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Annotated checklist and illustrated key to the species of *Trichogramma* Westwood (Hymenoptera: Trichogrammatidae) from South America

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Abstract

A checklist is provided for all 43 species of *Trichogramma* recorded in South America, including diagnoses, comments, hosts, and distributions. A key to the South American species based on males (external morphology and genitalia) is also presented. *Trichogramma koehleri* Blanchard is here placed as *species inquirenda*.

Key words: Chalcidoidea, identification, egg parasitoids, Lepidoptera

Introduction

Wasps of the genus *Trichogramma* Westwood are tiny (about 0.7 mm long) parasitoids of insect eggs. Several species are mass-reared for biological control of agricultural and forest pests. The genus, with about 235 species, is divided into three subgenera (Pinto 1999; 2006), only two of which are represented in South America: *Vanlisus* Pinto (2 species) and *Trichogramma sensu stricto* (41 species). Species of *Trichogramma* occur throughout South America, although there are no known formal records from French Guyana and Suriname so far. In South America, Brazil has the largest number of known species (Fig. 1).

Most surveys of *Trichogramma* in South America have been carried out in agroecosystems. Consequently, information on species of *Trichogramma* from undisturbed habitats is scarce (Querino & Zucchi 2003a). The still-incipient knowledge of the distribution pattern of *Trichogramma* in South America is hindered by the introduction of species with no taxonomic studies or previous surveys of the native species in the area.

All known host records except for two (*T. nomlaki* and *T. pretiosum* from Neuroptera) are species of Lepidoptera, which comprise 95% of the known hosts of these wasps in South America; no hosts are known for 18% of *Trichogramma* species. Fourteen species are known only from type material and 16 are associated with a single host (Fig. 2).

The most important study of the genus in the Americas was conducted by Pinto (1999), who revised the North American species, including some that also occur in South America. Keys to Neotropical species of *Trichogramma* exist for only two countries, Peru (Ruiz & Korytkowski 1979) and Brazil (Querino & Zucchi 2005; 2011). Ciociola *et al*. (2001) developed a molecular key for seven species of *Trichogramma*, Querino & Zucchi (2004) conducted a morphometric analysis of six species of *Trichogramma*, and Zucchi *et al*. (2010) compiled a list of hosts for the species of *Trichogramma* in South America.

This article compiles the scattered information on the species of *Trichogramma* occurring in South America, including information on diagnostic morphological characters, distribution by country, and hosts for each species. Finally, an illustrated key is provided for the species treated here.

Material and methods

This study was based mostly on specimens deposited at Escola Superior de Agricultura Luiz de Queiroz (ESALQ),

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Piracicaba, São Paulo, Brazil (Querino *et al.* 2018), which is the most comprehensive collection of species of *Trichogramma* for agroecosystems in South America. Additionally, specimens deposited at the United States Department of Agriculture—USDA (Beltsville) and at University of California Riverside (UCR) (Riverside) collections were also examined.

The figures are primarily line drawings from slide-mounted specimens; however, for some species which could not be examined (*T. atropos* Pinto, 1992; *T. erebus* Pinto, 1999; *T. nomlaki* Pinto & Oatman, 1985; *T. obscurum* Pinto, 1999; *T. stampae* Vincent, 1986), figures were sketched based on those published by original authors, and morphological characters were based on Pinto (1992, 1999). For *T. colombiense* Velásquez & Teran, 1995; *T. diazi* Velásquez & Terán, 2003; *T. terani* Velásquez & Terán, 2003 and *T. bennetti* Nagaraja & Nagarkatti, 1973, the characters used in the key are those discussed in the original description [see Velaìsquez & Teìran (2003) and Nagaraja & Nagarkatti (1973)]. *Trichogramma bellaunionense* Basso & Pintureau, 2001 was not included in the key, because it is difficult to separate morphologically from *T. lasallei* Pinto, 1999. *Trichogramma minutum* Riley, 1871 was included only in the key because although it has been recorded in South America, those records are probably misidentifications (Querino & Zucchi 2007). *Trichogramma koehleri* Blanchard, 1927 is not included in the key, as its description was based exclusively on females and no more specimens were found.

The terminology for the anatomical structures is based on Pinto (1999, 2006). The specific epithet related to the suffix denoting localities or countries (-ense) is spelled according to the Universal Chalcidoidea Database, Natural History Museum, London (Noyes 2018).

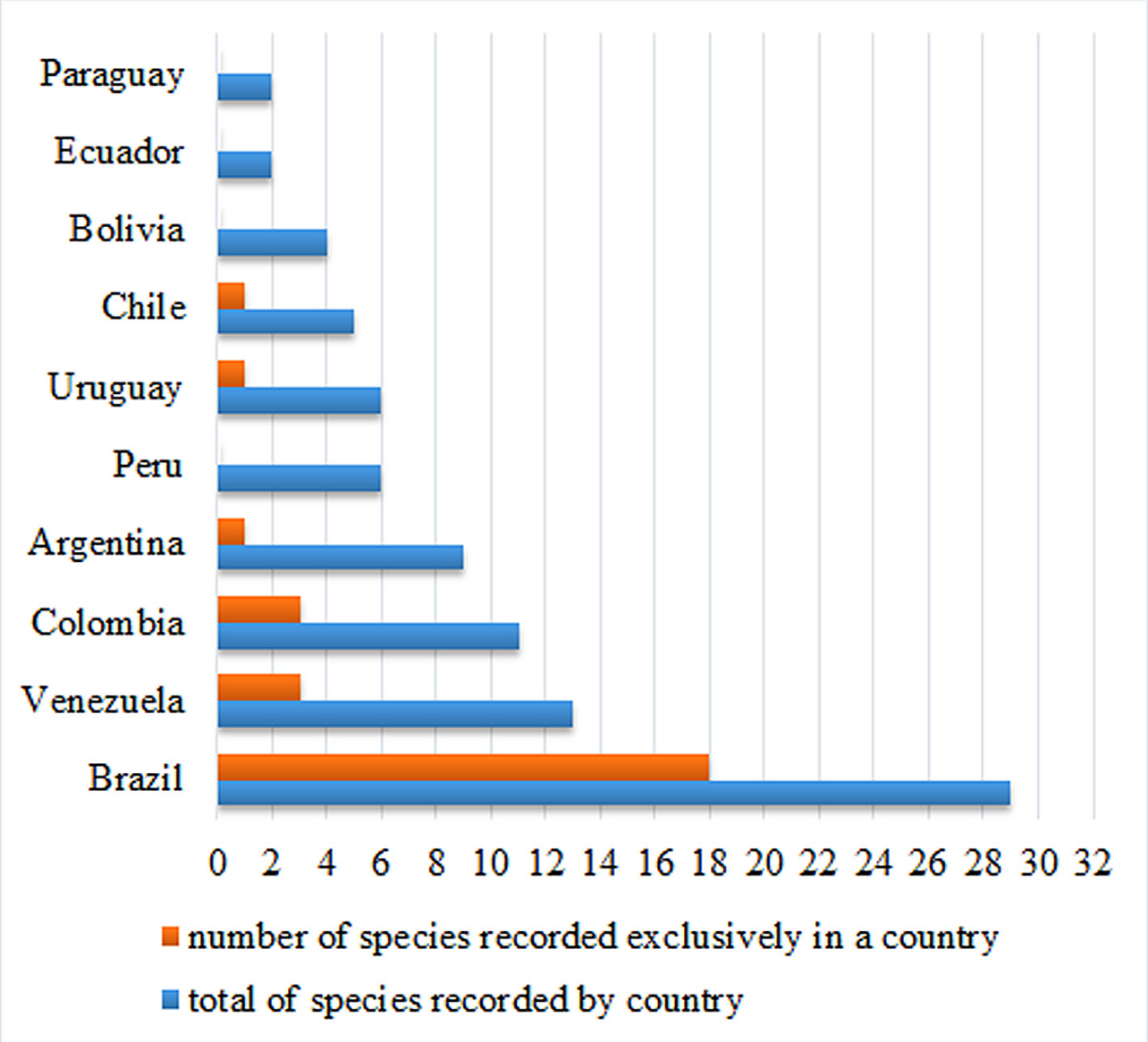

FIGURE 1. Number of species of *Trichogramma* in South America.

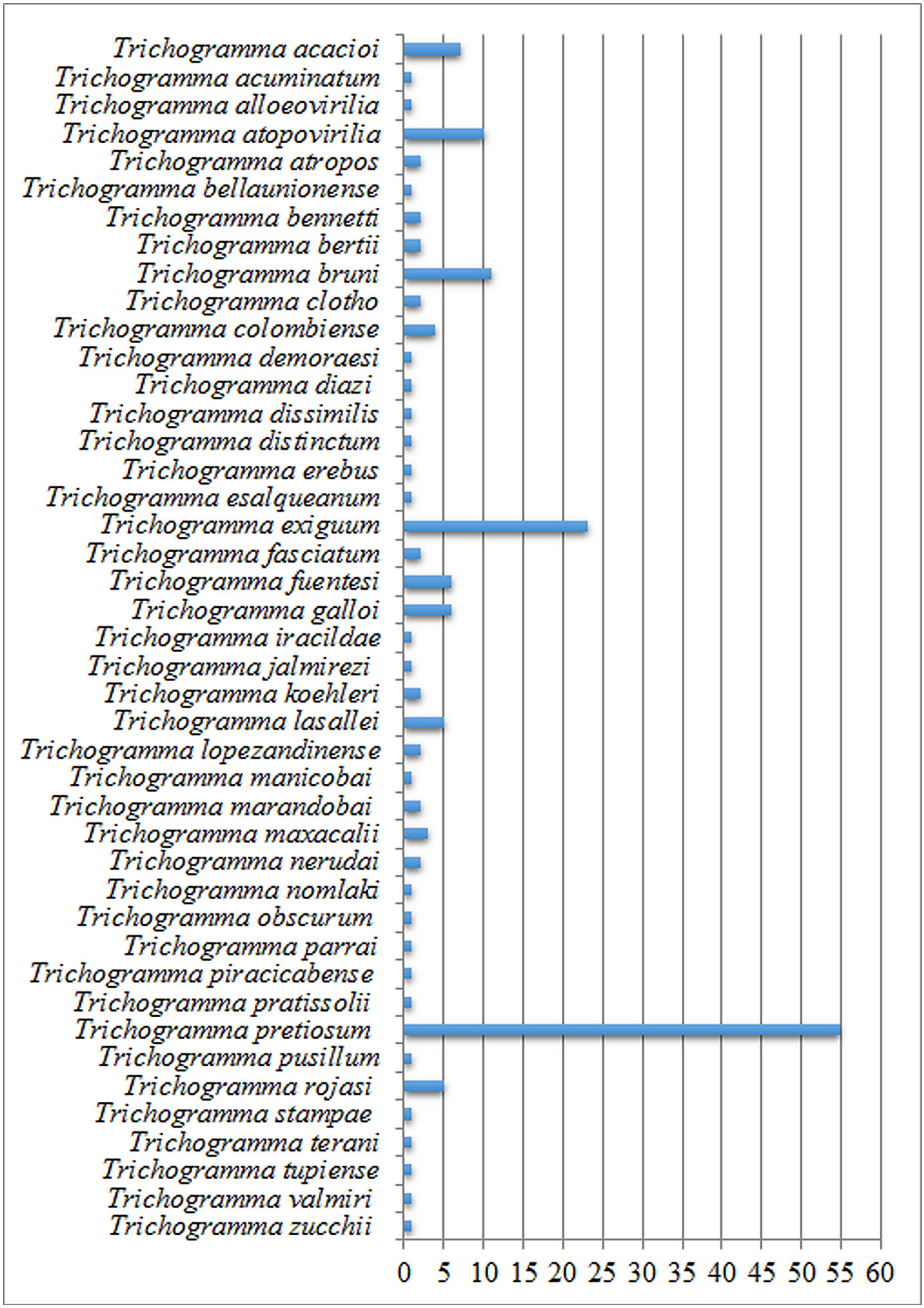

FIGURE 2. Number of lepidopteran hosts known for each species of *Trichogramma* in South America.

Checklist

Trichogramma acacioi Brun, Moraes & Soares, 1984

Diagnosis. Genital capsule broad; volsellae curved, with long straight spur at apex; intervolsellar process little defined; parameres curved; dorsal ridge developed; dorsal lamina broad, short, with distinct posterior extension.

Comments. This species is similar to *T. atopovirilia*; both species have a broad genital capsule and marked modifications in the volsellae and parameres. However, *T. acacioi* does not show an apical constriction of the volsellae, the parameres are arcuate, and the dorsal ridge is long.

Type repository. Universidade Federal de Minas Gerais (UFMG) collection (not found).

Type locality. Jaboticatubas, MG, Brazil.

Distribution in South America. Brazil.

Hosts. *Trichogramma acacioi* has been reared from six lepidopteran species from agricultural and forest habitats (Zucchi *et al*. 2010; Zucchi & Querino 2011). This species is mainly associated with Lepidoptera in forest environments, such as *Euselasia* sp. (Lepidoptera: Riodinidae) on *Eucalyptus* (Myrtaceae).

Trichogramma acuminatum Querino & Zucchi, 2003

Diagnosis. Dorsal lamina triangular, tapering gradually from base to apex, without basal constriction; posterior extension of dorsal lamina with pointed apex; intervolsellar process elongated, extending up to half-length of volsellae.

Comments. This species differs from *T. tupinense* Querino & Zucchi, 2003, in having the anterior setae of the scutellum short and thin, and the intervolsellar process elongated. *Trichogramma acuminatum* presumably belongs to the *Arcanum* section (John D. Pinto, pers. com.). This section currently includes three North American species, characterized primarily by the appearance of the dorsal lamina, which narrows considerably in the posterior region; the lack of a distinct basal notch; and a relatively short intervolsellar process, less than half the length of the volsellae (Pinto, 1999). *Trichogramma acuminatum* was collected in an electrical suction trap set in a forest reserve (Querino & Zucchi 2003a). Only the type material is known.

Type repository. ESALQ.

Type locality. Piracicaba, SP, Brazil.

Distribution in South America. Brazil.

Host. Unknown (forest habitat).

Trichogramma alloeovirilia Querino & Zucchi, 2003

Diagnosis. Scutellum with dark anterior setae, ventral processes swollen and far from each other, dorsal lamina without distinct basal constriction and pointed apex, intervolsellar process short.

Comments. The swollen ventral processes located at the base of the intervolsellar process distinguishes *T. alloeovirilia* from *T. acuminatum* and *T. tupinense.* It differs from *T. browningi* Pinto & Oatman, 1985, another species with swollen ventral processes, in having the dorsal lamina with a constriction and tapering to a narrow apex. Variation was observed in the number of sensilla (1-1-2-0-1-1). In smaller adults, the size of the structures and consequently the number of basiconic sensilla and setae also decrease. *Trichogramma alloeovirilia* was collected in an electrical suction trap set in a forest reserve (Querino & Zucchi 2003a). Only the type material is known.

Type repository. ESALQ.

Type locality. Piracicaba, SP, Brazil.

Distribution in South America. Brazil.

Host. Unknown (forest habitat).

Trichogramma atopovirilia Oatman & Platner, 1983

Diagnosis. Genital capsule broad; volsellae swollen, with accentuated lateral constriction; tubular ventral processes joined to intervolsellar process, dorsal ridge undeveloped (dorsal view) on midline of genital capsule; dorsal lamina short, with no distinct posterior extension.

Comments. This species is similar to *T. acacioi*, as both species have a similar genital-capsule shape; in *T. atopovirilia*, the volsellae are strongly constricted apically and have tubular ventral processes. According to Zucchi & Monteiro (1977), *T. caiaposi* Brun, Moraes & Soares is a junior synonym of *T. atopovirilia*.

Type repository. National Museum of Natural History, Washington, D.C. (holotype and paratypes).

Type locality. Sololá, Guatemala.

Distribution in South America. Argentina, Brazil, Colombia and Venezuela.

Hosts. This species has been recorded from seven different hosts, mostly lepidopterans of economic importance (Zucchi *et al*. 2010). It was first reared from parasitized *Vanessa* sp. eggs (Lepidoptera: Nymphalidae) on a species of Malvaceae from Guatemala. It was recorded on *Helicoverpa zea* and *Spodoptera frugiperda* in corn fields in Brazil (Zucchi & Monteiro 1994). *Trichogramma atopovirilia* has also been reared on factitious hosts, for biological control of the fall armyworm *Spodoptera frugiperda* (J.E. Smith, 1797) (Lepidoptera: Noctuidae) (Morales *et al*. 2004; Melo *et al*. 2007; Dias *et al*. 2010). In Brazil, *Anagasta kuehniella* (Zeller) and *Corcyra cephalonica* (Stainton) (Lepidoptera: Pyralidae) have been shown to be the most suitable factitious hosts for mass rearing (Parra *et al*. 2015).

Trichogramma atropos Pinto, 1992

Diagnosis. Second funicular segment subquadrate, incomplete anterior vein track present in hindwing, and posterior extension of dorsal lamina triangular.

Comments. *Trichogramma atropos* and *T. clotho* Pinto, 1999 are the only two species of the subgenus *Vanlius* recorded in South America. The indistinct microsculpture on the thorax and the subquadrate second funicular segment, which is slightly longer than wide, are the main characters that separate this species from *T. clotho*. The mesosoma is rugulose in *T. clotho.*

Type repository. National Museum of Natural History, Washington, D.C.

Type locality. Mérida, Venezuela (holotype).

Distribution in South America. Brazil and Venezuela.

Host. Unknown.

Trichogramma bellaunionense Basso & Pintureau, 2001

Diagnosis. Antenna with relatively long setae; base of dorsal lamina wide and with no notch laterally, dorsal lamina with pointed apex and not reaching volsellar apex; intervolsellar process triangular and moderately developed, not reaching dorsal lamina apex (Basso & Pintureau 2001).

Comments. *Trichogramma bellaunionense* is most similar to *T. lasallei* Pinto, 1999. According to Basso & Pintureau (2001), in *T. bellaunionense* the dorsal lamina has a pointed apex and no lateral notch, and in *T. lasallei* the dorsal lamina has the apex usually obscurely pointed, and two narrow notches at the base. It is very difficult to separate these species morphologically, thus *T. bellaunionense* was not included in the key.

Type repository. Muséum National d'Histoire Naturelle, Paris (holotype and paratypes); National Museum of Natural History, Washington, D.C. and Montevideo Faculty of Agronomy (paratypes).

Type locality. Bella Unión region, Artigas (northwestern Uruguay).

Distribution in South America. Uruguay.

Host. *Diatraea saccharalis* (Fabricius, 1794) (Lepidoptera: Crambidae), on rice (*Oryza sativa* L.).

Trichogramma bennetti Nagaraja & Nagarkatti, 1973

Diagnosis. Volsellae distinctly lobed laterally, intervolsellar process subtriangular, only about half length of volsellae; dorsal lamina broader at base and narrowing to linguiform posterior extension, this extension concealing most of volsellae.

Comments. It is readily separated from *T. atopovirilia* by its parameres not arcuate and the genital capsule small and oval; and from *T. pusillum* Querino & Zucchi, 2003, by its volsellae modified, the intervolsellar process subtriangular and about half the length of the volsellae. The record of *T. bennetti* in Brazil was a compilation error

(Querino & Zucchi 2007). In Venezuela, the species was described as *T. guariquensis* [sic] Velásquez & Terán, which is a junior synonym of *T. bennetti* according to Velaìsquez & Teìran 2003.

Type repository. National Museum of Natural History, Washington, D.C. (holotype) and Commonwealth Institute of Biological Control, Indian Station, Bangalore, India (paratypes).

Type locality. Trinidad (West Indies).

Distribution in South America. Colombia, Guyana, Trinidad & Tobago, Venezuela.

Hosts. *Hypsipyla ferrealis* (Hampson, 1929) (Lepidoptera: Pyralidae) on *Carapa guianensis* Aubl. (Meliaceae); *Anomis* sp. (Lepidoptera: Noctuidae) on *Malva* sp. (Malvaceae); and on eggs of an undetermined lepidopteran on *Spiracantha cornifolia* Kunth (Asteraceae) (Velásquez & Terán 1995).

Trichogramma bertii Zucchi & Querino, 2003

Diagnosis. Flagelliform setae short, with apex tapering abruptly; intervolsellar process distinctly pointed.

Comments. *Trichogramma bertii* has the flagelliform setae short, tapering abruptly apically, as in *T. exiguum*; but it is distinguished from *T. exiguum* by having the dorsal lamina with a shallow basal notch and the intervolsellar process at the same level as or slightly beyond the dorsal lamina. *Trichogramma bertii* is also similar to *T. pretiosum* but differs by the much shorter flagelliform setae and the intervolsellar process with its pointed apex reaching the same level as the apex of the dorsal lamina or extending slightly beyond it.

Type repository. ESALQ.

Type locality. Altinópolis, SP, Brazil.

Distribution in South America. Brazil.

Host. *Glena* sp. and *Melanolophia* sp. (Lepidoptera: Geometridae) (forest habitat).

Trichogramma bruni Nagaraja, 1983

Diagnosis. Flagelliform setae long; dorsal lamina with distinct basal constriction, extending about two-thirds of length of genital capsule; intervolsellar process short, not extending up base of volsellae.

Comments. The following combination of characters separates *T. bruni* from *T. lasallei* and *T. rojasi*: long flagelliform setae, basiconic sensilla in position 4, short anterior setae on scutellum, genital capsule yellowish, and long ventral ridge. According to Velásquez & Téran (2003), *T. castrensis* Velásquez & Téran is a junior synonym of *T. bruni*.

Type repository. Institute of Biological Sciences, Universidade Federal de Minas Gerais (UFMG) collection (holotype and paratypes); Natural History Museum, London and Commonwealth Institute of Biological Control, Indian Station, Bangalore (paratypes) (holotype examined).

Type locality. Belo Horizonte, MG, Brazil.

Distribution in South America. Argentina, Bolivia, Brazil, Chile, Venezuela.

Hosts. Associated with several lepidopteran hosts in agricultural (fruit orchards) and forest habitats (Zucchi *et al*. 2010). *Trichogramma bruni* was recently reared from eggs of *Heraclides astyalus* (Godart, 1819) (Lepidoptera: Papilionidae) on *Citrus* sp. (Rutaceae) (Querino *et al*. 2017). It is commonly found in areas with more stable plant cover, such as forests and fruit orchards. However, it has been collected in soybean areas in Argentina (Valverde *et al*. 2009, 2014) and in Brazil (Dudczak *et al*. 2017).

Trichogramma clotho Pinto, 1999

Diagnosis. Second funicular segment elongated, tapering apically; mesosoma with distinct rugulose microsculpture.

Comments. This species differs from all congeners in the unjoined funicular and club segments of the male antenna, and the two-segmented maxillary palp (Pinto 1992). *Trichogramma clotho* and *T. atropos* are the only species of the subgenus *Vanlisus* recorded in South America (Querino *et al*. 2017). The distinctive rugulose microsculpture readily differentiates it from *T. atropos*, a closely similar species. Only the type material is known.

Type repository. National Museum of Natural History, Washington, D.C. (holotype).

Type locality. Puntarenas, Costa Rica.

Distribution in South America. Brazil.

Hosts. *Parrhasius polibetes* (Stoll, 1781) (Lepidoptera: Lycaenidae) on *Pyrostegia venusta* (Ker Gawl.) Miers (Bignoniaceae) and *Schefflera vinosa* (Cham. & Schltdl.) Frodin & Fiaschi. (Araliaceae) (Querino *et al*. 2017).

Trichogramma colombiense Velásquez & Téran, 1995

Diagnosis. Dorsal lamina with slight basal and heavily sclerotized constriction, originating from the anterior part to middle of genital capsule and slightly exceeding volsellae; intervolsellar processes robust and tubular.

Comments. This species is very similar to *T. marandobai* Brun, Moraes & Soares, 1986, and it is very difficult to separate them morphologically; for distinguishing characters see Velásquez & Terán (2003). *Trichogramma colombiense* is the only species associated with *Erinnyis ello* on cassava not recorded in Brazil. There is some confusion in the literature regarding the year of the species description because the original authors have used 1994 (Velásquez & Téran, 2003). However, the correct date is 1995, when the description was formally published in Les Colloques del'INRA. In 1994, the description was published in a MSc thesis (Velásquez, 1994), which is not considered a publication by the International Code of Zoological Nomenclature for the purposes of describing a new species. In fact, the name published in 1994 is a *nomen nudum*.

Type repository. Museo de Zoologia, Facultad de Agronomia, Universidad Central de Venezuela, Venezuela.

Type locality. Burga, Colombia.

Distribution in South America. Colombia, Venezuela (Velásquez & Téran, 1995) and Uruguay (Grille *et al.* 2009).

Hosts. *Spodoptera frugiperda* (J. E. Smith, 1797) (Lepidoptera: Noctuidae) on maize (*Zea mays* L.) and *Erinnyis ello* (L., 1758) (Lepidoptera: Sphingidae) on cassava (*Manihot esculenta* Crantz).

Trichogramma demoraesi Nagaraja, 1983

Diagnosis. Genital capsule elongate and narrow, dorsal lamina narrow at base, fork-shaped; intervolsellar process narrow and distinct, apex slightly pointed, ventral processes positioned anterior to base of intervolsellar process; flagelliform setae moderately long, gradually tapering at the apex.

Comments. *Trichogramma demoraesi* was erroneously identified in Brazil as a parasitoid of *Erinyis ello,* a major pest of cassava. Examination of the paratype of *T. demoraesi* revealed that it was misidentified and actually corresponds to *T. marandobai* (Vieira *et al*. 2014). Therefore, *T. demoraesi* does not parasitize *E. ello* in Brazil (Vieira *et al*. 2014), and all records on that host previous 2014 are misidentifications. The most conspicuous character to separate these species is the dorsal lamina, which is narrow at the base and fork-shaped in *T. demoraesi*, and broader and not fork-shaped in *T. marandobai. Trichogramma demoraesi* was redescribed by Vieira *et al*. (2014).

Type repository. Institute of Biological Sciences, Universidade Federal de Minas Gerais, Brazil (UFMG) (holotype not found), Natural History Museum, London and Commonwealth Institute of Biological Control, Indian Station, Bangalore, India (paratype in NHM examined).

Type locality. Felixlândia, MG, Brazil.

Distribution in South America. Brazil.

Host. *Glena bipennaria* Guenée, 1858 (Lepidoptera: Geometridae) on *Eucalyptus* sp. (Myrtaceae). Records of *T. demoraesi* as a parasitoid of *Erinnyis ello* (L., 1758) (Lepidoptera: Sphingidae) on cassava (*Manihot esculenta* Crantz) in Brazil are errors (see Comments).

Trichogramma diazi Velásquez & Terán, 2003

Diagnosis. Dorsal lamina distinct, nearly reaching the base of the well-developed intervolsellar process.

Comments. *Trichogramma diazi* is distinguished from other South American species by the shape of the dorsal lamina. Only the type material is known.

Type repository. Entomological Collection, Universidad Nacional Experimental Rómulo Gallegos, San Juan de los Morros. estado Guárico, Venezuela (holotype).

Type locality. Las Lajas, Guárico, Venezuela.

Host. Unknown lepidopteran (Lepidoptera: Noctuidae) eggs on *Malachra* sp. (Malvaceae).

Distribution in South America. Venezuela.

***Trichogramma dissimilis* Zucchi, 1988**

Diagnosis. Flagelliform setae short, tapering abruptly at apex; genital capsule small and broad; dorsal lamina short, with narrow posterior extension; intervolsellar process conspicuous.

Comments. It is similar to other species associated with the sugarcane borer (*Diatraea saccharalis*) in Brazil (Zucchi 1988). However, among the South American species, the combination of characters mentioned in the diagnosis is found exclusively in *T. dissimilis.* Only the type material is known.

Type repository. ESALQ.

Type locality. Araras, SP, Brazil.

Distribution in South America. Brazil.

Host. *Diatraea saccharalis* (Fabricius, 1794) (Lepidoptera: Crambidae) (sugarcane borer).

***Trichogramma distinctum* Zucchi, 1988**

Diagnosis. Flagelliform setae moderately short, with apex tapering abruptly; dorsal lamina with slight basal constriction and concave laterally; intervolsellar process distinct, not extending to apex of volsellae.

Comments. *Trichogramma distinctum* is similar to *T. galloi* and *T. jalmirezi*, more closely resembling the former. It differs from *T. galloi* in having the intervolsellar process not extending to the apex of the volsellae and the dorsal lamina with a wider posterior extension than in *T. galloi*. The most conspicuous difference separating *T. distinctum* from *T. jalmirezi* is the marked constriction in the dorsal lamina of the latter. *Trichogramma galloi* and *T. distinctum* also differ biologically, as *T. distinctum* requires higher temperatures than *T. galloi* when these parasitoids are reared on factitious hosts under laboratory conditions (Parra *et al*. 1991). Only the type material is known.

Type repository. ESALQ.

Type locality. Carpina, PE.

Distribution in South America. Brazil.

Host. *Diatraea saccharalis* (Fabricius, 1794) (Lepidoptera: Crambidae) (sugarcane borer).

***Trichogramma erebus* Pinto, 1999**

Diagnosis. Genital capsule relatively narrow; volsellae extending only halfway to apex; ventral ridge indistinct; base of dorsal lamina without distinct notching or shoulders; posterior track of the hind wing elongated, approaching wing apex (Pinto 1999).

Comments. Among the South American species, the overall shape of the genital capsule of *T. erebus* resembles that of *T. pretiosum*, but the latter species can be separated by its more elongate flagelliform setae, less extensive hind wing setations, notched dorsal lamina, and shorter apical distance (Pinto 1999). *Trichogramma erebus* was collected in undisturbed habitats.

Type repository. National Museum of Natural History, Washington, D.C. (holotype); Natural History Museum, London; Canadian National Collection, Ottawa; University of California, Riverside (paratypes).

Type locality. Florida, USA.

Distribution in South America. Colombia.

Host. Eggs of an undetermined hesperiid (Lepidoptera) on *Desmodium* sp. (Fabaceae) (Pinto 1999).

***Trichogramma esalqueanum* Querino & Zucchi, 2003**

Diagnosis. Flagelliform setae long; basiconic sensilla oval-elongate; scutellum with long blackish anterior setae; genital capsule elongate; dorsal lamina short, with blunt apex at level of intervolsellar process, which is short.

Comments. This species is similar to *T. bruni*, but differs in having elongated basiconic sensilla, scutellum with long anterior setae, and short dorsal lamina extending to the level of the intervolsellar process. Samples of *T. esalqueanum* were analyzed for the ITS2 sequence of rDNA (GenBank ID AY182763.1), and the results showed that it differs from all other previously known species (Almeida & Stouthamer 2015). It was collected in a forest reserve.

Type repository. ESALQ (holotype) and University of California, Riverside.

Type locality. Piracicaba, SP, Brazil.

Distribution in South America. Brazil (forest reserve).

Hosts. *Mechanitis lysimnia* (Fabricius, 1793) and *Heliconius erato phyllis* (Fabricius, 1775*)* (Lepidoptera: Nymphalidae). Both butterfly species lay their eggs on *Passiflora* sp. (Passifloraceae).

Trichogramma exiguum Pinto & Platner, 1978

Diagnosis. Flagellum with short, robust setae, basiconic sensilla prominent and globose, dorsal lamina with broad, rounded shoulders and anteriorly widened ventral ridge.

Comments. *Trichogramma exiguum* is commonly associated with economically important lepidopterans and occurs in agricultural and disturbed habitats.

Type repository. National Museum of Natural History, Washington, D.C.

Type locality. Alabama, USA.

Distribution in South America. Argentina, Brazil, Chile, Colombia, Guyana, Peru, Uruguay and Venezuela.

Hosts. *Trichogramma exiguum* parasitizes 17 lepidopteran species in South America (Zucchi *et al*. 2010), although no host is known in Brazil.

Trichogramma fasciatum (Perkins, 1912)

Diagnosis. Distinguished by small oval genital capsule; dorsal lamina covering volsellae and intervolsellar process.

Comments. *Trichogramma fasciatum* was erroneously identified by several authors (see Pinto *et al*. 1978, 1983). Therefore, only the records published after these articles by Pinto and colleagues are considered to actually refer to this species. *Trichogramma fasciatum* showed considerable morphological variation, with intermediate forms (details in Pinto 1999). Based on microscope slide preparations loaned by C. Korytkoviski, deposited in the ESALQ collection, and figures from the article by Ruiz & Korytkoviski (1979), we concluded that the records of *T. fasciatum* reported by these authors are misidentifications. The specimens discussed by these authors correspond to *T. fuentesi.* Specimens from Peru identified as *T. fasciatum* by R. B. Querino belong to *T. exiguum* (Querino & Zucchi, 2003b). Therefore, we also consider that *T. fasciatum* has not been recorded in Peru so far. Similarly, the record of *T. fasciatum* in Venezuela, as listed in De Santis (1981), requires additional information to be confirmed. However, this species was recorded in Venezuela by Velásquez & Terán (2003).

Type repository. Bernice P. Bishop Museum, Honolulu (lectotype designated by Pinto *et al.* 1978).

Type locality. Orizaba, Vera Cruz, Mexico.

Distribution in South America. Ecuador and Venezuela.

Hosts. *Peridroma saucia* (Hübner, 1808) (Lepidoptera: Noctuidae) on *Agave sisalana* Perrine (Agavaceae), and egg of unidentified noctuid (Lepidoptera) on maize (Benzing 1998).

Trichogramma fuentesi Torre, 1980

Diagnosis. Flagelliform setae short with apex tapering abruptly; basiconic sensilla globular and absent in position 4; hindwing with posterior row of setae distinct, reaching or exceeding mid-length of middle row and almost reaching apex; intervolsellar process robust, with apex almost at the level of volsellae and ventral carina not exceeding middle of genital capsule.

Comments. As mentioned by Querino & Zucchi (2003b), *T. fuentesi* was erroneously identified by several authors, who confused it with *T. fasciatum* (e.g., Nagarkatti & Nagaraja 1971 and Ruiz & Korytkowski 1979). Pinto *et al*. (1983) clarified the misidentifications and discussed the characters to separate *T. fuentesi* and *T. exiguum*, which are based on the genital capsule and the posterior row of setae on the hindwing.

Type repository. Zoology Department, University of Havana, Cuba.

Type locality. San José de las Lajas, La Habana Province, Cuba.

Distribution in South America. Argentina and Peru.

Hosts. *Diatraea saccharalis* (Lepidoptera: Crambidae), *Helicoverpa zea* (Boddie, 1850), *Heliothis virescens* (Fabricius, 1777), and *Anomis texana* Riley, 1885 (Lepidoptera: Noctuidae) (Whu & Valdivieso 1999).

***Trichogramma galloi* Zucchi, 1988**

Diagnosis. Flagelliform setae short with apex tapering abruptly; basiconic sensilla sparse; dorsal lamina with narrow posterior extension generally extending beyond apex of volsellae; intervolsellar process long and distinct, almost at same level as apex of the volsellae; ventral ridge short, extending to middle of the genital capsule.

Comments. *Trichogramma galloi* most closely resembles *T. distinctum* and *T. jalmirezi*; however, it can be distinguished from these species by the following combination of characters: narrower posterior extension of the dorsal lamina, longer intervolsellar process, extending to the level of volsellae or just beyond. It is also separated from *T. distinctum* biologically since the thermal requirements are lower than *T. distinctum*, for both species reared on factitious hosts, under laboratory conditions (Parra *et al*. 1991). This species is reared massively for biological control of the sugarcane borer (Parra 2014).

Type repository. ESALQ.

Type locality. Araras, SP.

Distribution in South America. Argentina, Bolivia, Brazil, Colombia, Paraguay, Peru and Uruguay.

Host. *Diatraea saccharalis* (Fabricius, 1794) (Lepidoptera: Crambidae) (sugarcane borer).

***Trichogramma iracildae* Querino & Zucchi, 2003**

Diagnosis. Genital capsule broad, ventral processes clearly set far apart, very short intervolsellar process with apex bifid or pointed, posterior extension of dorsal lamina short and apex blunt.

Comments. *Trichogramma iracildae* is separated from all other South American species by the usually bifid intervolsellar process and the ventral processes located far apart (Querino & Zucchi, 2003b). This feature is also present in *T. marthae* Goodpasture, 1986 (a North American species), but in *T. iracildae* the ventral processes are far from each other, the intervolsellar process is usually bifid and the ventral ridge is long. Based on analysis of the ITS2 rDNA sequences (GenBank ID AY182760.1), *T. iracildae* differs from all other known species (Almeida & Stouthamer 2015). Only the type material is known.

Type repository. ESALQ (holotype) and University of California, Riverside (paratypes).

Type locality. Maceió, AL.

Distribution in South America. Brazil.

Host. *Calpodes ethlius* (Stoll, 1782) (Lepidoptera: Hesperiidae) on *Canna* sp. (*Cannaceae*).

***Trichogramma jalmirezi* Zucchi, 1988**

Diagnosis. Flagelliform setae short with apex tapering abruptly, dorsal lamina with conspicuous basal constriction, posterior extension of dorsal lamina extending beyond apex of volsellae, long and conspicuous intervolsellar process, not extending up to volsellae.

Comments. *Trichogramma jalmirezi* most closely resembles *T. distinctum* and *T. galloi*. The most conspicuous character to separate *T. jalmirezi* from the other two species is the larger constriction in the dorsal lamina. Additionally, it differs by the straight sides of the dorsal lamina (concave in *T. distinctum*), the posterior extension of the dorsal lamina tapering gradually, and the intervolsellar process not extending to the level of the volsellae (extending beyond the volsellae level in *T. galloi*). Only the type material is known.

Type repository. ESALQ.

Type locality. Macaé, RJ.

Distribution in South America. Brazil.

Host. *Diatraea saccharalis* (Fabricius, 1794) (Lepidoptera: Crambidae) (sugarcane borer).

***Trichogramma koehleri* Blanchard, 1927 [*species inquirenda*]**

Diagnosis. *Trichogramma koehleri* was described only from females, so there are no reliable characters for recognizing this species.

Comments. The identity of *T. koehleri* is not clear, as the original description was based exclusively on females. Voegele & Pintureau (1982) considered *T. koehleri* as "espèce dont le statut est en suspense". We therefore consider *T. koehleri* as *species inquirenda*. Only the type material is known.

Type repository. Not mentioned in the original description.

Type locality. Buenos Aires, Argentina.

Distribution in South America. Argentina.

Hosts. *Ecpantheria indecisa* Walker and *C. venata* [sic] (Blanchard, 1927); ?*Spodoptera frugiperda* on sugarcane (Guagliumi 1973).

Trichogramma lasallei Pinto, 1999

Diagnosis. Flagelliform setae long with apex uniformly pointed; scutellum with distinct, dark anterior setae; ventral ridge short, with anterior limit indistinct; ventral processes far from the base of intervolsellar process, which is short.

Comments. This species resembles *T. bruni* and *T. rojasi*; however, it differs from both in having the ventral processes far from the base of the intervolsellar process and a short ventral ridge. *Trichogramma lasallei* and *T. rojasi* were also characterized by molecular techniques (GenBank ID AF282237.1 and GenBank ID AF282239.1, respectively) (Ciociola *et al*. 2001). *Trichogramma bellaunionense* is similar to *T. lasallei* morphologically (see Comments on *T. bellaunionense*).

Type repository. National Museum of Natural History, Washington, D.C.

Type locality. Tortola, British Virgin Islands.

Distribution in South America. Bolivia, Brazil, Peru, Uruguay and Venezuela.

Hosts. *Trichogramma lasallei* parasitizes several major pests such as *Anticarsia gemmatalis* (Lepidoptera: Noctuidae) on soybeans in Brazil, *Diatraea saccharalis* (Lepidoptera: Crambidae) on sugarcane in Uruguay, and *Diatraea* sp. on rice in Venezuela.

Trichogramma lopezandinense Sarmiento, 1993

Diagnosis. Forewing with long setae; number of basiconic sensilla reduced; ventral ridge long, exceeding middle of genital capsule; ventral processes present, anterior to base of intervolsellar process.

Comments. *Trichogramma lopezandinense* is distinguished from other South American species mainly by the long setae of the forewing and the reduced number of basiconic sensilla (formula 1-0-0-1 (0)-1-1). This species is similar to *T. bruni*; however, it can be separated by structures of the wings: in *T. lopezandinense*, the forewing is narrower and the setae of the forewing fringe are considerably longer than in *T. bruni*. On the hind wing, the setae of the posterior row are longer in *T. lopezandinense* than in *T. bruni*. The structures on the genital capsule of *T. lopezandinense* are also similar to *T. bruni* (see Querino & Zucchi 2003b).

Type repository. National Taxonomic Collection "Luis Ma. Murillo" (holotype and paratypes), Santafé de Bogotá D.C and Natural History Museum, London (paratypes).

Type locality. Chipaque, Cundinamarca, Colombia.

Distribution in South America. Colombia (Andes).

Hosts. *Colias dimera* Doubleday, 1847 (Lepidoptera: Pieridae) on *Trifolium repens* (white clover), and *Copitarsia consueta* (Walker) (Lepidoptera: Noctuidae) on *Solanum tuberosum* L. (potato) (Zucchi *et al*. 2010).

Trichogramma manicobai Brun, Moraes & Soares, 1984

Diagnosis. Dorsal lamina with distinct lateral lobes, extending beyond lateral margin of the genital capsule; intervolsellar process distinct and short, with apical constriction.

Comments. This species can be readily separated from all other South American species by the dorsal lamina with lateral lobes extending laterally beyond the margin of the genital capsule. *Trichogramma manicobai* is one of the South American species that parasitize *Erinnyis ello* exclusively (Vieira *et al*. 2014). It was redescribed by Querino *et al*. (2017).

Type repository. Institute of Biological Sciences, Universidade Federal de Minas Gerais (UFMG) (not found).

Type locality. Felixlândia, MG.

Distribution in South America. Brazil.

Host. *Erinnyis ello* (L., 1758) (Lepidoptera: Sphingidae), a major cassava pest in Brazil.

Trichogramma marandobai Brun, Moraes & Soares, 1986

Diagnosis. Genital capsule long; dorsal lamina tapering from apex to base, not extending beyond apex of volsellae, dorsal lamina with narrow posterior extension and rounded apex at same level as intervolsellar process; intervolsellar process long and stout, ventral carina not extending beyond middle of genital capsule; flagelliform setae relatively short, tapering at apex (Vieira *et al*. 2014, 2015).

Comments. This species is similar to *T. demoraesi,* from which it differs mostly by the shape of the dorsal lamina. In Brazil, specimens obtained from eggs of *Erinnyis ello* were misidentified as *T. demoraesi*, when in fact, those specimens corresponded to *T. marandobai* (see comments under *T. demoraesi*). An integrative taxonomic study proved that the variations in the male genitalia of *T. marandobai* are intraspecific (Vieira *et al*. 2015).

Type repository. Institute of Biological Sciences, Universidade Federal de Minas Gerais (UFMG) (not found) (Vieira *et al.*, 2015).

Type locality. Felixlândia, MG.

Distribution in South America. Brazil and Peru.

Host. *Erinnyis ello* (L., 1758) (Lepidoptera: Sphingidae).

Trichogramma maxacalii Voegelé & Pointel, 1980

Diagnosis. Flagelliform setae relatively short; posterior extension of dorsal lamina straight laterally and apex rounded; length of intervolsellar process variable (short, extending to the base of volsellae, or beyond).

Comments. It is very similar to other species with a short intervolsellar process, but the oval shape of the genital capsule and the short distance between the volsellae and parameres separate it from the others. It was associated with eucalyptus and was found only in forest environment. According to Zucchi & Monteiro (1977), *T. soaresi* Nagaraja is a junior synonym of *T. maxacalii*.

Type repository: Muséum National d'Histoire Naturelle, Paris (holotype) and Zoological Station and Biological Control—l'INRA, Antibes (paratypes).

Type locality. Region between the right margin of the river Jequitinhonha and the left margin of the river Mucuri, MG.

Distribution in South America. Brazil.

Host. *Euselasia* spp. (Lepidoptera: Riodinidae) eggs on *Eucalyptus* sp. (Myrtaceae) (Zucchi & Monteiro, 1994).

Trichogramma nerudai Pintureau & Gerding, 1999

Diagnosis. Genital capsule narrow and strongly constricted at the level of intervolsellar process.

Comments. *Trichogramma nerudai* can be separated from *T. pintoi* Voegel, 1982 as follows: in *T. nerudai*, the sides of the genital capsule narrow abruptly at the level of the intervolsellar process and the parameres are straight toward the apex. In *T. pintoi*, the sides of the capsule are narrower and the parameres are arcuate. Other species that may be confused with *T. nerudai* were discussed by Pintureau *et al*. (1999), and according to J. D. Pinto (pers. com.), it is difficult to morphologically separate *T. nerudai* from *T. principium* Sugonjaev & Sorokina, 1976 (Querino & Zucchi 2003b). *Trichogramma nerudai* was originally described from Chile (Angol region) and has been recorded only in that country. It was introduced into Argentina from Chile, where it was collected from *Rhyacionia buoliana* (European pine shoot moth) to control this introduced pest in Argentina (Botto *et al*. 2004).

Type repository. Muséum National d'Histoire Naturelle, Paris (holotype); Museo Nacional de Historia Natural, Santiago de Chile and Pintureau's collection (paratypes).

Type locality. Angus, Chile.

Distribution in South America. Argentina and Chile.

Hosts. *Rhyacionia buoliana* (Denis and Schiffermuller, 1775) (Lepidoptera: Tortricidae) on *Pinus radiata* (Pintureau *et al*. 1999). *Trichogramma nerudai* was also reared from eggs of *Tuta absoluta* (Meyrick, 1917) (Lepidoptera: Gelechiidae) on tomato (*Lycopersicon esculentum*) in Chile.

***Trichogramma nomlaki* Pinto & Oatman, 1985**

Diagnosis. Dorsal lamina deeply emarginate; medial position of parameres approximate one another along midline of the genital capsule; volsellae highly modified, exceeding parameres posteriorly.

Comments. This species is found mostly in wooded areas. The host record in an agricultural habitat is an exception (Pinto 1999). *Trichogramma nomlaki* was described from a single male; subsequently, two male and one female were collected in North Carolina (Pinto *et al.* 1986), and an additional specimen from Chile (unknown host) was found out at University of California collection, Riverside (Zucchi & Monteiro 1977).

Type repository. National Museum of Natural History, Washington, D.C.

Type locality. Glenn Co., Stony Creek, 5 m. N. Elk Creek, California, USA.

Distribution in South America. Chile.

Host. Eggs of an undetermined hemerobiid (Neuroptera) on corn (Pinto 1999).

***Trichogramma obscurum* Pinto, 1999**

Diagnosis. Dorsal lamina originating posterior to middle of genital capsule, not notched or lobed at base, narrowing from base to form broad linguiform posterior extension that obscures most of volsellae in dorsal view; volsellae asymmetrical, median margin bowed, abruptly narrowed at apical half; intervolsellar process short, narrowly subtriangular (Pinto 1999).

Comments. This species belongs to the *Drepanophorum* section, based on the structure of the volsellae, the general shape of the dorsal lamina, and the presumed presence of a dorsal ridge (Pinto 1999).

Type repository. Canadian National Collection, Ottawa.

Type locality. Quintana Roo, Mexico.

Distribution in South America. Venezuela.

Host. *Dione juno juno* (Cramer, 1779) (Lepidoptera: Nymphalidae) on passion flower (golden passion fruit), *Passiflora edulis* f. *flavicarpa* (Passifloraceae).

***Trichogramma parrai* Querino & Zucchi, 2003**

Diagnosis. Unsocketed setae and basiconic sensilla prominent and globose; dorsal lamina slightly notched at base; posterior extension long, exceeding level of volsellae; intervolsellar process long and pointed or slightly rounded.

Comments. *Trichogramma parrai* might be confused with *T. nemesis* and *T. stampae*, but it is distinguished from them by the more elongate posterior extension and weakly lobed dorsal lamina with shoulders not approaching the sides of the genital capsule. It was collected in an electrical suction trap set in a forest reserve (Querino & Zucchi 2003a). Only the type material is known.

Type repository. ESALQ (holotype) and University of California, Riverside.

Type locality. Piracicaba, SP.

Distribution in South America. Brazil.

Host. Unknown (forest habitat).

***Trichogramma piracicabense* Querino & Zucchi, 2017**

Diagnosis. Genital capsule with sides typically gradually convergent posteriorly, not constricted at level of intervolsellar process, which is short; ventral process positioned anterior to base of intervolsellar process; ventral processes relatively distant from each other.

Comments. *Trichogramma piracicabense* differs from all other South American species by the funnel-shaped dorsal lamina with a narrow posterior extension. Only the type material is known.

Type repository. ESALQ.

Type locality. Piracicaba, SP.

Distribution in South America. Brazil.

Host. *Heraclides astyalus* (Godart, 1819) (Lepidoptera: Papilionidae) on *Citrus* sp. (Rutaceae).

***Trichogramma pratissolii* Querino & Zucchi, 2003**

Diagnosis. Dorsal lamina long, with posterior extension narrow, reaching level of volsellae or beyond; ventral ridge extending beyond middle of genital capsule; ventral processes broadly separated from each other and near base of short intervolsellar process.

Comments. *Trichogramma pratissolii* is similar to *T. bertii* but differs by the long flagelliform setae and the ventral processes broadly separated from each other. It resembles *T. bruni*, from which it is separated by the narrower posterior extension of the dorsal lamina and the short intervolsellar process. *Trichogramma pratissolii* was collected in egg traps of *Anagasta kueniella* (factitious host) hung on an avocado tree (Querino & Zucchi, 2003b).

Type repository. ESALQ (holotype) and University of California, Riverside.

Type locality. Conceição do Castelo, ES.

Distribution in South America. Brazil.

Host. Unknown.

***Trichogramma pretiosum* Riley, 1879**

Diagnosis. Flagelliform setae elongate and slender, gradually tapering to apex; dorsal lamina extending to level of volsellar apex; ventral ridge short, not reaching middle of genital capsule; ventral processes near base of intervolsellar process, which is pointed and long, not extending to apex of volsellae.

Comments. *Trichogramma pretiosum* is the most widespread species in the Americas and one of the most commonly collected in agricultural and disturbed habitats. It is probably a complex of cryptic species throughout its geographical range (Pinto 1999). Specimens collected in Brazil have shown variations in the length of the flagelliform setae and in the dorsal lamina (slight basal constriction, or absent). Subtle differences in the shape of the male genital capsule of *T. pretiosum*, reared on 10 species of lepidopterans, were detected by means of geometric morphometric analyses (Querino *et al*. 2002).

Type repository. National Museum of Natural History, Washington, D.C. (neotype designated by Pinto *et al.*, 1978).

Type locality. Selma, Alabama, USA.

Distribution in South America. Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Paraguay, Peru, Uruguay and Venezuela.

Hosts. *Trichogramma pretiosum* parasitizes eggs of dozens of lepidopteran species, mostly of agricultural importance, as well as eggs of *Chrysoperla* sp. (Neuroptera: Chrysopidae) (Zucchi *et al*. 2010) and of *Heraclides astyalus* (Godart, 1819) (Lepidoptera: Papilionidae) on *Citrus* sp. (Querino *et al*. 2017).

***Trichogramma pusillum* Querino & Zucchi, 2003**

Diagnosis. Genital capsule small; dorsal lamina with broad posterior extension; intervolsellar process extremely minute.

Comments. *Trichogramma pusillum* resembles *T. bennetti*, a Colombian species, but it differs by the short intervolsellar process, shorter flagelliform setae, unmodified volsellae, narrower genital capsule, and short ventral ridge with an indistinct anterior extremity. The most conspicuous character to distinguish them are the volsellae, which are distinctly lobate in *T. bennetti*. *Trichogramma pusillum* was collected in an electrical suction trap set in a forest reserve (Querino & Zucchi 2003a). Only the type material is known.

Type repository. ESALQ (holotype) and University of California, Riverside.

Type locality. Piracicaba, SP.

Distribution in South America. Brazil.

Host. Unknown (forest habitat).

***Trichogramma rojasi* Nagaraja & Nagarkatti, 1973**

Diagnosis. Hind wings with 12 to 15 setae in setae row, extending to apex; genital capsule dark; posterior extension of dorsal lamina tapering to pointed apex; ventral ridge short, extending nearly to middle of genital capsule; ventral processes very close to base of intervolsellar process.

Comments. *Trichogramma rojasi* can be confused with *T. lasallei*. However, these species can be separated by the following characters: posterior row of setae of the hind wing reaches the apex of the wing in *T. rojasi* (and does not in *T. lasallei*); the ventral ridge is more evident and can reach the middle of the genital capsule in *T. rojasi* (the ventral ridge is smaller and the anterior limit is not clear in *T. lasallei*); the ventral processes are very close at the base of the intervolsellar process in *T. rojasi* (these processes are very far from each other in *T. lasallei*). Both species were characterized by molecular techniques (*T. lasallei* GenBank ID AF282237.1/AY182762; *T. rojasi* ID GenBank AF282239.1) (Ciociola *et al*. 2001).

Type repository. National Museum of Natural History, Washington, D.C., Natural History Museum, London and Institute of Agricultural Research, La Cruz.

Type locality. La Cruz, Chile.

Distribution in South America. Argentina, Brazil, Chile and Peru.

Host. *Anticarsia gemmatalis* Hübner, 1818 (Lepidoptera: Noctuidae) on *Glycine max* (L.) Merr. (soybean).

***Trichogramma stampae* Vincent, 1986**

Diagnosis. Flagellum relatively short; the degree of fusion of funicular segments with one another and with claval segments is less than in most *Trichogramma* species (Pinto 1999).

Comments. Females of *T. stampae* are unique among *Trichogramma* species in having 8 placoid sensilla on the clava, in contrast to 5 in other species (Pinto 1999).

Type repository. National Museum of Natural History, Washington, D.C.

Type locality. Front Royal, Warren Co, Virginia, USA.

Distribution in South America. Colombia.

Host. *Chlosyne lacinia* (Geyer, 1837) (Lepidoptera: Nymphalidae) on *Helianthus* sp. (Asteraceae).

***Trichogramma terani* Velásquez & Terán, 2003**

Diagnosis. Flagelliform setae long; dorsal lamina triangular with no basal constriction and not reaching intervolsellar process; intervolsellar process weakly developed, but evident.

Comments. Velaìsquez & Teìran (2003) included *T. terani* in the *Drepanophorum* section. Although considerable heterogeneity occurs in the section, most species have a uniformly broad genital capsule, narrowing apically and often with strongly curved volsellae (as in the *atopovirilia-bennetti* clade), as mentioned by Pinto (1999). Therefore, *T. terani* probably does not belong to the *Drepanophorum* section. Only the type material is known.

Type repository. Entomological Collection, Universidad Nacional Experimental Rómulo Gallegos, San Juan de los Morros. estado Guárico.

Type locality. Las Lajas, Guárico, Venezuela.

Distribution in South America. Venezuela.

Hosts. Eggs of an undetermined noctuid (Lepidoptera) on *Sida* spp. (Malvaceae) (Velaìsquez & Teìran 2003).

***Trichogramma tupiense* Querino & Zucchi, 2003**

Diagnosis. Scutellum with long anterior setae; ventral process distinct, very close to base of intervolsellar process; dorsal lamina without basal constriction; intervolsellar process relatively short, extending to base of volsellae.

Comments. *Trichogramma tupiense* is similar to *T. bruni*, from which it is distinguished by a more elongate intervolsellar process, ventral processes more distinct and positioned at the base of the intervolsellar process, and the ventral ridge shorter and less distinct. In *T. bruni*, the ventral processes are in a more anterior position, the ventral ridge is longer and extends beyond the middle of the genital capsule, and the anterior setae of the scutellum are much shorter. Only the type material is known.

Type repository. ESALQ (holotype) and University of California, Riverside.

Type locality. Piracicaba, SP.

Distribution in South America. Brazil.

Host. Unknown (forest habitat).

Trichogramma valmiri Querino & Zucchi, 2017

Diagnosis. Flagellum relatively short, with unsocketed setae in all four regions; flagelliform setae very short; intervolsellar process short; ventral process positioned at base of intervolsellar process.

Comments. These features separate this species from other species of *Trichogramma*. In South America, *T. valmiri* is the unique species with short flagellum and unsocketed setae. Only the type material is known.

Type repository. ESALQ

Type locality. Jundiaí, SP.

Distribution in South America. Brazil.

Host. *Urbanus esta* Evans, 1952 (Lepidoptera: Hesperiidae) on *Desmodium uncinatum* (Fabaceae).

Trichogramma zucchii Querino, 2003

Diagnosis. Several setae with indistinct bases in first sections of flagellum; anterior setae of scutellum relatively long and dark; dorsal lamina long and linguiform, extending to volsellae; intervolsellar process relatively short.

Comments. *Trichogramma zucchii* can be readily distinguished from other Neotropical species by the dorsal lamina with a tongue-shaped posterior extension, extending beyond the volsellae; and by several unsocketed setae on the first sections of the flagellum.

Type repository: ESALQ (holotype) and University of California, Riverside.

Type locality: Piracicaba, SP.

Distribution in South America. Brazil.

Host. *Melanolophia* sp. (Lepidoptera: Geometridae), in a forest reserve (Querino *et al*. 2017).

Illustrated key to the species of South American *Trichogramma* (males)

1. Antenna with flagellar segments unjoined, flagellum consisting of two distinct funicular and three claval segments (Fig. 1a); marginal vein of forewing with seta near posterior border (Fig. 1b); hind wing without posterior vein track (Fig. 1c) (subgenus *Vanlisus*) (figures based on Pinto 1992, 1999) 2
1'. Antenna with flagellar segments joined, forming a single structure (Fig. 2a); marginal vein of forewing without seta near posterior border and with three long robust setae on dorsal surface (Fig. 2b); hind wing always with at least two vein tracks (Fig. 2c) (subgenus *Trichogramma*) 3
2. Mesoscutum and scutellum smooth, microsculpture indistinct; second funicular segment subquadrate, only slightly longer than wide (Fig. 3a); male genitalia with triangular posterior extension of dorsal lamina, this extension with rounded apex (Fig. 3b) (figures based on Pinto 1992, 1999). . . . . *T. atropos*
2'. Distinctive rugulose microsculpture on mesosoma; second funicular segment elongate and tapering apically (Fig. 4); male genitalia with dorsal lamina not lobed or notched at base, extremely broad over entire length, width of posterior extension subequal to parameres (figure based on Pinto, 1992, 1999) . . . . . *T. clotho*
3. Dorsal lamina without lateral lobe (not as below) 4
3'. Dorsal lamina with lateral lobe extending laterally beyond margin of genital capsule (Fig. 5a); intervolsellar process short, distinctly notched apically (Fig. 5b). . . . . *T. manicobai*
4. Dorsal lamina broad, wide, not narrowing appreciably from base to apex (Fig. 6a); dorsal ridge present (Fig. 6b) 5
4'. Dorsal lamina less broad, relatively narrow, or narrowing gradually from base to apex, or base wider than apex (Fig. 7); dorsal ridge absent. 11
5. Genital capsule relatively elongate and narrow; volsellae abruptly narrowed at apical half (Fig. 8) (figure based on Pinto 1999). . . . . *T. obscurum*
5'. Genital capsule broader, suboval (Fig. 9); volsellae variable. 6
6. Parameres arcuate (Fig. 10a); volsellae curved (Fig. 10b); genital capsule broad (width greater than 0.6 genital capsule length). 7
6'. Parameres not arcuate (Fig. 11); genital capsule small and oval (width less than 0.6 genital capsule length) 9
7. Dorsal lamina deeply bilobate apically (Fig. 12a); volsellae modified (Fig. 12b), extending beyond parameres (Fig. 12c) (Figures based on Pinto 1999). . . . . *T. nomlaki*
7'. Dorsal lamina otherwise. 8
8. Volsellae with strong constriction, broadly expanded laterally (Fig. 13a); parameres arcbroad posterior extension of dorsal lamina with apex roundeduate (Fig. 13b); intervolsellar process very short (Fig. 13c); ventral processes distinctly tubular (Fig. 13d). . . . . *T. atopovirilia*
8'. Volsellae curved, with pointed apex; spine of volsellae long, narrow and straight (Fig. 14a); parameres arcuate (Fig. 14b); intervolsellar process absent or obsolescent (Fig. 14c). . . . . *T. acacioi*
9. Dorsal lamina as wide as or wider than genital capsule (Fig. 15a), concealing volsellae (Fig. 15b) and intervolsellar process

(Fig. 15c) . . . . . *T. fasciatum*

9’. Dorsal lamina narrower than genital capsule 10

10. Volsellae modified (Fig. 16a), distinctly lobed laterally; intervolsellar process subtriangular, only about half-length of volsellae (Fig. 16b); posterior extension of dorsal lamina wide both at the apex as the base (Fig. 16c) (figures based on Nagaraja & Nagarkatti 1973) . . . . . *T. bennetti*

10’. Volsellae not modified (17a); intervolsellar process minute (17b); posterior extension of dorsal lamina narrower at the apex . . . . . *T. pusillum*

11. Dorsal lamina not extending beyond base of intervolsellar process 12

11’. Dorsal lamina extending beyond base of intervolsellar process 13

12. Intervolsellar process long (Fig. 18a); dorsal lamina short, almost reaching base of intervolsellar process (Fig. 18b) (figures based on Velásquez & Terán 2003 . . . . . *T. diazi*

12’. Intervolsellar process short, not reaching volsellae (Fig. 19a); dorsal lamina short, almost reaching base of intervolsellar process (Fig. 19b) (Figures based on Velásquez & Terán 2003) . . . . . *T. terani*

13. Dorsal lamina long, narrow, and posterior extension with apex rounded or just slightly rounded and always extending beyond volsellae (linguiform) (Fig. 20a,b) 14

13’. Dorsal lamina long or short, gradually narrowing from base to apex, or divided more or less into two portions, a wider basal section and a narrower apical section; posterior extension with apex pointed (Fig. 21a) or slightly rounded (Fig. 21b) 17

14. Posterior extension of dorsal lamina very narrow, its width near apex distinctly less than that of aedeagus 15

14’. Posterior extension of dorsal lamina narrow, its width near apex approximately or same as width of aedeagus (linguiform) . 16

15. Flagelliform setae long; dorsal lamina long, narrow, and posterior extension apically pointed (Fig. 22a); ventral ridge long, extending beyond middle of genital capsule (Fig. 22b) . . . . . *T. pratissolii*

15’. Flagelliform setae shorter; dorsal lamina funnel-shaped (Fig. 23a); ventral ridge short (Fig. 23b) . . . . . *T. piracicabense*

16. Posterior extension of dorsal lamina distinctly long and narrow, extending beyond volsellae (Fig. 24a); intervolsellar process short and pointed (Fig. 24b) . . . . . *T. zucchii*

16’. Posterior extension of dorsal lamina long, but not as narrow, extending beyond volsellae (Fig. 25a); intervolsellar process long and pointed or slightly rounded (Fig. 25b) . . . . . *T. parrai*

17. Dorsal lamina basal notch absent or indistinct (Fig. 26) 18

17’. Dorsal lamina with distinct basal notch (Fig. 27) 21

18. Intervolsellar process well-developed (Fig. 28) (figure adapted from Velaìsquez & Teìran (2003) . . . . . *T. colombiense*

18’. Intervolsellar process short (not well-developed) 19

19. Ventral processes swollen, distant from each other and placed at base of intervolsellar process (Fig. 29) . . . . . *T. alloeovirilia*

19’. Ventral processes distinct but not swollen, located near each other 20

20. Intervolsellar process relatively short and distinctly less than half length of volsellae (Fig. 30a); ventral processes at or very near base of intervolsellar process (Fig. 30b); anterior setae of scutellum elongate . . . . . *T. tupiense*

20’. Intervolsellar process elongate, reaching middle of volsellae (Fig. 31a); ventral processes close to base of intervolsellar process (Fig. 31b); anterior setae of scutellum short and thin . . . . . *T. acuminatum*

21. Genital capsule sides constricted near level of intervolsellar process (Fig. 32) 22

21’. Genital capsule sides not constricted near level of intervolsellar process 23

22. Genital capsule narrowing abruptly near level of intervolsellar process (Fig. 34a); parameres straight (Fig. 34b) . . . *T. nerudai*

22’. Genital capsule narrowing more gradually at level of intervolsellar process (35a); parameres distinctly arcuate (35b) . . . . . *T. pintoi*

23. Intervolsellar process short (extending at most to base of volsellae) (Fig. 36) 24

23’. Intervolsellar process long (extending at least half length of volsellae) (Fig. 37) 31

24. Fringe setae of forewing long, 0.6 length of hind tibia (Fig. 38) . . . . . *T. lopezandinense*

24’. Fringe setae of forewing short, less than 0.3 length of hind tibia (Fig. 39) 25

25. Hind wing, posterior row of setae elongate, with 10 or more setae, last setae reaching apex of wing (Fig. 40a); ventral processes located very near base of intervolsellar process (Fig. 40b) . . . . . *T. rojasi*

25’. Hind wing, posterior row of setae with fewer than 10 setae, last setae reaching or not to midlength of middle row of setae (Fig. 41) 26

26. Dorsal lamina short, with apex rounded, at most extending to base of volsellae (Fig. 42) 27

26’. Dorsal lamina long, with apex pointed or rounded, extending beyond base and reaching or not to apex of volsellae (Fig. 43)28

27. Genital capsule dark; ventral processes located far from base of intervolsellar process (Fig. 44a); intervolsellar process with apex pointed (Fig. 44b); anterior setae of scutellum long (Fig. 44c) . . . . . *T. esalqueanum*

27’. Genital capsule not dark; ventral processes far from each other and located near intervolsellar process (Fig. 45a); intervolsellar process usually bifid (Fig. 45b); anterior setae of scutellum short (Fig. 45c) . . . . . *T. iracildae*

28. Ventral ridge short, with anterior limit indistinct (Fig. 46); basiconic sensilla subglobose; anterior setae of scutellum elongate and dark; genital capsule dark . . . . . *T. lasallei*

28’. Ventral ridge long or moderately elongate, distinct (Fig. 47) 29

29. Flagellum relatively short, with unsocketed setae in all four regions (Fig. 48) . . . . . *T. valmiri*

29’. Flagellum different, with no unsocketed setae 30

30. Ventral ridge long and distinct, reaching about 2/3 length of genital capsule (Fig. 49); basiconic sensilla oval, formula 2(1)-2(1)-2-0(1)-1; anterior setae of scutellum short . . . . . *T. bruni*

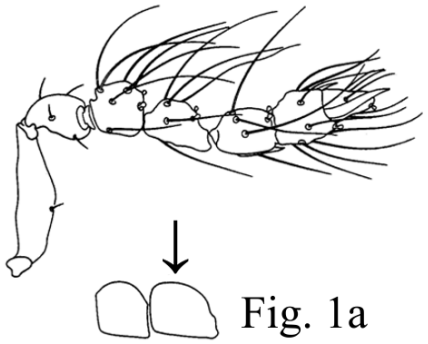

Fig. 1a

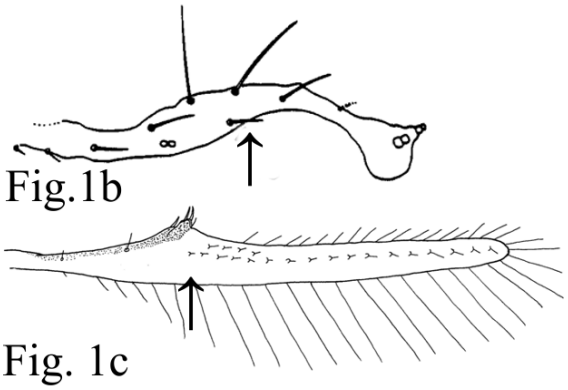

Fig.1b

Fig. 1c

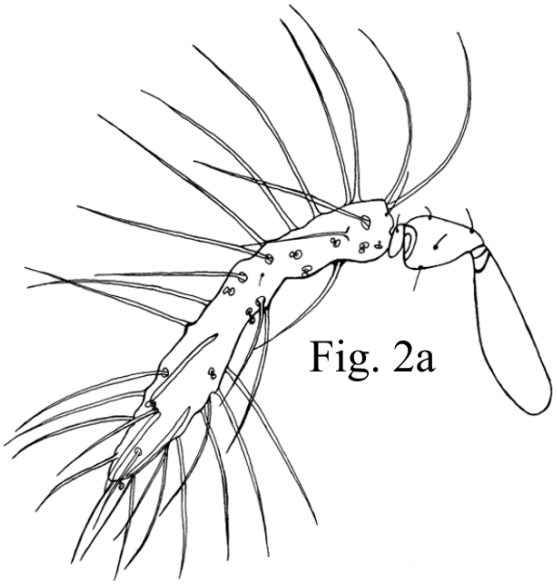

Fig. 2a

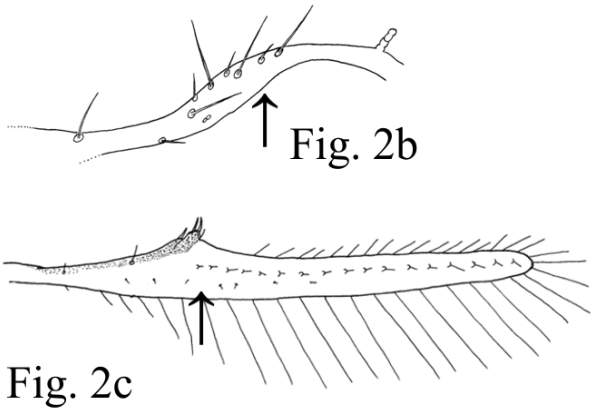

Fig. 2b

Fig. 2c

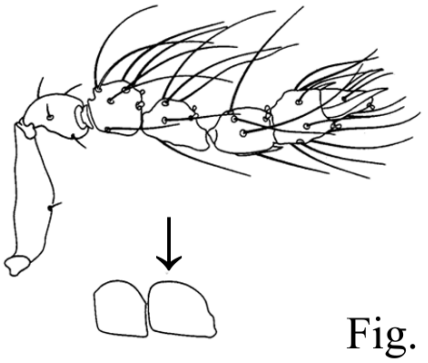

Fig. 3a

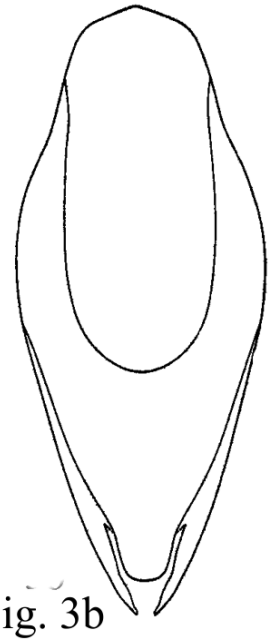

Fig. 3b

Fig. 4

PLATE 1 (Key figures 1–4). Morphological characters of *Trichogramma* (key steps 1–2').

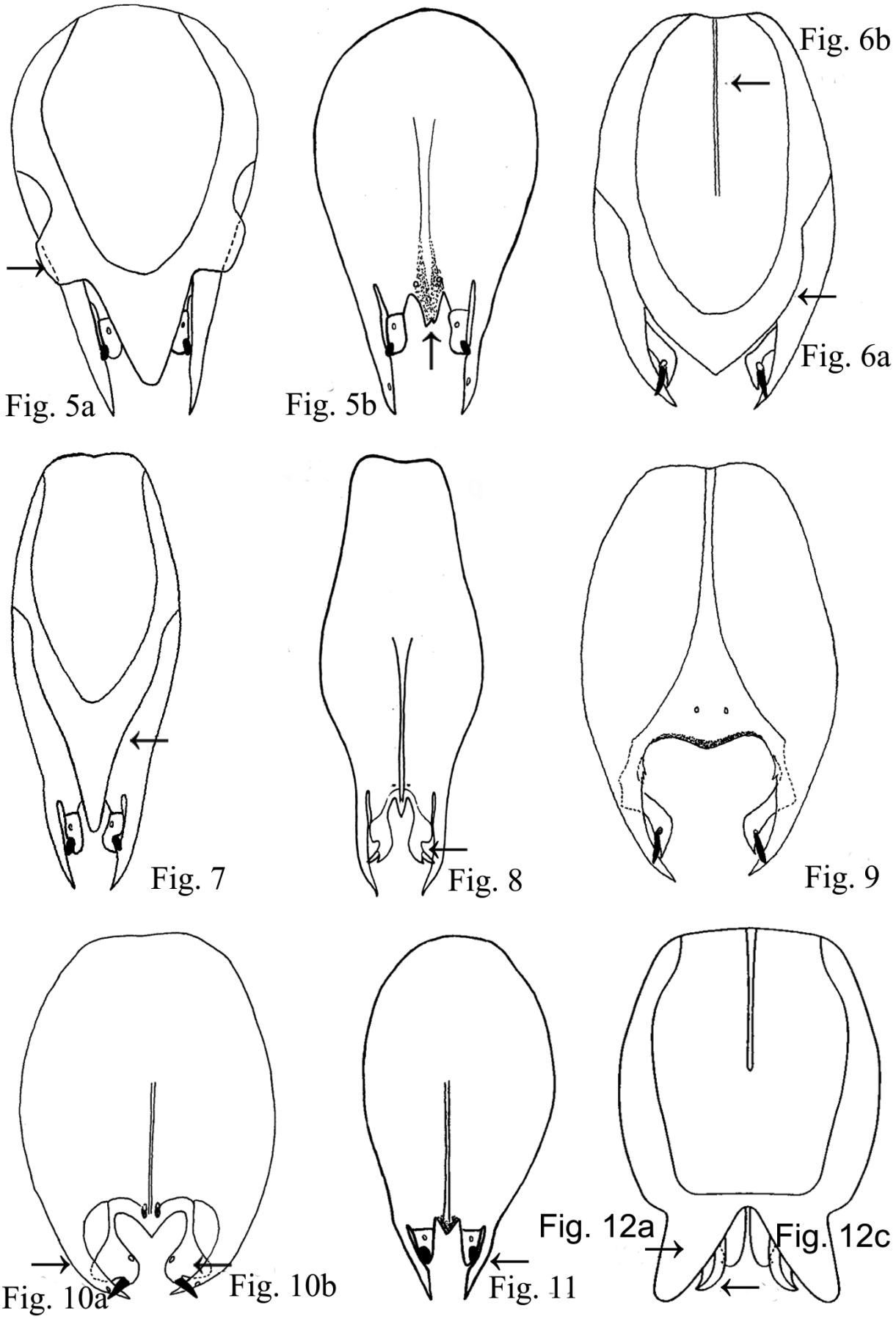

PLATE 2 (Key figures 5–12). Genital capsule of *Trichogramma* (key steps 3'–7).

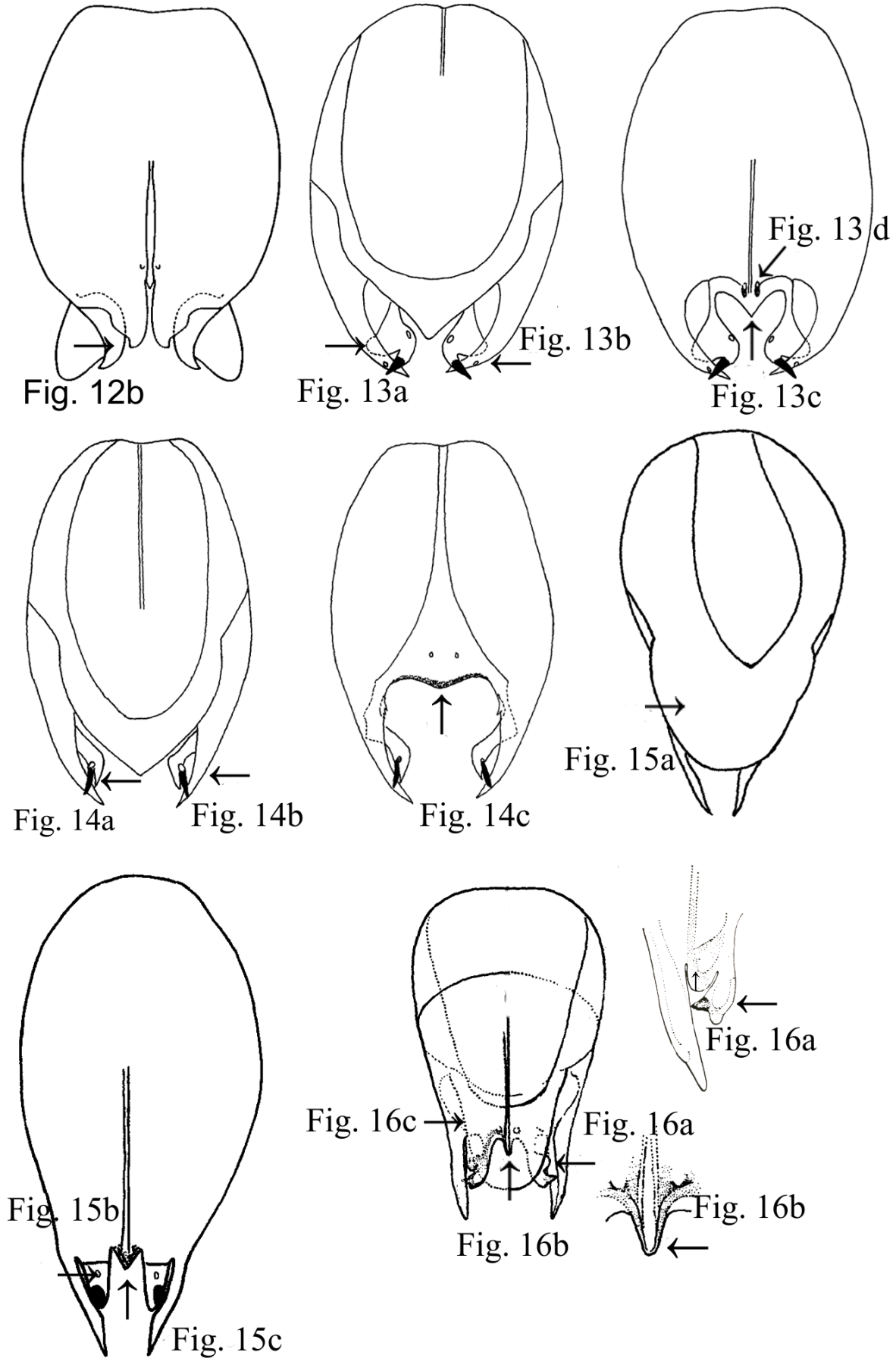

PLATE 3 (Key figures 12–16). Genital capsule of *Trichogramma* (key steps 7–10).

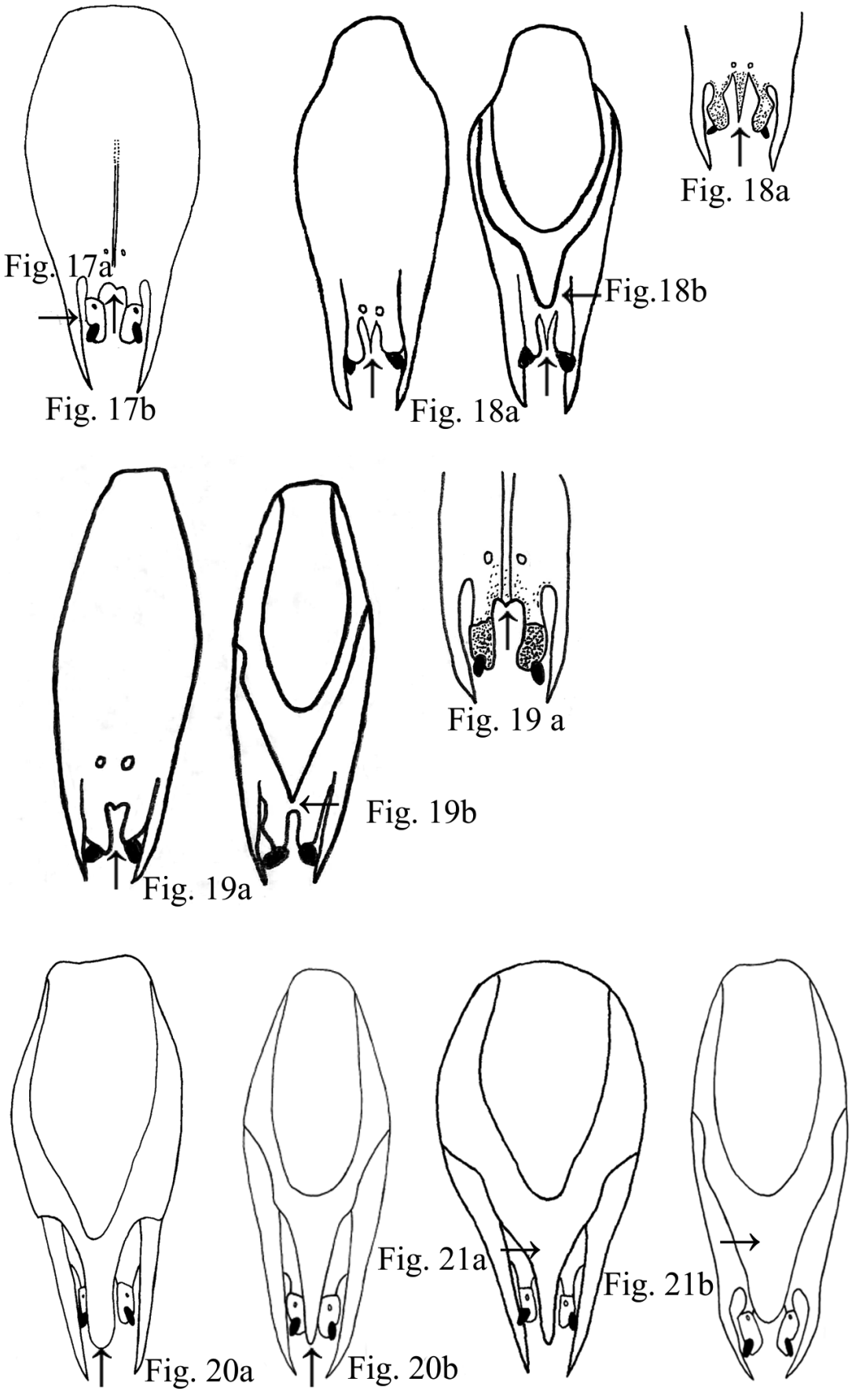

PLATE 4 (Key figures 17–21). Genital capsule of *Trichogramma* (key steps 10'–13').

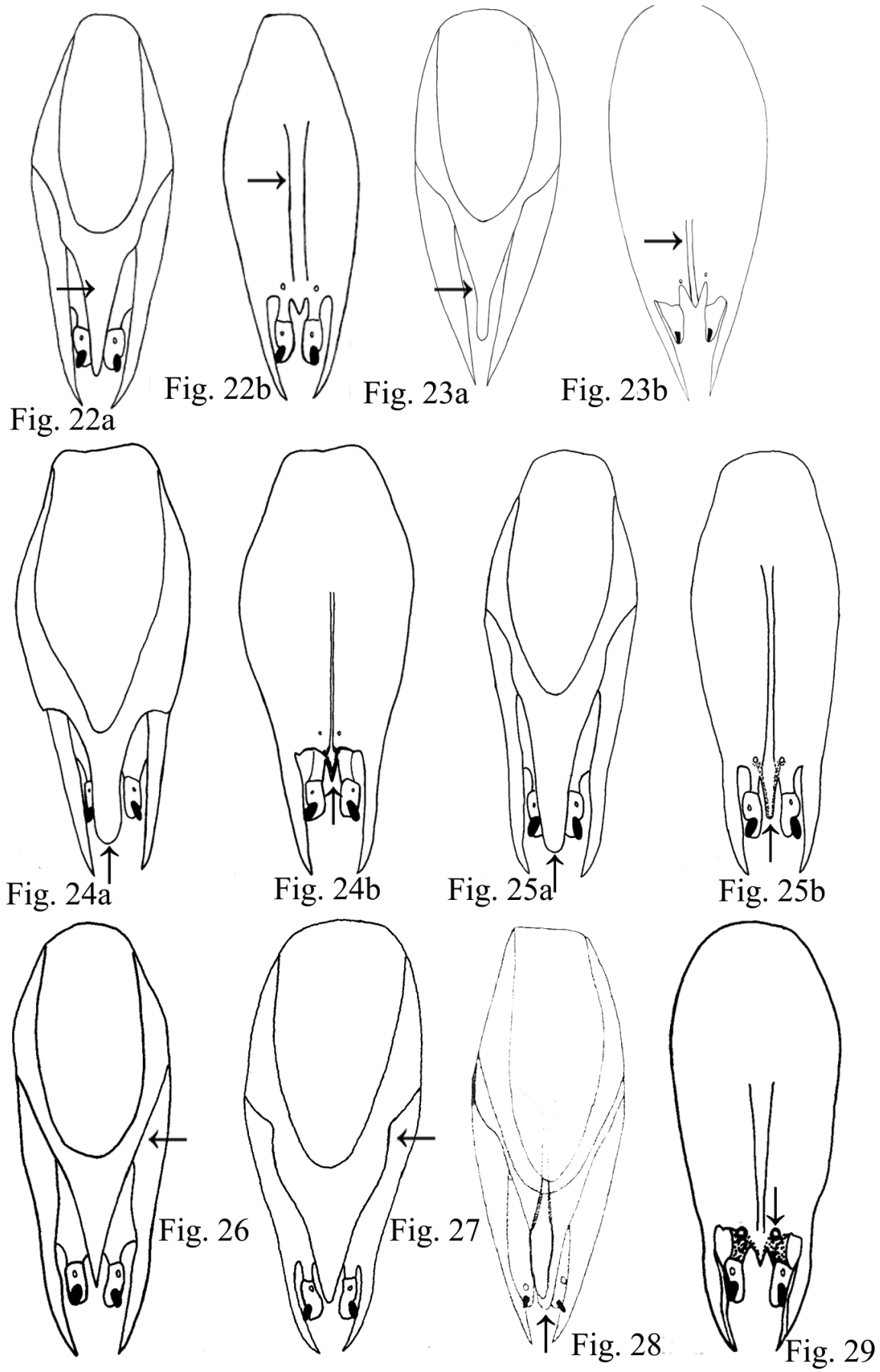

PLATE 5 (Key figures 22–29). Genital capsule of *Trichogramma* (key steps 15–19).

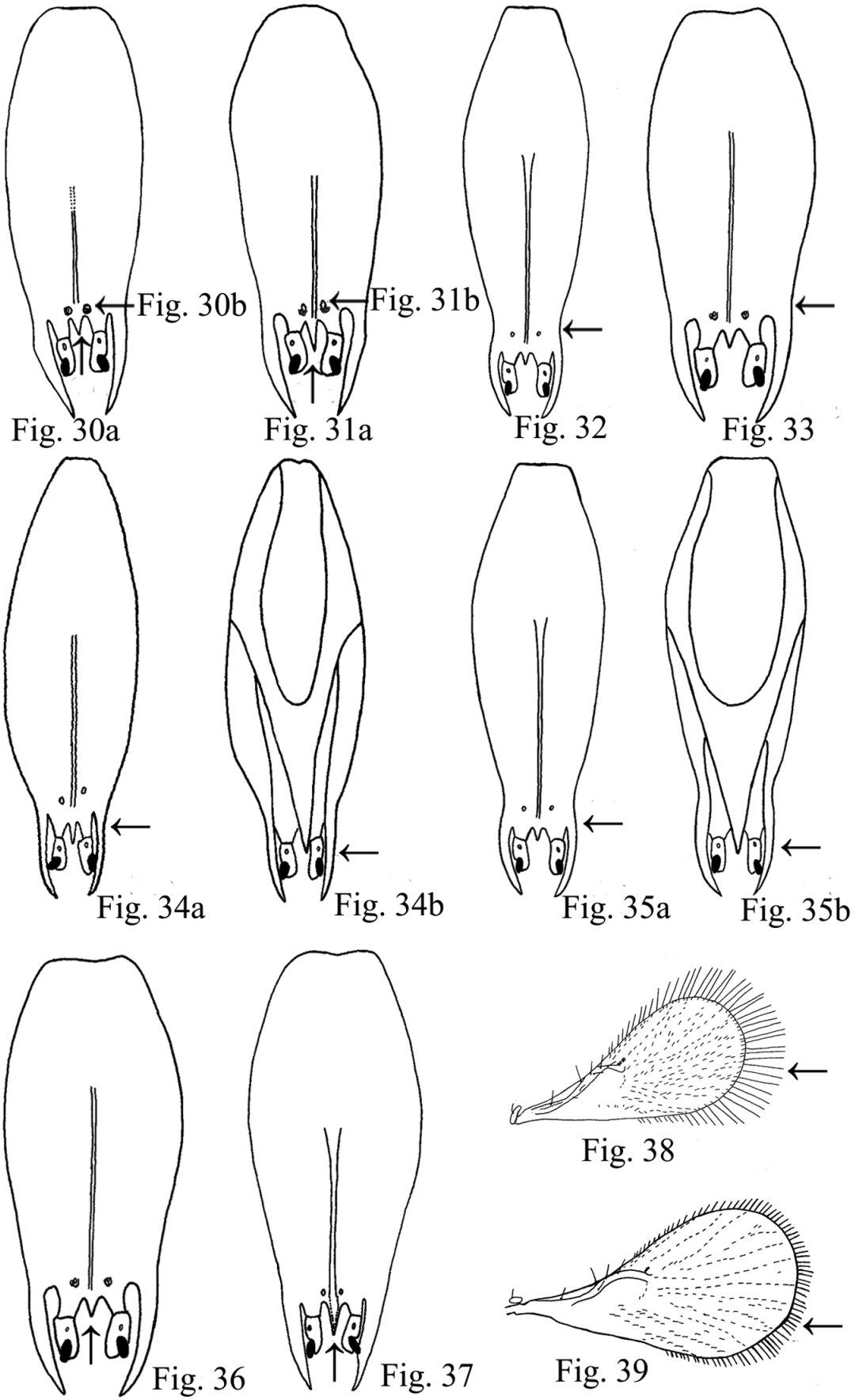

PLATE 6 (Key figures 30–39). Morphological characters of *Trichogramma* (key steps 20–24').

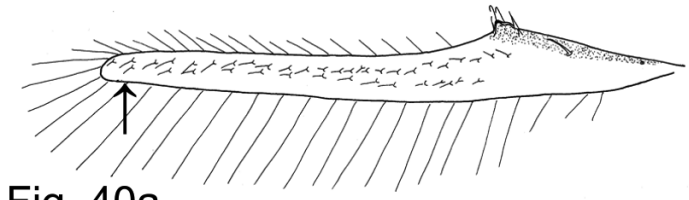
Fig. 40a

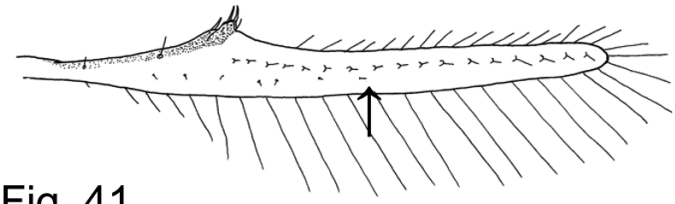
Fig. 41

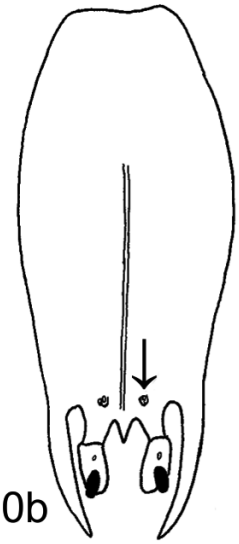
Fig. 40b

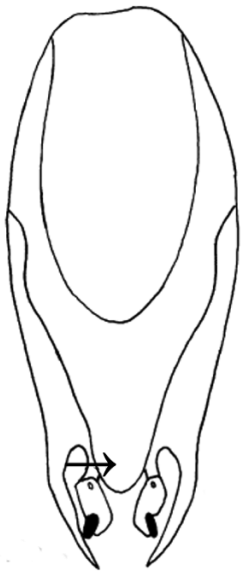
Fig. 42

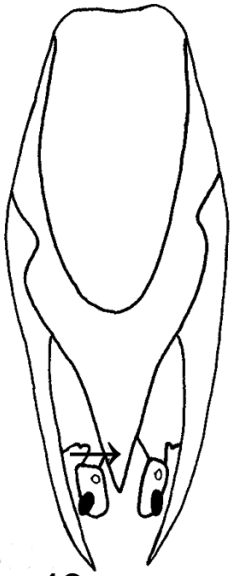
Fig. 43

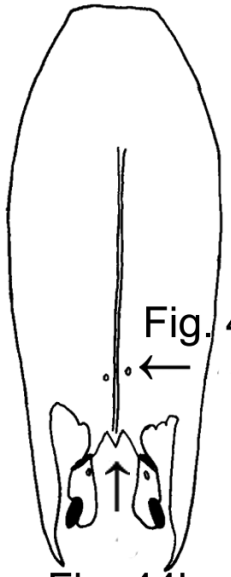
Fig. 44a

Fig. 44b

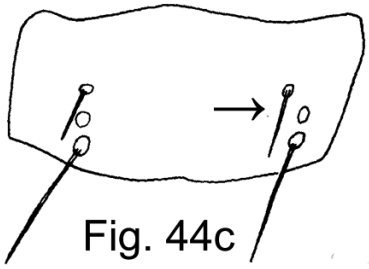
Fig. 44c

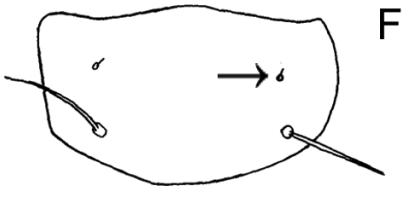
Fig. 45c

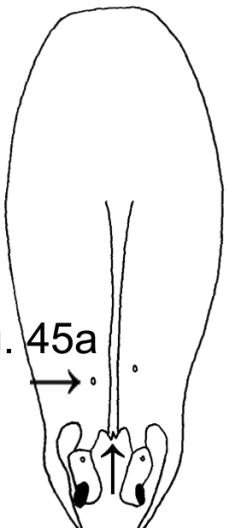
Fig. 45a

Fig. 45b

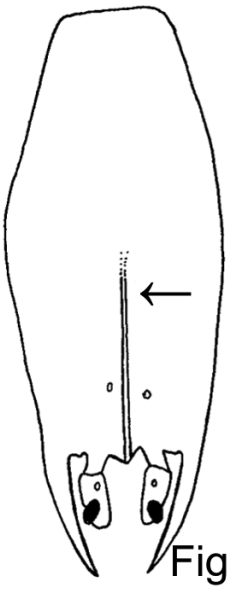
Fig. 46

PLATE 7 (Key figures 40–46). Morphological characters of *Trichogramma* (key steps 25–28).

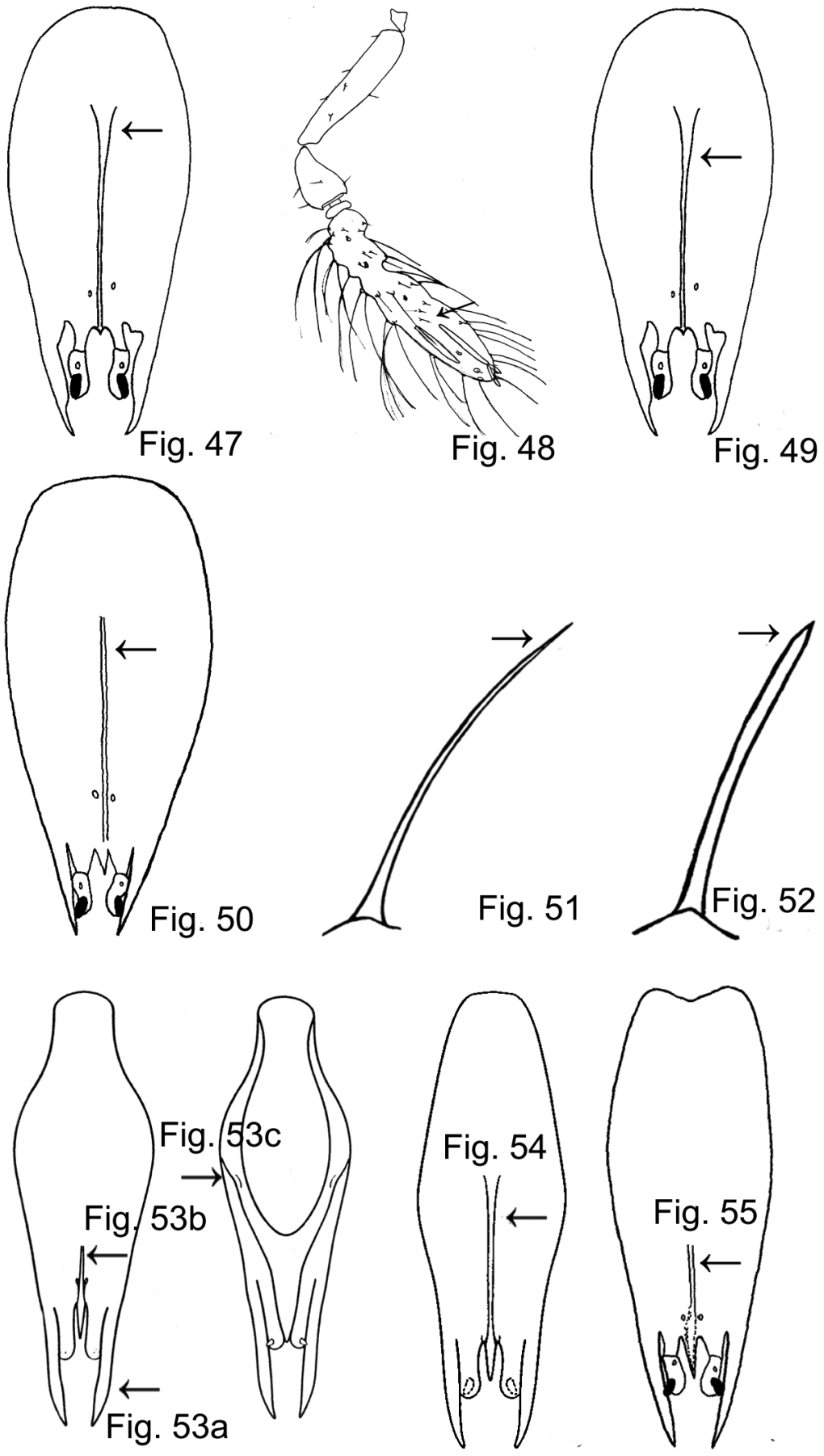

PLATE 8 (Key figures 47–55). Morphological characters of *Trichogramma* (key steps 28'–33').

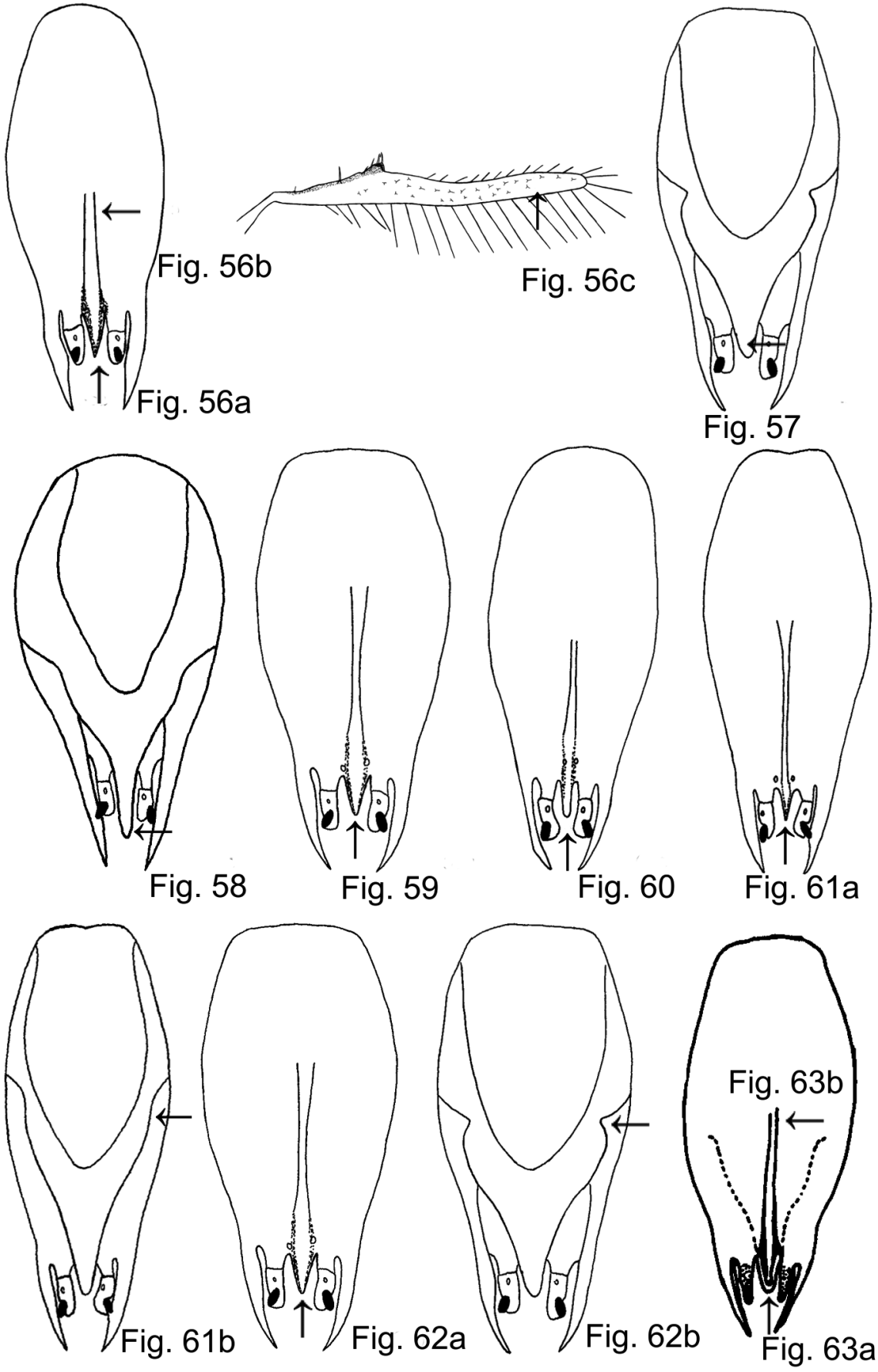

PLATE 9 (Key figures 56–63). Morphological characters of *Trichogramma* (key steps 34–38).

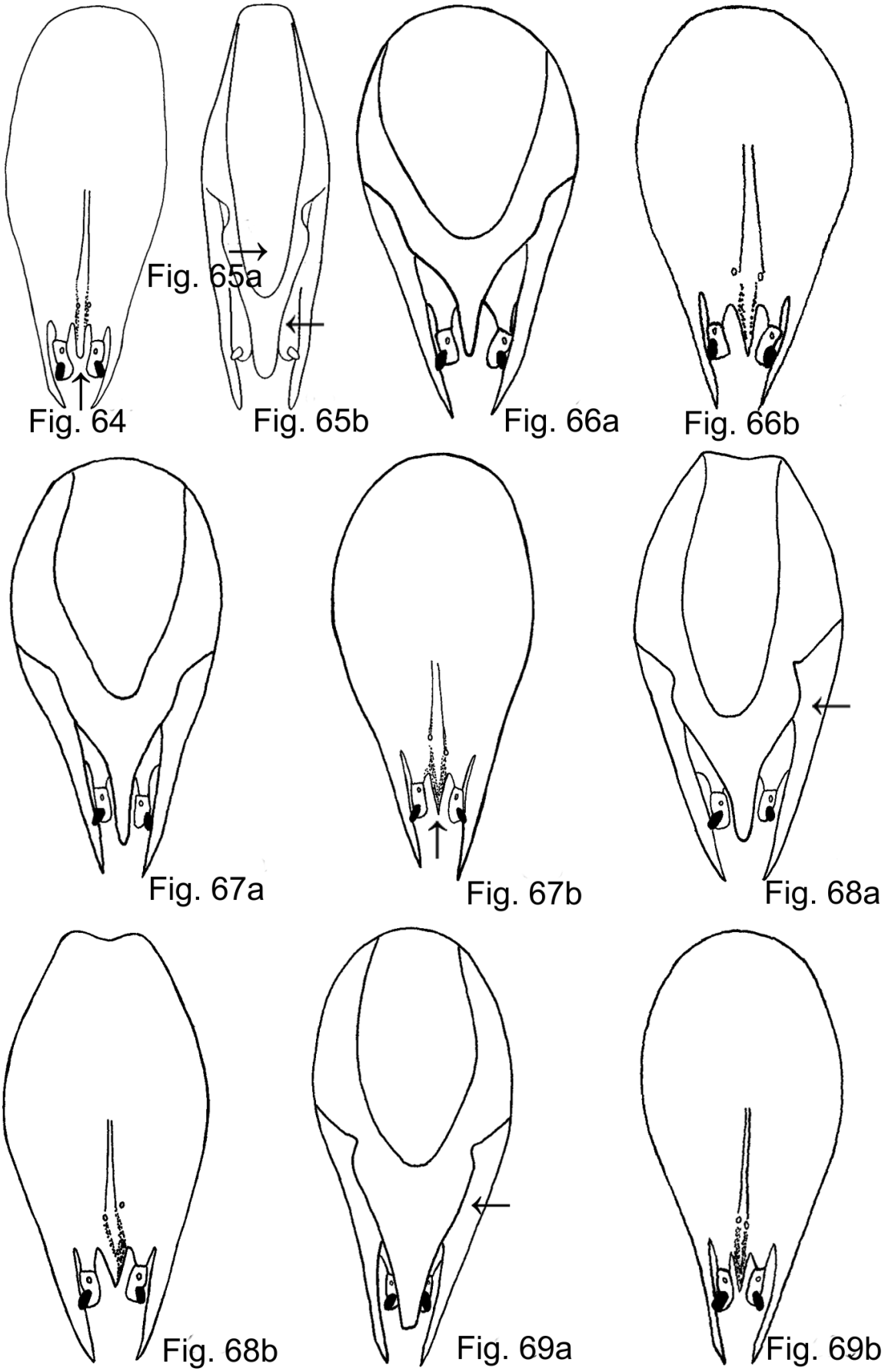

PLATE 10 (Key figures 64–69). Genital capsule of *Trichogramma* (key steps 38'–42').

30’. Ventral ridge long, reaching or extending slightly beyond middle of genital capsule (Fig. 50); basiconic sensilla formula 1-2-2-0(1)-1-1 (usually associated with *Euselasia* spp. on eucalyptus). . . . . *T. maxacalii*
31. Flagelliform setae long, tapering evenly to tips (CSF/LF>2.5) (Fig. 51). 32
31’. Flagelliform setae short, robust, tapering more abruptly apically (CSF/LF<2,5) (Fig. 52). 34
32. Genital capsule with apical distance long (Fig. 53a); ventral ridge indistinct (Fig. 53b); absence of distinct notching and shoulder at the base of the dorsal lamina (Fig. 53c); setae in posterior row on hind wing elongate, 10 or more setae present (figures based on 1999) . . . . . *T. erebus*
32’. Genital capsule with apical distance short; notching and shoulder at base of dorsal lamina varying, but not completely absent; setae in posterior row on hind wing short, with fewer than 10 setae 33
33. Ventral ridge narrow and elongate, extending to middle of genital capsule (Fig. 54); apical third of longest terminal sensillum extending beyond tip of flagellum (a single report from Venezuela) (figure based on Pinto 1999) . . . . . *T. minutum*
33’. Ventral ridge short, not reaching middle of genital capsule (Fig. 55); apical fourth of longest terminal sensillum extending beyond tip of flagellum; posterior extension of dorsal lamina usually slightly sclerotized, its apex difficult to observe in optical microscope; flagelliform setae longer (widely distributed in the Neotropics). . . . . *T. pretiosum*
34. Intervolsellar process robust, long, usually pointed or truncated at level of apex of volsellae (Fig. 56a); ventral ridge short, little developed, not extending beyond middle of genital capsule (Fig. 56b); posterior row of setae on hind wing elongate, extending nearly to apex of wing (Fig. 56c) . . . . . *T. fuentesi*
34’. Intervolsellar process long, reaching or not apex of volsellae 35
35. Posterior extension of dorsal lamina not reaching apex of volsellae (Fig. 57) 36
35’. Posterior extension of dorsal lamina approximately at same level or extending beyond apex of volsellae; if at same level, intervolsellar process close to or at level or besides the volsellae (Fig. 58) 39
36. Intervolsellar process long, usually with pointed apex; if truncated, ventral ridge extending beyond middle of genital capsule (Fig. 59) 37
36’. Intervolsellar process long, with rounded apex, or truncated; if truncated, ventral ridge not extending to middle of genital capsule (Fig. 60). 38
37. Intervolsellar process at same level or extending slightly beyond apex of dorsal lamina (Fig. 61a); dorsal lamina with shallow basal notch (Fig. 61b) (associated with lepidopterans in forest habitats). . . . . *T. bertii*
37’. Intervolsellar process shorter, never extending beyond apex of dorsal lamina (Fig. 62a); dorsal lamina with deeper basal notch (Fig. 62b); basiconic sensilla prominent and globose (commonly associated with lepidopterans of agricultural importance). . . . . *T. exiguum*
38. Intervolsellar process robust, pointed or truncated at apex (Fig. 63a); ventral ridge not extending beyond middle of genital capsule (Fig. 63b); dorsal lamina with posterior extension narrow and rounded apex at same level of intervolsellar process (associated with eggs of *Erinnyis ello* on cassava) . . . . . *T. marandobai*
38’. Intervolsellar process with rounded apex (associated with eggs of *Euselasia* spp. on eucalyptus) (Fig. 64) . . . . . *T. demoraesi*
39. Flagellum of antennae relatively short; degree of fusion of funicular segments with one another and with claval segments less than in most species; basiconic sensilla prominent and globose; dorsal aperture elongate, narrowing apically (Fig. 65a); width of dorsal lamina after basal notch considerably smaller than base, sides gradually tapering apically, with sublinguiform appearance (Fig. 65b) (figure based on Pinto, 1999) . . . . . *T. stampae*
39’. Flagellum of antennae with funicular segments fused with one another; basiconic sensilla smaller and fewer; dorsal lamina otherwise (associated with eggs of *Diatraea saccharalis* on sugarcane). 40
40. Genital capsule wide (larger than 0.50 ± 0.02 mm) (Fig. 66a, b). . . . . *T. dissimilis*
40’. Genital capsule relatively narrow (less than 0.50 ± 0.02 mm). 41
41. Intervolsellar process at level or extending beyond apex of volsellae (Fig. 67a, b) . . . . . *T. galloi*
41’. Intervolsellar process not reaching apex of volsellae. 42
42. Dorsal lamina with sinuous sides (Fig. 68a,b) . . . . . *T. distinctum*
42’. Dorsal lamina with straight sides (Fig. 69a,b) . . . . . *T. jalmirezi*

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