

Research Article

The importance of biological collections for public health: The case of the Triatominae collection of the Museum of the Institute of Agricultural Zoology “Francisco Fernández Yépez”, Venezuela

La importancia de las colecciones biológicas para la salud pública: El caso de la colección de Triatominae del Museo del Instituto de Zoología Agrícola “Francisco Fernández Yépez”, Venezuela

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Abstract. Entomological collections help scientists to rapidly identify invasive insects that affect agriculture, forestry, and human and animal health and to infer about global change biology. There are several collections with deposited Chagas disease vectors that are distributed throughout the world, but most of them present in Brazil. Faced with the need to disclose the biological material deposited in these collections, Brazilian articles were published compiling the information about the Triatomines Collections of the Oswaldo Cruz Institute, the Collection of Chagas Disease Vectors, the Entomologic collections of the Faculty of Public Health of the University of São Paulo, and the Entomological Collection of Instituto Butantan. The Museum of the Institute of Agricultural Zoology “Francisco Fernández Yépez” (MIZA) in Venezuela has more than four million arthropods deposited in its collection, being more than 4,500 holotypes. Based on the importance of disseminating to the world the richness of species deposited in biological collections, with emphasis on the entomological collections of vectors that can present important epidemiological information on the distribution of the vector-borne diseases, the present work compiles all the information related to triatomines deposited in MIZA. Through the analysis of the triatomines deposited in the MIZA was possible to highlight that there are over one thousand triatomines deposited in the entomological collection, distributed in 39 species grouped in four tribes: Bolboderini (two species), Cavernicolini (one species), Rhodniini (seven species) and Triatomini (29 species). In addition, eleven new occurrence points were described for Venezuelan states, namely, Miranda (*Cavernicola pilosa* and *Eratyrus mucronatus*), Amazonas (*Rhodnius pictipes* and *E. mucronatus*), Aragua (*R. robustus*), Federal District (*E. mucronatus*), Barinas (*Panstrongylus geniculatus*), Bolívar (*P. rufotuberculatus*), Carabobo (*Triatoma nigromaculata*), Falcón (*T. nigromaculata*) and Táchira (*T. nigromaculata*). The analysis of the entomological collection of MIZA allowed to group important information on the richness of biological material deposited for the subfamily Triatominae, as well as for the epidemiology of Chagas disease in the States of

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Venezuela, emphasizing the importance of the dissemination of information on biological collections to the scientific community in the form of manuscripts or official sites aiming the internationalization and valuation of collections and deposited material.

Key words: Biological collections, taxonomy, triatomines, vectors.

Resumen. Las colecciones entomológicas ayudan a los científicos a identificar rápidamente los insectos invasores que afectan a la agricultura, silvicultura y la salud humana y animal e inferir sobre la biología del cambio global. Hay varias colecciones con deposito de vectores de la enfermedad de Chagas que se distribuyen en todo el mundo, pero la mayoría de ellas están presentes en Brasil. Ante la necesidad de divulgar el material biológico depositado en estas colecciones, se publicaron en Brasil artículos que recopilan información sobre la Colección de Triatominos del Instituto Oswaldo Cruz, la Colección de Vectores de la Enfermedad de Chagas, las colecciones Entomológicas de la Facultad de Salud Pública de la Universidad de Sao Paulo, y la Colección Entomológica del Instituto Butantan. El Museo del Instituto de Zoología Agrícola “Francisco Fernández Yépez” (MIZA) de Venezuela, tiene más de cuatro millones de artrópodos depositados en su colección, reuniendo más de 4,500 holotipos. Basados en la importancia de diseminar al mundo la riqueza de las especies depositadas en colecciones biológicas, con énfasis en las colecciones entomológicas de vectores que pueden presentar información epidemiológica importante sobre la distribución de las enfermedades transmitidas por vectores, el presente trabajo recopila toda la información relacionada a triatominos depositados en MIZA. A través del análisis de los triatominos depositados en esta colección fue posible destacar que hay más de mil triatominos representados, distribuidos en 39 especies agrupadas en cuatro tribus: Bolboderini (dos especies), Cavernicolini (una especie), Rhodniini (siete especies) y Triatomini (29 especies). Además, se describieron once nuevos puntos de ocurrencia para los estados venezolanos de Miranda (*Cavernicola pilosa* y *Eratyrus mucronatus*), Amazonas (*Rhodnius pictipes* y *E. mucronatus*), Aragua (*R. robustus*), Distrito Federal (*E. mucronatus*), Barinas (*Panstrongylus geniculatus*), Bolívar (*P. rufotuberculatus*), Carabobo (*Triatoma nigromaculata*), Falcón (*T. nigromaculata*) y Táchira (*T. nigromaculata*). El análisis de la colección entomológica del MIZA permitió agrupar información importante sobre la riqueza del material biológico depositado para la subfamilia Triatominae, así como para la epidemiología de la enfermedad de Chagas en los estados de Venezuela, enfatizando la importancia de la difusión de información sobre colecciones biológicas a la comunidad científica en forma de manuscritos o sitios oficiales como una forma de internacionalización y valoración de colecciones y material depositado.

Palabras clave: Colecciones biológicas, taxonomía, triatominos, vectores.

Introduction

Biological collections are defined as a set of fossil or living organisms (which may be complete or only part of them) duly preserved and catalogued for the purpose of didactic-scientific studies (SiBBr 2018). There are, in general, three broad categories of biological collections, namely, zoological collections, botanical collections (herbariums) and collections of microorganisms (SiBBr 2018). Furthermore, collections can also be classified depending on the types of biological material stored and the storage methods, for example, cryogenic collections, and “classical” collections. The biological collections regarded as classical were the first collections of biological material in the world and include collections of zoological museums and herbaria (Kamenski *et al.* 2016). Zoological museum collections are very important sources of biological samples for genetic diversity studies which can be used to compare past and present diversity and detect possible loss of genetic diversity and to infer about global change biology (Baker 1994; Weber *et al.* 2000; Moraes-Barros &

Morgante 2007) and herbaria collections are one of the main sources of preserved material for plant and fungal diversity studies (Krinitsina *et al.* 2015; NYBG 2018). They provide an invaluable record of the distribution of plants and animals throughout the world and are being used in many types of studies including those focused on climate change, movement of invasive species, and niche modeling (Wen *et al.* 2015). Recently it has become clear that these collections of biological material, in addition to being used to study biodiversity, are a valuable source of DNA that can be extracted from the specimens stored and analyzed using the methods of molecular genetics leading to the discovery of cryptic species (Moraes-Barros & Morgante 2007; Krinitsina *et al.* 2015; Kamenski *et al.* 2016). In addition, order to make the museum specimens more accessible, several biological collections worldwide are directing efforts to increase digital collections (FAPESP 2020; NHM 2020).

Entomological collections help scientists to rapidly identify invasive insects that affect agriculture, forestry, and human and animal health (ESA 2018). It is estimated that there are 5,5 million of insects (Stork *et al.* 2015) [with only 1 million insect species described (Stork 2018), being suggested that 1,84-2,57 million of species is of the order Hemiptera (Stork 2018). Although there are 79,000 described species of Hemiptera (Stork 2018), roughly 7,000 species belong to Reduviidae family (group of worldwide distributed predatory or haematophagous bugs) and are distributed into 25 subfamilies (Weirauch *et al.* 2014). All haematophagous are grouped in the Triatominae subfamily that currently presents 154 species divided in 18 genera and five tribes (Just *et al.* 2014; Dorn *et al.* 2018; Oliveira *et al.* 2018; Lima-Cordón *et al.* 2019; Nascimento *et al.* 2019; Poinar 2019) and all extant species are considered as potential Chagas disease vectors [neglected disease that has no cure and reaches about 8 million people worldwide, mostly in Latin America] (WHO 2018a).

There are several entomological collections with deposited triatomines that are distributed throughout the world (Lent & Wygodzinsky 1979; Galvão 2014), but most of them present in Brazil (Lent and Wygodzinsky 1979; Gonçalves *et al.* 1993; Marassá & Barata 2000; Costa *et al.* 2008; Galvão 2014; Rodrigues *et al.* 2015; Souza *et al.* 2014; Vendrami *et al.* 2018). Faced with the need to disclose the biological material deposited in these collections, Brazilian articles were published compiling the information of the deposited in the Triatomines Collection of the Oswaldo Cruz Institute (CTIOC/FIOCRUZ), State of Rio de Janeiro (Gonçalves *et al.* 1993; Rodrigues *et al.* 2015), in the Collection of Chagas Disease Vectors (COLVEC/FIOCRUZ), State of Minas Gerais (Souza *et al.* 2014), in the Entomologic collections of the Faculty of Public Health of the University of São Paulo, State of São Paulo (FSP/USP) (Vendrami *et al.* 2018), and in the Entomological Collection of Instituto Butantan, State of São Paulo (Butantan) (Marassá & Barata 2000).

The Museum of the Institute of Agricultural Zoology “Francisco Fernández Yépez” (MIZA) was founded in 1948, as a support teaching collection at the Faculty of Agronomy of the Central University of Venezuela (UCV), in Maracay, Aragua state, Venezuela. After 70 years of its founding, the MIZA has more than four million arthropods deposited in its collection, being more than 4,500 holotypes. Based on the importance of disseminating to the world the richness of species deposited in biological collections, with emphasis on the entomological collections of vectors that can present important epidemiological information on the distribution of the vector-borne diseases (WHO 2018b), the present work compiles all the information related to triatomines deposited in MIZA.

Material and Methods

As performed by Souza *et al.* (2014) for the COLVEC, the triatomines deposited in the entomological collection of the MIZA were organized in tribes and species into a table by alphabetical order. Whenever available, we also added information about the sex of

the specimens deposited, country, state, localization and date of capture, and information about the collector and the researcher who identified the species. Digital photographs of male and / or female of the 39 species deposited in the collection (Figs. 1-63) were taken with a Nikon D5200 digital camera fitted with a modified Nikkor Medical 200 mm lens with Mitutoyo Plan Apo 5x and 10x microscope objectives, mounted on a StackShop Pro from Cognysis. The information related to the points already known and the new occurrence points were compiled into a table (Appendix 1).

Results

Through the analysis of the triatomines deposited in the MIZA it was possible to highlight that there are over one thousand triatomines deposited in the entomological collection, distributed in 39 species grouped in four tribes: Bolboderini (two species), Cavernicolini (one species), Rhodniini (seven species) and Triatomini (29 species). In addition, eleven new occurrence points were described (Appendix 1).

Tribe Bolboderini

1. *Belminius pittieri* Osuna & Ayala, 1993 (Fig. 1)

Holotype: VENEZUELA, Aragua, Rancho Grande, 1 female, 20.VI.1979, leg. J.M. Ayala.

2. *Belminius rugulosus* Stal, 1859 (Figs. 2, 3)

VENEZUELA, Aragua, Colonia Tovar, 1 female, 1 male, 25.VI.1964, col. C.J. Rosales, det. J.M. Ayala.

Tribe Cavernicolini

1. *Cavernicola pilosa* Barber, 1937 (Fig. 4)

VENEZUELA, Miranda, SW of Panaquire Río Cuíra, 1 female, 21.IX.1979, col. F. Fernandez Y., det. J. Clavijo.

Tribe Rhodniini

1. *Psammolestes arthuri* (Pinto, 1926) (Figs. 5, 6)

VENEZUELA, Anzoátegui, Pariaguán, 1 female, 13.VIII.1967, col. J. Bechyne, det. J. Oliveira; Apure, Achaguas (Santa Lucia), 9 females, 18 males, 21 nymphs, 29.VI.1981, col. J. Pulido, det. J. Oliveira; Portuguesa, 1 female, 1 male, VII.1973, det. J. Oliveira; San Genaro de Boconoíto (San Nicolas), 3 females, 11 males, 23.VIII.1976, det. J. Oliveira; 1 male, 27.IV.1975, det. J. Oliveira.

2. *Rhodnius brethesi* Matta, 1919 (Figs. 7, 8)

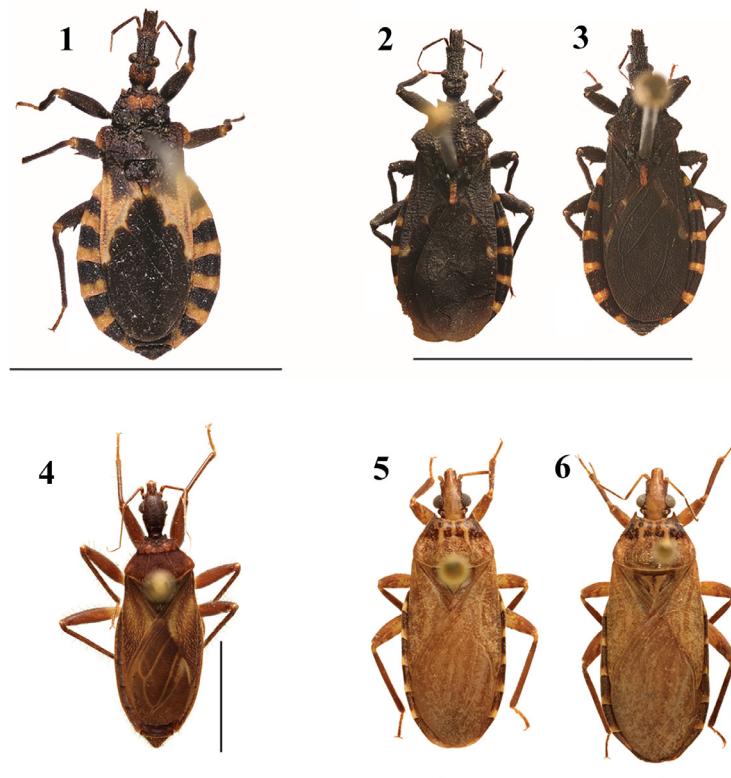
VENEZUELA, T.F. Amazonas, Atabapo (Santa Cruz), 1 female, 1 male, IV.1945, col. R. Lichy, det. J. Oliveira; Maroa (River Casiquiare), 2 females, 1 male, 11.X.1987, det. J. Oliveira.

3. *Rhodnius neglectus* Lent, 1954 (Figs. 9, 10)

Colony of laboratory (no information), 4 females, 2 males, 9.III.1981.

4. *Rhodnius neivai* Lent, 1953 (Figs. 11, 12)

VENEZUELA, Lara, 5 females, 1 male, 1975, det. J. Oliveira; 30 females, 24 males, 49 nymphs, 23.X.1979, det. J. Oliveira.



Figures 1-6. 1. Female of *Belminius pittieri*, 2. Male of *Belminius rugulosus*, 3. Female of *Belminius rugulosus*, 4. Female of *Cavernicola pilosa*, 5. Male *Psammolestes arthuri*, 6. Female *Psammolestes arthuri*. Bar: 10 mm.

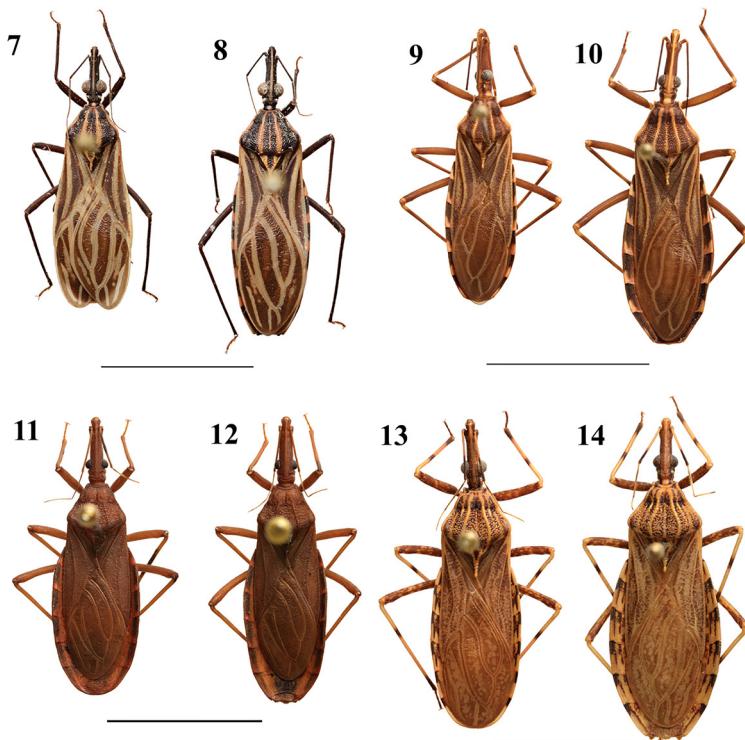
5. *Rhodnius pictipes* Stål, 1872 (Figs. 13, 14)

VENEZUELA, Aragua, Bahía de Cata, 2 females, 2 males, 19.V.1983, col. A. Fernandez; El Limón, 1 female, 25.V.1977, col. F.Y. Fernandez; 2 females, 1 male, 2.III.1988, col. J. Joly; 1 male, 1.VI.1988, J.M. Gonçalves; 1 female, 6.V.1992, col. J. Joly; Maracay (Rancho Grande), 1 female, col. J.M. Gonzalez; Bolívar, River Caura, 1 male, 10.IX.1980, col. J. Clavijo and E. Osuna; Carabobo, San Esteban, 1 male, 8.XI.1974, col. J. Salcedo and J.L.C. Garcia; Cojedes, Tinaquillo, 5 females, 6 males, 1974; Delta Amacuro, San Jose de Amacuro, 1 male, 3.XI.1980; Falcón, Chichiriviche, 1 male, 26.I.1977; Miranda, Río Cuira, 3 females, 1 male, 21.IX.1979; Río Negro, 1 female, 1 male, 19.VI.1980; Sucre, Las Melenas, 1 male, 24.XI.1993; Macuro, 1 male, 20.VII.1974, col. J. Clavijo and J. Salcedo; T.F. Amazonas, Sierra de la Neblina, 1 female, 1 male, 25.II.1985; Río Mavaca, 1 male, 6.III.1989, col. A. Chacon; Yaracuy, Agua Negra, 2.I.1921, col. R. Varella; Sierra de Aroa, 1 male, 9.VI.1996, col. C.J. Rosales and V. Savini.

6. *Rhodnius prolixus* Stål, 1859 (Figs. 15, 16)

VENEZUELA, Anzoátegui, Pariaguán, 1 female, 13.VIII.1967, col. J. Bechyne; Apure, Achaguas (Santa Lucia), 9 females, 18 males, 21 nymphs, 29.VI.1981, col. J. Pulido; Aragua, Maracay, 5 females, 6 males, 2 nymphs, 5.IX.1953; 1 nymph, 12.VII.1976, col. R. Mattei; Barinas, Ticoporo (Forest reserve), 3 females, 10 males, 20.II.1968; Bolívar, Sifontes (El Dorado), 4 females, 10.IV.1957; River Guaniamo, 2 males, 29.II.1979; Carabobo, Tocuyito, 2 males, 19.X.1957, col. C.J. Rosales; Valencia, 1 male, 2 nymphs, 15.VIII.1962, det. E. Osuna; 1 male, 27.IV.1985, col. C.J. Rosales; Lara, Sanare, 1 male, 2.VIII.1953, col. R. Prieto; Portuguesa, Campanuela, 1 male, 13.XI.1949, col. F.Y.

Fernandez; 1 female, 1 male, VII.1973; San Genaro de Boconoíto (San Nicolas), 1 male, 27.IV.1975; 2 males, 11.V.1975, det. E. Osuna; 3 females, 11 males, 23.VIII.1976; 2 females, 4 males, 20.IV.1977; Trujillo, 2 males, 22.VII.1961, col. E. Osuna; no information, 4 females and 1 male, 15.VIII.1935.



Figures 7-14. 7. Male of *Rhodnius brethesi*, 8. Female of *Rhodnius brethesi*, 9. Male of *Rhodnius neglectus*, 10. Female of *Rhodnius neglectus*, 11. Male of *Rhodnius neivai*, 12. Female of *Rhodnius neivai*, 13. Male of *Rhodnius pictipes*, 14. Female of *Rhodnius pictipes*. Bar: 10 mm.

7. *Rhodnius robustus* Larrousse, 1927 (Figs. 17, 18)

VENEZUELA, Aragua, Maracay, 2 males, 1979; Falcón, Mene de Mauroa, 1 female, 1974.

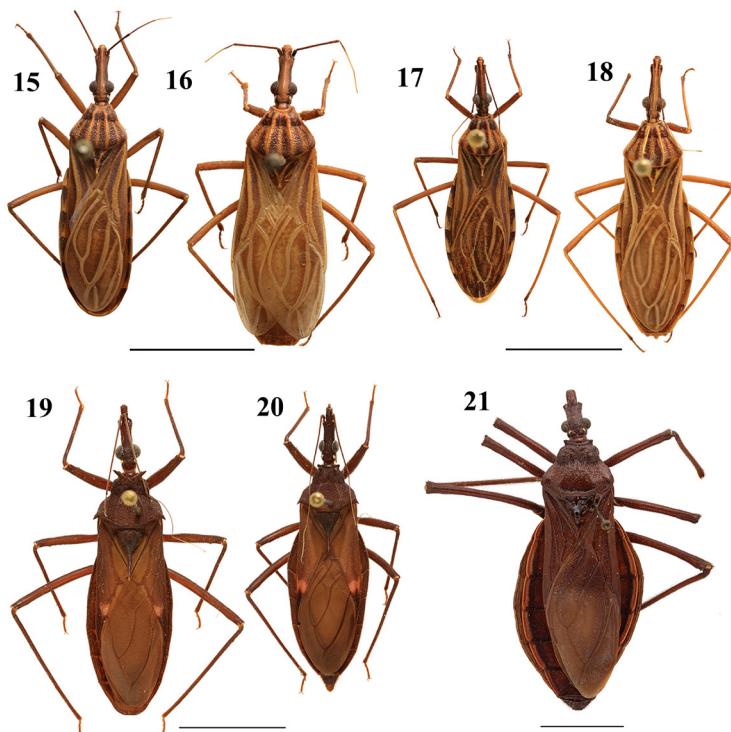
Tribe Triatomini

1. *Eratyrus mucronatus* Stål, 1859 (Figs. 19, 20)

VENEZUELA, Anzoátegui, San José de Guanipa, 1 male, 5.III.1978, col. J. Clavijo; Aragua, Bahía de Cata, 1 female, 18.VIII.1984, col. F.J.F. Yepez; El Limón, 1 male, 24.I.1982; Barina, Ticoporo (Forest reserve), 5 males, 28.II.1968, det. F.J.F. Yepez; Bolívar, Anacoco, 2 males, 30.VIII.1979; El Dorado, 5 males, 30.V.1987; Santa Elena de Uairén, 2 males, 29.VIII.1957, det. F.J.F. Yepez; Salto Pará (River Caura), 1 male, 22.XI.1978; Uria, 1 male, 17.XII.1974, col. E. Osuna; Caracas, Los Caracas, 1 male, 22.IV.1960, det. C.J. Rosales; Falcón, no information, 1 male, 28.XI.1978, col. Expedition of UCV; Miranda, Santa Lucia, 1 male, 21.XI.1982, col. A. Chacon; Portuguesa, Colony UCV, 2 females, 3 males, 1975; Táchira, La Morita, 1 male, 17.04.1972; no information, 1 male, 6.VI.1982; T.F. Amazonas, San Carlos de Río Negro, 1 male, 13.XI.1942; no information, 1 male 12.X.1987; Trujillo, Betijoque, 1 male, 9.XII.1946, col. J. Clavijo; La Guaca, 1 female, 1 male, 1980, col. J.M. Ayala; Valera, 1 male, 11.V.1982.

2. *Dipetalogaster maxima* (Uhler, 1894) (Fig. 21)

1 female, no information.



Figures 15-21. 15. Male of *Rhodnius prolixus*, 16. Female of *Rhodnius prolixus*, 17. Male of *Rhodnius robustus*, 18. Female of *Rhodnius robustus*, 19. Male of *Eratyrus mucronatus*, 20. Female of *Eratyrus mucronatus*, 21. Female of *Dipetalogaster maxima*. Bar: 10 mm.

3. *Triatoma* (=*Meccus*) *longipennis* Usinger, 1939 (Figs. 22, 23)
MEXICO, Nayarit, El Pantanal, 2 females, 1 male, 25.VIII.1929.

4. *Triatoma* (=*Meccus*) *pallidipennis* Stål, 1872 (Figs. 27, 28)
MEXICO, Colony UCV, 6 females, 4 males, 3.VI.1971, col. D. Vilasmil; Colima, Colony of laboratory, 8 females, 3 males.

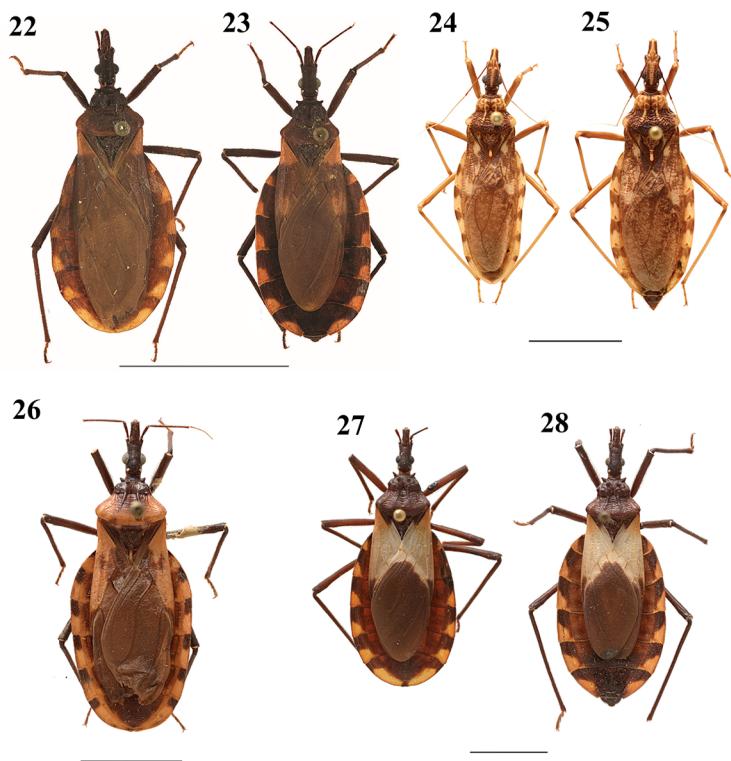
5. *Triatoma* (=*Meccus*) *picturatus* Usinger, 1939 (Fig. 26)
MEXICO, Nayarit, El Pantanal, 1 male, 5.VII.1939, det. H. Brailovsky.

6. *Nesotriatoma confusa* Oliveira et al. (2018) [identified as *N. flavida* (Neiva, 1911)] (Figs. 24, 25)
CUBA, Creation of José Manuel Ayala, 1 female, 1 male, det. J. Oliveira.

7. *Panstrongylus geniculatus* (Latreille, 1811) (Figs. 29, 30)
VENEZUELA, Anzoátegui, La Caraqueña, 2 males, 1.V.1967, col. O. Linares; Los Altos de Santa Fé, 1 male, 10.XI.1968; no information, 1 male, 1971; Aragua, Bahía de Cata, 1 female, 3.VIII.1973; El Castaño, 2 females, 1 male, 20.XII.1976, col. E. Doreste; 1 male, 28.III.1978; 1 male, 20.IV.1979, col. M.D. Medina; El Castaño (Palmirito), 1 male, 21.IV.1983, col. L.D. Otero; El Limón, 1 female, 5 males, 26.V.1959, col. F.J.F. Yepez; 2 males, 15.V.1961, col. C.J. Rosales; 1 female, 14.III.1963, col. C.J. Rosales; 2 females, 2 males, 27.X.1964, col. F.J.F. Yepez; 1 female, 5 males, 3.III.1965, col. C.J. Rosales; 1 female, 16.V.1966, col. F.J.F. Yepez; 2 females, 19.XII.1966, col. C.J. Rosales; 3 females, 2 males, 7.V.1967, col. F.J.F. Yepez; 1

male, 16.XII.1968; 2 females, 7 males, 18.XII.1968, col. J. Joly; 1 male, 9.II.1969, col. J. Joly; 1 female, 3 males, 28.III.1970, col. F.J.F. Yepez; 2 females, 5.III.1973, col. C.J. Rosales; 5 females, 8 males, 19.III.1973, col. F.J.F. Yepez; 4 males, 29.VII.1980, col. J. Bechyne; 1 female, 2 males, 21.IV.2003, col. C.J. Rosales; 1 male, V.2013, col. J. Joly; Cabrera, 1 male; Cata, 1 female, 2 males, 19.V.1983, col. R. Fernandez; Choroni, 7 males, 30.XI.1973, col. J. Salsedo; Choroni, 2 males, 12.VI.1977, col. O. Mattei; 1 male, 30.XI.1978, col. J. Salsedo; Choroni (La Isleta), 5 males, 15.V.1980, col. O. Mattei; 9 females, 7 males, 16.03.1998, col. C.F. Romero; no information, 1 male, 23.IV.1945, col. F.J.F. Yepez; Güiripa, 1 male, 23.XI.1974, col. L. Joly; La Esperanza, 1 male, 1.IV.1973; Maracay, 1 male, 15.VIII.1935; 1 male, 7.IX.1955, col. C.J. Rosales; 1 male, 18.XII.1967, col. A. Motangne; 1 female, 26.II.1972, col. O. Mattei; Ocumare de la Costa, 1 female, 16.IX.1972, col. E. Osuna, det. E. Osuna; 1 male, 2.VII.1974, col. M. Gelber; National Park, 3 male, 1.II.1978, col. C. Padron; Pie del Cerro, 1 male, 29.III.1956, col. E. Garcia; Tiara, 1 male, 12.II.1966, col. A. Chacon; 1 male, 6.VI.1977, col. A. Chacon; 1 male, 17.V.1993, col. A. Chacon; Villa de Cura, 1 male, 3.III.1981, col. J.L. Garcia; no information, 3 females, 9 males, 15.VI.1984, col. A. Chacon; Barinas, Ticoporo (Forest reserve), 3 males, 10.IX.1966, col. F.J.F. Yepez, det. L. Joly; Barinitas, 2 females, 22.II.1969, col. C.J. Rosales; Bolívar, Expedition of UCV (El Bochinche), 3 females, 2 males, 13.XII.1974; Expedition of UCV (El Dorado – River Yuruan), 2 females, 9 males, 20.V.1987; El Hormiguero, Meseta de Burla, 1 male, 13.XII.1974; El Pao, 1 female, 28.XI.1964, col. A. Fernandez; Guri, 1 male, 6.VII.1998, col. J. Joly; Kanaracuni, 1 female, 6.II.1967, col. A. Fernandez; La Gran Sabana, 1 male, 10.V.1988, col. A. Chacon; Mantecal, 1 female, 27.III.1970, col. F.J.F. Yepez and C.J. Rosales; River Caura, 1 female, 1 male, 23.XI.1978, col. J. Bechyne; River Paragua, 2 females, 17 males, 11.IX.1983; San Juan de Manapiare, 2 males, 25.II.1978; Santa Elena de Uairén, 3 females, 3 males, 14.XIII.1957, col. A. Fernandez and C.J. Rosales; Carabobo, River Borburata, 2 females, 4 males, 6.04.1950, col. F.J.F. Yepez and C.J. Rosales; 2 females, 1 male, 25.VI.1971, col. F.J.F. Yepez and J. Salsedo; San Esteban, 1 male, 20.XII.1964, col. J.M. Pélaez; 1 female, 25.IX.1970, col. J. Clavijo; 2 females, males, 8.X.1974, col. J. Salsedo, R. Dietz and J.L. Garcia; 1 female, 6.XI.1974, col. J.L. Garcia; Cerro El Café, 1 male, III.1979, col. D. Otero; Montalbán, 1 male, 9.IV.1982; Palmichal (Canoabo), 2 females, 8.03.1987; 1 female, 23.III.2001, col. J.S. Garcia; La Guacamaya, 1 male, col. F.J.F. Yepez; Caracas, El Valle, 1 male 20.XI.1943, col. C.H. Ballou; no information, 1 male, 20.III.1949, col. F.J.F. Yepez; 1 female, 26.III.1950; Antimano, 1 male, 1959, col. R.W. Garrison; Los Caracas, 1 male, 20.VIII.1965; Cojedes, La Cierra, 5.XI.1983, col. A. Chacon; Falcón, no information, 1 male, 10.VII.1954, col. J.M. Gonçales; Sanare, 1 male, 12.VI.1965, col. C.J. Rosales; Las Dos Bocas, 1 male, 7.VI.1969, col. R. Casares, J.B. Teran and M. Gelber; Chichiriviche, 1 male, 26.I.1977, col. C.J. Rosales and J. Joly; Expedition of UCV (Sanare), 3 females, 11 males, 28.X.1978, col. J. Clavijo and A. Chacon; Curimagua, 3 females, 6 males, 25.V.1983, col. J. Joly, V. Savini and A. Chacon; no information, 1 male, 30.IV.1989, col. J. Joly; 2 males, 28.III.1995, A. Chacon; Guárico, San Jose de Tiznados, 1 male, 28. IV. 1979, F. Cerdá and J. Clavijo, det. E. Osuna; San Francisco de Macaira, 2 males, 26.XII.1983, col. J.A. Gonçalez; no information, 1 male, 18.V.1985, col. A. Chacon; 1 male, 15.VII.1989, col. A. Wilinski; Miranda, Las Mercedes, 1 male, 27.II.1950; Cueva (Cruxelte), 1 male, 17.VII.1966; Capaya, 3 female, 10.VI.1980, col. J. Clavijo and A. Chacon; Barlovento, 1 male, 17.VI.1996, col. O. Hernandez; El Cafetal, 1 male; no information, 1 female, 23.VI.1955; 1 nymph, 27.IX.1964, col. O. Linhares; 1 male, 17.VII.1966; 1 male, 2.V.1971, col. A.J. Perez.; 1 female, 1 male, 1.I.1979, col. J.L. Garcia; 1 male, 19.IX.1985, col. A. Chacon; Monagas, no information, 1 male, 20.XII.1964, col. J.A. Gonçalez; 1 male, 20.III.1993, col. C.J. Rosales; Portuguesa, Mesa de Cavaca, 1 male, 7.II.1962, col. A. D'ascoli; Expedition of UCV (El Pilar – San Nicolas), 5 males, 5.XI.1991; Sucre, Las Melenas, 13 males, 9.V.1993; Caicara, 2 males, 12.IV.1974; Irapa (River Grande Arriba), 1 male, 19.X.1980, col. O. Quijada; Táchira, Expedition of UCV (River Frio), 1 male, 23.IV.1982, San Cristóbal, 2 females, 1 male, 1.XI.1981; Chucuri, 5

females, 8 males, 30.III.1989; no information, 2 males, 9.III.1967, col. J. Joly; T.F. Amazonas, Atabapo (Santa Cruz), 1 male, IX.1945; San Juan de Manapiare, 2 males, 29.III.1958; San Carlos de Río Negro, 1 male, 31.VIII.1976, col. J. Salsedo and A. Fernandez; Santa Lucia, 1 female, 3 males 21.XI.1982, col. A. Chacon; Sierra de la Neblina, 1 male, 29.II.1984; 1 female, 20.II.1985; no information, 2 males, 24.V.1987; 1 male; Alto Rio Siapa, 1 male, 27.II.1989, col. A. Chacon; Alto Río Maravaca, 1 male, 6.III.1989, col. A. Chacon; San Carlos de Río Negro, 1 male, 13.XII.1992, col. A. Chacon; Trujillo, La Gira, 1 male, 9.XII.1966, col. J. Clavijo; Vargas, Caraballeda, 1 female, 4 males, 15.VII.2015, col. C. Vasquez; Yaracuy, Agua Negra, 1 male, 24.II.1921, col. M. Madriz; Yumare, 8 females, 9 males, 5.VI.1970, col. J. Sacedo and C. Padron; La Hoya, 3 males, 30.VI.1973, col. F.J.F. Yepez, J. Salsedo and J. Clajido; Aroa, 1 female, 1 male, 13.VIII.1976, det. R.E. Dietz; Sierra de Aroa, 1 male, 8.VI.1998, col. C.J. Rosales and V. Savini; Zulia, Sierra de Perijá (River Yasa), 3 male, 15.XII.1962; no information, 1 male, 13.IV.1960; 3 females, 1 male.



Figures 22-28. 22. Male of *Triatoma longipennis*, 23. Female of *Triatoma longipennis*, 24. Male of *Nesotriatoma confusa*, 25. Female of *Nesotriatoma confusa*, 26. Male of *Triatoma picturatus*, 27. Male of *Triatoma pallidipennis*, 28. Female of *Triatoma pallidipennis*. Bar: 10 mm.

8. *Panstrongylus lignarius* (Walker, 1873) (identified as *P. herreri* Wygodzinsky, 1948) (Figs. 31, 32).

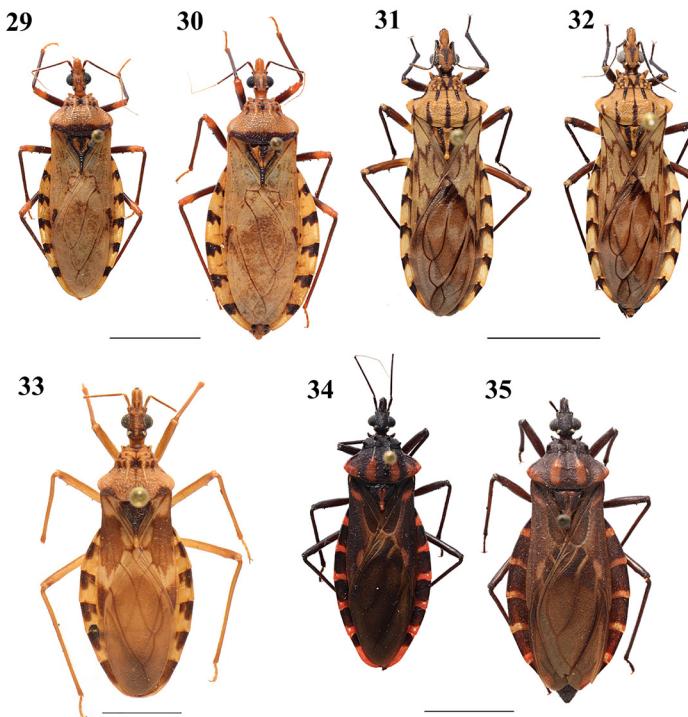
PERU, no information, Cajaruru (San Juan de la Libertad), 1 female, 1 male, 15.V.1980; VENEZUELA, T.F. Amazona, San Fernando de Atabapo, 1 male, 10.IV.1988, col. M. Aleman; no information, 2 females, 4 males.

9. *Panstrongylus martinezorum* Ayala, 2009 (Fig. 33)

Holotype: VENEZUELA, T.F. Amazonas, Río Cataniapo, 1 male, 14.XII.1990, col. R. Mattei, det. J.M. Ayala; Cerro Arakamuni (Exp. Terramar), 1 male, 24.X.1987, det. J.M. Ayala.

10. *Panstrongylus megistus* (Burmeister, 1835) (Figs. 34, 35)

BRASIL, Santa Catarina, Nova Teutonia, 1 male, II.1975, col. F. Plaumann; no information, 1 female.



Figures 29-35. 29. Male of *Panstrongylus geniculatus*, 30. Female of *Panstrongylus geniculatus*, 31. Male of *Panstrongylus lignarius*, 32. Female of *Panstrongylus lignarius*, 33. Male of *Panstrongylus martinezorum*, 34. Male of *Panstrongylus megistus*, 35. Female of *Panstrongylus megistus*. Bar: 10 mm.

11. *Panstrongylus rufotuberculatus* (Champion, 1899) (Figs. 36, 37)

VENEZUELA, Aragua, Maracay (Rancho Grande), 1 male, 5.VIII.1955, col. C.J. Rosales and F.J.F. Yepez; 1 male, 14.VI. 1979, col. J. Clavijo and G. Yepez; 1 female, 23.V.1979, col. J.A. Gonçalez, det. Osuna E.; 4 males, 31.V.1987, col. M. Alemann; National park Henri Pittier, 3 males, 21.IV.1993.; Tiara, 1 male, 15.III.1994, col. A. Chacon; Bolívar, el Dorado (River Yuruan), 2 females, 30.V.1987; Caracas, Museo de Historia Natural La Salle, 1 male, 25.VIII.1958; Guárico, Dam of Calabozo, 2 nymphs, 29.X.1981, col. R. Garcia; Miranda, no information, 1 male, 27.VIII. 1965, col. T. Ramirez; 1 male, XI.1984, col. R. Candia; National Park Guatopo, 1 male, 9.V.1974, col. J. Salsedo; Portuguesa, 1 male; Sucre, Las Melenas, 3 males, 8.V.1993, col. J. Lattquer; T.F. Amazonas, 1 nymph, 9.XII.1985, col. E. Osuna; Río Mavaca, 4 males, 6.III.1989, col. J. Marmela and A. Chacon

12. *Triatoma barberi* Usinger, 1939 (Figs. 38, 39)

MEXICO, no information, 1 male, 5.I.1944, det. J.M. Ayala; 1 female.

13. *Triatoma brasiliensis* Neiva, 1911 (Fig. 40)

BRASIL, Colony of laboratory, 1 male.

14. *Triatoma breyeri* Del Ponte, 1929 (Fig. 41)

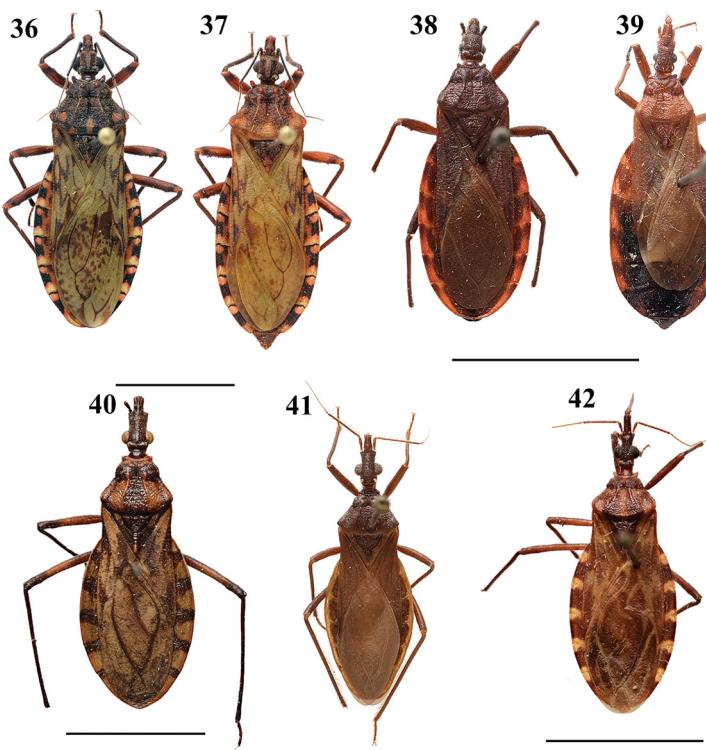
ARGENTINA, Córdoba (Cruz del Eje), 1 male, 18.I.1967, col. Vaez, det. R.U. Carcavallo.

15. *Triatoma carrioni* Larrousse, 1926 (Fig. 42)

ECUADOR, no information, 1 male.

16. *Triatoma delpontei* Romaña & Abalos, 1947 (Fig. 43)

ARGENTINA, Córdoba (Cruz del Eje), 1 female, III.1965, R.U. Carcavallo.



Figures 36-42. 36. Male of *Panstrongylus rufotuberculatus*, 37. Female of *Panstrongylus rufotuberculatus*, 38. Male of *Triatoma barberi*, 39. Female of *Triatoma barberi*, 40. Male of *Triatoma brasiliensis*, 41. Male of *Triatoma breyeri*, 42. Male of *Triatoma carrioni*. Bar: 10 mm.

17. *Triatoma dimidiata* (Latreille, 1811) (Figs. 44, 45)

MEXICO, Quintana Roo, Yucatán, 43 females, 49 males, 13.V.1967, col. E.C. Welling; COSTA RICA, Province of Heredia, 1 female, 6.X.1979, col. R. Ezequiel.

18. *Triatoma eratyrusiformis* Del Ponte, 1929 (Fig. 46)

ARGENTINA, Córdoba (Diquecito), 1 male, I.1965, col. R.U. Carcavallo; San Juan (Los Berros), 1 female, III.1960, col. R.U. Carcavallo.

19. *Triatoma guasayana* Wygodzinsky & Abalos, 1949 (Fig. 47)

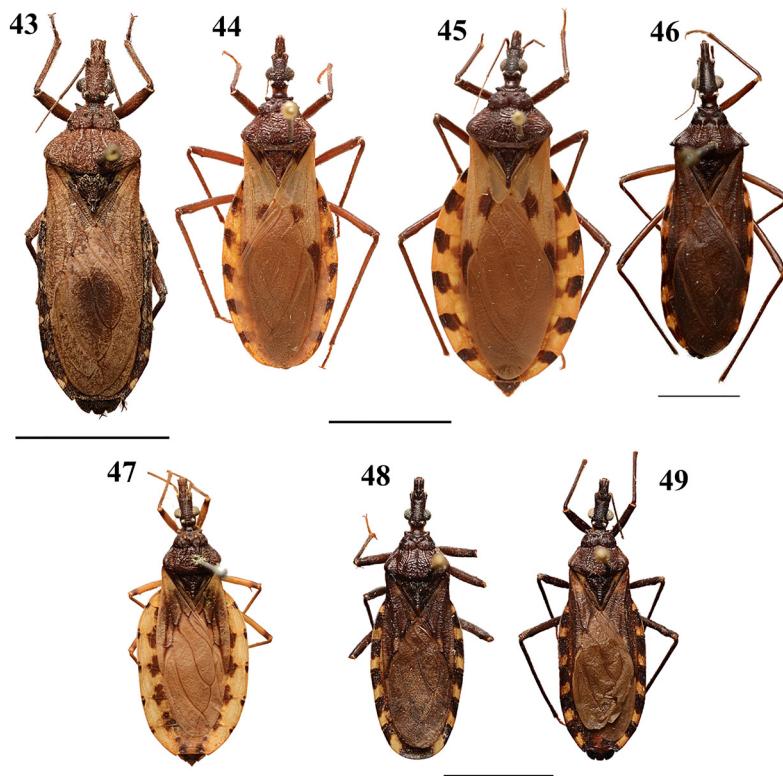
ARGENTINA, Córdoba, 1 female, I.1960, col. R.U. Carcavallo.

20. *Triatoma infestans* (Klug, 1834) (Figs. 48, 49)

ARGENTINA, Santiago del Estero (El Pinto), 1 male, IX.1956, col. R.U. Carcavallo; BOLIVIA, Magdalena (Departament of Beni), 1 male, IV.1972, det. E.C. Wellington; Province Chiquitos (Departamento of Santa Cruz), 4 females, 2 males, V.1970; Province Chapare (Departament of Cochabamba), 1 male, IX.1968, col. F. SteBach; BRASIL, São Paulo, 1 female, 3 males, 1.V.1950.

21. *Triatoma maculata* (Erichson, 1848) (Figs. 50, 51)

VENEZUELA, Anzoátegui, Barcelona, 1 female, 22.I.1967, col. J. Joly and J.L. Garcia; Valle de Guanape, 1 female, 24.I.1983, col. G. Iapez; Aragua, Maracay, 2 females, 16.II.1953; 1 male, 26.II.1973, col. V. Vargas; 3 females, 13.I.1975, col. E. Osuna; 1 male, 8.III.2001, col. J. Clavijo, det. J. Clavijo; El Limón, 1 female, 2 males, 13.XI.1954, col. M.G. Luez, det. E. Osuna; Bolívar, Guri, 1 male, 17.XI.1966, col. E. Osuna; 1 male, 6.VII.1998, col. L.J. Joly; Carabobo, Vigirima, 1 male, 11.VII.1967; Vigirima (El Toco), 1 male, 12.II.1972; Valencia, 1 male, 2.II.1974, col. J.L. Garcia; no information, 1 female, 18.IX.1996; 1 female, 1 male, 1.VII.1959; Caracas, Punta de Piedras (Margarita), 3 females, 2 males, XI.1972, col. Y. Ramires; Cerro Cimarron, Nova Esparta (El Tirano), 1 female, 8.VIII.1988, col. M. Abornoz; Cojedes, El Baúl, 1 female, 1 male, 10.V.1967, col. J. Bechyne; Falcón, 2 females, 23.VIII.1951; 1 female, 4.VIII.1970, col. V. Vargas; 1 female, 31.V.1974, col. SP. Barbosa; 1 male, 10.IX.1976; Guárico, Ortiz, 1 female, 1 male, 12.V.1955; Calabozo, 1 female, 6.XI.1958, col. H. Fantaro; Hatos Las Lajas, 1 female, 21.V.1966; El Calvario, 1 female, 10.IV.1977, col. R.A. Costa; Palo Seco, 1 female, 14.XII.1976, col. J. Marcano; Miranda, National Park Guatopo, 1 female, 28.VIII.1965, col. J. Joly; Caño Caribe (Expedition UCV), 1 female, 17.II.1978; Monagas, no information, 1 male, 29.V.1990; Portuguesa, San Genaro de Boconóto (San Nicolas), 1 female, 3 males, 24.III.1975; Papelón (Colony UCV), 1 female, 1 male, 1974; Trujillo, El Cenizo, 1 male, 15.IX.1950; Vargas, Taguao, 1 female, 11 males, XIII.1965, col. C.J. Rosales; Zulia, Maracaibo, 1 male, 19.VI.1959, col. C.J. Rosales; 1 female, 2.V.1960, col. C.J. Rosales; Colony of laboratory, 3 males, 5 nymphs.



Figures 43-49. 43. Female of *Triatoma delpontei*, 44. Male of *Triatoma dimidiata*, 45. Female of *Triatoma dimidiata*, 46. Female of *Triatoma eratyrusiformis*, 47. Female of *Triatoma guasayana*, 48. Male of *Triatoma infestans*, 49. Female of *Triatoma infestans*. Bar: 10 mm.

22. *Triatoma nigromaculata* (Stål, 1872) (Figs. 52, 53)

VENEZUELA, Aragua, Maracay (Rancho Grande), 2 females, 6 males; 13.V.1949; 1 female, 1 male, 13.VII.1967, col. A. Ramires; 1 male, 19.IX.1968; 1 male, 23.X.1971; col. J. Salcedo, det. E. Osuna; 1 female, 20.VII.1977, col. J. Clavijo; 2 females, 15.V.1998, col. V. Savini; 1 nymph, 1 female, 3 males, 10.VIII.1991; 1 nymph, 1 male, 2003, col. D. Conde; Carabobo, 2 males, 20.IX.1968, col. J. Perez; Falcón, Curimagua, 1 male, 20.VII.1984; Tachira, Rubio, 2 males, 17.VI.1982; Yaracuy, 1 male, 28.IV.1979, col. J. Lattke; Museo de Historia Natural La Salle, 1 male.

23. *Triatoma patagonica* Del Ponte, 1929 (Fig. 54)

ARGENTINA, San Luis (La Toma), 1 male, II.1962, col. R.U. Carcavallo.

24. *Triatoma platensis* Neiva, 1913 (Figs. 55, 56)

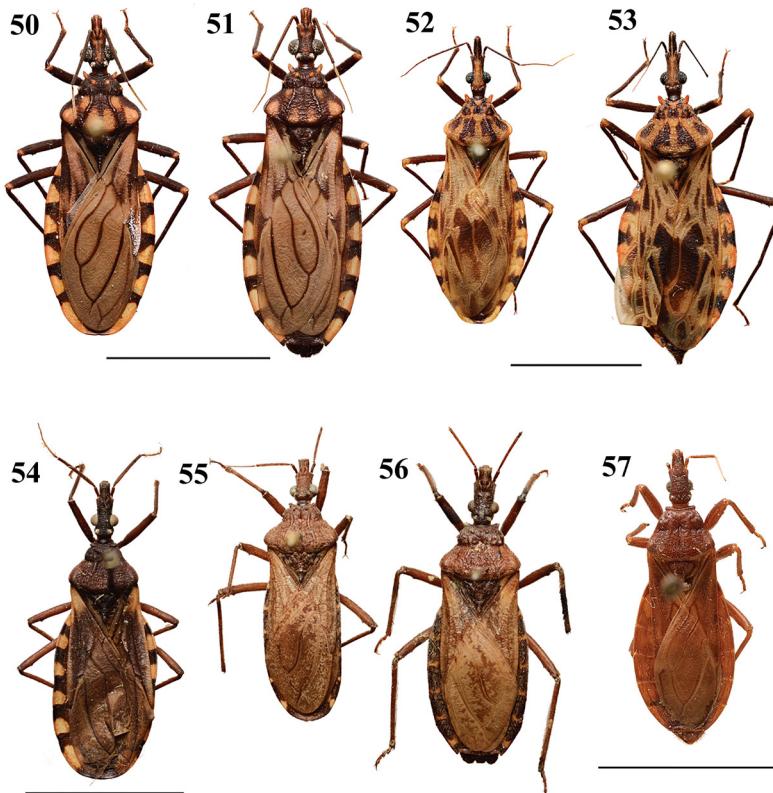
ARGENTINA, San Luis (La Verde), 1 female, XI. 1955, col. R.U. Carcavallo; Córdoba, 1 male, IX.1970; no information, 1 female, 14.IV.1964.

25. *Triatoma protracta* (Uhler, 1894) (Fig. 57)

ESTADOS UNIDOS, California, 1 female, VI.1968; no information, 1 female.

26. *Triatoma rubrovaria* (Blanchard, 1843) (Fig. 58)

Colony of UCV, 1 female, 1964.



Figures 50-57. 50. Male of *Triatoma maculata*, 51. Female of *Triatoma maculata*, 52. Male of *Triatoma nigromaculata*, 53. Female of *Triatoma nigromaculata*, 54. Male of *Triatoma patagonica*, 55. Male of *Triatoma platensis*, 56. Female of *Triatoma platensis*, 57. Female of *Triatoma protracta*. Bar: 10 mm.

27. *Triatoma sanguisuga* (LeConte, 1855) (Fig. 61)

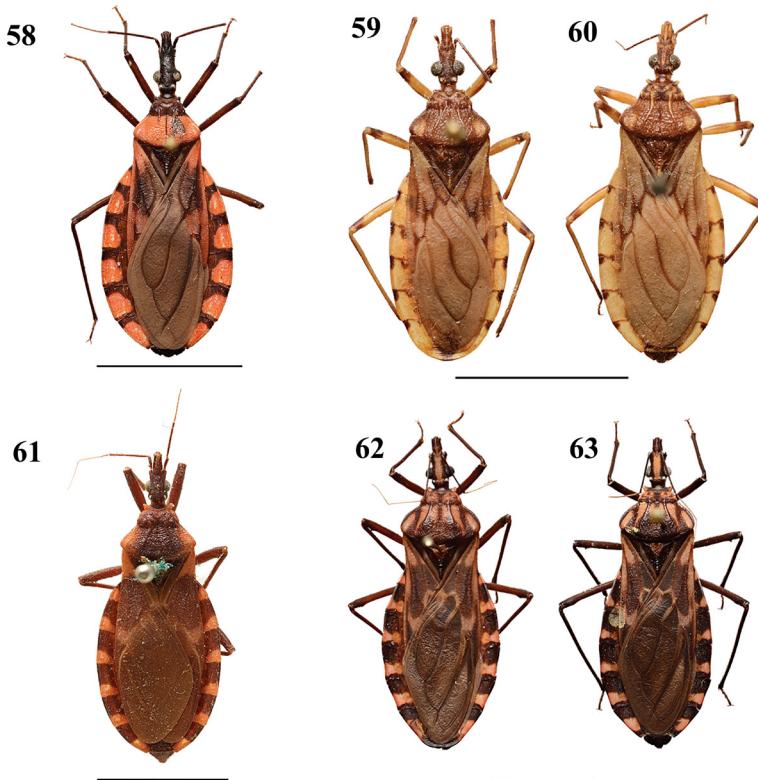
No information, 1 female.

28. *Triatoma sordida* (Stål, 1859) (Figs. 59, 60)

BOLIVIA, Departament of Santa Cruz (Province of Chiquitos), 1 male, V.1970, det. F. Istembach; Departament of Cochabamba (Province of Chapare), 1 female, IX.1968, det. F. Istembach; Colony of Segea, 1 female.

29. *Triatoma vitticeps* (Stål, 1859) (Figs. 62, 63)

Colony of UCV, 3 females, 3 males, 1961.



Figures 58-63. 58. Female of *Triatoma rubrovaria*, 59. Male of *Triatoma sordida*, 60. Female of *Triatoma sordida*, 61. Female of *Triatoma sanguisuga*, 62. Male of *Triatoma vitticeps*, 63. Female of *Triatoma vitticeps*. Bar: 10 mm.

Discussion

The International Code of Zoological Nomenclature (ICZN) established recommendations for all institution in which name-bearing types are deposited should (ICNZ 1999). Among the recommendations, we can highlight that all institutions should publish lists of name-bearing types in its possession or custody (ICNZ 1999). The entomological collection of MIZA presents only two holotypes of deposited triatomine, namely, *Belminius pittieri* Osuna & Ayala, 1993 and *Panstrongylus martinezorum* Ayala, 2009 (Osuna & Ayala 1993; Ayala 2009). However, taking into account that the biological collections are foundational across from documenting and describing species and their tremendous diversity, assisting in public health, agricultural practices, food security,

monitoring environmental contamination; and in the studying the effects of biological invasions and global climate change (Suarez & Tsuitsui 2006; Amorim *et al.* 2016; Short *et al.* 2017), we highlight the importance of the good preservation conditions of triatomine specimens deposited in MIZA (Appendix 1) for taxonomy, systematic and diversity studies, as well as for the epidemiology of Chagas disease vectors.

Currently there are 22 species of triatomines living in Venezuela (Cazorla-Perfetti & Nieves-Blanco 2010). Only five species are not deposited in MIZA, namely, *Alberprosenia goyovargasi* Martínez & Carcavallo, 1977, *Microtriatoma trinidadensis* (Lent, 1951), *Eratyrus cuspidatus* Stål, 1859, *Panstrongylus chinai* (Del Ponte, 1929) and *Triatoma rubrofasciata* (De Geer, 1773). As the Triatominae taxonomy is much discussed (Lent and Wygodzinsky 1979; Carcavallo *et al.* 2000; Galvão *et al.* 2003; Oliveira *et al.* 2018), some taxa deposited in MIZA are outdated: *Nesotriatoma confusa* Oliveira *et al.*, 2018 is characterized as *N. flavida* (Neiva, 1911) [for more details, see the discussion on the taxonomy of *Nesotriatoma* spp. recently performed by (Oliveira *et al.* 2018)] and *P. lignarius* is deposited in MIZA as *P. herreri* [the synonymization of the species occurred only in 2002 by Marcilla *et al.* (2002) and the specimens were deposited before 1988].

By means of analysis of collection data for triatomines deposited in MIZA, it was possible to highlight new points of occurrence in the Venezuelan states for seven species (Appendix 1). This information is extremely important from an epidemiological point of view, because taking into account that all species have been deposited in the last century (Appendix 1), the notifications regarding the new points of occurrence that have been archived for decades in MIZA could have contributed to vector control programs in Venezuela, mainly because the seven species have already been found naturally infected with *Trypanosoma cruzi* (Chagas, 1909), the etiologic agent of Chagas disease (Cazorla-Perfetti & Nieves-Blanco 2010).

Chagas disease was first detected in Venezuela in 1919 (Tejera 1919). With the implementation of the National Program against Chagas Disease, based on the chemical control of the vectors by the spraying of insecticides and in improving housing, the rate of domestic infestation of triatomines was reduced from 17.9% to 5% and the incidence of the disease in the population decreased from 44.4% to 11.7% (Acquatella 2003; Feliciangeli 2009; Cazorla-Perfetti & Nieves-Blanco 2010). However, in the 21st century cases of oral transmission of Chagas disease were reported in Venezuela, by means of the ingestion of food contaminated with feces of the triatomines infected with *T. cruzi* (Noya *et al.* 2015), stressing, once again, the epidemiological importance of these vectors.

Conclusion

The analysis of the entomological collection of MIZA allowed to group important information on the richness of the biological material deposited for the subfamily Triatominae (39 species), as well as for the epidemiology of Chagas disease in the states of Venezuela (eleven new points of occurrence), emphasizing the importance of the dissemination of information on biological collections to the scientific community in the form of manuscripts or official sites [as well as recommended by ICZN (1999)] aiming the internationalization and valuation of collections and deposited material.

Acknowledgements

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Appendix 1. Distribution of the seven triatomines species that presented new points of occurrence in Venezuela. New occurrence points highlighted in bold.

Species	Points of occurrence in the Venezuelan states
<i>C. pilosa</i>	Amazonas ¹ , Cojedes ¹ , Federal District ² , Lara ¹ , Miranda , Portuguesa ¹ and Táchira ¹
<i>R. pictipes</i>	Amacuro ¹ , Amazonas , Anzoátegui ¹ , Apure ¹ , Aragua ¹ , Bolívar ¹ , Carabobo ¹ , Cojedes ¹ , Delta Amacuro ¹ , Falcón ¹ , Lara ³ , Mérida ¹ , Miranda ¹ , Monagas ¹ , Portuguesa ¹ , Sucre ¹ , Táchira ¹ , Trujillo ¹ , Yaracuy ¹ and Zulia ¹
<i>R. robustus</i>	Apure ¹ , Aragua , Barinas ¹ , Bolívar ¹ , Cojedes ¹ , Falcón ¹ , Mérida ¹ , Monagas ¹ , Sucre ¹ , Táchira ¹ , Trujillo ¹ and Yaracuy ¹
<i>E. mucronatus</i>	Amazonas , Anzoátegui ² , Aragua ¹ , Barinas ¹ , Bolívar ² , Carabobo ¹ , Cojedes ¹ , Falcón ¹ , Guárico ¹ , Lara ¹ , Mérida ¹ , Miranda , Monagas ¹ , Portuguesa ¹ , Sucre ¹ , Trujillo ¹ , Táchira ¹ , Yaracuy ¹ and Zulia ¹
<i>P. geniculatus</i>	Amazonas ³ , Anzoátegui ¹ , Aragua ¹ , Barinas , Bolívar ¹ , Carabobo ¹ , Cojedes ³ , Delta Amacuro ¹ , Falcón ¹ , Federal District ¹ , Guárico ¹ , Lara ¹ , Mérida ¹ , Miranda ¹ , Monagas ¹ , Portuguesa ³ , Sucre ³ , Táchira ¹ , Trujillo ³ , Vargas ² , Yaracuy ¹ and Zulia ¹
<i>P. rufotuberculatus</i>	Amazonas ³ , Aragua ¹ , Bolívar , Carabobo ¹ , Cojedes ¹ , Delta Amacuro ¹ , Falcón ¹ , Federal District ¹ , Guárico ¹ , Lara ¹ , Mérida ² , Monagas ¹ , Portuguesa ¹ , Táchira ¹ , Trujillo ¹ , Sucre ¹ , Yaracuy ¹ and Zulia ¹
<i>T. nigromaculata</i>	Anzoátegui ³ , Aragua ¹ , Barinas ¹ , Bolívar ¹ , Carabobo , Cojedes ¹ , Delta Amacuro ¹ , Falcón , Federal District ¹ , Lara ¹ , Mérida ¹ , Monagas ¹ , Portuguesa ¹ , Sucre ¹ , Táchira ¹ , Vargas ⁴ and Yaracuy ¹

¹Galvão *et al.* (2003), ²Cazorla-Perfetti and Nieves-Blanco (2010), ³Ramírez-Pérez *et al.* (1987), ⁴Stal (1859)

