

A PRELIMINARY SURVEY OF THE NON-BITING MIDGES (DIPTERA: CHIRONOMIDAE) OF THE DOMINICAN REPUBLIC

Fabio Laurindo da Silva^{1,*}, Sofia Wiedenbrug² and Brian D. Farrell¹

¹Museum of Comparative Zoology, Department of Organismic and Evolutionary Biology, Harvard University, 26 Oxford Street, Cambridge, MA 02138, USA.

E-mails: laurindodasilva@fas.harvard.edu, bfarrell@fasmail.harvard.edu

²Zoologische Staatssammlung München, Münchhausenstr. 21, 81247 München, Germany.

E-Mail: sofia.wig@gmail.com

*Corresponding author.

Abstract

Chironomidae (Diptera) are among the most diverse and widespread aquatic insects, with roughly 5,500 described species. However, prior to the present work, no species of Chironomidae had been documented from the island of Hispaniola. Collections of non-biting midges, with emphasis on the lotic fauna, were made in the Dominican Republic during July of 2015. In total, 578 specimens belonging to 27 genera and at least 44 species within the subfamilies Chironominae (20 taxa), Orthoclaadiinae (16 taxa) and Tanypodinae (8 taxa) were found. The subfamilies Chironominae and Orthoclaadiinae predominated. *Polypedilum* was the most widespread and diverse genus of Chironominae. *Metriocnemus* were collected in bromeliad tanks. The chironomid fauna in Dominican Republic includes multiple genera with worldwide distributions, including Holarctic and Neotropical components.

Introduction

Non-biting midges, belonging to the family Chironomidae (Diptera), are the most widely distributed free-living holometabolous insects (Ferrington 2008). The immature stages of most species occur in freshwater, but numerous terrestrial or marine species are known (Sæther and Ekrem 2003). The adult life stage of chironomids is short, and most of the lifespan is spent as a larva. The great species and habitat diversity makes this family not only a valuable indicator species for lentic and lotic aquatic ecosystems, but also a most interesting group for phylogenetic and biogeographical analyses (Silva and Ekrem 2015). However, in order to obtain the most biologically informative data, it is crucial to determine taxa to species, since within a single genus, species may respond in a different way to environmental changes (Lenat and Resh 2001). Usually, the lack of descriptions and keys to a local fauna prevents species identifications, or workers choose to overlook the Chironomidae in

favor of groups (e.g. Ephemeroptera, Plecoptera, Trichoptera) that are more restricted in number and diversity (Spies et al. 2009).

Approximately 900 chironomid species are recognized from the Neotropical region (M. Spies, personal communication). This number has been increasing in recent years thanks to intense taxonomic work being done, particularly in Brazil (e.g. Andersen and Pinho 2014, Andersen et al. 2015, Oliveira et al. 2013, Silva and Wiedenbrug 2015, Silva et al. 2014a,b, Siri and Donato 2015, Trivinho-Strixino et al. 2013, 2015). Regarding Central America and the Caribbean, the chironomid fauna remains poorly known. No list of Chironomidae in Dominican Republic has been published so far and our knowledge consists basically of fossil records (Grund 2004, 2006, Perez-Gelabert 2008). Recent fauna have been sparsely mentioned by some authors. Margalef (1986), investigating the limnology of Lake Enriquillo in Dominican Republic, documented some chironomid larvae, identified only to family. Moreover, Perez-Gelabert (2008) compiled a checklist of arthropods of Hispaniola, which included chironomid species in amber and only one recent species, *Chironomus redeuns* Walker, considered a nomen dubium by Spies and Reiss (1996). In this context, the goal of our study was to provide data on the Chironomidae of the Dominican Republic, in order to contribute to the overall knowledge of Caribbean fauna.

Material and Methods

Study area

Hispaniola (Fig. 1) is the second largest island (76,480 km²) in the archipelago of the Greater Antilles, Caribbean Region. It is centrally located in the Caribbean basin just south of the Tropic of Cancer at 17°40' and 19°56' North latitude and 68°20' and 72°01' West longitude. This natural geographic unit is shared by two countries with different languages and cultures, Haiti on the western one third (27,750 km²) and the Dominican Republic

lic on the eastern two thirds (48,730 km²) (Perez-Gelabert 2008). The Dominican shores are washed by the Caribbean to the south and the Atlantic Ocean to the north. It has a varied terrain comprising rainforest, savannah and highlands, including Pico Duarte which, at about 3100 m elevation, is the Caribbean's tallest mountain. Climate in the Dominican Republic is tropical maritime, ranging from 18 to 32°C, with relatively high humidity. Mean annual precipitation along the southeastern coast around Santo Domingo is 1,400 mm with a distinct wet season from May to October. The island has some large saline or hypersaline inland lakes. There are several smaller islands and cays that are part of the Dominican territory. A complex topography and variety of local weather patterns generate numerous microhabitats, which support a rich flora and fauna with significant numbers of endemic species (Perez-Gelabert 2008).

Collection and identification

Collections were made at 13 localities in July 2015 (Table 1, Fig. 1). Most were lotic environments, ranging from small springs to large rivers, at elevations from 20 to 2,250 m above sea level. The main emphasis was on adult sampling, collected with a sweep net near aquatic systems. Dipnets

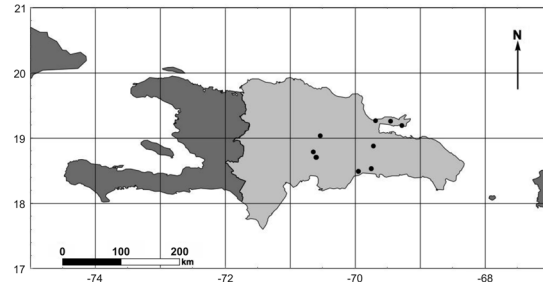


Figure 1. Map of the island of Hispaniola showing collecting localities in Dominican Republic (shown in light grey shading). Sampling sites are denoted as black dots. Some sites overlap due to their proximity and scale of map. See table 1 for more details on sampling localities.

(20 cm dia, 250 µm mesh) were used to collect immatures at some localities. Samples were also taken by aspiration of the water and organisms from the central tank of bromeliads. All samples were field-preserved using 96% ethanol. In the laboratory, after initial sorting and identification, representatives of every taxon in each sample were slide mounted in Euparal for species identification following the procedure outlined by Pinder (1983, 1986, 1989). Voucher specimens will be deposited in the Museum of Comparative Zoology at Harvard University.

Table 1. Localities, habitat type and geographic coordinate of chironomid collections in the Dominican Republic, July 2015.

Code	Province	Habitat type	Latitude	Longitude
A	Santo Domingo	River, heavy organic pollution	18°31'52.2"N	69°45'12.7"W
B	Samaná	River, with rocky bottom	19°16'06.2"N	69°41'15.7"W
C	La Vega	Pool, surrounded by grass	18°42'15.8"N	70°36'14.3"W
D	Santo Domingo	Lake, without surrounding vegetation	18°29'42.3"N	69°57'15.9"W
E	La Vega	Stream, with sparse riparian vegetation	18°42'23.1"N	70°36'12.7"W
F	La Vega	River, with moderate canopy cover	19°02'10.0"N	70°32'35.2"W
G	Santo Domingo	River, heavy organic pollution	18°31'51.1"N	69°45'12.8"W
H	Samaná	River, with dense canopy cover	19°15'48.5"N	69°27'29.9"W
I	Santo Domingo	River, heavy organic pollution	18°29'41.5"N	69°56'59.6"W
J	Monte Plata	Stream, with dense riparian vegetation	18°52'46.6"N	69°43'20.7"W
K	Samaná	Stream, with moderate canopy cover	19°11'32.9"N	69°17'04.5"W
L	La Vega	River, surrounded by grass	18°47'32.4"N	70°38'46.9"W
M	La Vega	Bromeliad tanks	18°42'15.9"N	70°35'56.0"W

Results

In total, 578 representatives of three subfamilies were collected (Table 2). Twenty-seven genera have been identified, containing at least 44 species. At least two additional orthoclad species could not be assigned to any described genera. Chironominae and Orthoclaadiinae predominated in all samples. Tanypodinae were often sampled, but rarely in large numbers. Chironomini was represented by at least 10 genera, but species diversity was low. Except for *Polypedilum*, no genus was represented by more than two species. The most widespread Chironomini were *Polypedilum (Asheum) beckae* (Sublette) and other *Polypedilum* spp. *Polypedilum* is one of the largest chironomid genera containing about 440 described species (Saether et al. 2010). Larvae of *Polypedilum* occur in virtually all kinds of still and flowing waters. A few species are also found in bromeliad tanks (Epler et al. 2013). Other commonly encountered Chironominae were *Goeldichironomus* spp. With the exception of *Chironomus* sp., *Paralauterborniella nigrohalteralis* and *Stenochironomus* sp. 1, collected in two localities, the remaining species were rare and found in only one locality. Two species of *Stenochironomus* and one of *Xestochironomus* were found, the larvae of these genera are often found mining decayed leaves or wood in freshwater habitats, which suggests woody debris as an available food item in those streams. The tribe Pseudochironomini was represented by *Manoa pahayokeensis* Jacobsen & Perry and *Pseudochironomus* sp., while *Tanytarsus* was the only genus belonging to Tanytarsini.

Ten genera of Orthoclaadiinae have been identified. Except for *Cricotopus*, most of these were collected from single localities. *Comptosmittia croizati* Mendes, Andersen & Saether and a related, undescribed species were collected in three localities in Dominican Republic. Furthermore, numerous

larvae of *Metriocnemus* were collected in bromeliad tanks at the base of leaves, petals or bracts. *Metriocnemus* is a cosmopolitan midge with seven endemic species from the Neotropics and commonly found in pitcher plants, hollow trees and phytotelmata (Siri and Donato 2014). Despite much searching near the bromeliad phytotelmata where larvae were found, no adults of *Metriocnemus* were collected. Finally, several specimens belonging to *Diplosmittia* were collected at the National Botanical Garden (Santo Domingo) in a highly organic, polluted river. The examination of this not readily identifiable material, suggests that this species does not belong to any of the currently recognized *Diplosmittia* species. The new species can be separated from other *Diplosmittia* by the narrow and elongate anal point. The description of the new species will be done in a later manuscript.

Tanypodinae was the least abundant subfamily sampled in the Dominican Republic. Pentaneurini was represented by at least four genera with very low species diversity. *Labrundinia* was represented by three morphospecies, while *Pentaneura* by two. There appear to be numerous undescribed species of *Labrundinia* from the Neotropical region (Roback 1987). In a worldwide revision of the genus Silva et al. (2014a) described four species of *Labrundinia* from Central America. However none of the Dominican species could be ascribed to any of the previously described species. Only immatures of *Thienemannimyia* were collected. Although we assigned these specimens to *Thienemannimyia*, an identification of *Thienemannimyia* group (Silva and Ekrem 2015) may be more appropriate since the immatures of this complex are difficult to separate at the generic level (Cranston and Epler 2013). Only one pupal exuvia belonging to *Procladius* (*Holotanypus*) was collected.

Table 2. Chironomid taxa collected in the Dominican Republic, July 2015. A = adult, L = larva, P = pupal exuviae. Localities according to the table 1.

Chironomidae taxa	Life Stage	Locality
Chironominae		
Chironomini		
<i>Chironomus</i> sp.	A, L	A, H
<i>Einfeldia</i> sp.	A	H
<i>Goeldichironomus</i> sp. 1	A	G, H
<i>Goeldichironomus</i> sp. 2	A	A, G
<i>Microchironomus</i> sp.	A	D

Chironomidae taxa	Life Stage	Locality
<i>Parachironomus yanomani</i> Spies, Fittkau & Reiss	A	D
<i>Paralauterborniella nigrohalteralis</i> (Malloch)	A	C, H
<i>Polypedilum (Asheum) beckae</i> (Sublette)	A	A, D, G, H
<i>Polypedilum</i> sp. 1	A	B, E, J, K, L
<i>Polypedilum</i> sp. 2	A	B, F, H, K
<i>Polypedilum</i> sp. 3	A	H, J
<i>Polypedilum</i> sp. 4	A	H
<i>Polypedilum</i> sp. 5	A	H
<i>Stenochironomus</i> sp. 1	A	H, J
<i>Stenochironomus</i> sp. 2	A	H
<i>Xestochironomus</i> sp.	A	H
Pseudochironomini		
<i>Manoa pahayokeyensis</i> Jacobsen & Perry	A	J
<i>Pseudochironomus</i> sp.	A, P	L
Tanytarsini		
<i>Tanytarsus excavatus</i> group	P	C, L
<i>Tanytarsus</i> sp.	A	H
Orthoclaadiinae		
<i>Antillocladius</i> sp.	A	F
<i>Comptosmittia croizati</i> Mendes, Andersen & Sæther	A	H, I
<i>Comptosmittia</i> sp. 1	A	D
<i>Cricotopus</i> sp. 1	A	B, C, D, H
<i>Cricotopus</i> sp. 2	A	B, H, J
<i>Diplosmittia</i> sp.	A	I
<i>Lipurometriocnemus glabalis</i> Sæther	A	C
<i>Lipurometriocnemus</i> sp.	A	F
<i>Metriocnemus</i> sp.	L	M
Orthoclaadiinae sp. 1	A	H
Orthoclaadiinae sp. 2	A	J
<i>Orthocladus</i> sp.	A	D
<i>Parametriocnemus</i> sp.	A	L
<i>Psectrocladius</i> sp. 1	L, P	L

Chironomidae taxa	Life Stage	Locality
<i>Psectrocladius</i> sp. 2	L	C
<i>Pseudosmittia</i> sp.	A	D
Tanypodinae		
Pentaneurini		
<i>Labrundinia</i> sp. 1	A	H
<i>Labrundinia</i> sp. 2	A	H, J
<i>Labrundinia</i> sp. 3	A	H
<i>Monopelopia</i> sp.	A	A, K, L
<i>Pentaneura</i> sp. 1	A	J
<i>Pentaneura</i> sp. 2	A	F, H
<i>Thienemannimyia</i> sp.	A, P	E
Procladiini		
<i>Procladius (Holotanypus)</i> sp. 1	P	C

Discussion

At the generic level the chironomid fauna in Dominican Republic includes multiple genera with worldwide distributions with Holarctic and Neotropical components. The Neotropical component is typically an extension of the warm adapted fauna of lowland South America (Watson and Heyn 1992). At the level of species it is possible to infer that *Comptosmittia croizati*, known from Brazil and Venezuela (Mendes et al. 2004) and *Parachironomus yanomami* described from Brazil (Spies et al. 1994) would represent the Neotropical component. Within this component, genera such as *Diplosmittia*, *Goeldichironomus*, *Labrundinia*, *Lipurometriocnemus*, *Pentaneura* and *Polypedilum (Asheum)* possess a Pan-American distribution, having secondarily dispersed into the southern Nearctic via Central America or the Caribbean (Reiss and Sublette 1985). According to Jacobsen and Perry (2002) *Manoa pahayokeensis* Jacobsen & Perry would belong to the fauna with primarily Neotropical or pantropical distribution. Other genera such as *Microchironomus* and *Orthocladus* are most widespread in the Holarctic region. *Paralauterborniella*, monotypic for *P. nigrohalteralis* (Malloch), has almost a worldwide distribution, only unrecorded for the Australian region (Sæther and Spies 2013). Spies and Reiss (1996) catalogued information and references for all chironomid taxa known from the entire Neotropical Region. However, no species was documented

from the Dominican Republic or Haiti. Our study recorded 44 chironomid species in the Dominican Republic.

Assuming the limited duration and extension of our study, this species richness documented here is probably lower than the true richness of chironomid fauna in the Dominican Republic. Comparing our results with Ferrington et al. (1993), who sampled in a mountain stream during one year in the neighbouring island of Puerto Rico, we could expect that some species of the following genera are still found in streams of the Dominican Republic: *Ablabesmyia*, *Corynoneura*, *Djalmabatista*, *Larsia*, *Paratendipes*, *Rheotanytarsus*, *Skutzia* and *Thienemanniella*. Additional orthoclad genera were found on Saint Vincent by Saether (1981): *Bryophaenocladus*, *Eurycnemus*, *Onconeura*, *Paraphaenocladus* and *Smittia*. A study performed by Anderson et al. (2014) on San Salvador Island (Bahamas) identified only 12 chironomid species. The authors suggested that low diversity might occur on individual islands, with a much larger collective community in the Bahamas as a whole. According to Bass (2003), other important factors influencing the diversity of freshwater macroinvertebrate communities on Caribbean islands probably include climate and island dispersal capabilities or limitations of specific populations.

Although our results document a relatively small chironomid community in the Dominican Republic, we believe that collections in different periods

(including both the rainy and dry seasons) and broadening the variety of sampling habitats and geographic area will reveal much greater diversity than currently detected. While recent years have seen increased activity concerning the chironomid fauna in the Neotropical region, the knowledge of the diversity and taxonomy as well as biogeography and phylogeny, especially in the Central America and Caribbean region, remains fragmentary. Thus, additional inventories are required to discover and analyse possible areas of endemism in the Greater Antilles archipelago. The present study contributes to the knowledge of chironomid fauna in the Dominican Republic and will hopefully motivate further studies in the area.

Acknowledgements

The authors extend their thanks to Martin Spies and Marion Kotrba, who provided us with working space in the Zoologische Staatssammlung München (ZSM). Thanks also to Ruth Bastardo from the Institute of Botanical and Zoological Investigations (Dominican Republic) for her help in planning fieldwork. We are greatly indebted to Juan Carlos Núñez for his assisting in the field and information from Dominican Republic. Many thanks to Anthony Kiszewski, his support and company made the collection of material an enjoyable experience. We are very grateful to Whit Farnum for the assistance in the preparation of the map. Collecting in Dominican Republic was possible thanks to the generosity of George Putnam, through a Putnam Expedition Grant from the Museum of Comparative Zoology at Harvard University. F. L. Silva was supported by a Postdoctoral Fellowship from the Coordination for the Improvement of Higher Education Personnel (CAPES).

References

- Andersen, T., Mendes, H., F. and Pinho, L.C. 2015. *Mariamberea*, a new genus of Orthoclaadiinae from Brazil (Insecta: Diptera, Chironomidae). - *Studies on Neotropical Fauna and Environment* 50(1): 24-30.
- Andersen, T. and Pinho, L.C. 2014. A new species of *Saetherocryptus* Andersen et Mendes, 2007 (Diptera: Chironomidae, Orthoclaadiinae) from the Amazon rainforest, Brazil. - *Norwegian Journal of Entomology* 61: 160-164.
- Anderson, A., Kranzfelder, P., Egan, A. and Ferrington, L.C. Jr. 2014. A Survey of Neotropical Chironomidae (Diptera) on San Salvador Island, Bahamas. - *Florida Entomologist* 97(1): 304-308.
- Bass D. 2003. A comparison of freshwater macroinvertebrate communities on small Caribbean islands. - *Bioscience* 53(11): 1094-1100.
- Cranston, P.S. and Epler, J.H. 2013. The larvae of Tanypodinae (Diptera: Chironomidae) of the Holarctic region - Keys and diagnoses. In Andersen, T., Cranston, P.S. and Epler, J.H. (Eds) Chironomidae of the Holarctic Region - Keys and diagnoses. Part 1. Larvae. - *Insect Systematics & Evolution, Supplement* 66: 39-136.
- Epler, J.H., Ekrem, T. and Cranston, P.S. 2013. The larvae of Chironominae (Diptera: Chironomidae) of the Holarctic region - Keys and diagnoses. In Andersen, T., Cranston, P.S. and Epler, J.H. (Eds) Chironomidae of the Holarctic Region - Keys and diagnoses. Part 1. Larvae. - *Insect Systematics & Evolution, Supplement* 66: 387-556.
- Ferrington, L.C. Jr. 2008. Global diversity of non-biting midges (Chironomidae; Insecta-Diptera) in freshwater. - *Hydrobiologia* 595: 447-455.
- Ferrington, L.C. Jr., Buzby, K.M. and Masteller, E.C. 1993. Composition and Temporal Abundance of Chironomidae Emergence from a Tropical Rainforest Stream at El Verde, Puerto Rico. - *Journal of the Kansas Entomological Society* 66(2): 167-180.
- Grund, M. 2004. Chironomids (Diptera: Chironomidae) of Dominican amber. *Ablabesmyia electrohispaniolana*, sp.n. and paleoecological indications due to subfamily proportions. - *Insect Systematics and Evolution* 36: 29-34.
- Grund, M. 2006. Chironomidae (Diptera) in Dominican amber as indicators for ecosystem stability in the Caribbean. - *Palaeogeography, Palaeoclimatology, Palaeoecology* 241: 410-416.
- Jacobsen, R.E. and Perry, S.A. 2002. A new species of *Manoa* (Diptera: Chironomidae) from Everglades National Park. - *Journal of the North American Benthological Society* 21(2): 314-325.
- Lenat, D.R. and Resh, V.H. 2001. Taxonomy and stream ecology - The benefits of genus- and species-level identifications. - *Journal of the North American Benthological Society* 20(2): 287-298.
- Margalef, R. 1986. Limnología del Lago Enriquillo. (República Dominicana). - *Oecologia Aquatica* 8: 1-10.
- Mendes, H.F., Andersen, T. and Sæther, O.A. 2004. A review of *Antillocladius* Sæther, 1981;

- Comptosmittia* Sæther, 1981 and *Litocladius* new genus (Chironomidae, Orthoclaadiinae). – *Zootaxa* 594: 1-82.
- Oliveira, C.S.N., Silva, F.L. and Trivinho-Strixino, S. 2013. *Thalassomyia gutae* sp. n., a new marine chironomid (Chironomidae: Telmatogetoninae) from the Brazilian coast. *Zootaxa* 3701: 589-595.
- Perez-Gelabert, D.E. 2008. Arthropods of Hispaniola (Dominican Republic and Haiti): A checklist and bibliography. – *Zootaxa* 1831: 1-530.
- Pinder, L.C.V. 1983. The larvae of Chironomidae (Diptera) of the Holarctic region – Introduction. – *Entomologica Scandinavica Supplement*, 19: 7-10.
- Pinder, L.C.V. 1986. The pupae of Chironomidae (Diptera) of the Holarctic region – Introduction. – *Entomologica Scandinavica Supplement*, 28: 5-7.
- Pinder, L.C.V. 1989. The adult of Chironomidae (Diptera) of the Holarctic region – Introduction. – *Entomologica Scandinavica Supplement*, 34: 5-9.
- Reiss, F. and Sublette, J.E. 1985. *Beardius*, new genus with notes on additional Pan-American taxa. – *Spixiana, Supplement* 11: 179-193.
- Roback, S.S. 1987. The immature chironomids of the eastern United States. IX. Pentaneurini -Genus *Labrundinia* with the description of some Neotropical material. – *Proceedings of the Academy of Natural Sciences of Philadelphia* 139: 159-209.
- Sæther, O.A. 1981. Orthoclaadiinae (Diptera: Chironomidae) from the British West Indies, with descriptions of *Antillocladius* n. gen., *Lipurometriocnemus* n. gen., *Comptosmittia* n. gen. and *Diplosmittia*. – *Entomologica Scandinavica Supplement*, 16: 1-46.
- Sæther, O.A., Andersen, T., Pinho, L.C. and Mendes, H.F. 2010. The problems with *Polypedilum* Kieffer (Diptera: Chironomidae), with the description of *Probolum* subgen. n. – *Zootaxa* 2497: 1-36
- Sæther OA, Ekrem T. 2003. Biogeography of Afrotropical Chironomidae (Diptera), with special reference to Gondwanaland. – *Cimbebasia* 19: 175-191.
- Sæther, O.A. and Spies, M. 2013. *Fauna Europaea: Chironomidae*. In: Pape T, Beuk P. (Eds) *Fauna Europaea: Diptera*, version 2.6. <http://www.faunaeur.org/>
- Silva, F.L. and Ekrem, T. 2015. Phylogenetic relationships of non-biting midges in the subfamily Tanypodinae (Diptera: Chironomidae) inferred from morphology. – *Systematic Entomology* xx: xx-xx. (Early View)
- Silva, F.L., Fonseca-Gessner, A.A. and Ekrem, T. 2014a. A taxonomic revision of genus *Labrundinia* Fittkau, 1962 (Diptera: Chironomidae: Tanypodinae). – *Zootaxa* 3769: 1-185.
- Silva, F.L., Oliveira, C.S.N. and Trivinho-Strixino, S. 2014b. *Metapelopia corbii* gen. n., sp. n., a new Tanypodinae (Diptera: Chironomidae) from the Neotropical Region. – *Annales de Limnologie - International Journal of Limnology* 50: 85-95.
- Silva, F.L. and Wiedenbrug, S. 2015. *Amazonimyia gigantea* gen. n., sp. n., a new Tanypodinae (Diptera: Chironomidae) from the Neotropical Region. – *Zootaxa*, 3947(2): 275–281.
- Siri, A. and Donato, M. 2014. *Monopelopia caraguata* (Chironomidae: Tanypodinae: Pentaneurini) and *Phytotelmatocladus delarosai* (Chironomidae: Orthoclaadiinae): two phytotelmatous chironomids distributed from Florida to Argentina. – *Florida Entomologist* 97(3): 1226-1231.
- Siri, A. and Donato, M. 2015. Phylogenetic analysis of the tribe Macropelopiini (Chironomidae: Tanypodinae): adjusting homoplasies. – *Zoological Journal of the Linnean Society* 174: 74-92.
- Spies, M., Andersen, T., Epler, J.H. and Watson, C.N. Jr. 2009. Chironomidae (non-biting midges). *Manual of Central American Diptera*. (eds Brown BV, Borkent A, Cumming JM, Wood DM, Woodley NE, Zumbado M), pp. 437-480. NRC Research Press, Ottawa.
- Spies, M., Fittkau, E.J. and Reiss, F. 1994. The adult males of *Parachironomus* Lenz, 1921, from the Neotropical faunal region (Insecta, Diptera, Chironomidae). – *Spixiana Supplement* 20: 61-98.
- Spies, M. and Reiss, F. 1996. Catalog and bibliography of Neotropical and Mexican Chironomidae (Insecta, Diptera). – *Spixiana, Supplement* 22: 61-119.
- Trivinho-Strixino, S., Silva, F.L. and Oliveira, C.S.N. 2013. *Tapajos cristinae* n. gen., n. sp. (Diptera: Chironomidae: Chironominae) from Neotropical Region. – *Zootaxa* 3710: 395-399.

Trivinho-Strixino, S., Wiedenbrug, S. and Silva, F.L. 2015. New species of *Tanytarsus* van der Wulp (Diptera: Chironomidae: Tanytarsini) from Brazil. - *European Journal of Environmental Sciences* 5(1): 92-100.

Watson, C.N. Jr. and Heyn, M.W. 1992. A preliminary survey of the Chironomidae (Diptera) Of Costa Rica, with emphasis on the lotic fauna. - *Netherlands Journal of Aquatic Ecology* 26(2-4): 257-262.

Article submitted 18. September 2015, accepted 3. November 2015, published 22. December 2015.