Costa Rica, and southern Brazil) have four known species from Chile, two of which are also present in Argentina; *Ohakunea* also has species in Australia, New Zealand, Papua New Guinea, New Caledonia, and southern South America. *Ohakunea chilensis* Freeman is abundant in southern Chile, with records for Argentina. There appears to be an undescribed genus of this family in the temperate rainforests of southern Chile.

Scatopsidae (Fig. 19)

The family Scatopsidae comprises 380 extant species worldwide and is grouped into four subfamilies and 36 genera (Haenni & Amorim 2017). In Chile, the subfamilies Ectaetiinae, Psectrosciarinae and Scatopsinae are represented by eight genera and eight species (Amorim 2009b). The two species described by Philippi (1865) are currently unrecognized and unplaced. *Ectaetia* Enderlein and *Anapausis* Enderlein are distributed worldwide, and one described species of each has been recorded for Chile; *Anapausis fuscinervis* Edwards—is considerably common in southern Chile. The Rhegmoclematini genus *Diamphidicus* Cook has only one known species in Chile and one in Australia, whereas *Holoclema* Amorim & Haenni is endemic to Chile. The genus *Neorhegmoclemina* Cook has one described species and at least one other undescribed species. Most known scatopsid species in Chile are from temperate rainforests; however, it is worth mentioning that *Psectrosciara rossi* Cook, described from Coquimbo, an area with different environmental conditions from temperate rainforest. This genus is known from other dry areas, at least in the Americas (Amorim & Brown 2020). *Scatopse notata* (Linnaeus) and *Coboldia fuscipes* (Meigen) are introduced species in Chile with a worldwide distribution.

Sciaridae

The family comprises 2,720 extant species in 83 genera and 45 subgenera (Menzel & Smith 2017). The family was not treated in CDASUS. For Chile only 10 species are recognized belonging to four genera (Amorim 1992). There are no recent taxonomic studies on the family. Many more species can be expected to occur in Chile.

6. Suborder Brachycera

Brachycerans are characterized by the reduction or fusion of antennal segments to eight or fewer in number and by modifications to the larval head capsule. They play many roles in the food web, being key pieces, not only for invertebrate communities but also for vertebrates and ecosystems. The larvae colonize different aquatic and terrestrial ecosystems, such as decaying wood, leaf litter, dung, carrion, rivers, swamps, and caves. The classification of Brachycera has undergone a number of changes following successive proposals of phylogeny of the group, which remains unresolved. Our classification for the lower Brachycera follows Wiegmann & Yeates (2017). For Chile, this suborder is represented by 2,329 species grouped into 75 families (Tables 2–5). The number of genera and species to date, increased by 48.61% (n = 229) and 49.77% (n = 774), respectively in comparison to the numbers outlined in CDASUS (n = 471 genera and n = 1,555 species).

TABLE 2. Number of genera and species of infraorders Xylophagomorpha, Stratiomyomorpha, Tabanomorpha, superfamilies Nemestrinoidea, Asiloidea, Bombyliidae, Mythicomyiidae, and Empidoidea in CDSASUS and to date in Chile, follows Wiegmann & Yeates (2017). For each fly family, the percentage increase (+) or decrease (–) in the number of genera and species is shown. A symbol (-) is presented when the family was added, no new genera or species were described, and it was synonymized or removed for the Dipterofauna of Chile after the publication of CDASUS.

Family	N° genera CDASUS	N° species CDASUS	N° genera 2024	N° species 2024	genera (%)	species (%)
Xylophagidae[a]	3	16	1	1	–33.33	–93.75
Athericidae[b]	-	-	1	16	-	-
Austroleptidae	-	-	1	5	-	-
Pelecorhynchidae	1	7	2	9	+100	+28.57
Tabanidae	17	74	25	116	+47.05	+56.75
Rhagionidae	3	20	3	18	-	–10
Stratiomyidae	22	30	24	73	+9.09	+143.33
Acroceridae	-	-	10	38	-	-
Nemestrinidae	4	41	4	39	-	–4.87
Bombyliidae	24	151	34	142	+41.66	–5.96
Mythicomyiidae[c]	-	-	3	11	-	-
Apioceridae[d]	2	9	1	4	–50	–55.55
Asilidae	40	61	44	136	+10	+122.95
Evocoidae	-	-	1	1	-	-
Mydidae	4	16	5	18	+25	+12.5
Scenopinidae	1	1	1	1	-	-
Therevidae	-	-	13	39	-	-
Atelestidae	-	-	1	2	-	-
Brachystomatidae[e]	-	-	5	37	-	-
Empididae	33	221	25	170	–24.24	–23.07
Ragadidae	-	-	2	2	-	-
Dolichopodidae	16	88	23	118	+43.75	+34.09
Hybotidae[f]	-	-	10	27	-	-
Homalonecmidae[g]	-	-	1	2	-	-
Leptogastridae[h]	1	1	-	-	-	-
Total	**171**	**736**	**240**	**1.025**	**+40.35**	**+39.26**

[a]James (1975) included the genera *Atherimorpha* White (now in Rhagionidae) and *Austroleptis* Hardy (now in Austroleptidae); [b]James (1968) included in Rhagionidae. Erected as a family status by Stuckenberg (1973); [c]Painter *et al.* (1978) included as a subfamily of Bombyliidae; [d]Genus *Megascelus* Philippi was transferred to Mydidae (Yeates & Irwin 1996); [e]Several genera included in Empididae (Smith 1967) and elevated to family status by Sinclair & Cumming (2006); [f]As a subfamily of Empididae in Smith (1967); [g]Genus *Homalocnemis* Philippi included in Hybotinae (Empididae) (Smith 1967) and elevated to family status by Amorim (2009b); [h]Now under Asilidae.

A. Section Homeodactyla

According to Shin *et al.* (2018), this clade is supported by "Brachyceran flies with pulvilliform empodium, a character state in which the medial lobe on the pretarsus is pad-like."

1. Infraorder Xylophagomorpha

Based on an analysis of mitochondrial DNA, Ding *et al.* (2019) recovered the monophyly of Xylophagidae, suggesting that the Xylophagomorpha is sister to Stratiomyomorpha.

Xylophagidae (Fig. 20)
The family comprises over 134 species in 11 extant genera (Woodley 2011). Only *Heterostomus curvipalpis* Bigot (Woodley 2011) is known from Chile (James 1975b). Coscarón *et al.* (2013) described the puparium of this species.

2. Infraorder Tabanomorpha

The molecular analysis of Wiegmann *et al.* (2011) indicated that the Tabanomorpha should include the families Rhagionidae, Pelecorhynchidae, Tabanidae, Austroleptidae, Athericidae, Bolbomyiidae, Oreoleptidae and Vermileonidae, with the latter three absent from Chile. The monophyly of this infraorder is suggested by the presence of the first expanded ventrolateral cercal segment in females, bulbous clypeus of adults, a brush on the larval mandible and the retractile head capsule of the larva (Wiegmann *et al.* 2000; Kerr 2010; Morita *et al.* 2016; Wiegmann & Yeates 2017).

Athericidae (Fig. 21)
The family comprises more than 123 species, grouped into two subfamilies divided among 10 genera (Stuckenberg 2000). Stuckenberg (1973) elevated the group to family rank, separating it from the Rhagionidae. Several contributions to the Neotropical fauna have been made with new species descriptions and taxonomic data (e.g., Rafael & Henriquez 1991; Coscarón & Coscarón 1995, 1996; Woodley 2007). A total of 16 species are recorded from Chile, all house within the genus *Dasyomma* Macquart (González *et al.* 2019b).

Austroleptidae (Fig. 22)
The Austroleptidae comprises 11 species grouped into a single genus in the family, *Austroleptis* Hardy (Fachin *et al.* 2018, 2020). The genus is known from Australia and southern South America. There are five known species from Chile, mainly distributed throughout southern Chile and Argentina. Some of the Chilean species have been illustrated in Fachin *et al.* (2018).

Pelecorhynchidae (Fig. 23)
The Pelecorhynchidae comprises 51 extant species in three genera (Llanos *et al.* 2015). Its classification remained stable since Mackerras & Fuller (1942) proposed it as a family, although some studies have argued that it would be more closely related to Rhagionidae or Tabanidae (Kerr 2010). Two species were recently described by Llanos & González (Llanos *et al.* 2015), increasing the number to nine species for Chile (González & Elgueta 2020). Recently, González *et al.* (2023c) re-established the generic status of *Coenura* Bigot, 1857, and together with *Pelecorhynchus* Macquart are the only genera present in the southern South America.

Rhagionidae (Fig. 24)
The Rhagionidae comprises more than 700 species, grouped into four subfamilies and 16 extant genera (Kerr 2010). For Chile, 18 species are cited in three genera, *Atherimorpha* White, *Chrysopilus* Macquart, and *Litoleptis* Chillcott. One species described in the genus "*Leptis* Fabricius" was kept as *incertae sedis* (González *et al.* 2020).

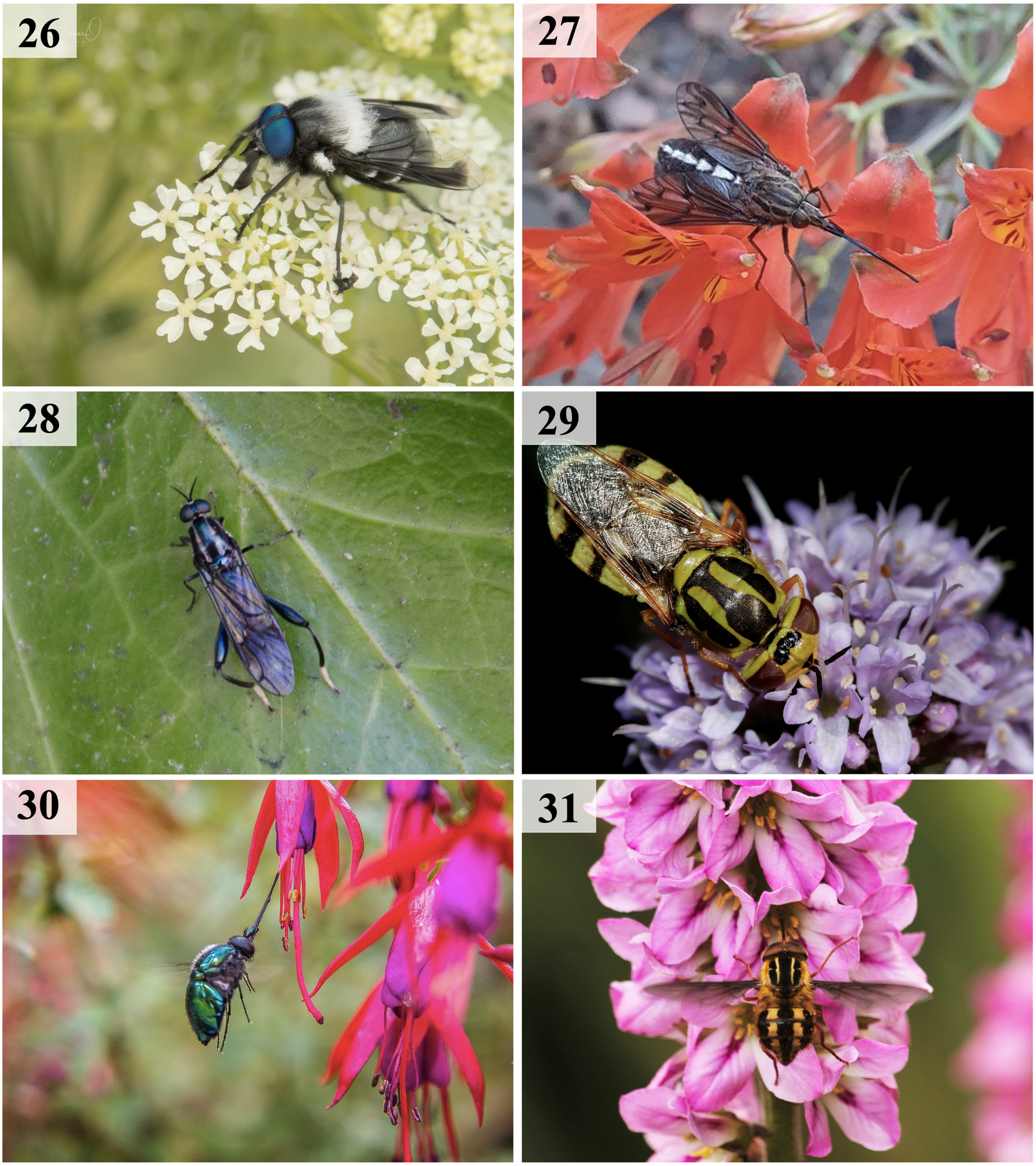
Tabanidae (Figs 25–27)
Tabanids comprise more than 4,500 species, grouped into three subfamilies and 160 genera (Morita *et al.* 2016; Chainey 2017). The suprageneric classification of the family proposed by Mackerras (1954) was stable for decades, until Lessard *et al.* (2013) and Morita *et al.* (2016) proposed a new arrangement based on molecular data. Studies of Chilean Tabanidae were conducted by Coscarón (1976b, 1991), Coscarón & González (1989, 1991), and González (1999, 2007, 2014, 2017). For Chile, 116 species in 25 genera are reported. The genus *Dasybasis* Macquart is

the richest genus in Chile with 33 species. Seven genera (*Mycteromyia* Philippi, *Promycteromyia* Coscarón & Philip, *Archeomyotes* Philip & Coscarón, *Austromyans* Philip & Coscarón, *Chaetopalpus* Philippi, *Pseudomelpia* Enderlein, and *Sixtomyia* Krolow, Henriques & González), three subgenera (*Esenbeckia* (*Astomyia*) Burger, *E.* (*Palassomyia*) Fairchild, and *Protodasyapha* (*Protodasyapha*) Enderlein), and 64 species are known only from Chile (González *et al.* 2022).

FIGURES 20–25. Xylophagomorpha and Tabanomorpha of Chile: (20) *Heterostomus curvipalpis* Bigot (Xylophagidae, photo by Asiel Olivares); (21) *Dasyomma caeruleum* Macquart (Atherecidae, photo by Matías Gargiulo); (22) *Austroleptis penai* Nagatomi & Nagatomi (Austroleptidae, photo by Dalton de Souza Amorim); (23) *Coenura biguttatus* (Philippi) (Pelecorhynchidae, photo by Ricardo Varela); (24) *Atherinomorpha* sp. (Rhagionidae, photo by Daniel Llavaneras); (25) *Osca lata* (Guerin-Méneville), larvae (Tabanidae, photo by Christian R. González).

3. Infraorder Stratiomyomorpha

Shin *et al.* (2018) placed this infraorder as a sister group of Tabanomorpha, including the families Stratiomyidae, Xylomidae, and Panthophthalmidae. Only Stratiomyidae is present in Chile.



FIGURES 26–31. Tabanomorpha (continued), Stratiomyomorpha and Nemestrinoidea of Chile: (26) *Osca varia* (Walker) (Tabanidae, photo by Guillermo Arenas); (27) *Mycteromyia conica* (Bigot) (Tabanidae, photo by Romina Lobe); (28) *Exaireta longicornis* James (Stratiomyidae. photo by Gabriela Germain); (29) *Psellidotus elegans* (Macquart) (Stratiomyidae, photo by Cristian Correa); (30) *Lasia nigritarsis* (Blanchard) (Acroceridae, photo by Francisco Barrera); (31) *Trichophthalma barbarossa* (Bigot) (Nemestrinidae, photo by Fanny Araya).

Stratiomyidae (Figs 28–29)

The Stratiomyidae comprises over 2,800 extant species, grouped into 12 subfamilies and 369 genera (Woodley 2001). The subfamily Parhadrestiinae is only known from Chile (Hauser *et al*. 2017a). Several morphological and molecular studies have corroborated the monophyly of this family and its subfamilies (Woodley 2001; Brammer & von Dohlen 2007, 2010). Knowledge of the family in Chile is mainly based on the work of James (1973, 1974, 1975a). A recent catalog for the Stratiomyidae of Chile includes 73 species in 24 genera; the genus *Macromeracis* Enderlein is the most species-rich genus in Chile, with 18 species (Fachin *et al.* 2021).

Superfamily Nemestrinoidea

Shin *et al.* (2018) hypothesized that the monophyly of this infraorder to include Nemestrinidae and Acroceridae, for which a synapomorphy would be hypermetamorphic parasitic larvae (Woodley 1989). Both families are present in Chile.

Acroceridae (Fig. 30)

The family comprises over 422 species (extant and fossils), grouped into five subfamilies and 58 genera (Winterton & Barraclough 2017; Gillung *et al.* 2018). The family was not treated in CDASUS. A recent catalog of the family for Chile listed 33 species in nine genera (González *et al.* 2018). Recently, new species of *Ogcodes* Latreille and *Holops* Philippi were added by Barahona-Segovia *et al.* (2020a, 2021c), while González & Ramírez (2021) described a new genus for Chile: *Coquena* Schlinger, with a new species, *C. coquimbensis* González & Ramírez.

Nemestrinidae (Fig. 31)

The Nemestrinidae comprises 275 species, grouped into five subfamilies and 23 extant genera (Bernardi 1973; Woodley 2009). Bernardi (1973) divided the family into five subfamilies, Atriadopsinae, Cyclopsideinae, Hirmoneurinae, Nemestrininae and Trichopsideinae. Papavero & Bernardi (2009) corrected the names of the subfamilies Atriadopinae and Falleniinae and replaced them with those of Atriadopsinae and Trichopsideinae, respectively. The knowledge of the family in the country is largely based on the works of Stuardo (1932, 1934, 1936) and Angulo (1971). For Chile, 39 species are grouped in four genera, *Hyrmophlaeba* Rondani, *Hirmoneuropsis* Bequaert, *Neorrhyncocephalus* Lichtwardt, and *Trichophthalma* Westwood (Papavero & Bernardi 2009). An updated catalog of Chilean nemestrinids has been published by González *et al.* (2023a).

B. Section Heterodactyla

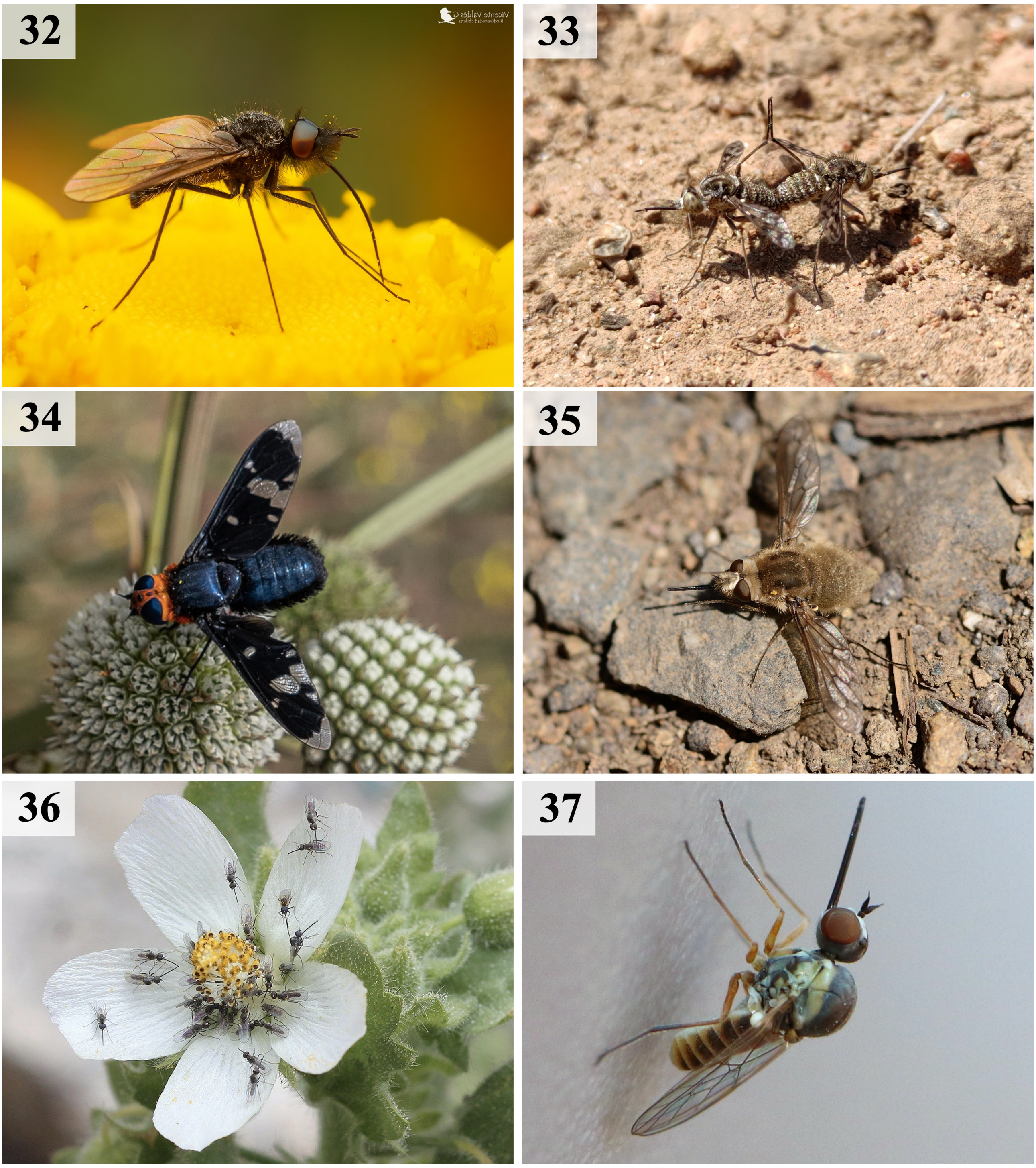
This monophyletic group contains all Brachycera flies with a reduced or absent tarsal empodium, although both characters are homoplasious (Shin *et al.* 2018).

Bombyliidae (Figs 32–35)

Bombyliids comprise more than 4,500 species, grouped into 16 subfamilies and 100 extant genera worldwide (Evenhuis & Greathead 1999; Evenhuis & Lamas 2017). The current classification of this family largely corresponds to the proposal by Evenhuis (1990), which has changed the placement of some genera. Later, Zaitzev (1992) elevated the subfamily Mythicomyiinae to family status. Knowledge of the family in Chile must be credited to Hall (1976), Evenhuis (1993), and Yamaguchi & Lamas (2014). For Chile, 142 species recorded are grouped into 34 genera (Evenhuis 2015).

Mythicomyiidae (Figs 36–37)

The family comprises over 380 species, grouped into six subfamilies and 30 extant genera (Evenhuis 2002; Evenhuis 2017). Since their separation from Bombyliidae (Zaitzev 1992), several authors have corroborated their position as sisters to Bombyliidae (for example, Wiegmann *et al.* 2011). Greathead & Evenhuis (2001) proposed six subfamilies: Psiloderoidinae, Platypyginae, Glabellulinae, Empidideicinae, Leylaiyinae and Mythicomyiinae. For Chile, 11 species are referred to three genera: *Mythicomyia* (*Heterhybos*) Coquillet, with nine species; and *Glella quebradae* Hall and *Pieza agnastis* (Hall) (Evenhuis 2002) with one species each.



FIGURES 32–37. Bombyliidae and Mythicomyiidae of Chile: (32) *Phthiria tristis* Bigot (Bombyliidae, photo by Vicente Valdés); (33) *Nectaropota setigera* Philippi (Bombyliidae, photo by ValeG); (34) *Hyperalonia chilensis* Rondani (Bombyliidae, photo by Luis Romero); (35) *Platamomyia depressa* (Loew) (Bombyliidae, photo by Matías Cortés); (36) *Mythicomyia* sp., (Mythicomyiidae, photo by Mauricio Quezada), and (37) *Mythicomyia problis* Hall (Mythicomyiidae, photo by Michael Weymann).

I. Superfamily Asiloidea

In Wiegmann *et al.* (2011) and Wiegmann & Yeates (2017), this superfamily is composed of Apioceridae, Asilidae, Evocoidae, Therevidae, Scenopinidae, Mydidae, and Apsilocephalidae, with the latter being absent from Chile. As a synapomorphy of the clade, the larval posterior spiracles arise dorsally in the penultimate abdominal segment (Sinclair *et al.* 1994).

Apioceridae (Fig. 38)
The Apioceridae comprises over 143 species in a single genus, *Apiocera* Westwood, with four subgenera: *Apiocera*, *Anypenus* Philippi, *Pyrocera* Yeates & Irwin, and *Ripidosyrma* Hermann (Dikow 2017). The only phylogenetic analysis for this family was proposed by Yeates & Irwin (1996). The most important contribution to the knowledge of the apiocerids in Chile was made by Artigas (1970a). For Chile, four species are reported and all of them in the subgenus *Anypenus*: *A. aurelia* Artigas, *A. monticola* Artigas, *A. obscura* (Philippi), and *A. philippii* (Brèthes).

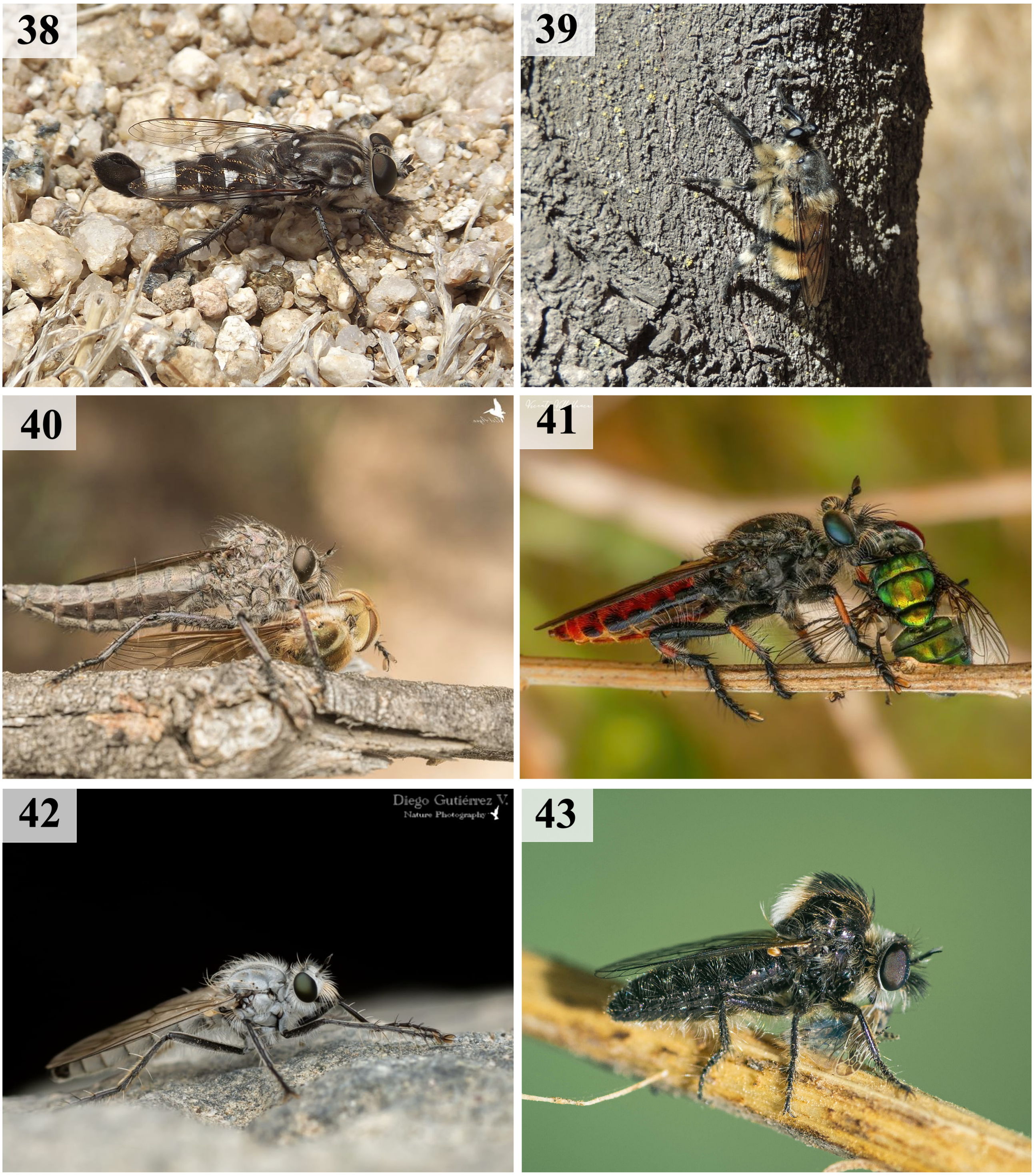
Asilidae (Figs. 39–43)
Asilidae includes over 7,650 species, grouped into 14 subfamilies and 577 genera (Londt & Dikow 2017). Artigas (1970b) published a monograph of this family for Chile, including 111 species in 40 genera, of which, 27 genera and 72 species are recognized as endemic. Artigas (1996), Artigas & Parra (2006), Artigas *et al.* (2005) and Hengst & Artigas (2003) published additional contributions, with studies of the genera *Martintella* Artigas & Papavero, *Alyssomyia* Hull, *Tillobroma* Hull, and *Philonerax* Bromley. Artigas *et al.* (1997) contributed with keys and spermatheca atlas for females. An updated catalog of Chilean robber flies recognized 135 species in 44 genera (Papavero 2009). Other species have recently been added, such as the second *Mallophora* species cited for the country, *Mallophora leschenaulti* Macquart (Barahona-Segovia & Pañinao-Monsálvez 2020).

Evocoidae
This monotypic family, endemic to Chile, was described by Yeates *et al.* (2003, 2006). *Evocoa chilensis* (Yeates, Irwin & Wiegmann) is found in the sclerophyllous forests of central Chile.

Mydidae (Figs 44–46)
The Mydidae comprises 470 species worldwide, grouped into 11 subfamilies and 66 extant genera (Dikow 2010). The early papers on the family in Chile were those of Séguy (1939) and Reed & Ruiz (1941). More complete knowledge of the family in Chile should be credited to Artigas (1973). Artigas & Palma (1979) described new species of *Megascelus* Philippi and *Mitrodetus* Gerstaecker for Chile. Papavero (2013) updated the species number, to 18 species in five genera. There are no recent taxonomic studies on the family.

Scenopinidae (Fig. 47)
The family comprises 420 species worldwide, grouped into three subfamilies and 25 extant genera (Yeates 1992). Winterton & Ware (2015) conducted a phylogenetic study of this family, and Kelsey (1969, 1971, 1974) published keys to known species. There is reference to only one scenopinid species in Chile, *Heteromphrale chilensis* (Kröber) (Kelsey 1969).

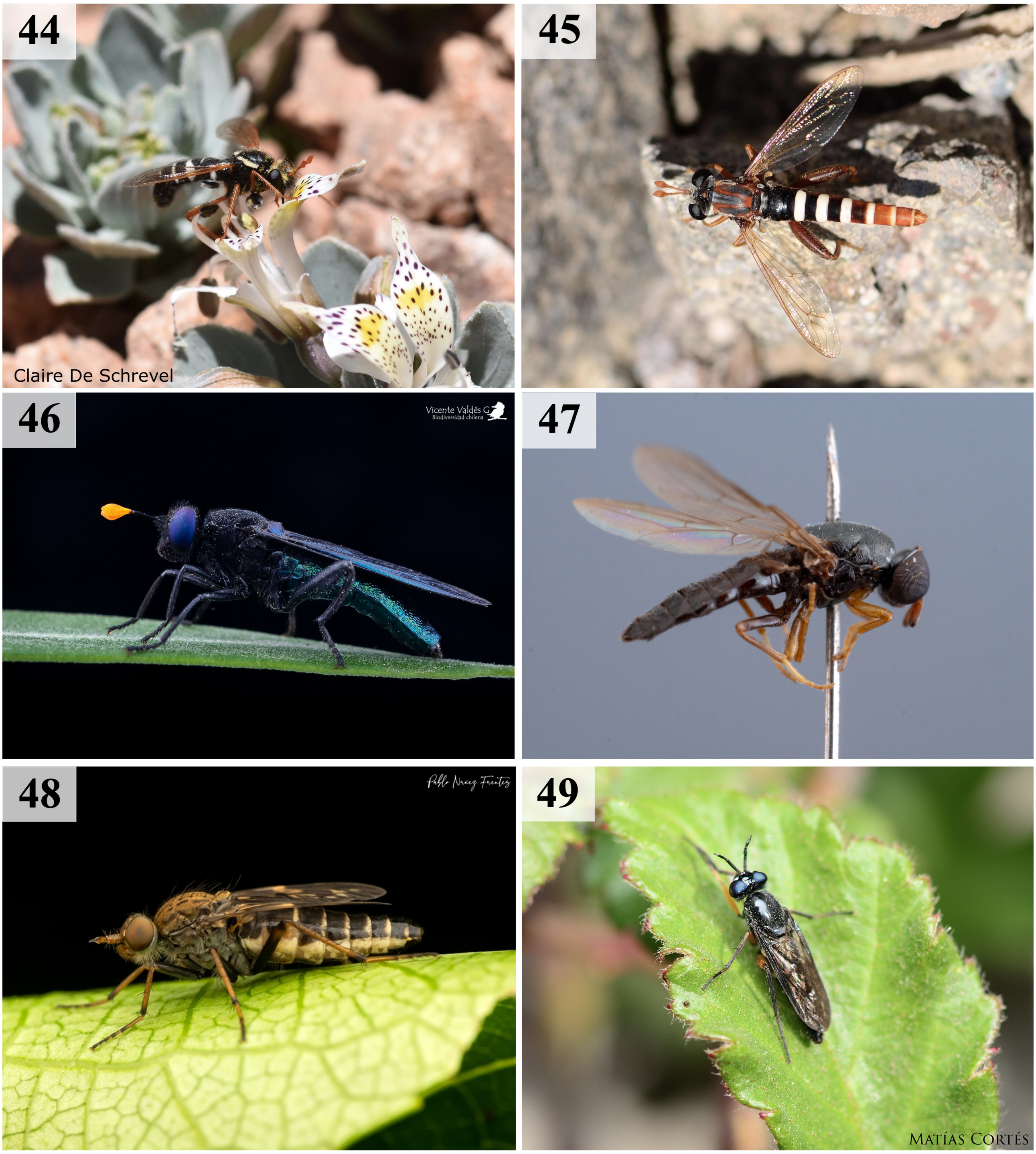
Therevidae (Figs 48–49)
Therevids comprise more than 1,170 species, grouped into four subfamilies and 124 genera (Hauser *et al.* 2017b). The family was not treated in CDASUS. Webb *et al.* (2013) compiled the first catalog of this family in the New World, with 255 species distributed among 45 genera. Recently, Irwin & Winterton (2020a) added a new genus, *Dasythereva* Irwin & Winterton with two new species: *D. penai* and *D. patagonia*. Posteriorly, the genus *Sigalopella* Irwin & Winterton was created with four new and endemic species in Chile (Irwin & Winterton 2020b). The genus *Argolepida* Metz & Irwin was cited for the first time in Chile by Irwin & Winterton (2021a) and described four new species for the country. Later, Irwin & Winterton (2021b) described four new species of *Pachyrrhyza* Philippi. Finally, Winterton & Irwin (2023) recently revised the genera *Entesia* Oldroyd, *Melanothereva* Malloch, added six new species and described a new genus, *Pachylopella* Winterton & Irwin, with the species *P. antennata* Winterton & Irwin. For Chile, the number of genera is 13 and 39 species are cited.



FIGURES 38–43. Asiloidea of Chile: (38) *Apiocera philippii* Brèthes (Apioceridae, photo by Asiel Olivares); Asilidae: (39) *Obelophorus terebratus* (Macquart) (photo by Javiera Delaunoy); (40) *Asilus crassus* Bromley prey on *Trichophthalma* (photo by Antonia Cornejo); (41) *Andrenosoma rufiventre* (Blanchard) prey on *Chrysomya albiceps* (photo by Vicente Villablanca); (42) *Graptostylus dolosus* Hull (photo by Diego Gutiérrez), and (43) *Dasycyrton gibbossus* Philippi prey on Cicadellidae (photo by Kmron).

C. Section Eremoneura

This large group includes flies that have only three larval instars, and their monophyly is well-supported by molecular data (Wiegmann *et al.* 2011; Shin *et al.* 2018).



FIGURES 44–49. Asiloidea (continued) of Chile: (44) *Mitrodetrus dentitarsis* (Macquart) (Mydidae, photo by Claire de Schrevel); (45) *Apiophora paulseni* Philippi (Mydidae, photo by Matías Cortés) (46) *Paramydas igniticornis* (Bigot) (Mydidae, photo by Vicente Valdés); (47) *Heteromhrale chilensis* (Kröber) (Scenopididae, photo by Ricardo Varela), (48) *Pachyrrhiza subpictipennis* Irwin & Winterton (Therevidae, photo by Pablo Núñez), and (49) *Sigalopella rufifemoralis* Irwin & Winterton (Therevidae, photo by Matías Cortés).

II. Superfamily Empidoidea

The monophyly of the Empidoidea was shown by Sinclair & Cumming (2006) to be supported by morphological characters of the final instar larval mandible, in addition to homoplasies such as the recurved CuA_2, the dorsal and ventral sclerites of the metepisternum well separated, the anteroapical fore tibial and hind tibial anteroapical combs, ejaculatory apodeme lever-like, a reduced alula, and a single spermatheca (Sinclair *et al.* 2023). The monophyly of the empidoid clade is supported by molecular data (Wiegmann *et al*. 2011). Empidoids in Chile are one of the most outstanding elements of the fly fauna, with a large number of species and a large number of endemic clades. The classification of Empididae *s.l.*, a recognized paraphyletic group, has changed considerably during the last 20 years (Sinclair & Cumming 2006).

Atelestidae

The Atelestidae comprises 15 extant species, divided into two subfamilies and five genera (Sinclair & Grimaldi 2020). For Chile, only two species belonging to the subfamily Atelestinae are known: *Acarteroptera recta* Collin and *A. licina* Collin (Smith 1967). There are no recent taxonomic studies on the family.

Brachystomatidae (Fig. 50–51)

The Brachystomatidae comprises more than 155 species, grouped into three subfamilies and 22 extant genera (Sinclair 2017a). Sinclair & Cumming (2006) conducted a morphological cladistic study and separated the superfamily Empidoidea into five families, one of which is Brachystomatidae. The fauna of the family in Chile is particularly rich and diverse. This includes large and minute species recently described such as *Gondwanodromia mikae* (Sinclair & Saigusa 2022). Moreover, *Gondwanamyia chilensis* Cumming & Saigusa (Sinclair *et al.* 2016) has been suggested that it could belong to this family due to the morphological characteristics of the female terminalia, placing it within Trichopezinae. The current fauna for this family accounts for 37 species in six known genera (González *et al.* 2021a; Sinclair & Saigusa 2022).

Empididae (Figs 52–55)

The family comprises more than 3,500 species, grouped into five subfamilies and 73 genera (Sinclair & Daugeron 2017; Sinclair *et al.* 2023). Walhberg & Johanson (2018) studied the phylogenetic relationships within the Empidoidea using molecular analysis. Six new species of the genus *Chelipoda* Macquart and seven of *Chelipodozus* Collin were added by Plant (2008, 2009). At the same time, Sinclair (2008) described eight species of *Clinocera* Meigen from Chile. Sinclair (2015) added a new species, *Asymphyloptera chilensis* Sinclair. There is no updated catalog of Chilean Empididae. At present, an estimated 170 species in 25 genera are known for the country.

Dolichopodidae (Fig. 56–58)

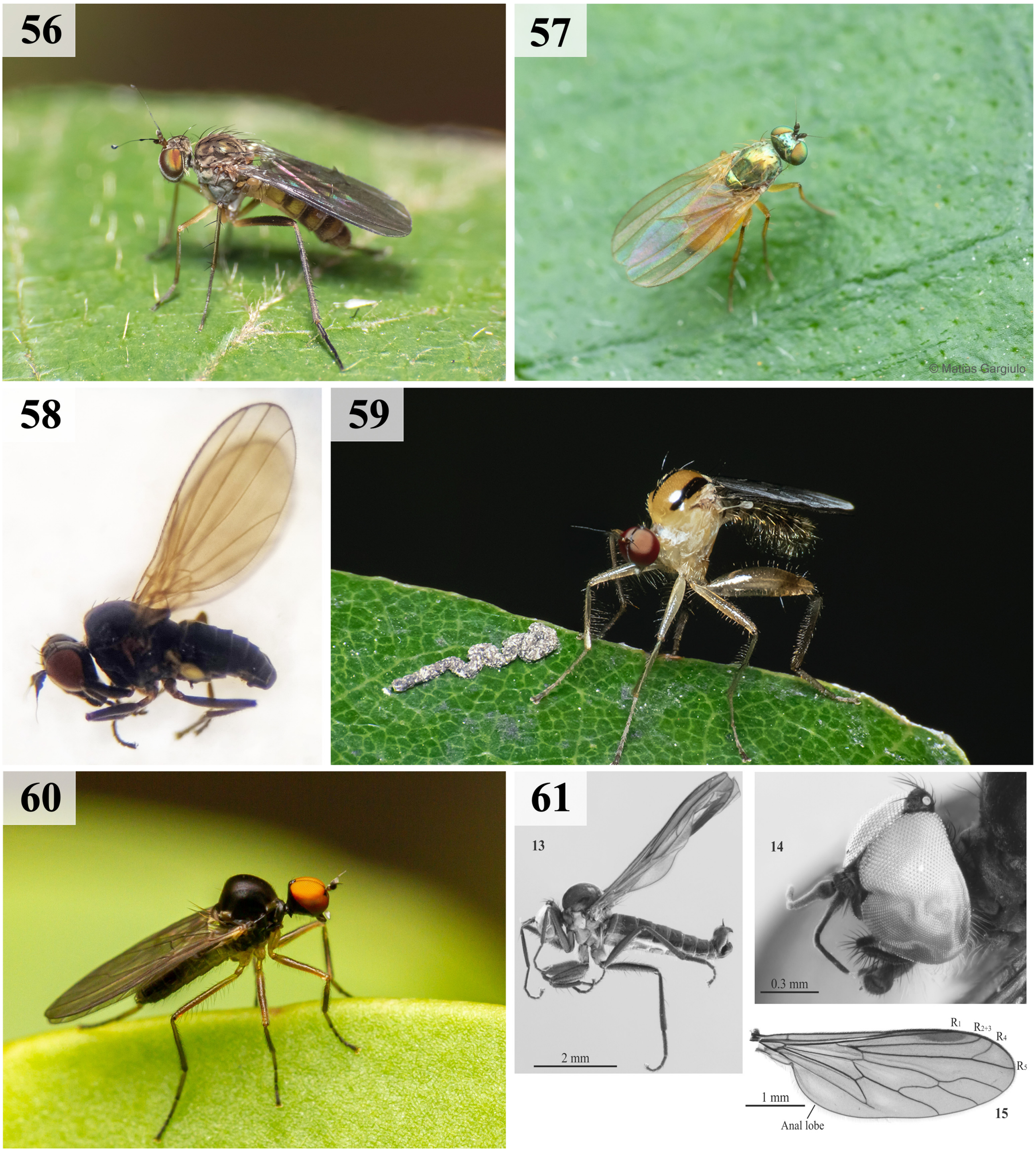
The Dolichopodidae comprises over 7,500 species, grouped into 12 subfamilies and 226 extant genera (Grichanov & Brooks 2017). Several authors have contributed to the study of the Chilean fauna, for example, Naglis (2003) described the Neotropical genus *Viridigona,* including three species and keeping *Neurigona lamprostethus* Philippi as a *nomen dubium*. Pollet (2005) added new species of *Achalcus* Loew, transferred three species to the genus *Australachalcus* Pollet, and described seven species for the latter genus. Bickel (2004, 2007) described *Maipomyia* Bickel based on two Chilean species, and *Pharcoura* Bickel based on three species from *Nothofagus* forests. In addition, Runyon & Pollet (2019) added four species to *Enlinia* Aldrich. It is also worth noting the presence of the subfamily Parathalassiinae in Chile (Cumming & Brooks 2019), usually known from rocky or sandy sea-coasts, river banks and stream margins. *Neothalassius* Brooks & Cumming (2016) has two species restricted to Chile and Peru, whereas there is a particular subgroup of the genus *Microphorella* collected close to freshwater away from the sea (Cumming & Brooks 2019; Brooks & Cumming 2023). A total of 118 species divided among 23 genera have been cited for Chile (Van Duzee 1930; Naglis 2003; Bickel 2004, 2007; Pollet 2005; Brooks & Cumming 2016; Runyon & Pollet 2019).

Hybotidae (Fig. 59–60)

The family comprises 1,700 species, grouped into seven subfamilies and 64 genera (Sinclair & Cumming 2017; Wahlberg & Johanson 2018; Sinclair 2019). Ale-Rocha (2007) studied the Chilean Ocydromiinae, and Barros *et al*. (2023) revised the genus *Scelolabes* Philippi describing two new species. A total of 27 species distributed among 10 genera are known from Chile (González *et al.* 2021b).

FIGURES 50–55. Empidoidea of Chile: (50) *Gondwanamyia chilensis* Sinclair & Saigusa (cf. Brachystomatidae, photo by Dalton de Souza Amorim); Empididae: (51) *Heterophlebus* sp. (Empididae, photo by Michael Weymann); (52) *Empis fulvicollis* Collin and (53) *Allochrotus poecilus* (Philippi) (Empididae, both photos by Vicente Valdés); (54) *Hilara* sp. (Empididae, photo by Matías Gargiulo), and (55) *Rhamphomyia* sp. (Empididae, photo by Miguel Mellado).

Homalocnemidae (Fig. 61)
The Homalocnemidae includes only the genus *Homalocnemis* Philippi with seven known species (Sinclair 2017b). Homalocnemidae was given family rank by Pape *et al.* (2011) and was considered a sister-group within the Empidoidea (Sinclair 2017b), and *Homalocnemis*, together with *Iteaphila* and *Oreogeton* are sister to remaining Empidoidea (Badano *et al.* 2023). Two species are reported to Chile, *H. nigripennis* Philippi and *H. praesumpta* Collin (Rafael *et al.* 2022).



FIGURES 56–61. Empidoidea (continued) of Chile: (56) *Sympycnus miricornis* Parent (Dolichopodidae, photo by Claudio Maureira); (57) *Chrysotimus* sp. (Dolichopodidae, photo by Matías Gargiulo); (58) *Neothalassius triton* Brooks & Cumming (Dolichopodidae, photo by Dalton de Souza Amorim); (59) *Scelolabes bivittatus* Philippi (Hybotidae, photo by Claudio Maureira); (60) *Neotrichina* sp. (Hybotidae, photo by Matías Gargiulo), and (61) *Homalocnemis praesumpta* Collin (Homalocnemidae, photo by José Albertino).

Ragadidae

Ragadidae comprises 31 species (including two fossils) in five genera (Sinclair 2016; Pape & Thompson 2020). Wahlberg & Johanson (2018) elevated Ragadidae to family level. For Chile, two genera and two species are reported, *Hydropeza curicoa* Sinclair & Plant and *Dipsomyia spinifera* Bezzi (Sinclair & Plant 2008; Sinclair 2016; Wahlberg 2019).

D. Section Cyclorrhapha

This taxon is divided into two sections: Aschiza, which is paraphyletic, and Schizophora, which includes all Acalyptratae superfamilies, and the Calyptratae, which is divided into 13 families. The most prominent autapomorphies in this group are the loss of the larval head capsule and pupation of third-instar larval skin (Wiegmann & Yeates 2017).

Division Aschiza. This group in Chile is composed of six families, 76 genera and 210 valid species (Table 3). The group includes two clades: Platypezoidea and Syrphoidea. Some authors suggest that the Pipunculidae are sister to Schizophora, and not to Syprhidae (see, for example, Pauli *et al*. 2018). No catalogs of the four platypezoid families (Opetiidae, Lonchopteridae, Phoridae, and Platypezidae) were included in CDASUS. The aschizan genera and species have increased by 117.14% (n = 41) and 114.28%, respectively (n = 112).

TABLE 3. Genera and species number of the Clade Cyclorrhapha (= Aschiza), in CDSASUS and to date in Chile, follows Wiegmann & Yeates (2017). For each fly family, the percentage increase (+) or decrease (–) in the number of genera and species is shown. A symbol (-) is presented when the family was added, no new genera or species were described, and it was synonymized or removed for the Dipterofauna of Chile after the publication of CDASUS.

Family	N° genera CDASUS	N° species CDASUS	Nº genera 2023	Nº species 2023	genera (%)	species (%)
Lonchopteridae	1	1	1	1	-	-
Opetiidae	-	-	1	1	-	-
Phoridae	-	-	20	52	-	-
Platypezidae	-	-	1	1	-	-
Pipunculidae	3	4	6	21	+100	+425
Syrphidae	30	92	47	134	+56.66	+45.65
Sciadoceridae[a]	1	1	-	-	-	-
Total	**35**	**98**	**76**	**210**	**+117.14**	**+114.28**

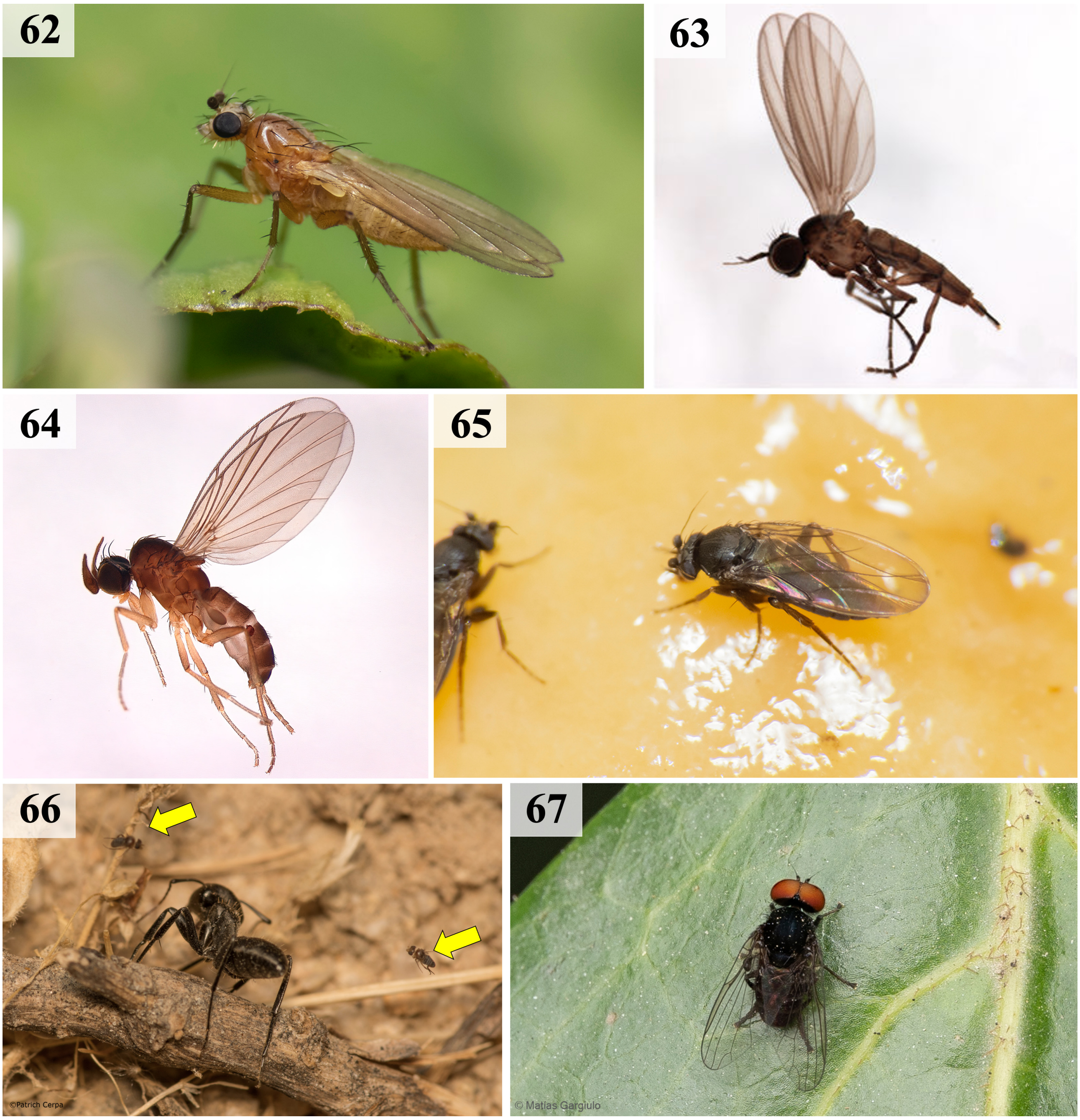
[a]Now under Phoridae (Brown 1992).

III. Superfamily Platypezoidea

The Platypezoidea includes the families Ironomyiidae, Platypezidae, Lonchopteridae, Opetiidae, and Phoridae. Ironomyiidae is absent from Chile (Wiegmann *et al.* 2011; Wiegmann & Yeates 2017).

Lonchopteridae (Fig. 62)
Lonchopteridae comprises 65 species in a single genus, *Lonchoptera* Meigen (Whittington & Kirk-Spriggs 2021). For Chile, only *L. bifurcata* (Fallén) (Malloch 1932) has been recorded, but more species of the genus may be present in the country. Lonchopterids are usually associated with a wide variety of vegetation ranging from deciduous forests to dry grasslands (Martin Ebejer pers. com.). The specimens of *L. bifurcata* known from Chile are all females and parthenogenesis has been well-documented in this genus (Stalker 1956).

Opetiidae (Fig. 63)
The Opetiidae comprises five species grouped in only two genera, *Opetia* Meigen and *Puyehuemyia* Amorim & Silva. *Opetia* is restricted to four species, one in Europe, two in Japan and one in Russia (Martin Ebejer pers. com.). The family was unknown outside the Palearctic Region and was not treated in the CDASUS. The first record of opetiids from the Southern Hemisphere was recently made by Amorim *et al.* (2018), who described *Puyehuemyia chandleri* Amorim & Silva based on a single female collected from the Puyehue National Park in Chile. This female has a sclerotized, elongated terminalia, as also occurs in female *Opetia*, and is similar to those seen in the parasitoid groups.



FIGURES 62–67. Platypezoidea of Chile: (62) *Lonchoptera bifurcata* (Fallen) (Lonchopteridae, photo by Claudio Maureira); (63) *Puyehuemyia chandleri* Amorim, Silva & Brown (Opetiidae, photo by Dalton de Souza Amorim); (64) *Archiphora* cf. *patagonica* (Schmitz) (Phoridae, photo by Dalton de Souza Amorim); (65) Phorid fly species feed on juices (Phoridae, photo by Claudio Maureira); (66) phorid fly attacking to *Camponotus* ant. The yellow arrows identify the flies (Phoridae, photo by Patrich Cerpa), and (67) Platypezidae (photo by Matías Gargiulo).

Phoridae (Figs 64–66)
This family comprises over 3,000 extant species, grouped into five subfamilies and 250 genera (Brown *et al.* 2015). Sciadocerinae, formerly belonging to the family rank, is now considered a subfamily of Phoridae (Brown 1992). The sister group relationship of sciadocerines with the remaining phorids was corroborated by a detailed morphological phylogeny by Brown *et al.* (2015). Borgmeier (1971), Calcaterra *et al.* (2007) and Ament (2018) recorded for the first time in Chile the genera *Beckerina* Malloch, *Pseudacteon* Coquillet, and *Hirotophora* Brown, Amorim & Kung. Silva (1916) published one of the early works on the family in Chile. A total of 52 species belonging to 20

genera are currently known from Chile. It is worth mentioning that *Archiphora*, known from a single species in Chile, is a sister to *Sciadocera*, present in New Zealand and Australia.

Platypezidae (Fig. 67)
The platypezids comprise 250 extant species, grouped into four subfamilies and 18 genera (Chandler 2021). The family was not treated in CDASUS. For Chile, there is only one reference to *Lindneromyia brunnescens* (Collin 1931).

IV. Superfamily Syrphoidea

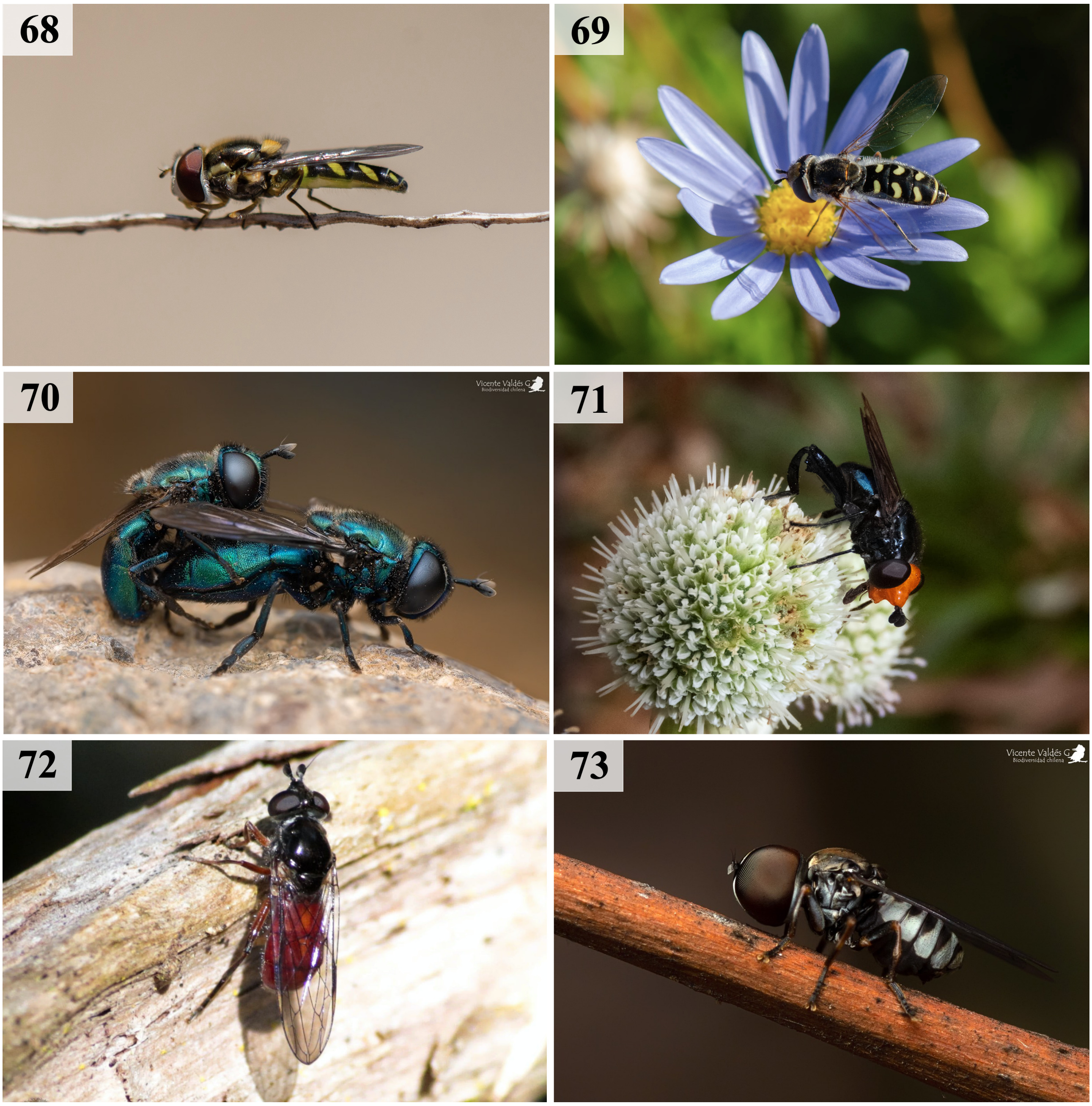
This superfamily formerly included both Syrphidae and Pipunculidae. Evidence suggests that Pipunculidae is sister to Schizophora and here, was treated as unplaced in the Diptera systematic (Wiegmann *et al.* 2011; Young *et al.* 2016; Pauli *et al.* 2018); therefore, Syrphoidea now includes only the Syrphidae.

Syrphidae (Figs 68–72)
The family Syrphidae comprises over 6,200 extant species, grouped into four subfamilies and 210 genera worldwide (Thompson *et al.* 2010). New additions to the fauna of Chile were provided by Etcheverry (1966), Thompson & Marnef (1977), Thompson & Thompson (2006), Barahona-Segovia & Barceló (2019) and Barahona-Segovia *et al.* (2021a). Furthermore, Barahona-Segovia *et al.* (2021b) added ten genera to the list of Chilean fauna, seven of which corresponded to new combinations, and two new records: *Sphiximorpha* Rondani and *Paragus* Latreille. Here we confirm the presence of *Platycheirus walkeri* (Lynch Arribálzaga) (omitted in Barahona-Segovia *et al.* 2021b) in Región de Magallanes. There are currently 134 valid species separated into 47 genera in Chile (Barahona-Segovia *et al.* 2021b).

Unplaced family

Pipunculidae (Fig. 73)
The pipunculids comprise over 1,400 species, grouped into four subfamilies and 21 genera (de Meyer & Skevington 2000), with a well-supported molecular phylogeny by Motamedinia *et al.* (2021). This family in Chile has been studied by Rafael & Ale-Rocha (1997), and Skevington *et al.* (2021), who added a second species from southern Chile to the genus *Protonephrocerus*: *P. flavipilus* Skevington, Marques & Rafael. *P. flavipilus* is fairly abundant in the higher latitudes of the southern temperate rainforests. The genus *Protonephrocerus*, a member of the subfamily Protonephocerinae, is endemic to southern South America. The Protonephocerinae is considered sister to Pipunculinae (Skevington & Yeates 2000; Kehlmaier *et al*. 2014). In the family, 21 species of six genera are known for Chile (Rafael *et al.* 2023).

Division Schizophora (Acalyptratae).
Acalyptratae, one of the most species-rich clades grouped in ~30,000 described species divided among ~70 families (Wiegmann & Yeates 2017; Bayless *et al.* 2021). Currently, this clade in Chile is composed of 33 families, 173 genera and includes 548 valid species in Chile (Table 4). Nine families are newly recognized for Chile since the publication of CDASUS, whereas Otitidae, Tethinidae, Trixoscelididae, Notomyzidae, and Cnemosphatidae were downgraded from the family rank. Since CDASUS, the numbers of genera and species increased by 63.20% (*n* = 67) and 53.50% (*n* = 191).



FIGURES 68–73. Syrphoidea and Pipunculidae of Chile: (68) *Allograpta hortensis* (Philippi) and (69) *Austroscaeva melanostoma* (Macquart) (Syrphidae, Syrphinae, both photos by Gabriela Germain); (70) *Microdon violaceus* (Syrphidae, Microdontinae, photo by Vicente Valdés); (71) *Stilbosoma rubiceps* Philippi (Syrphidae, photo by Josefina Arce); (72) *Valdiviomyia ruficauda* (Syrphidae, photo by Patricia Medina), and (73) *Eudorylas posticus* (Collin) (Pipunculidae, photo by Vicente Valdés).

TABLE 4. Number of genera and species from clade Cyclorrhapha (Schizophora: Acalyptratae) in CDSASUS and to date in Chile, follows Wiegmann & Yeates (2017). For each fly family, the percentage increase (+) or decrease (–) in the number of genera and species is shown. A symbol (-) is presented when the family was added, no new genera or species were described, and it was synonymized or removed for the Dipterofauna of Chile after the publication of CDASUS.

Family	Nº genera CDASUS	Nº species CDASUS	Nº genera 2023	Nº species 2023	genera (%)	species (%)
Micropezidae	1	1	1	1	-	-
Neriidae	-	-	1	1	-	-

......*continued on the next page*

TABLE 4. (Continued)

Family	Nº genera CDASUS	Nº species CDASUS	Nº genera 2023	Nº species 2023	genera (%)	species (%)
Pseudopomyzidae	-	-	2	2*	-	-
Conopidae	2	5	5	12	+150	+140
Lonchaeidae	-	-	2	5	-	-
Pallopteridae	3	3	4	5	+33.33	+66.66
Piophilidae	1	3	3	3	+200	-
Pyrgotidae	2	4	2	3	-	–25
Tephritidae	15	54	23	70	+53.33	+29.62
Ulidiidae[a]	5	12	7	16	+40	+33.33
Chamaemyiidae	-	-	5	14	-	-
Lauxaniidae	-	-	7	26	-	-
Helcomyzidae	1	2	1	2	-	-
Helosciomyzidae	-	-	1	2*	-	-
Sciomyzidae	10	25	11	26	+10	+4
Sepsidae	-	-	1	1	-	-
Drosophilidae	3	23	3	36	-	+56.52
Ephydridae	13	54	18	73	+38.46	+35.18
Cypselosomatidae[b]	1	1	-	-	-	-
Dryomyzidae[c]	1	1	-	-	-	-
Braulidae	1	1	1	1	-	-
Canacidae[d]	3	6	4	16	+33.33	+166.66
Carnidae	-	-	1	1	-	-
Chloropidae	11	19	11	18	-	–5.26
Cryptochetidae	-	-	1	1	-	-
Milichidae	5	9	5	13	-	+44.44
Chyromyidae	-	-	1	1	-	-
Heleomyzidae	8	36	15	39	+87.5	+8.33
Sphaeroceridae	5	49	15	62	+200	+26.53
Agromyzidae	6	22	12	74	+100	+236.36
Anthomyzidae	-	-	4	5	-	-
Clusiidae	2	11	1	15	–100	+36.36
Opomyzidae	-	-	1	1	-	-
Paraleucopidae	-	-	3	13	-	-
Teratomyzidae	1	2	2	2	+100	-
Notomyzidae[e]	1	3	-	-	-	-
Cnemosphatidae[f]	1	9	-	-	-	-
Total	**58**	**188**	**97**	**308**	**+67.24**	**+63.82**

[a]As a subfamily of Otitidae in Steyskal (1968); [b]Erected by Hendel (1931), currently the Chilean species are placed under Pseudopomyzidae (McAlpine 1966; Lonsdale 2020); [c]Steyskal (1977) erected the family including the genus *Sciogriphoneura*; however, Barnes (1981) reaffirmed the family rank of Helosciomyzidae, transferring also the genus *Sciogriphoneura*. [d]Currently included the species treated as Tethinidae by Foster (1976) after Buck (2006); [e]Excluded from Agromyzidae by Spencer (1963), but erected as Notomyzidae by Griffith (1972). Currently, treated as Heleomyzidae in the work of McAlpine (1985); [f]Erected by Enderlein (1938) and grouped as Heleomyzidae by McAlpine (1985).
(*) undescribed species included.

V. Superfamily Nerioidea

The Nerioidea contains the families Neriidae, Micropezidae, Cypselosomatidae, Fergusoninidae, Strongylophthalmiidae, Tanypezidae and Pseudopomyzidae (Wiegmann & Yeates 2017). Only Micropezidae, Neriidae, and Pseudopomyzidae are present in Chile.

Micropezidae (Fig. 74)

The Micropezidae comprises 500 extant species, grouped into six subfamilies and 54 genera (McAlpine 1998; Marshall 2021). The genus *Cryogonus* Cresson is known from only three species in southern South America, and *C. formicarius* (Rondani) is the only species known from Chile.

FIGURES 74–79. Neridoidea and Tephritoidea of Chile: (74) *Cryogonus formicarius* (Rondani) (Micropezidae, photo by Vicente Valdés); (75) *Telostylinus lineolatus* (Wiedemann) (Neriidae, photo by Hugo García); (76) *Zodion* sp. and (77) *Myopa metallica* Camras (Conopidae, both photos by Gabriela Germain); (78) *Physocephala segethi* (Conopidae, photo by Andrés Ramírez) and (79) *Lonchaea* cf. *patagonica* Malloch (Lonchaeidae, photo by Juan Mauricio Contreras).

Neriidae (Fig. 75)
The Neriidae comprises 112 species, grouped into two subfamilies and 12 genera (Carvalho-Filho 2021). Christian R. González (unpublished data) identified one specimen in poor condition of Neriidae from Rapa Nui (Eastern Island). There is an additional recent record of *Telostylinus lineolatus* (Wiedemann) from Easter Island by iNaturalist. This is a widespread species, especially in Southeast Asia and Australasia. Here, we recognize Neriidae for the first time for Chile.

Pseudopomyzidae
Pseudomomyzids comprise 23 species in six genera, separated into three "groups" (McAlpine 1996; Lonsdale 2020). However, the monophyly and composition of this family remain controversial. For Chile, *Heloclusia imperfecta* Malloch was until recently the only species recorded in the family. The systematic position of *Heloclusia* Malloch has successively changed, from Helomyzidae (= Heleomyzidae) to Cypselosomatidae, and most recently to Pseudopomyzidae (Malloch 1933; Prado 1984; Lonsdale 2020). A thesis reviewing the family cited a second species for Chile, belonging to *Pseudopomyza* (*Apops*) (Yau 2023).

VI. Superfamily Conopoidea

Considered by some authors as a clade sister to all remaining Schizophora, this group is often referred to as being composed only of the family Conopidae. Traditionally, the genus *Stylogaster* Macquart has been included as the subfamily Stylogastrinae in the Conopidae (Gibson & Skevington 2013; Stuke 2021). Conopids are parasitoids of bees and wasps, although Stylogastrinae species are known parasitoids of cockroaches, orthopterans and other flies (Smith & van Someren 1985; Stuke 2017; Jensen *et al.* 2020). Conopidae are characterized by small- to large-sized flies, sometimes with shiny metallic or striking body patterns; antennae with flagellum variable in size; thorax subquadrate, with vein CuA+CuP reaching or almost reaching wing margin, vein A1 not reaching wing margin, and male terminalia with well-developed epandrium and cercus (Stuke 2021).

Conopidae (Figs. 76–78)
The family comprises over 810 species, grouped into five subfamilies and 55 genera (excluding extinct subfamilies) (Gibson & Skevington 2013; Stuke 2017, 2021). In Chile, Barahona-Segovia & Barceló (2020) reviewed *Myopa* Fabricius, while Barahona-Segovia *et al*. (2020b) reviewed *Physoconops* Szilády, describing new species for both genera. Additionally, the genera *Physocephala* Schiner and *Zodion* Latreille are represented by one and two species, respectively, but many more are undescribed or are new records for Chile (R. Barahona-Segovia, unpublished data). The total number of genera increased to 5 while the number of species added to 12, compared with CDASUS.

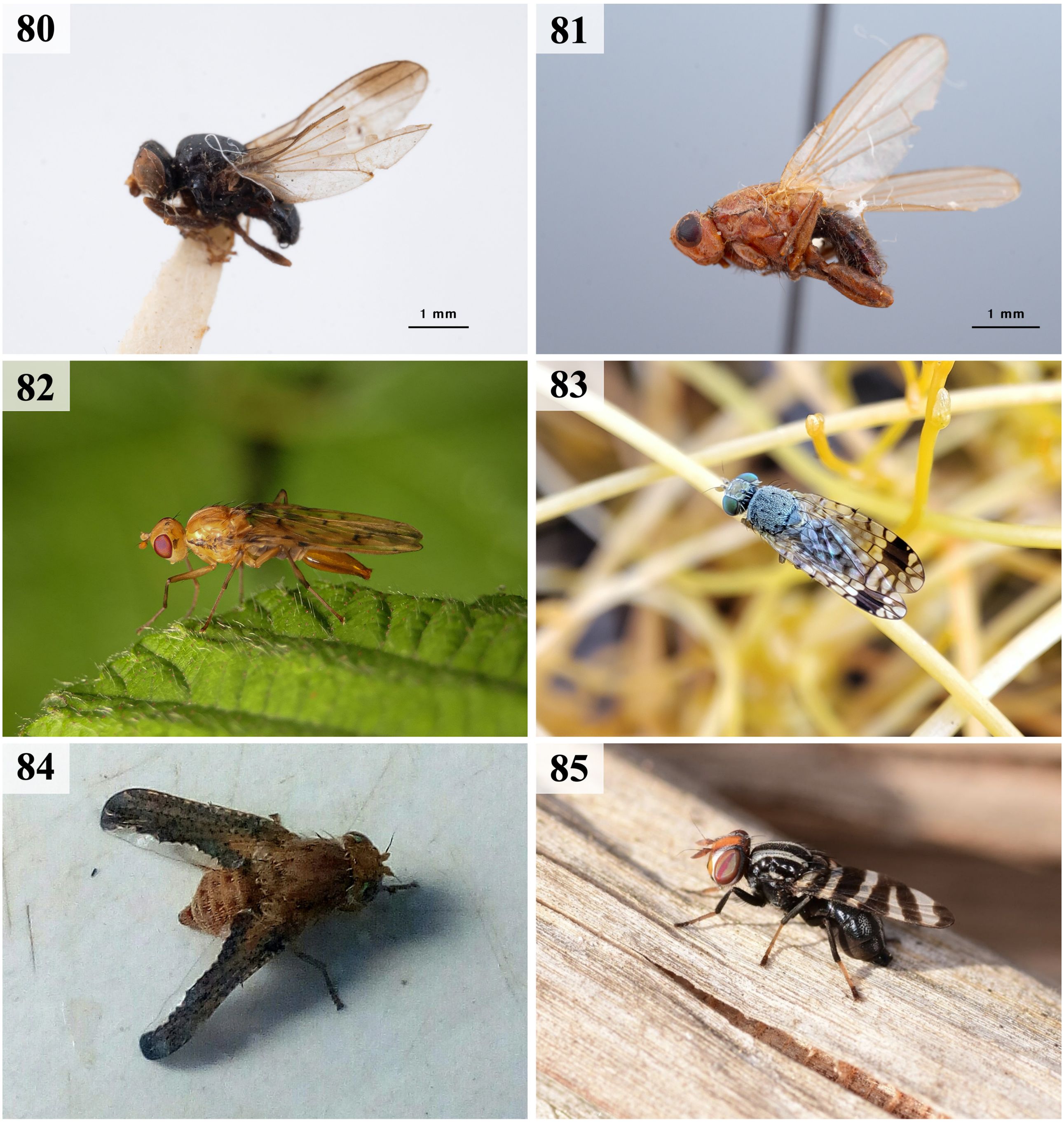
VII. Superfamily Tephritoidea

Six of the ten families included in this superfamily are present in Chile. The missing families are Ctenostylidae, Platystomatidae, Richardiidae, and Eurygnathomyiidae (Han & Ro 2016).

Lonchaeidae (Fig. 79)
The Lonchaeidae are composed of over 570 species, grouped into two subfamilies and nine genera (MacGowan & Rotheray 2021). Not included in the CDASUS, the lonchaeids were reported for Chile by McAlpine (1983), Luna (1987), and Rodrigues & González (2022), with five species in two genera, *Lonchaea* Fallén and *Protearomyia* McAlpine.

Pallopteridae (Figs 80–81)
The Pallopteridae comprise 60 species divided among 13 extant genera (Merz 1998) worldwide, but the generic composition of the family was questioned by Papp (2011) who concluded that *Aenigmatomyia* Malloch, *Heloparia* Malloch and *Pseudopyrgota* Malloch did not fit in the family. These three genera, added to *Homaroides* Malloch, comprise pallopterids of Chile. Until the placement of these four genera is resolved, we are including them under the

Pallopteridae. *Aenigmatomyia* is monotypic, including only the type species *A. unipunctata* Malloch, which is known in Chile from Casa Pangue and Puerto Varas. *Heloparia* has three species, all from southern South America—*H. lentiphora* (Hendel) and *H. bicolor* (Walker) known from Chile. *Pseudopyrgota* is also monotypic, and *P. caudata* Malloch described from the Peulla (Región de Los Lagos). *Homaroides* is also monotypic, including *H. spiniventris* Malloch, described from Lake Nahuel Huapi, but also known from southern Chile. *Scatella* (*Scatella*) *guttipennis* (Bigot) was originally described under *Palloptera* and cited in the CDASUS as belonging to *Palloptera* Fallén. The species was transferred to *Scatella* (Ephydridae) by Edwards (1933).



FIGURES 80–85. Tephritoidea (continued) of Chile: (80) *Aenigmatomyia unipunctatus* Malloch and (81) *Heloparia bicolor* (Walker) (Pallopteridae, photos by Ricardo Varela); (82) *Teretrura tinctipennis* Malloch (Pyrgotidae, photo by Willy Leyton); (83) *Euarestoides acutangulus* (Thomson) (Tephritidae, photo by Valeria Gómez); (84) *Rachiptera limbata* Bigot (Tephritidae, photo by Ani Mari) (85) *Pterotaenia fasciata* Malloch (Ulidiidae, photo by Belén Fernández).

Piophilidae
The family Piophilidae comprises 102 species, grouped into two subfamilies and 20 genera (Muller 2021). Initially, the CDASUS only included one genus present (*i.e*., *Piophila* Fallén), although currently, three species in three genera have been cited, *Piophila* (*P. casei* Linnaeus), *Stearibia* Lioy (*S. nigriceps*), and *Prochyliza* Walker (*P. nigrimana* (Meigen)). All three species have been introduced to Chile (Ozerov & Norrbom 2010).

Pyrgotidae (Fig. 82)
The Pyrgotidae comprises 365 species, grouped into two subfamilies and 55 extant genera (Korneyev 2021). The Teretrurinae includes five genera and are restricted to southern South America (Argentina and Chile) and Oceania. The major contributions to the study of pyrgotids were reported by Korneyev (2016a, b) and Korneyev & Norrbom (2006). For Chile, only two genera of Teretrurinae are known: the monotypic genus *Pyrgotosoma* Malloch, (*P. flavida* Malloch), and *Teretrura* Bigot, which includes *T. flaveola* Bigot and *T. tinctipennis* Malloch (González *et al.* 2021c).

Tephritidae (Figs. 83–84)
The Tephritidae are composed of over 4,800 species, grouped into six subfamilies and 500 genera (Norrbom 2010). Foote (1980), Frías (1984, 1992, 2005), and Frías *et al.* (1993a, b) made several contributions to the knowledge of the family in Chile, which include 70 species assigned to 23 genera (González 2021).

Ulidiidae (Fig. 85)
The Ulidiidae includes over 671 species, grouped into two subfamilies and 108 genera (Pape & Thompson 2020). There are several contributions to the knowledge of the family in Chile especially by Steyskal (1982, 1991) and Frías (1978, 1981). A total of 16 species belonging to nine genera are reported for the country (Mello *et al.* 2024).

VIII. Superfamily Lauxanioidea

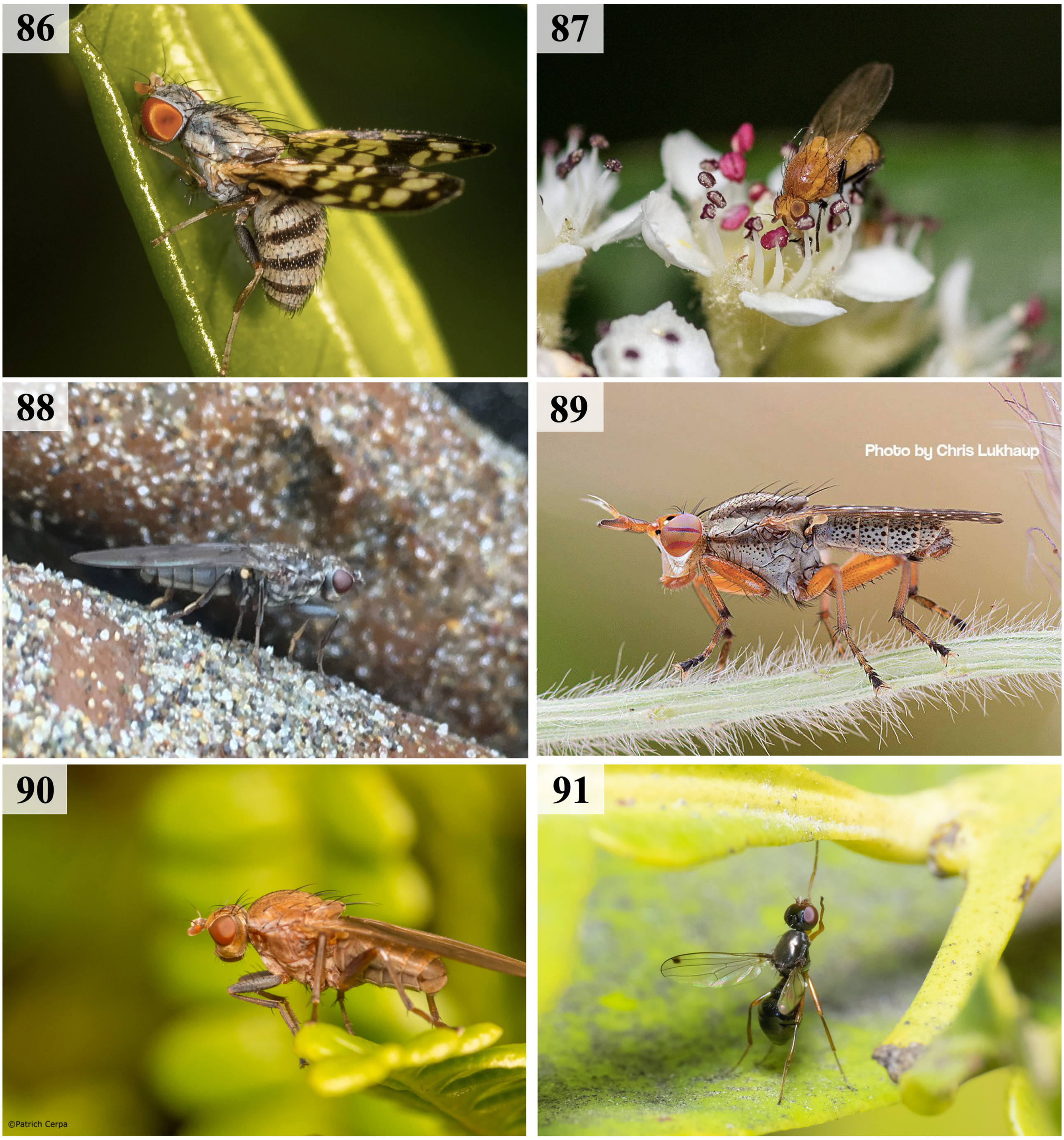
Two of the three Lauxanioidea families are found in Chile; Celyphidae is absent (Gaimari & Silva 2020).

Chamaemyiidae (Fig. 86)
The Chamaemyiidae comprises 335 extant species, grouped into two subfamilies and 28 genera (Gaimari 2012). In Chile, the family comprises 14 species in five genera, including *Leucopis* Meigen and *Ortalidina* Blanchard (Gaimari 2012; Gaimari *et al*. 2024).

Lauxaniidae (Fig. 87)
The Lauxaniidae comprises 2,000 extant species, grouped into three subfamilies and 158 genera (Gaimari & Silva 2010). The family was not treated in the CDASUS. Gaimari & Silva (2020) cataloged Neotropical lauxanids, with a rearrangement of the genera previously referred to for Chile: *Camptoprosopella* Hendel (one species); *Dryosapromyza* Hendel (one species); *Minettia* Robineau-Desvoidy (five species); *Myzaprosa* Gaimari & Silva (four species); *Physegenua* Macquart (one species); *Poecilolycia* Shewell (two species); and *Zamyprosa* Gaimari & Silva (12 species). In Chile, Lauxaniidae comprises 26 species divided into seven genera (Gaimari & Silva 2020).

IX. Superfamily Sciomyzoidea

The Sciomyzoidea currently includes the families Sciomyzidae, Coelopidae, Dryomyzidae, Helcomyzidae, Heterocheilidae, Helosciomyzidae, Huttoninidae, Natalimyzidae and Sepsidae (Wiegmann *et al.* 2011). In Chile, only four of these families are present.



FIGURES 86–91. Lauxanoidea and Sciomyzoidea of Chile: (86) *Ortadilina celullaris* Blanchard (Chamaemyiidae, photo by Anthony Campos); (87) *Zamyprosa* sp. (Lauxaniidae, photo by Luis Candia); (88) *Paractora* sp. (Helcomyzidae, photo by Diego Almendras); (89) *Protodyctia chilensis* (Sciomyzidae, photo by Chris Lukhaup); (90) *Pherbellia philippii* Malloch (Sciomyzidae, photo by Patrich Cerpa), and (91) *Sepsis punctum* (Fabricius) (Sepsidae, photo by Claudio Maureira).

Helcomyzidae (Fig. 88)
The Helcomyzidae is a small family comprising only 13 species worldwide and belongs to three genera (Mathis 2011). The family is found exclusively on seashores in association with rotting kelp. Only *Paractora* Bigot is present in Chile, with *P. antarctica* (Thomson) and *P. angustata* Malloch. There are undescribed species of the family in the Chilean fauna.

Helosciomyzidae

This small family of flies comprises 28 species in 11 genera worldwide (Pereira-Colavite 2013). The family was not treated in the CDASUS. Barnes (1981) transferred *Sciogriphoneura nigriventris* Malloch to the Helosciomyzidae. It was the only species of the family present in Chile, previously included in Dryomyzidae, but Pereira-Colavite (2013) refer to a second undescribed species of the genus in the Valparaíso region.

Sciomyzidae (Figs 89–90)

The Sciomyzidae comprises over 541 species, grouped into three subfamilies and 63 genera (Murphy *et al*. 2022). Recent studies (Marinoni & Mathis 2000; Tóthová *et al*. 2013) have made significant changes to the family system. For Chile, 26 species in 11 genera are cited by Murphy *et al*. (2022), a paper that has a key for the identification of the genera present in Chile.

Sepsidae (Fig. 91)

Sepsids currently comprise more than 317 extant species in 37 genera worldwide (Ozerov 2005), while the Neotropical fauna includes 45 species in 12 genera (Silva 2016). In particular, *Sepsis* Fallén contains approximately 90 described species. Silva *et al*. (2023) reported the first record of the family from Chile, *Sepsis punctum* (Fabricius), considered a recently introduced species.

X. Superfamily Ephydroidea

According to Winkler *et al.* (2022), this superfamily is composed of eight families, including well-known vinegar flies (Drosophilidae) and shore flies (Ephydridae), two of which are present in Chile: Drosophilidae and Ephydridae. This superfamily is one of only a few well-supported superfamilies of acalyptrate flies (Bayless *et al.* 2021).

Drosophilidae (Fig. 92)

The family Drosophilidae comprises over 4,000 extant species, grouped into two subfamilies and 73 genera (Brake & Bächli 2013). Brncić (1983) revised the species of *Scaptomyza* Hardy in Chile, and Brncić & Martínez (1990) updated the species list for the country, now with 36 species known from the genera *Drosophila* Fallén, *Leucophenga* Mik, and *Scaptomyza* Hardy.

Ephydridae (Fig. 93)

The Ephydridae comprises approximately 2,000 species, grouped into five subfamilies and 130 genera (Mathis & Zatwarnicki 1995; Mathis *et al.* 2021). The family in Chile is represented by 18 genera and 73 species since the publication of the CDASUS (Wirth 1968), with the addition of *Neoephydra* Mathis (including species transferred from *Dimecoenia* Cresson) and *Paraephydra* Mathis (Mathis 2008), *Eleleides* Mathis (Mathis 1978), and *Diasemocera girschneri* (von Röder) (Zatwarnicki 2018).

XI. Superfamily Carnoidea

The Carnoidea includes nine families, six of which are represented in Chile.

Braulidae

The family Braulidae comprises seven species in the genera *Braula* Nitzsch and *Megabraula* Grimaldi & Underwood (Grimaldi & Underwood 1986). In Chile, only *Braula coeca* Nitzsch, a kleptoparasitic fly of honeybee colonies that lives associated with adult bees and hive wax, is present. Its importance and damage to honeybees are normally negligible for beekeeping (Büscher *et al.* 2021), and most probably, this is an introduced species.

Canacidae (Fig. 94)

Canacids comprise 321 species, grouped into six subfamilies and 28 genera (Munari & Mathis 2021). McAlpine

(2007) included Tethinidae as a subfamily within the Canacidae. Fifteen species have been reported from Chile, included in the genera *Nocticanace* Malloch, *Masoniella* Vockeroth, *Pelomyia* Williston, and *Tethina* Haliday. Munari (2013) recently described a new species from the Coquimbo Region, *Pelomyia avittata* Munari.

Carnidae

Carnids comprise 127 species in five extant genera (Swann & Stuke 2021). For Chile, only the endemic *Neomeoneurites chilensis* Hennig is cited (Brake 2011). There are no recent taxonomic works that include Chilean species.

FIGURES 92–97. Ephydroidea and Carnoidea of Chile: (92) *Drosophila hydei* Sturtevant (Drosophilidae, photo by Diego Gutiérrez); (93) *Neoephydra araucaria* Mathis (Ephydridae, photo by Claudio Maureira); (94) cf. *Pelomyia crassiseta* Foster & Mathis (Canacidae, photo by Patrich Cerpa); (95) *Thaumatomyia* sp. (Chloropidae, photo by Leonardo Rodríguez); (96) *Cryptochaetum* (*Lestophonus*) *iceryae* (Williston) (Cryptochaetidae, photo by Claudio Maureira), and (97) cf. *Milichiella* sp. (Milichiidae, photo by Juan Mauricio Contreras).

Chloropidae (Fig. 95)
The family Chloropidae comprises more than 3,000 extant species, grouped into four subfamilies and 207 genera (Nartshuk 2012; Riccardi & Amorim 2020), although some authors (Wheeler 2010) have recognized only three subfamilies. Paganelli (2002) provided a key to the identification of genera in the Neotropical Region. For Chile, 18 species in 11 genera are known (Pape & Thompson 2020). Currently, there are no taxonomic studies of the Chilean species of chloropids.

Cryptochetidae (Fig. 96)
The Cryptochetidae comprises over 30 species in two extant genera, *Cryptochetum* Rondani and *Librella* McAlpine (Kirk-Spriggs & Nartshuk 2021). *Cryptochetum* (*Lestophonus*) *iceryae* (Williston) is the only recorded species of this family in Chile, but was not addressed in the CDASUS. This species was introduced to the country to combat the scale insect *Icerya purchasi* Maskell in the 1930s (Koch 1977).

Milichiidae (Fig. 97)
The family Milichiidae comprises 390 species, grouped into two subfamilies and 18 genera worldwide (Brake 2022). Brake (2009) studied the genus *Milichiella* Giglio-Tos in Chile and described new species; there are records for 13 species belonging to five genera: the endemic *Meoneurites chilensis* Hennig, and the cosmopolitan *Desmometopa m-nigrum* (Zetterstedt), *D. singaporensis* Kértesz, *Paramyia nitens* (Loew), and *Milichiella* with many species described and grouped in (1) the *chilensis* group: *M. breviarista* Brake, *M. chilensis* Brake and *M. conventa* Brake; (2) *frontalis* group with *M. concava* (Becker), *M. frontalis* (Becker), and *M. montana* (Becker); (3) *lacteipennis* group with *M. lacteipennis* (Loew) and *M. lucidula* Becker, and a ungrouped species: *M. tricincta* Becker (Sabrosky 1973; Brake 2009).

XII. Superfamily Sphaeroceroidea

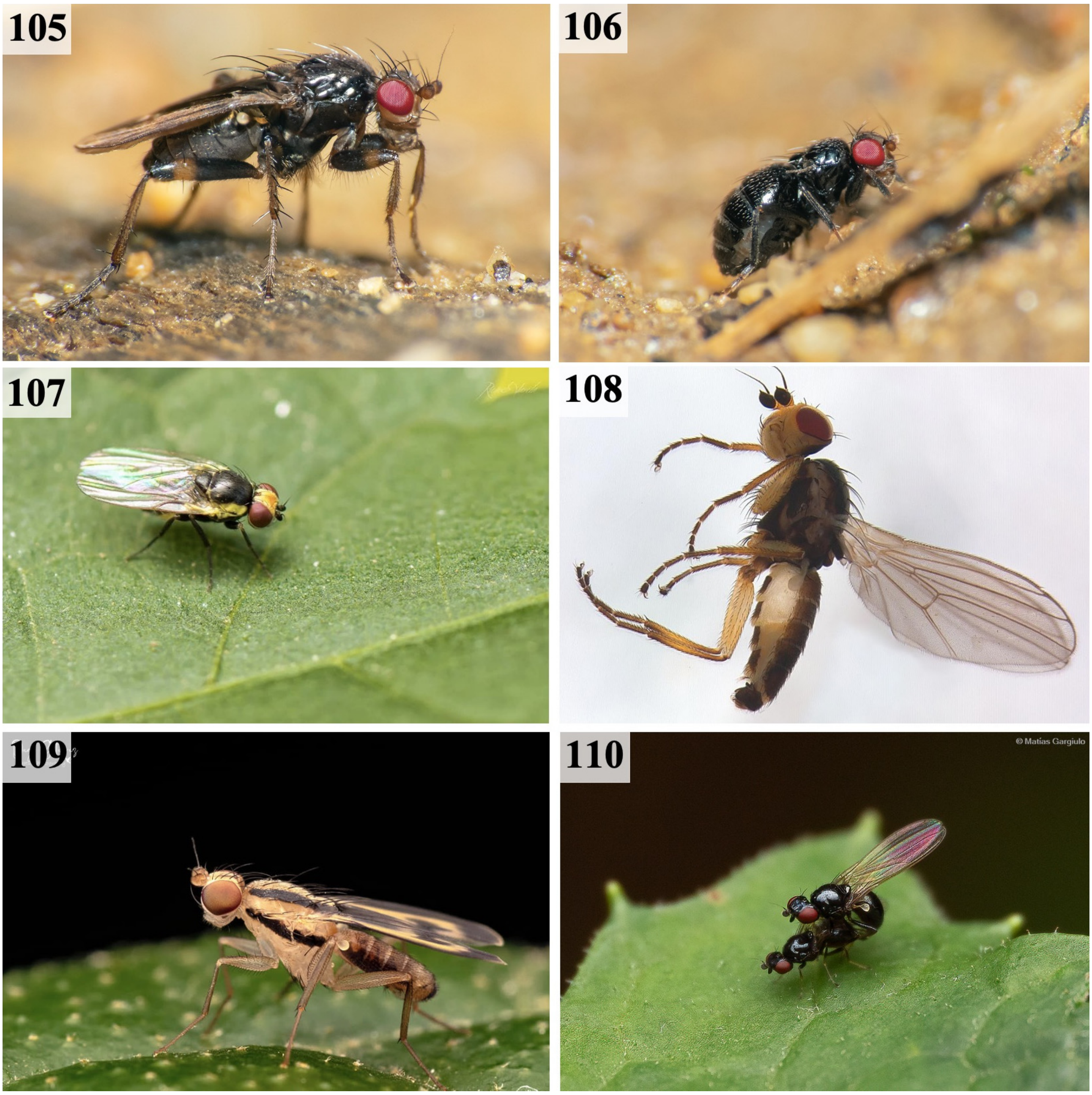
The Sphaeroceroidea contains four families (McAlpine 1989), three of them are known from Chile.

Chyromyidae
The Chyromyidae is a small family of Acalyptratae. The family comprises over 189 species grouped into nine extant genera (Ebejer 2021). Pires do Prado (1984) and Wheeler & Sinclair (1994) published records of species of the genus *Aphaniosoma* Becker for Mexico and Galápagos Islands, respectively. Ebejer (2023) published the first records for the family in Chile, with *Tethysimyia chilensis* Ebejer described from northern Chile.

Heleomyzidae (Figs. 98–104)
The Heleomyzidae is one of the most distinctive and complex schizophoran families in Chile. The family comprises 540 described species grouped into 76 extant genera (Pape *et al.* 2011). Some authors have published Chilean species of heleomyzids (Aldrich 1926; Malloch 1933; McAlpine 1985). Some families with species described from Chile are now included with the Heleomyzidae as Notomyzidae (*Notomyza* Malloch, with *N. abrupta* Malloch, *N. edwardsi* Malloch, and *N. micropyga* Malloch), Trixoscelidae (with *Spilochroa guttata* Macquart), and Cnemosphatidae (with nine species of *Prosopanthrum* Enderlein). No taxonomic studies on Chilean species of Heleomyzidae have been published recently.

Sphaeroceridae (Figs. 105–106)
The sphaerocerids worldwide comprise over 1,550 species, grouped into six subfamilies and 144 genera (Marshall *et al.* 2011), three of which are restricted to the Neotropical Region: Archiborborinae (Kits *et al.* 2013), Tucminae (Marshall 1996) and Homalomitrinae (Roháček & Marshall 1998). The most important contributions to the knowledge of the family in Chile were made by Buck & Marshall (2009), Kits & Marshall (2011), and Marshall *et al*. (2011). There are 15 genera and 62 species presently known from Chile.

FIGURES 98–104. Sphaeroceroidea of Chile, Heleomyzidae: (98) cf. *Tephrochlamys* and (99) *Blaesochaetophora polita* (Malloch) (both photos by Matías Gargiulo); (100) *Blasesochaetophora* cf. *picticornis* (Bigot) (photo by Dalton de Souza Amorim); (101) *Trixoscelis chilensis* (Schiner) (Photo by Gabriela Germain); (102) *Mayomyia diversipennis* Malloch (photo by Dalton de Souza Amorim); (103–104) *Cephodapedon* cf. *fulvicornis* Malloch and a couple mating (Photo by Paulo Lago).



FIGURES 105–110. Sphaeroceridae (continued) and Opomyzoidea of Chile: (105) *Antrops annulatus* (Richards) and (106) *Frutillaria* sp. (Sphaeroceridae, both photos by Claudio Maureira); (107) *Liriomyza* cf. *huidobrensis* (Blanchard) (Agromyzidae, photo by Ricardo Varela); (108) *Cerodontha flavifrons* (Philippi) (Agromyzidae, photo by Dalton de Souza Amorim); (109) *Apiochaeta similis* (Malloch) (Clusiidae, photo by Diego Gutiérrez), and (110) *Schizostomyia* cf. *atra* Malloch (Paraleucopidae, photo by Matías Gargiulo).

XIII. Superfamily Opomyzoidea

The Opomyzoidea contains 13 families (McAlpine 1989), six of which are present in Chile.

Agromyzidae (Figs. 107–108)
The Agromyzidae comprises 3,127 species, grouped into two subfamilies and 16 extant genera (Lonsdale & von Tschirnhaus 2021). In Chile, Aguilera (1972) studied the biology of *Liriomyza langei* Frick, Spencer (1964) studied agromyzids from the Juan Fernández Islands, and Spencer (1982) revised the family and described 23 new species.

Spencer (1982) published the first records for Chile of *Amauromyza* Hendel, *Calycomyza* Hendel, *Galiomyza* Spencer, *Haplopeodes* Steyskal, and *Chromatomyia* Griffiths, and the family now totals 74 species in 12 genera.

Anthomyzidae
The Anthomyzidae comprises 152 species, grouped into two subfamilies and 28 extant genera (Roháček & Barber 2016). For Chile, only five species are cited: *Chamaebosca microptera* Speiser, *Melanthomyza polita* Malloch, two species of *Anthomyia* Fallén, and *Mumetopia interfeles* Rohácek, recently described by Roháček & Tóthová (2021).

Clusiidae (Fig. 109)
The family Clusiidae comprises 636 species, grouped into three subfamilies and 14 extant genera (Lonsdale 2017). Lonsdale & Marshall (2008) revised the genera listed in the CDASUS and synonymized *Alloclusia* Hendel in *Apiochaeta* Czerny. For Chile, only Sobarocephalinae is present, with 15 species in the genus *Apiochaeta*.

Opomyzidae
This small family comprises 55 species worldwide, grouped into three genera (Pape & Thompson 2020; van Zuijlen 2017). For Chile, only one species has been cited, *Opomyza marginipennis* Blanchard (Pape & Thompson 2020).

Paraleucopidae (Fig. 110)
This small family comprises at least 12 species distributed in the Nearctic, Neotropical and Australasian Regions and is grouped into three genera (Wheeler & Sinclair 2019). Previously included in the family Psilidae, Paraleucopidae was erected to family rank by Wheeler & Sinclair (2019), who described several species from different parts of the world into three genera. In Chile, all three genera of the family are represented: *Schizostomyia atra* Malloch, *Paraleucopis bispinosa* Wheeler & Sinclair, and *Mallochianamyia* Santos-Neto, with 11 species (Wheeler 2000; Wheeler & Sinclair 2019).

Teratomyzidae
The Teratomyzidae corresponds to a small family previously included in Anthomyzidae. It comprises 23 species in seven genera worldwide (Rodrigues *et al*. 2016). The group typically has a temperate distribution, known from South America, New Zealand, and Australia, with an extension to the Oriental region. There are two species described from Chile. McAlpine & Keyzer (1994) described *Stepta* McAlpine & Keyzer, including only *S. latipennis* Malloch, which was previously included in the genus *Teratomyza* Malloch. On the other hand, *Teratoptera* Malloch was raised to genus, including only *Teratoptera chilensis* Malloch. Rodrigues *et al.* (2016) and Rodrigues & González (2022) mentioned that both species were endemic to the Chiloé archipelago, but both species have also been found in Puyehue National Park, continental Chile (Dalton S. Amorim, pers. comm.).

Division Schizophora (Calyptratae)
Calyptratae, a monophyletic lineage, one of the most species-rich fly clades grouped ~25,000 described species in ~15 families (Narayanan Kutty *et al.* 2019; Bayless *et al.* 2021). In Chile, this clade is composed of 12 families, 211 genera and 546 valid species (Table 6). Streblidae and Scathophagidae were not treated in the CDASUS, whereas Gasterophilidae and Cuterebridae are currently considered subfamilies of Oestridae. The number of genera and species presented in Chile increased by 31.05% (n = 50) and by 50% (n = 182) respectively, compared to CADSUS.

TABLE 5. Number of genera and species of the Clade Cyclorrhapha, Schizophora (Calyptratae), in CDSASUS and to date in Chile, follows Wiegmann & Yeates (2017). For each fly family, the percentage increase (+) or decrease (–) in the number of genera and species is shown. A symbol (-) is presented when the family was added, no new genera or species were described, and it was synonymized or removed for the Dipterofauna of Chile after the publication of CDASUS.

Family	Nº genera CDASUS	Nº species CDASUS	Nº genera 2023	Nº species 2023	genera (%)	species (%)
Hippoboscidae	5	6	8	10	+60	+66.66
Nycteribiidae	1	1	1	1	-	-

......continued on the next page

TABLE 5. (Continued)

Family	Nº genera CDASUS	Nº species CDASUS	Nº genera 2023	Nº species 2023	genera (%)	species (%)
Streblidae	-	-	1	1	-	-
Anthomyiidae	6	14	6	14	-	-
Fanniidae[a]	-	-	2	16	-	-
Muscidae	32	124	34	144	+6.25	+16.12
Scathophagidae	-	-	1	2	-	-
Calliphoridae	13	24	12	20	–7.69	–20
Oestridae	2	2	3	3	+50	+50
Rhinophoridae[b]	1	1	2	2	+100	+100
Sarcophagidae	14	26	20	69	+42.85	+165.38
Tachinidae	85	144	122	264	+43.52	+83.33
Gasterophilidae[c]	1	1	-	-	-	-
Cuterebridae[d]	1	1	-	-	-	-
Total	**161**	**364**	**211**	**546**	**+31.05**	**+50**

[a]As a subfamily of Muscidae in CDASUS (Pont 1972); [b]As a subfamily of Tachinidae in CDASUS (Guimaraes 1971); [c]Currently as a subfamily of Oestridae (Pape 2010); [d]Currently as a subfamily of Oestridae (Pape 2010).

XIV. Superfamily Hippoboscoidea

Hippoboscoidea comprises four ectoparasitic dipteran lineages—Hippoboscidae, Nycteribiidae, Streblidae, and Glossinidae, the latter is absent in Chile. The Glossinidae are the only free-living ectoparasites, while the other three families are obligate ectoparasites. They share morphological characteristics such as tarsomeres with stout claws adapted for clinging and pulvilli pad-like with microstructures to promote adhesion. Eyes and ocelli are absent. The presence of wings is variable within the lineage, and they may always be present, shed after finding a suitable host, or being wingless (Dittmar *et al*. 2015).

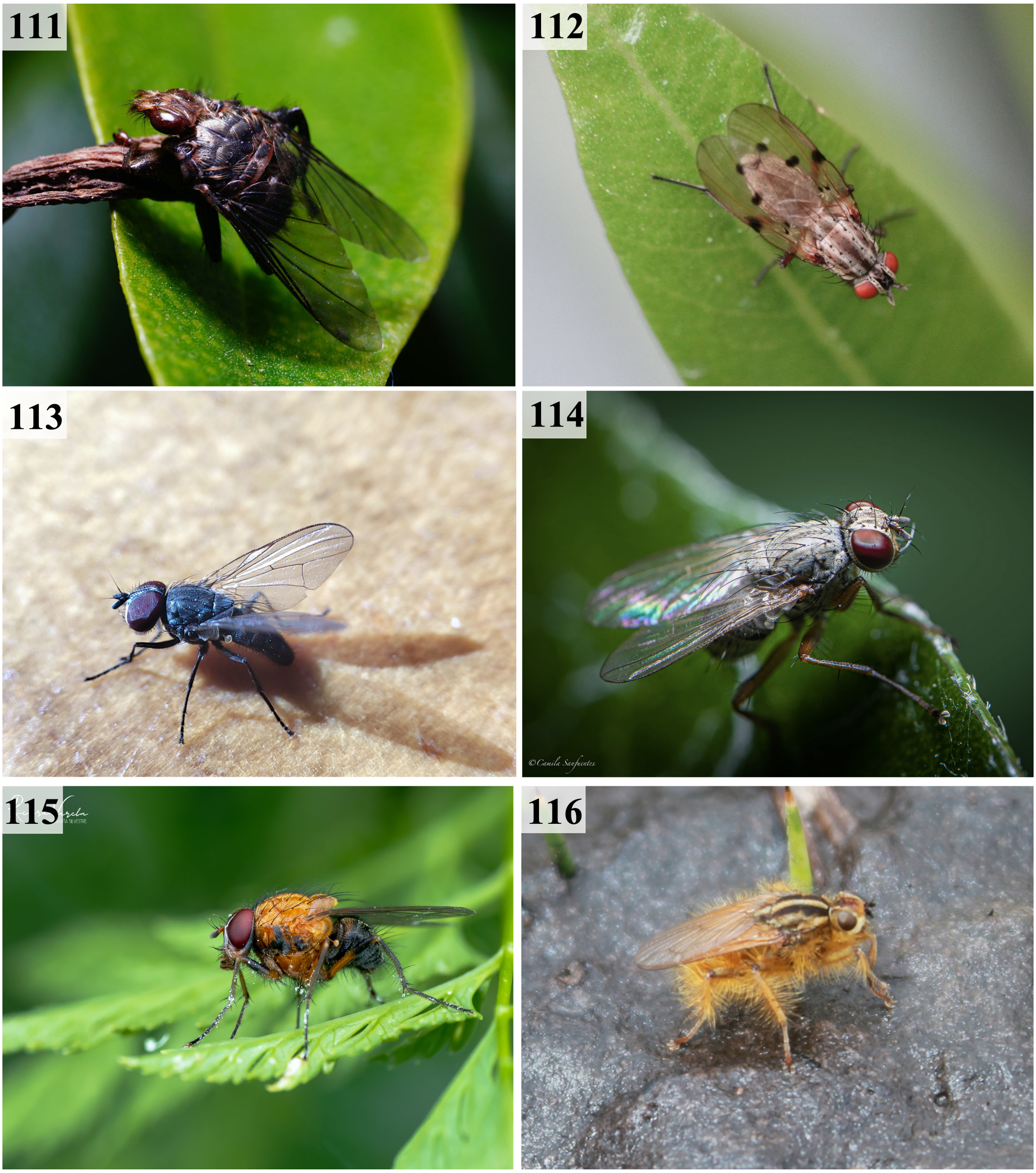
Hippoboscidae (Fig. 111)
The family Hippoboscidae comprises approximately 200 species, grouped into three subfamilies and 21 extant genera (Maa 1969), two of which are known from the Neotropical Region (Wood 2010). Bequaert (1934) published one of the first lists of the species of Chile. Chile has ten species in eight genera, as listed by Guimarães (1968) and Maa (1969). *Lipoptena pudui* Peterson & Maa was described (Peterson & Maa 1970) after the publication of the CADSUS.

Nycteribiidae
The Nycteribiidae comprises approximately 274 species, grouped into three subfamilies and 11 extant genera (Graciolli & Dick 2006). Only one species is listed from Chile, *Basilia silvae* (Brèthes) (Guimarães 1968; Graciolli *et al.* 2007).

Streblidae
Streblids comprise 229 species, grouped into five subfamilies and 33 genera (Dick & Patterson 2006; Dick & Miller 2010). Only the species *Trichobius parasiticus* Gervais has been reported for Chile (Guerrero 1997).

XV. Superfamily Muscoidea

Members of Muscoidea are ecologically diverse and many play essential roles in decomposition and nutrient cycling by feeding on decaying organic matter. However, some species can also pose a nuisance or be vectors of disease**.** Narayanan Kutty *et al*. (2008) have suggested that the Muscoidea is paraphyletic. Although the monophyly of the families Fanniidae, Muscidae, and Scathophagidae have been supported, the phylogenetic relationship of the family Anthomyiidae has been more uncertain. The Muscoidea includes more than 7,000 species distributed in all biogeographic regions.



FIGURES 111–116. Hippoboscoidea and Muscoidea of Chile: (111) Hippoboscidae (photo by Adrián Trigos); (112) *Anthomyia punctipennis* Wiedemann (Anthomyiidae, photo by Liliana de Marchi); (113) *Fannia* sp. (Fanniidae, photo by Felipe Karelovic); (114) cf. *Coenosia attenuata* Stein (Muscidae, photo by Camila Sanfuentes); (115) *Palpibrachus* sp. (Muscidae, photo by Ricardo Varela), and (116) *Scathophaga tropicalis* Malloch (Scathophagidae, photo by Natalia Gutiérrez).

Anthomyiidae (Fig. 112)
The family Anthomyiidae comprises approximately 2,000 species, grouped into 40 extant genera (Michelsen 2010; Gomes *et al.* 2021). Gomes *et al.* (2018) cited three genera and four species for the Juan Fernández Islands, while

Gomes & Carvalho (2022) present a revision of *Calythea* Schnabl & Dziedzicki providing a key to the Neotropical species where they include a species present in Chile, *C. comis* (Stein). Fourteen anthomyiid species in six genera are known from Chile (Pape & Thompson 2020).

Fanniidae (Fig. 113)
The Fanniidae comprises approximately 541 species grouped into four extant genera (Savage 2010). It was earlier ranked as a subfamily of Muscidae, treated as family rank for various more recent studies (Roback 1951; Griffiths 1972; Pont 1977). A total of 16 species are known from Chile and are placed in two genera, *Euryomma* Stein and *Fannia* Robineau-Desvoidy (Carvalho *et al.* 2003).

Muscidae (Figs. 114–115)
The Muscidae comprises about 6,000 species worldwide, grouped into seven subfamilies and 180 extant genera (Grzywacs *et al.* 2021). A series of changes have recently been proposed for the suprageneric classification of the family based on molecular studies (Grzywacs *et al.* 2021). Several authors have recently contributed to the knowledge of families in Chile, particularly for the genera *Psilochaeta* Stein and *Dalcyella* Carvalho (Carvalho 1989) *Apsil* Malloch (Couri 2002, 2003); *Notoschoenomyza* Malloch (Couri & Marques 2004), *Palpibracus* Rondani (Couri & Penny 2006), *Brachygasterina* Macquart (Couri *et al.* 2007), *Coenosia* Meigen (Couri & Salas 2010; Patitucci *et al*. 2020, 2021), and *Helina* Robineau-Desvoidy (Patitucci *et al.* 2016). For Chile, 144 species grouped into 34 genera are listed by Carvalho *et al.* (2005).

Scathophagidae (Fig. 116)
The family Scathophagidae comprises approximately 500 species, grouped into two subfamilies and 66 extant genera (Vockeroth 2010). The family was not treated in the CDASUS. For Chile, only two species are cited, *Scatophaga chilensis* (Albuquerque) and *S. tropicalis* Malloch (González & Henry 1989; Bernasconi & Šifner 2021).

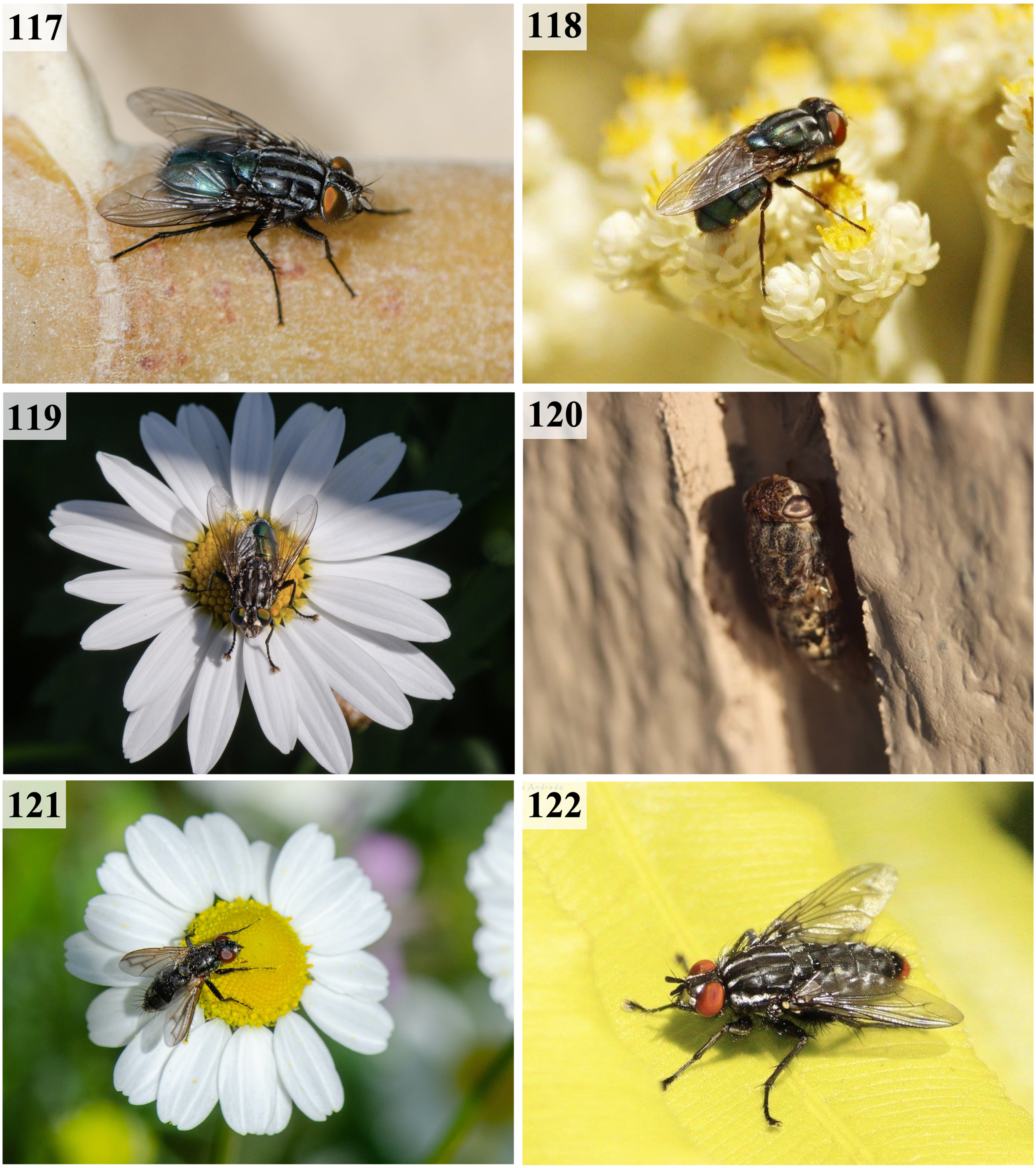
XVI. Superfamily Oestroidea

Oestroidea belongs to a group of families often accepted as monophyletic and comprises over 15,000 species (Narayanan Kutty *et al.* 2019). Family level relationships within the monophyletic Oestroidea remain controversial, especially as Calliphoridae were clearly recovered as not monophyletic.

Calliphoridae (Figs 117–119)
The Calliphoridae in the delimitation of Nasser *et al.* (2021) comprises approximately 1,500 extant species, grouped into 11 subfamilies and over 100 genera. Some studies have improved knowledge of the relationships of the smaller clades included with Calliphoridae by using molecular data (Singh & Wells 2013; Marinho *et al.* 2016) as well as morphological data (Peris 1992; Whitworth 2012, 2014). For Chile, 20 species are cited in 12 genera (González *et al.* 2017b).

Oestridae (Fig. 120)
The oestrids comprise more than 166 species, grouped into four subfamilies and 63 extant genera (Pape *et al.* 2011). Taxa previously dealt with at the family rank (Gasterophilidae, Cuterebridae, Oestridae, and Hypodermatidae) are now assigned as subfamilies within Oestridae (Pape 2001, 2010a). For Chile, three species grouped into three genera have been cited, *Oestrus ovis* (Linnaeus), *Dermatobia hominis* (Linnaeus) recorded from imported animals and *Gasterophilus nasalis* Linnaeus recorded from horses (Guimarães, 1967; Alcaíno & Gorman 1999). Two other species, *Hypoderma bovis* (Linnaeus) and *Hypoderma lineatus* (Villers), were introduced, but have been eradicated in the country (Alcaíno & Gorman 1999).

Rhinophoridae (Fig. 121)
The family Rhinophoridae comprises 182 extant species, grouped into 37 genera (Pape & Arnaud 2001; Pape 2010b; Cerretti *et al.* 2020). The exotics *Melanophora roralis* (Linnaeus) and *Stevenia deceptoria* (Loew) are the only species cited from Chile (González 1998; Barahona-Segovia *et al*. 2024).

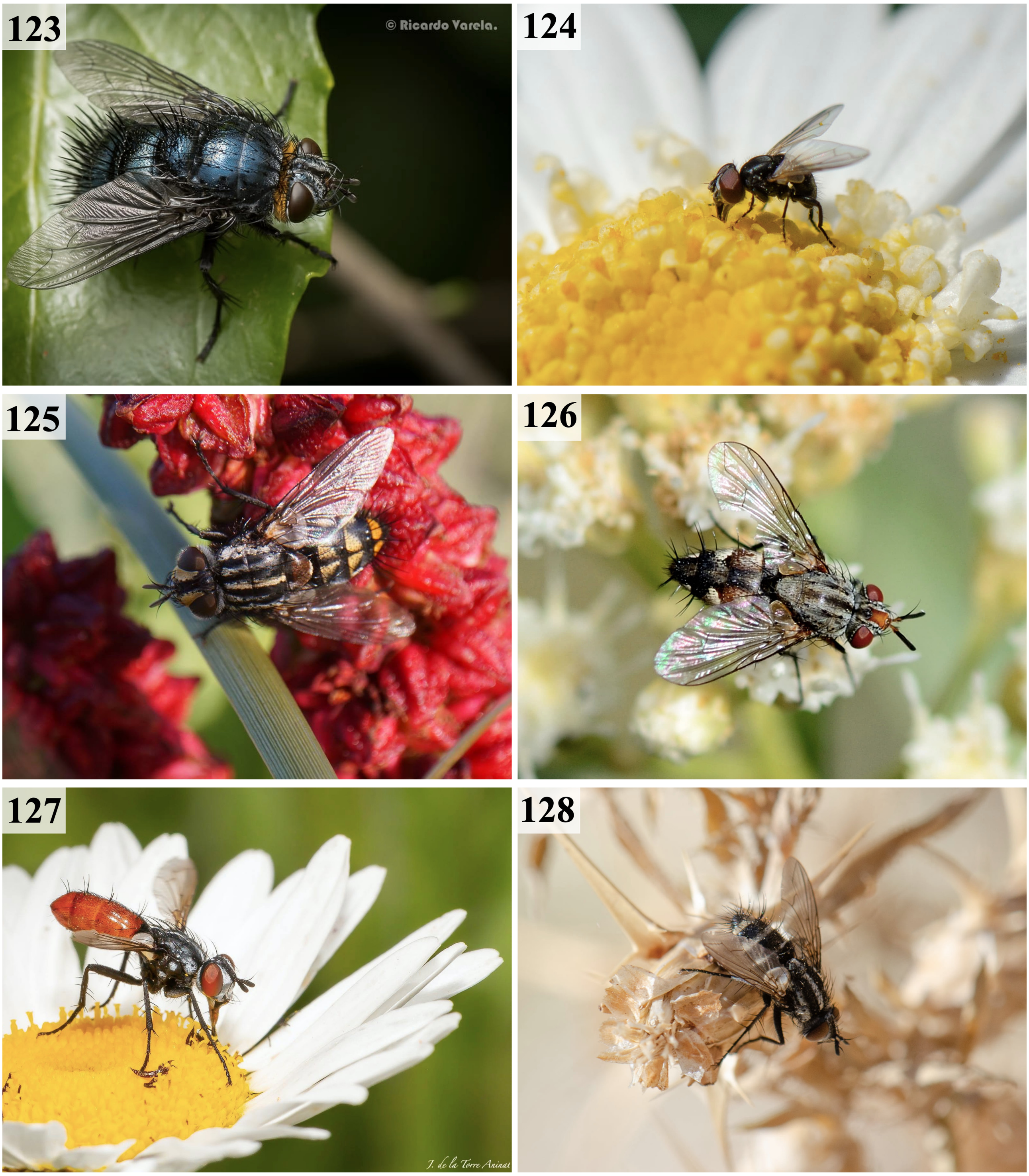


FIGURES 117–122. Oestroidea of Chile: (117) *Sarconesiopsis magellanica* Le Guillou (Calliphoridae, photo by Gabriela Germain); (118) *Cochliomyia macellaria* (Fabricius) (Calliphoridae, photo by Patricia Medina); (119) *Sarconesia chlorogaster* Wiedemann (Calliphoridae, photo by Gabriela Germain); (120) *Oestrus ovis* Linnaeus (Oestridae, photo by Jonathan Zavala); (121) *Stevenia deceptoria* (Loew) (Rhinophoridae, photo by Gabriela Germain), and (122) *Arachnidomyia travassosi* Tibana & Mello (Sarcophagidae, photo by Patricia Medina).

Sarcophagidae (Figs. 122)

The Sarcophagidae comprises approximately 2,700 species, grouped into three subfamilies and over 108 genera (Pape 1996; Pape & Dahlem 2010). The monophyly of this family has been well established based on molecular studies (Yan *et al.* 2021). Several authors have contributed to the knowledge of the family in Chile, such as Lopes

& Tibana (1982) and Mulieri *et al.* (2015). Currently there are 69 species in 20 genera are cited from the country. There is no updated catalog for Sarcophagidae in Chile.



FIGURES 123–128. Tachinidae of Chile: (123) *Edwynia robusta* (Aldrich) (Tachinidae, photo by Ricardo Varela); (124) *Phasia* sp. (Tachinidae, photo by Gabriela Germain); (125) *Drino insignis* (van der Wulp) (Tachinidae, photo by Fernando Tellez); (126) *Epicoronimyia mundelli* (Blanchard) (Tachinidae, photo by Matías Cortés); (127) *Cylindromya porteri* (Brèthes) (Tachinidae, photo by Jorge de La Torre Aninat), and (128) cf. *Incamyia chilensis* Aldrich (Tachinidae, photo by Gabriela Germain).

Tachinidae (Figs. 123–128)

The family Tachinidae comprises almost 8,600 extant species, grouped into four subfamilies and over 1,500 genera (O'Hara *et al.*, 2020). Recent molecular studies have provided new proposals for subfamily classification and relationships of Tachinidae (Stireman *et al.* 2006, 2019). Cortés & Hichins (1969, 1979), Cortés & Campos (1971, 1974), Cortés (1986), and Cortés & González (1989) made important contributions to the knowledge of the family in Chile. There are 264 species grouped in 122 genera cited for Chile (O'Hara *et al.* 2021).

The Diptera fauna from Chile and biogeographical patterns

New branching events along the unfolding of a phylogeny occurs in parallel to changes in the geographic distribution of species. In some cases, the area occupied by a species is separated by vicariance; in other cases, pre-existing barriers disappear, and the species remains in a metapopulation; sometimes, a subpopulation moves across an existing barrier and colonizes unoccupied areas (Croizat 1958, 1964). This combination of the underlying processes of phylogeny and biogeographical evolution produces local patterns of biotic composition, in which clades of different ages are in sympatry. This means that the composition of any biota corresponds to a mixture of elements from different biogeographical layers (Amorim *et al*. 2009).

Lands that belonged to the southern end of Gondwana (e.g., southern Africa, but in most cases New Zealand, southern South America, and Australia) correspond to clear examples of this biotic overlap of layers. It is well documented that many changes in the composition of the flora and fauna of southern Gondwana occurred between the late Jurassic and the Cenozoic, resulting in the present extant biotic diversity in the southern temperate islands and continents (see, e.g., Amorim *et al.* 2009; Almeida *et al.* 2012; Lessard *et al.* 2013). Almost the entire evolution of angiosperms and an important part of the diversification of conifers, hexapods, arachnids, and fungi took place since the Jurassic, gradually changing the biotic composition in this part of the globe.

The biogeographic nature of Chilean biodiversity has attracted the attention and interest of scientists, even before the theory of biological evolution. For example, Joseph D. Hooker (1844–1845, 1845–1847, 1853, 1860) described the plants collected in the Erebus expedition to Tasmania, New Zealand, parts of South America, and other circum-Antarctic areas, with comments on the similarities between these floras. Chile is particularly complex in terms of its environmental diversity. There are deserts in the north and temperate rainforests in the south, with a variety of specialized environments in between, of which forests with *Araucaria* at mountain tops along a restricted latitudinal range is an example. The present composition of the Chilean biota includes animals, plants, and fungi clades that originated at different stages of the Mesozoic and Cenozoic. Among plants and animals, there are elements typical of the early existence of Gondwana, the "Temperate transantarctic track" of Cranston (2005), a late Jurassic layer, elements of a more typical Cretaceous layer, and Cenozoic elements (both fitting Cranston's "Temperate amphinotic track"). The Cretaceous and Cenozoic layers have biogeographical patterns that connect southern South America with New Zealand/Australia, or only with the latter. This means that connections of southern South America with Africa and New Zealand, not properly explained by secondary occupation, do not belong to the same layer as the cases of disjunction of southern South America with Australia (Amorim *et al*. 2009).

Most studies on the biogeographical distribution of elements of Chilean fly fauna (e.g., Croizat 1958, 1964; Monrós 1958; Hennig 1960; Kuschel 1960; Crisci *et al*. 1991a, b; Craw 1989; Cranston 2005) have concentrated on older (*i.e*., Gondwanan) biotic connections. Morrone (*e.g*., 1996a, b, 2015) and Posadas *et al*. (1997) clarified the connections of Chilean fauna with other southern South American areas and with elements in more northern areas along the Andes. In Kuschel's (1960) important early general study on Chilean fauna, connections of elements of the Valdivian Forest with Holarctic and southern Brazilian elements are included, in addition to the usual relationships with other southern cold-temperate areas (including many cases of groups also present in Africa). Hennig (1960, 1964) also carefully considered the connections of Chilean fly fauna with Australia and New Zealand.

A biogeographical layer does not correspond to the age of the disjunction of a clade into its smaller geographically separate components. A set of elements of a given layer in one region connects with corresponding elements in another region to constitute what Croizat (1958, 1964) called a biogeographical trait (see, e.g., Cranston 2005). The age of a biogeographical layer, hence, corresponds to the time of occupation of the ancestral species of a disjunct clade over its entire original range, later split into separate areas in cases of vicariance, or from which a subclade later spread to another area.

Some examples clarify this concept. Along the evolution of the subfamily Bombyliinae, the clade (Adelidini + Nothoschistini) belongs to an Early Jurassic layer, even though the separation of the Adelidini (mostly in Africa) from its sister-group, the Nothoschistini (mostly in South America) may have occurred in the Late Jurassic (Li & Yeates 2019). In the evolution of the apoid family Colletidae, the South American subfamily Xeromelissinae is sister to the Australian clade (Callomelittinae + Hylaeinae) and the Neopasiphaeinae have elements both in Australia and South America (Almeida *et al*. 2012). The Colletidae as a whole is supposed to have originated late in the Cretaceous, and the Neopasiphaeinae, is assumed to have originated in the early Eocene, while the disjunction between the Australian and the South American groups occurred only in the Late Eocene due to vicariance along the final separation of the plates at the southern-most end of Gondwana (South America, Antarctica and Australia).

There is still insufficient information to classify the entire Chilean fly fauna into layers. This requires phylogenies for all families down to the genus/species level, fossil data for most clades below the family level, age of clade divergence based on molecular inferences, and geographic sampling across the country. Nevertheless, there are an important number of well-known cases that can be associated with these layers from the Jurassic to Cenozoic. When additional, more detailed reconstructions of the evolution of all fly families become available, it may be possible to split these general layers into even smaller sublayers (e.g., Lower and Upper Jurassic, Lower, Mid and Upper Cretaceous, Palaeocene, Eocene etc.).

We compiled here in (Table 6), connections of elements of the Chilean fly fauna with elements in Laurasia, Africa, New Zealand and Australia, as well as in other areas in South America (southern Argentina, southern Brazil, and northward along the Andes, in some cases reaching North America). Groups in Chile with connections to tropical areas in South America also correspond to a layer, less explored in the literature, and are mentioned here. Some cases of recently introduced species (the latest layer in the fauna) are mentioned. The main difference between the data below (Table 6) and previously published compilations (e.g., Kuschel 1960; Hennig 1964) is that: (1) the information now available on phylogeny, fossils, age of divergence based on molecular data, and geology allows us to better understand the origin of dipteran groups and to discriminate to which layers cases of disjunction belong to; (2) cases of connections with other temperate and tropical areas in South America are highlighted. This allowed the consideration of most fly families in the process of understanding the composition of the fauna.

TABLE 6. Summary of zoogeographical patterns between Chilean fly fauna and other Gondwanan and South American genera and species. Each example provided also associated with a geological layer where the fly family originates.

Family	Example of taxon in Chile (or southern Argentina)	Taxon (disjunct areas)	Geological layer	Reference
Trichoceridae	*Paracladura* group *chilensis*	*Paracladura* group *antipoda* (New Zealand)	Cretaceous	Krzemińska 1992, 2001
Cylindrotomidae	*Stibadocerina chilensis* Alexander (1 species)	*Stibadocerodes* (Australia), *Stibadocera* (Papua New Guinea), *Stibadocerella* (SE Asia)	Cretaceous	Ribeiro (2009)
Limoniidae	*Gynoplistia* Westwood (31 species)	*Gynoplistia*—overall, 314 species (Australia, New Zealand, Papua New Guinea	Cretaceous	Ribeiro (2008); Oosterbroek (2023)
Pediciidae	*Tricyphona* Zetterstedt (8 species)	*Tricyphora* species (Australia, New Zealand, Holarctic)	Cretaceous	Podenas (2001)
Tipulidade *s.s.*	*Ischnotoma* Skuse (19 species)	*Ischnotoma*—32 other species (Australia, Argentina, southern Brazil)	Mid Cenozoic	Oosterbroek (2023)
Chironomidae	*Parochlus* group *araucanus*	*Parochlus* group *araucanus* (New Zealand and Australia)	Cretaceous	Cranston (2006)
Dixidae	*Nothodixa* Edwards (4 species)	*Nothodixa* species—6 species (New Zealand, Australia)	Cretaceous	Edwards (1930); Belkin (1968)
Canthyloscelidae	*Canthyloscelis* (*Araucoscelis*) Edwards (3 species)	*Canthyloscelis* (*Canthyloscelis*)—6 species (New Zealand)	Pangean	Hutson 1977; Amorim 2000

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TABLE 6. (Continued)

Family	Example of taxon in Chile (or southern Argentina)	Taxon (disjunct areas)	Geological layer	Reference
Thaumaleidae	*Austrothaumalea* Tonnoir (4 species)	*Austrothaumalea*—New Zealand (11 species), Australia (27 species)	Cretaceous	Edwards (1930); Pivar *et al.* (2020, 2021)
	Niphta Theischinger (11 species)	*Niphta*—3 species (Australia)	Mid Cenozoic	Pivar *et al.* (2018, 2020, 2021)
Perissommatidae	*Perissomma congrua* Colless	*Perissomma* spp.—5 species (Australia)	Mid Cenozoic	Colless (1962, 1969)
Anisopodidae	*Lobogaster paradoxus* Philippi	*Carreraia*—1 species (Holarctic Cretaceous fossils, Southern Brazil)	Cretaceous	Edwards (1930); Corrêa (1947); Amorim & Tozoni (1994); Elgueta *et al*. (2019)
Ditomyiidae	*Nervijuncta conjuncta* Freeman	*Nervijuncta laffooni*—(Brazil), *Nervijuncta* 16 spp. (New Zealand)	Cretaceous	Tonnoir & Edwards 1927; Freeman 1951; Lane 1952; Falaschi & Amorim 2009
	Australosymmerus (*Australosymmerus*) *stigmaticus* (Philippi)	*Australosymmerus* (*Australosymmerus*) spp.—3 species (New Zealand)	Mid Cenozoic	Munroe 1974
	Australosymmerus (Crionisca) magellani Munroe	*Australosymmerus (Crionisca)*—2 species (Australia)	Mid Cenozoic	Munroe 1974
Rangomaramidae	*Ohakunea* Tonnoir & Edwards (1 species)	*Ohakunea*—Southern Brazil (1 undescribed), Australia (1 species), Australia/New Zealand (1 species), Papua-New Guinea (2 species), New Zealand (1 species)	Mid Cenozoic	Tonnoir & Edwards 1927; Colless 1963; Jaschhof & Hippa 2003; Amorim & Rindal 2007
	Colonomyia Colless (4 species)	*Colonomyia*—Southern Brazil (1 species), Costa Rica (1 species), Australia (1 species), Papua-New Guinea (1 species)	Mid Cenozoic	Colless (1963); Matile & Duret (1994); Hippa & Jaschhof (2004); Amorim & Rindal (2007)
Mycetophylidae	*Allocotocera* Mik (2 species)	*Allocotocera*—Southern Brazil (2 species), New Zealand (4 species), Australia (undescribed), PA (3 spp), NE (2 spp.)	Cretaceous	Matile 1989; Oliveira & Amorim 2014
	Aneura Marshall (4 species)	*Aneura*—11 species (New Zealand)	Cretaceous	Matile 1989; Borkent & Wheeler 2013; Oliveira & Amorim 2014
	Eudicrana Loew (3 species)	*Eudicrana*—Southern Brazil (2 species), Andes (2 species), Australia (3 species), PA (2 species)	Mid Cenozoic	Matile 1989; Borkent & Wheeler 2013; Oliveira & Amorim 2014
	Neoaphelomera Miller (3 species)	*Neoaphelomera*—Southern Brazil (1 species), New Zealand (7 species), Australia (1 species)	Mid Cenozoic	Matile 1989; Borkent & Wheeler 2013; Oliveira & Amorim 2014

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TABLE 6. (Continued)

Family	Example of taxon in Chile (or southern Argentina)	Taxon (disjunct areas)	Geological layer	Reference
	Paratrizygia Tonnoir (4 species)	*Paratrizygia*—1 species (Australia)	Mid Cenozoic	Matile 1989; Borkent & Wheeler 2013; Oliveira & Amorim 2014
	Parvicellula Marshall (2 species)	*Parvicellula*—Southern Brazil (1 species), New Zealand (9 species), Panama (1 species)	Cretaceous	Matile 1989; Borkent & Wheeler 2013; Oliveira & Amorim 2014
	Duretophragma Borkent (5 species)	*Duretophragma*—Southern Brazil (4 species), Andes (3 species); *Stenophragma*—Australia/New Caledonia (4 species)	Mid Cenozoic	Matile 1989; Borkent & Wheeler 2013; Oliveira & Amorim 2014
	Paraleia Armbruster (7 species)	*Paraleia*—Andes (9 species), Australia (1 species)	Mid Cenozoic	Oliveira & Amorim 2012, 2014
Scatopsidae	*Diamphidicus chilensis* Cook	*Diaphidicus australis* Cook (Australia)	Mid Cenozoic	Cook (1971); Amorim (1989)
	Neorhegmoclemina Cook (2 species)	*Neorhegmoclemina* (Neotropical, Nearctic)	Late Cenozoic	Amorim (1982)
Austroleptidae	*Austroleptis* Hardy (5 species)	*Austroleptis*—Southern Brazil (2 species), Australia (3 species)	Mid Cenozoic	Hardy (1920); Nagatomi & Nagatomi (1987); Fachin *et al*. (2018, 2020)
Tabanidae	Scionini—*Scaptia*	Other Scionini genera (South America, Australia, New Zealand)	Mid Cenozoic	Lessard *et al*. 2013
Stratiomyidae	*Hylorops philippii* Enderlein	*Hylorops*—Australia (2 species)	Mid Cenozoic	Lessard *et al.* 2020
Acroceridae	*Arrhynchus*, *Archipialaea*	*Corononcodes*—South Africa; *Ocnaea* and *Exetasis*—Andes and Costa Rica; *Rhysogaster*—Oriental	Jurassic	Schlinger 1959
Apioceridae	*Apiocera* (*Anypenus*) *philippii* Brèthes	*Apiocera (Ripidosyrma)*—South Africa; *Apiocera* (*Apiocera*)—Australia	Jurassic	Yeates & Irwin 1996
Mydidae	*Megascelus* (5 species)	*Tongamya*—South Africa (2 species); *Neorhamphiomidas* (7 species)—Australia	Jurassic	Yeates & Irwin 1996
Therevidae	(*Entesia* Oldroyd + *Melanothereva* + *Pachyrrhiza* Philippi)	Other Agapophytinae genera (Australia, New Zealand, Fiji, New Caledonia, New Guinea, Eastern Indonesian archipelago)	Cenozoic	Winterton *et al.* 2016
Hybotidae	*Isodrapetis meridionalis* Sinclair & Cumming (+ 1 undescribed species)	*Isodrapetis* Collin—New Zealand (8 species)	Cretaceous	Collin (1928); Plant (1999); Sinclair & Cumming (2013)
Brachystomatidae	*Gondwanamyia chilensis* Cumming & Saigusa	*Gondwanamyia zealandica* Sinclair & Brooks—New Zealand	Jurassic	Sinclair *et al*. 2016; Amorim *et al*. 2022
Homalocnemidae	*Homalocnemis* (2 species)	*Homalocnemis*—New Zealand (4 species), Namibia (1 species)	Jurassic	Chvála (1991)

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TABLE 6. (Continued)

Family	Example of taxon in Chile (or southern Argentina)	Taxon (disjunct areas)	Geological layer	Reference
Empididae	*Proagomyia torrentium* Collin	*Proagomyia*—Australia (undescribed species)	Cenozoic	Sinclair (1995)
	Empidadelpha sobrina Collin	*Empidadelpha*—New Zealand (3 species)	Cretaceous	Collin (1928, 1933); Smith (1964)
Ragadidae	*Hydropeza* Sinclair, 1999 (1 species)	*Hydropeza*—New Zealand (10 species), Australia (9 species)	Cretaceous	Sinclair (1999); Sinclair & McLellan (2004); Sinclair (2016)
Opetiidae	*Puyehuemyia chandleri* Amorim *et al.*	*Opetia*—Europe (1 species), Japan (2 species)	Jurassic	Chandler (2001); Amorim *et al*. 2018
Phoridae	*Archiphora*—1 species	*Sciadocera*—New Zealand, Australia / *Sciadocera*-like Holarctic Cretaceous fossils	Cretaceous	Hennig (1964); Brown (2007); Grimaldi (2018)
Pipunculidae	*Protonephrocerus*—2 species	Eocene Baltic and Colorado fossil *Metanephrocerus* (4 species)	Mid Cenozoic	Skevington & Yeates (2000); Archibald *et al*. (2014)
Agromyzidae	*Cerodontha* Rondani	*Cerodontha*—over 280 species worldwide	Late Cenozoic	Boucher (2010)
Canacidae	*Nocticanace chilensis* Malloch	*Nocticanace*—35 species worldwide	Late Cenozoic	Munari & Mathis (2010)
Tethininae	*Pelomyia* Hendel (9 species)	*Pelomyia*—28 species (West South America, Central America, Nearctic)	Late Cenozoic	Munari & Mathia (2010)
Chamaemyiidae	*Ortalidina* Blanchard (5 species)	*Ortalidina*—overall, 17 species (Argentina, southern Brazil, Ecuador, Caribbean, El Salvador, southeast USA)	Late Cenozoic	Gaimari (2012)
Chloropidae	*Diplotoxa rufomarginata* Duda, 1930	*Diplotoxa*—8 species (worldwide)	Late Cenozoic	Malloch (1934a); Sabrosky & Paganelli (1984); Nartshuk (2012)
Clusiidae	*Apiochaeta* Czerny (17 species)	Other Sobarocephalinae (tropical Neotropical)	Late Cenozoic	Lonsdale (2017)
Drosophilidae	*Scaptomyza* Hardy (7 species)	*Scaptomyza*—273 species worldwide (including one Dominican amber fossil)	Late Cenozoic	Brncic (1983); Brake & Bächli (2013)
Ephydridae	*Neoephydra* Mathis (13 species)	*Neoephydra* spp.—4 other species (Argentina, Brazil, Bolivia, Peru, Ecuador)	Late Cenozoic	Mathis & Marinoni (2016)
Helcomyzidae	*Paractora* spp. (5 species in southern South America)	*Paractora* spp.—3 other species (Crozet Island, Macquarie Island, Marion Island)	Late Cenozoic	Malloch (1933); Mathis (2011)
Heleomyzidae	*Dioche kooi* McAlpine	*Pentachaeta physopus* McAlpine (Australia)	Mid Cenozoic	McAlpine (1985)
Helosciomyizidae	*Sciogriphoneura nigriventris* Malloch	*Sciogriphoneura brunnea* Steyskal (southern Brazil), other helosciomyzid genera (Australia)	Mid Cenozoic	McAlpine (2012); Pereira-Colavite (2015)
Lauxaniidae	*Dryosapromyza pirioni* (Malloch)	*Dryosapromyza gigas* (Schiner)	Late Cenozoic	Gaimari & Silva (2020)
Lonchaeidae	*Lonchaea* (3 species)	*Lonchaea*—235 species (worldwide)	Late Cenozoic	Norrbom & Korytkowski (2009)

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TABLE 6. (Continued)

Family	Example of taxon in Chile (or southern Argentina)	Taxon (disjunct areas)	Geological layer	Reference
Milichiidae	*Milichiella* Giglio-Tos (5 species)	other *Milichiella*—41 extant species, 7 Dominican amber species	Late Cenozoic	Brake (2009)
Pallopteridae	*Aenigmatomyia unipunctata* Malloch	other Pallopteridae genera (worldwide)	Late Cenozoic	Malloch (1933); Papp (2011), questionably connected to true pallopterids
Paraleucopidae	*Mallochianamyia nigrohalterata* (Malloch) and *Schizostomyia* Malloch	*Paraleucopis* Malloch—9 species (southwestern United States, northwestern Mexico)	Late Cenozoic	Wheeler & Sinclair (2019)
Pseudopomyzidae	*Heloclusia imperfecta* Malloch	*Heloclusia flavitarsis* Harrison (New Zealand), *Heloclusia antipoda* Harrison (Australia)	Late Cenozoic	Malloch (1933); Harrison (1955, 1959)
Pyrgotidae	Teretrurinae Malloch (2 genera, 3 species)	other Teretrurinae—3 genera, 8 species (Oceania)	Late Cenozoic	Malloch (1933); González *et al.* (2021)
Sciomyzidae	*Protodictya* Malloch (1 species)	other *Protodictya*—7 species (tropical Neotropical region)	Late Cenozoic	Malloch (1933); Marinoni & Carvalho (1993)
Sphaeroceridae	*Antrops* Duda (13 species)	other *Antrops*—39 species (from Argentina to Venezuela)	Late Cenozoic	Richards (1931); Kits *et al.* (2013)
Sepsidae	*Sepsis pulchrum* (Fabricius)	populations of *Sepsis pulchrum* in different parts of the world	Last ~5 years	Silva *et al.* (2023)
Tephritidae	*Trupanea* Schrank ()	other *Trupanea* species—total of 218 species worldwide	Late Cenozoic	Malloch (1933); Norrbom & Neder (2014)
Teratomyzidae	*Teratoptera chilensis* Malloch and *Stepta latipennis* (Malloch)	*Camur* McAlpine & Keyzer—1 species (southern Brazil); *Auster* McAlpine & Keyzer—1 species (Australia)	Late Cenozoic	McAlpine & Keyzer (1994)
Ulidiidae	*Euxesta* spp. (at least 10 spp.)	other *Euxesta* species—almost 100 species, mostly in the Neotropical, Nearctic and Palaearctic regions	Late Cenozoic	Malloch (1933)
Fanniidae	*Fannia* spp. (11 species recorded, some of which cosmopolitan)	other *Fannia* species—about 260 species, all biogeographical regions	Late Cenozoic	Domínguez (2007)
Anthomyiidae	*Calythea comis* Stein (also known from southern Peru and southern Brazil)	other *Calythea* species—overall, 15 species in the Neotropical, Nearctic, Palearctic and Afrotropical regions	Late Cenozoic	Gomes & de Carvalho (2022)
Muscidae	*Coenosia inaequalis* Malloch and *Coenosia chaetosa* Malloch	other *Coenosia* species—overall, 360 species in all biogeographical regions	Late Cenozoic	Malloch (1934b); Patitucci *et al.* (2020); Patitucci *et al.* (2021)
Sarcophagidae	*Microcerella* (17 species)	other *Microcerella* species—overall, 25 species in the Neotropical and Nearctic regions	Late Cenozoic	Mulieri *et al.* (2015)

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TABLE 6. (Continued)

Family	Example of taxon in Chile (or southern Argentina)	Taxon (disjunct areas)	Geological layer	Reference
Calliphoridae	*Neta chilensis* (Walker), *Sarconesia* (4 species) and *Toxotarsus* (2 species)	other Taxotarsinae species (same genera)—Argentina, Uruguay, southern Brazil, Peru, Ecuador, and Colombia	Late Cenozoic	Tauhyl *et al.* (2023)
Tachinidae	*Incamyia* Townsend (10 species)	*Incamyia peruviana* Townsend (Peru), *Incamyia unica* Townsend (Peru)	Late Cenozoic	O'Hara *et al.* (2020, 2021)

Discussion

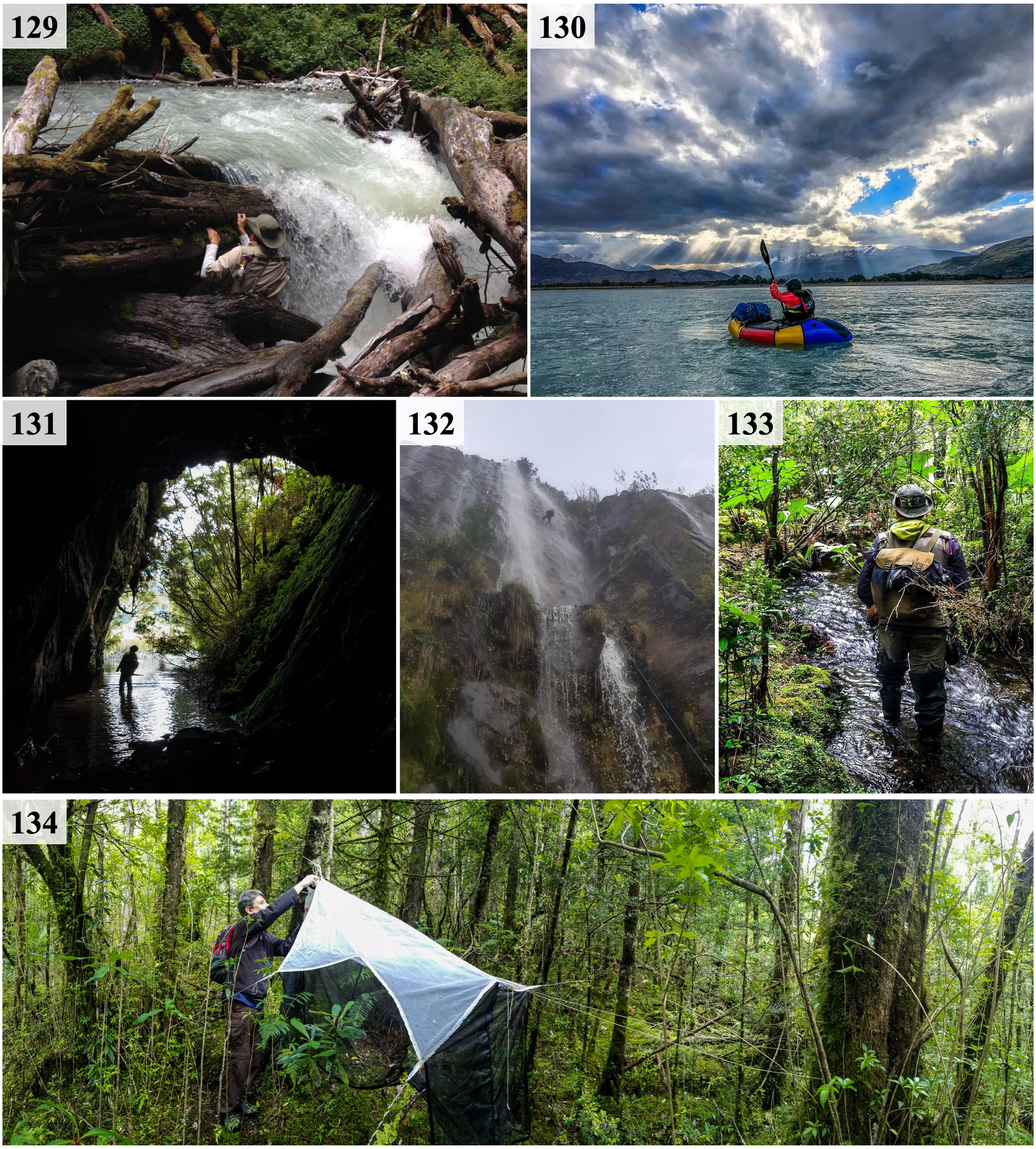
Brief history of the study of Chilean Diptera

The exploration of the different ecosystems of the planet had a major impetus during the 19th century, when explorers and scientists, mostly connected to European museums, traveled through Africa, Asia, Australia, and South America. Once their expeditions were completed, their valuable cargo with samples of the biota collected during their journeys were transported to Europe. Several explorers traveled throughout South America, including Alexander von Humboldt, searching for the biological riches of the great continent. Chile was no stranger to these explorations and received several explorers who traveled the country for years or stayed for short periods. Claudio Gay travelled throughout Chile making collections of the fauna and flora and defined the physical characteristics of the country for ca. 40 years. He published a monumental work in several volumes, the *Historia Física y Política de Chile* over the course of 28 years, from 1844 to 1871, seven volumes of which, are devoted to the Diptera. Gay commissioned his work and years of prospecting in Chile to the French scientist C.E. Blanchard (1854), who mentioned the dipteran species described by other naturalists, such as the French dipterist Macquart and the German dipterist Wiedemann. The treatment of Diptera was divided into eight large groups ("Culicianos, Tipulianos, Midasianos, Asilianos, Tabanianos, Sirfianos, Dolicopodianos, and Muscianos"), grouping 208 species from Chile, with a brief diagnosis for each group. Other dipteran species from Chile were also collected, transported to Europe and described by the most renowned scientists at the time. The long lists of experts who described the first dipteran species from Chile were Walker (1836), Guérin-Méneville (1838), Macquart (1844, 1851), Bigot (1857, 1888), Schiner (1868), Robineau-Desvoidy (1863), Rondani (1863) and van der Wulp (1881, 1883).

We cannot fail to mention the contribution made by R.A. Philippi (1865) to the study of the Diptera of Chile. He emigrated to Chile in 1851, first settling in Valdivia and later in Santiago, where he was appointed director of the Museo Nacional de Historia Natural until 1897. His *Aufzählung der chilenische Dipteren*, published in 1865, stands out as his most significant contribution to dipterology, with the description of 424 species of Diptera (Camousseight 2005). More recently, the contributions to Chilean dipterology made by Raúl Cortés (1915–2001) (e.g., Cortés & Hichins 1969, 1979; Cortés & Campos 1971, 1974; Cortés 1986; Cortés & González 1989) and Jorge N. Artigas (1929–2022) (e.g., Artigas 1970a, b, 1996; Artigas & Parra 2006; Artigas *et al.* 1997, 2005; Hengst & Artigas 2003) must be mentioned because they have prepared and motivated new generations of dipterists to continue their studies on flies.

Diversity

There are relatively important advances to the knowledge of dipteran taxonomy in Chile summarized in this paper, 56 years after the CDASUS began to be published. The updated number of families, genera, and species of flies recorded for Chile increased respectively by 38.57% (27 additional families), 57.62% (340 additional genera) and 77.85% (1,793 additional species) with respect to the numbers in the CDASUS. Interestingly, the number of infraorders, families, genera and species can grow even more. We adopted a schema phylogenetically conservative (*sensu lato*) for some infraorders such as Tipulomorpha. However, morphological, mitochondrial and transcriptomic phylogenies support the presence of several families within of Tipulomorpha such as Cylindrotomidae, Limoniidae, Pediciidae, and Tipulidae (Kang *et al.* 2017; Lukashevich & Ribeiro 2018; Zhang *et al.* 2023), which are widely accepted to date. The presence of new infraorders could increase this taxa type, although this discussion is not absence of debate and ambiguity. For example, Perissommatidae has been considered as *incertae sedis* by Bertone *et al.* (2008), Wiegmann *et al.* (2011) and Wiegmann & Yates (2017), but also has been classified in Bibionomorpha (e.g., Shcherbakov *et al.* 1995, Lukashevich 2011), Psychodomorpha (Wood & Borkent 1989), and Axymyiomorpha (e.g., Krzemiński & Krzemińska 2003), even within of the own infraorden by Pape *et al.* (2011).



FIGURES 129–134. Diptera diversity prospections on unexplored and uncommon habitats, both for larvae as well as adults: (129) surveying larvae in deadwood in torrential rivers of Patagonia (photo by K. Lindsay); (130) exploring rivers in Patagonia (photo by Anand Varma); (131) surveying Diptera larvae in caves (photo by R.I Madriz); (132) surveying waterfalls (photo by J. Sepulveda); (133) exploring streams in forest ecosystems (photo by K. Lindsay), and (134) surveying Diptera in forest ecosystems with a Malaise trap (photo by R. I. Madriz).

The presence of endemic taxa at the family level, such as Evocoidae, or families represented globally by few species such Perissommatidae, Canthyloscelidae, or Homalonecmidae, clearly demonstrate the uniqueness of the Chilean Diptera fauna (Tables 1–2). New families such as Ragadidae have been added thanks to advances in molecular techniques (Wahlberg & Johanson 2018) or according to morphological revision such as Chyromyidae (Ebejer 2023), while the validity of others such as Trixoscelididae (Zatwarnicki & Irwin 2018), requires greater taxonomic and molecular efforts to clarify their presence in Chile. Many families of Chilean Dipterofauna have not been studied for a long time because of the current lack of specialists in the country and the limited effort to update the taxonomy and phylogeny of some groups (e.g., many groups of lower Diptera).

The most important advances for Chilean Diptera have been at the genera and species levels, where many of these taxa have been revised or described as new for science in the last decades (e.g., Therevidae (Irwin & Winterton 2020a, b, 2021a, b) or Acroceridae (Barahona-Segovia *et al.* 2020a, 2021a; González & Ramírez 2021)), but is expected that many more remain unnamed. For example, flies within poorly assessed families (e.g., Phoridae or Cecidomyiidae; Hartop *et al.* 2022) require extensive revision and new methodological approaches to reveal their hidden diversity, particularly from areas under explored. Moreover, new records in poorly surveyed areas of known ecosystems could increase the number of genera and species as have occurred recently for Syrphidae (Barahona-Segovia *et al.* 2021b), Empididae (Sinclair & Saigusa 2022) or Muscidae (Patitucci *et al.* 2020, 2021). Future advances in the study of Chilean taxonomy and Diptera diversity would seem, however, to depend largely on solving some major requirements, which irremediably interact with taxonomic activity and therefore, should be of special interest to those who wish to continue the study of biodiversity. These major requirements are: (1) long-term systematic sampling throughout the country; (2) understanding the taxonomic, spatial, and temporal patterns of the group; and (3) investigating anthropogenic effects on the biology and ecology of Chilean flies and compared to poorly- or unimpacted native ecosystems. Other important points of view such as training of new taxonomists, funding, access to types and old literature have already been treated by González (1995) and Solervicens (1995).

1. Long-term systematic sampling

Chile is the latitudinally longest country on the planet, spanning from 18º north to 55º south (excluding Antarctic and Pacific Islands); therefore, it includes a wide variety of climates and ecosystems, ranging from absolute desert to temperate rainforests and glaciers. Some of these ecosystems have many habitats that are still unexplored owing to limited access through border areas, ravines, waterfalls, core habitats of large fragments of native forests, deadwood in torrential rivers, caves, glaciers, or remote islands (Figs 129–134). In these ecosystems, both adults and larvae of many habitat specialist species would be discovered through systematic sampling in several poorly surveyed microhabitats such as ponds, cumulated water in caves or ferns and bromelias in the canopy, tree holes, soil and many others. Although some extreme ecosystems for Diptera have been surveyed in recent years, (Convey & Block 1996; Kelley *et al.* 2014; Cepeda-Pizarro *et al.* 2015), many parts of the Andes and their foothills, Atacama Desert (particularly coast and some interior parts), and the fjords of Aysén and Magallanes remain unexplored (Figs. 129–134) and likely to have a large number of undescribed faunal elements.

A recent example of systematic sampling in Chilean Arthropoda, recorded +49,000 individuals, ca. 1,800 species and describing 87 new species (Vergara-Asenjo *et al.* 2023). Similarly, the SISBIOTA-Diptera Brazilian Network, was a two-years survey that analyzed 12 localities, 300,000 fly specimens from ~60 families, and describe 101 new species and three new genera (Lamas *et al.* 2023). For Chile, a study conducted by Amorim *et al.* (2022) in southern Chile at a single site found the first opetiid in the southern hemisphere, *P. chandleri* (Amorim *et al.* 2018), a new species: *Protonephrocerus flavipilus* (Skevington *et al.* 2021), and of rarely collected species such as *Gondwanamyia chilensis* Cumming & Saigusa, *Mayomyia diversipennis* Malloch or *Melantomyza polita* Malloch. For all cases mentioned, samples obtained can be analyzed for several years by different specialists. However, biodiversity policies and funds to study these ecosystems are completely necessary.

2. Taxonomic, spatial, and temporal biases of Chilean Diptera

The knowledge of many dipteran groups in Chile faces large temporal and spatial gaps. Numerous species have not been recorded since their original description with huge temporal gaps over the years. Some recent examples of these “missing” species were provided by Barahona-Segovia *et al.* (2017, 2018, 2022a) or Amorim *et al.* (2022), but many others maintain large temporal gaps without observations or collection. At the same time, historical spatial biases along Chile’s ecosystem gradient, prevent us from establishing how the general Diptera diversity is distributed across the country. For example, the diversity of some families (e.g., Syrphidae; Barahona-Segovia *et al.* 2021b) or genera (e.g., *Trichophthalma*; González *et al.* 2023a) of Diptera increase towards the center-south of the country, coinciding with the greater richness of plants, butterflies and freshwater invertebrates (Myers *et al.* 2000; Samaniego & Marquet 2009; Valdovinos 2018), while other Diptera families decrease (e.g., Ulidiidae; Mello *et al.* 2024). But for the vast majority of families, this knowledge is nonexistent or diffuse. Lastly, taxonomic biases in sampling also reinforce the absence of records of poorly assessed taxa (tiny, dark- or pale-colored flies, or species resembling mosquitoes in the sense of Hartop *et al.* 2022) than for those with striking characteristics (e.g., large size, metallic colors, or abundant in urban areas).

One solution deployed to fill the gaps exposed above is citizen science. The *Moscas Florícolas de Chile* use social media such as Facebook (https://web.facebook.com/groups/774986852548819) and iNaturalist (https://www.inaturalist.org/projects/moscas-floricolas-de-chile; Figs. 135–138) to gather records of Diptera through several ecosystems (see details in Barahona-Segovia *et al.* 2022b). In almost 10 years, this citizen science project has: (1) rediscovered missing species (Barahona-Segovia *et al*. 2017, 2018, 2022c), reducing their temporal gaps; (2) recognized the increase in the range of invasive species, as with *Chrysomya albiceps* (Wiedemann) (Barahona-Segovia & Barceló 2021) or the exotic *Trichopoda* (*Galactomyia*) *pictipennis* Bigot (Barahona-Segovia *et al.* 2023a); (3) report new records for native species for Asilidae (Barahona-Segovia & Pañinao-Monsalvéz 2020), Tanyderidae (Barahona-Segovia *et al.* 2023b), and many syrphids (Barahona-Segovia *et al.* 2021a, b), expanding their known distributions for all of them; and (4) support photographically, updated catalogs of families like Syrphidae (Barahona-Segovia *et al.* 2021b), Nemestrinidae (González *et al.* 2023a) or Ulidiidae (Mello *et al.* 2024). In addition, citizen science also increases the knowledge of the natural history and ecology of Chilean Diptera by showing new prey-predator interactions (Barahona-Segovia & Pañinao-Monsálvez 2020) and flowers as refuge (Barahona-Segovia *et al.* 2022a). This project has also participated in different educational initiatives, news, symposia, international, and national ecological congresses, and workshops to generate more empathy and new insights for non-specialists (Figs 139–140).

3. Advance of biology and ecology vs threats to Diptera diversity

Our knowledge of the biology and ecology of Chilean Diptera is poor if we compare it with the current advance of anthropogenic pressures on ecosystems, many of which impact biodiversity at a large scale such as climate change, exotic and invasive species, pesticide application, or habitat loss (Wagner *et al.* 2021). Habitat loss has significantly fragmented many ecosystems such as coastal forests in central-southern Chile by forestry (Echeverría *et al.* 2006; Miranda *et al.* 2017) or Andean basin rivers by hydropower development (Díaz *et al.* 2019), affecting the availability of water. With habitat fragmentation and edge effect operation, many of the resources occupied by flies (adults or larvae) are vulnerable to decreasing habitat quality. For this reason, some species are considered threatened based on the IUCN Red List criteria (Alaniz *et al.* 2018; Barahona-Segovia 2019; Barahona-Segovia & Zúñiga-Reinoso 2021; MMA 2022). Concurrently, with a high percentage of endemic species for Chile (~55% of the total; González 1995; Barahona-Segovia 2019), habitat loss can act synergistically with invasive fly species and participate in the disappearance of more specialized species, as the case of *Neta chilensis* (Walker), a putatively extinct species due to a combination of these threats (Mulieri *et al.* 2022). One human driver that needs more regulation in the Chilean territory is the use of pesticides. Both rural-urban areas and crops in Chile use pesticides forbidden in the European Union (Henríquez-Piskulich *et al.* 2021), with an enormous impact on fly family's benefits such as pollination or biological control from Syrphidae, Chamaemyiidae, Tachinidae, or Bombyliidae. Finally, still is not clear how climate change interplays with other threats to affect Diptera diversity, although narrow temperature tolerance species are expected to be more impacted than those with a wider thermal niche.

To decrease the loss of fly biodiversity in ecosystems, it is necessary to understand the characteristics of habitats that influence their fitness or presence/absence. For example, urban ecosystems can retain part of the local Chilean diversity, although invasive species are also present (Figueroa-Roa & Linhares 2002, 2004). The resilience of this insect fauna in urban areas has been recently addressed, for example, in Los Angeles (Brown *et al*. 2014; Ganjisaffar *et al*. 2018; Hartop *et al.* 2015, 2016a, b, 2018; Brown & Hartop 2016; Prudic *et al*. 2018, Amorim & Brown 2020). Indeed, positive contributions of nature to Chilean ecosystems such as pollination, pest control, and organic decomposition provided by several fly families are still not well understood. Therefore, some solutions based on nature are (1) to improve the structural complexity of ecotones and generate biological corridors in urban environments, promoting the spill-over and their movement of native pollinator flies into anthropogenic landscapes (e.g., Hall *et al.* 2017; Dylewski *et al.* 2019); (2) restoration and agroecological practices increase and promote

FIGURES 135–140. *Moscas Florícolas de Chile* citizen science activities: (135) photographing a tachinid fly that is taking refuge in a flower from the wind in the flowering desert 2022, Atacama Region (photo by Ricardo Varela); (136) volunteer of the project (Matías Cortés) photographing a *Hemipenthes* bee fly from Sclerophyllous forest (2019); (137) Ricardo Varela and Vicente Valdés photographing a *Stizolestes* robber fly attacking a Elateridae beetle, Chiloé, Los Lagos Region (photo by Eduardo Muñoz); (138) volunteer taking a photo a Calliphoridae, humedal de Lluta, Arica (photo by Dalila Parráguez). Red arrow identifies the position of a fly species; (139) activity with childrens and adults in the Museo Nacional de Historia Natural of Chile (2017) (photo by Gabriela Carrasco), and (140) Diptera identification workshop organized by the Chilean Pollination Network (2018).

Diptera diversity with a friendly environment and generate win-win strategies. Whereas programs such as the +*Bosque* of the FAO and private initiatives help to restore and manage +25,000 hectares of native forest, agroecological techniques, reduce the use of pesticides, and share land (Henríquez-Piskulich *et al.* 2021). Thus, using Diptera as bioindicators is possible to evaluate the success of the measures adopted or environmental conditions (Frouz 1999; Burgio & Sommargio 2007; Cabrini *et al.* 2013; Arimoro *et al.* 2018); (3) the strengthening of public policies for the management of invasive species and protected areas, such as the National Biodiversity and Protected Areas Service (SBAP) or the wetland conservation law (Biblioteca del Congreso Nacional de Chile 2020), which would protect terrestrial and aquatic dipterofauna, respectively; and (4) finally, although the protection of Diptera species is problematic because the misguided perception due to the species that transmit diseases and that are nuisances, education programs about taxonomy and citizen science could change this negative perception. These ecological tools could be important, especially for central Chile ecosystems, where major fragmentation has been produced by human drivers.

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