A SURVEY OF NEOTROPICAL CHIRONOMIDAE (DIPTERA) ON SAN SALVADOR ISLAND, BAHAMAS

Alyssa Anderson[1], Petra Kranzfelder[2]*, Alexander Egan[2] and Leonard C. Ferrington, Jr[2]
[1]Northern State University, Dept. Biol. Chem. Physics & Math., Aberdeen, SD 57401, USA

[2]University of Minnesota, Dept. Entomol., St. Paul, Minnesota 55108, USA

*Corresponding author: kranz081@umn.edu

Chironomidae (Diptera), a family of flies commonly known as non-biting midges, are one of the most diverse and widespread groups of insects with aquatic life stages (Ferrington et al. 2008). Scientists currently recognize approximately 5,500 described species (Ashe & O'Conner 2012), but realistic estimates of actual world fauna range up to 20,000 species (Ferrington et al. 2008). The immature stages of these flies make effective biological indicators of aquatic ecosystems (Wiederholm 1984). Therefore, accurate assessments of their diversity and richness can be critical for biological monitoring studies (Hayford & Ferrington 2005). However, in order to obtain the most biologically informative data, it is critical to resolve taxa to genus, or preferably, species because within a single genus, species may respond differently to environmental changes (Bailey et al. 2001; Lenat & Resh 2001).

Nearly 900 species are recognized from the Neotropical zoogeographical region (M. Spies, Zoologische Staatssammlung München, personal communication), while over 1,200 species are known from the Nearctic region (Ferrington et al. 2008). This discrepancy in diversity is likely due to lower taxonomic coverage of Chironomidae in the Neotropical region. Spies & Reiss (1996), for example, have asserted that hundreds of species remain to be described in the Neotropics. Moreover, Coffman & de la Rosa (1998) determined that Chironomidae species richness was 1.8 times greater in streams of northwestern Costa Rica than in streams of similar size in western Pennsylvania, USA over a 1-yr period.

Within the Neotropics, very little emphasis has been placed in the Caribbean region. Prior to the present study, only 4 species of Chironomidae had been recorded from the Bahamas: *Goeldichironomus amazonicus* (Fittkau), *Clunio marshalli* Stone & Wirth, *Ablabesmyia cinctipes* (Johannsen), and *Tanypus neopunctipennis* Sublette (Spies & Reiss 1996). Graves & Cole (2007) examined invertebrate communities of San Salvador Island and documented Chironomidae larvae, identified only to family, in one coastal freshwater pool. Finally, Elliott et al. (2009) compiled a checklist of insects of San Salvador, which included no chironomid species. The goal of our study, therefore, was to provide basic species data on the Chironomidae of San Salvador Island, and to contribute to the overall knowledge of Bahamian fauna.

San Salvador Island covers an area of approximately 150 km^2 in the east-central part of the Bahamas (N 24° W 74°) (Fig. 1). Climate on the island is relatively stable, ranging from 20 to 28 °C, with relatively high humidity (Sealy 2006). The island is composed primarily of limestone rock and calcareous sand, and has several large saline or hypersaline inland lakes that are connected by subterranean channels (Diehl et al. 1986). As on most Bahamian islands, all freshwater is supplied by precipitation (Crump & Gamble 2006). Mean annual precipitation is 1,007 mm (Crump & Gamble 2006), with the majority of rainfall occurring from Aug to Nov or in May and Jun (Elliott et al. 2009). During the dry season, evaporation is greater than precipitation, resulting in diminished water levels or arid conditions (Sealey 2006; Elliott et al. 2009).

In Mar of 2012, various tidal pools, wetlands, ponds and lakes, representing a range of fresh, brackish, and saline waters were sampled for both chironomid larvae and pupal exuviae. Dipnets (20 cm diam, 500 µm mesh) were used to collect larvae. Collections of surface-floating pupal exuviae followed methods of Ferrington et al. (1991). All samples were field-preserved using 70% ethanol, and later sorted in the laboratory under 12X magnification. Representatives of every taxon in each sample were slide mounted in Euparal® for species identification. Voucher specimens will be deposited in the University of Minnesota's Insect Collection (UMSP).

Chironomidae larvae and pupal exuviae were found at 2 locations: rock pools located on "The Gulf" (hereafter referred to as "Gulf Tide Pools"; N 23° 56.84' W 74° 30.82') on the southern coast of San Salvador and a small quarry pond (hereafter referred to as "Hard Bargain Pond"; N 24° 03.65' W 74° 27.23') located at the trail head to Six Pack Pond (locally known as Hard Bargain Trail). As indicated by Elliott et al. (2009), Hard Bargain Pond has been permanent at least since the year 2000. Chironomidae larvae were collected from tidal pools at Gulf Tide Pools and Hard Bargain Pond, while pupal exuviae were found exclusively at Hard Bargain Pond (Table 1).

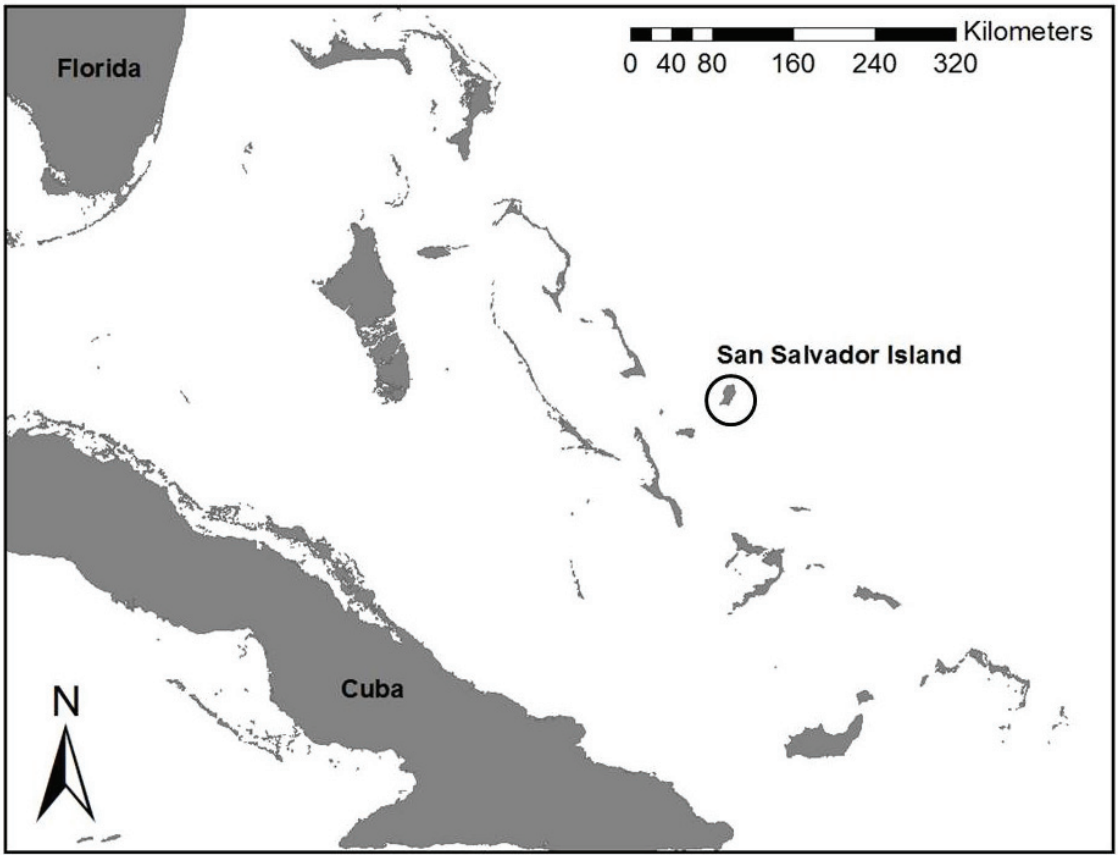

Fig. 1. Location of San Salvador Island within the Bahamas.

Analyses of pupal and larval specimens revealed the following 12 species: *Chironomus* Meigen (3 morphospecies), *Dicrotendipes* sp. A sensu Epler (2001), *Polypedilum* (*Tripodura*) *scalaenum* group (1 morphospecies), *Goeldichironomus fluctuans* Reiss, *Tanytarsus mendax* Kieffer, *Tanytarsus* cf. *confusus* Malloch, *Ablabesmyia* (*Sartaia*) *metica* Roback, *Labrundinia maculata* Roback, *Paramerina anomala* Beck & Beck, and *Djalmabatista pulchra* (Johannsen) (Table 1). These species are all new records for the Bahamas, with *Tanytarsus mendax* and *Paramerina anomala* new for the Neotropical region.

In the genus *Chironomus*, 2 morphospecies were discerned from larvae and 3 from exuviae. However, none of these could be determined to subgenus or species, and we recognize the possibility that more than 3 species may be present in our collection. *Dicrotendipes* sp. A is noted in Epler (2001) from Lake Okeechobee and the Suwannee River basin in Florida, but has not been described formally, thus, this identification should be considered tentative (J. H. Epler, personal communication). *Polypedilum* specimens key to the subgenus *Tripodura* and the *scalaenum* group in both Epler (2001) and Maschwitz & Cook (2000), but larvae cannot be identified to species at this time. Reiss (1974) noted *G. fluctuans* from dead plant material on central Amazonian lakes and rivers, and artificial ponds on Caribbean islands. *Tanytarsus confusus* is known from creeks, reservoirs, and lakes throughout the eastern USA, including Florida, while *T. mendax* is broadly distributed in the Holarctic and is found in ponds, lakes, and creeks (Ekrem et al. 2003). Specimens that key to *T. confusus* do not fit all measurements for this species in Ekrem et al. (2003), leading us to include a "cf." modifier for caution. *Ablabesmyia* (*Sartaia*) *metica* have been associated with macrophytes in southern Brazilian ponds and a lagoon in central Colombia. *Ablabesmyia metica* has only been recorded in South America, and *Sartaia* is a monotypic subgenus (Roback 1983; Oliveira et al. 2008). Specimens fit the key and descriptions in Oliveira et al. (2008); however, they may represent an undescribed species rather than a significant range expansion. *Labrundinia maculata* is known from ditches, reservoirs, rivers, creeks, and ponds in states including California, Florida, Georgia, Kansas, North Carolina, and Texas, as

Table 1. Chironomidae taxa collected on San Salvador Island, Bahamas, Mar 2012. L = larvae, PEX = pupal exuviae; GTP = Gulf Tide Pools, HBP = Hard Bargain Pond.

Chironomidae Taxa	Life Stage Collected	Locality
Chironominae		
Chironomini		
Chironomus sp. 1	Pex, L	HBP, GTP
Chironomus sp. 2	Pex, L	HBP, GTP
Chironomus sp. 3	Pex	HBP
Dicrotendipes sp. A sensu Epler	L	HBP
Polypedilum (*Tripodura*) *scalaenum* group	Pex, L	HBP
Goeldichironomus fluctuans Reiss	Pex	HBP
Tanytarsini		
Tanytarsus mendax Kieffer	Pex	HBP
Tanytarsus cf. *confusus* Malloch	Pex	HBP
Tanypodinae		
Pentaneurini		
Ablabesmyia (Sartaia) metica Roback	Pex	HBP
Labrundinia maculata Roback	Pex	HBP
Paramerina anomala Beck & Beck	Pex	HBP
Procladiini		
Djalmabatista pulchra (Johannsen)	Pex	HBP

well as from Mexico and Trinidad (Roback 1987; Epler 2001). *Paramerina anomala* is known from a northern Florida creek (Beck & Beck 1966), and has been separated from similar exuviae by Roback (1972). Finally, larvae of *Djalmabatista pulchra* are known as predators of arthropods in rivers, creeks, lakes, and ponds in the eastern and southern USA (Roback & Tennessen 1978).

Geographically, Bahamian Chironomidae should represent both Nearctic and Neotropical faunas, which is observed in our collections, including several important range expansions. Spies and Reiss' (1996) comprehensive Neotropical overview included 4 valid chironomid species known from the Bahamas at that time. The addition of 12 species found in our research brings the total fauna to 16, increasing species richness by a factor of 4. Given the limited duration and scope of our study, this species richness is likely lower than the true richness of Chironomidae on San Salvador Island. Caddisfilies (Trichoptera) have received much more attention in the Caribbean region, yet with similar results based on island size. Flint (1992) reported 90 species of Trichoptera from Cuba, 39 species from Jamaica, 42 species from Puerto Rico, 30 species from Haiti and the Dominican Republic, and 130 species from the Lesser Antilles. Likewise, a study conducted by Ferrington et al. (1993) in a second-order, high gradient mountain stream on the island of Puerto Rico identified only 30 chironomid species from weekly emergence trap collections made over the course of 1 year. Based on these studies, we suspect low diversity may occur on individual islands, with a much larger collective community in the Bahamas as a whole.

Island size and elevation appear to drive aquatic insect diversity differences on Caribbean islands. Karst geology and limited flowing surface freshwater of islands, such as San Salvador, may partially explain the low species richness found in our study. Other key mechanisms influencing the diversity of Chironomidae populations on islands likely include climate, weather patterns and island dispersal capabilities or limitations of specific populations (Bass 2003).

Species diversity appears low for Bahamian Chironomidae, yet it is important to consider that few studies have investigated Chironomidae diversity in the Caribbean region. While our results document a relatively small community, consideration of the small island area and limited aquatic habitat suggests that targeted sampling for Chironomidae across the Bahamas will reveal much greater diversity than previously detected. Additional species richness is likely to be revealed by: 1) broadening the collection period, including both the rainy and dry seasons, 2) sampling from various habitats, such as terrestrial, phytotelmata and brackish water, and 3) collecting across a wider geographic area that include a variety of Bahamian islands. The current study contributes to the expansion of chironomid research in the Bahamas and will hopefully stimulate further studies in this area.

Many thanks to Eric Cole, Pat Ceas, and Jon Saur of St. Olaf College for aiding with fieldwork logistics, site location, and transportation, and students of St. Olaf College for aiding with field collections and laboratory processing. Thanks also to the College of the Bahamas Gerace Research

Station for providing laboratory facilities, vehicles, and board for the duration of this research. The Dayton-Wilkie Fund of the Bell Museum of Natural History at the University of Minnesota provided funding for this research. Finally, we appreciate the input from 4 anonymous reviewers whose comments helped improve the manuscript and Dr. Greg Evans for helping with Spanish translation of the summary.

Summary

Chironomidae (Diptera) are among the most diverse and widespread aquatic insects, with approximately 5,500 species described. However, prior to the present work, only 4 species of Chironomidae were reported from the Bahamas. The goal of our study was to provide basic species data on the Chironomidae of San Salvador Island. In March of 2012, a variety of aquatic habitats representing fresh to saline waters were sampled for chironomid larvae and pupal exuviae. Twelve species were found: *Chironomus* Meigen (3 morphospecies), *Dicrotendipes* sp. A sensu Epler, *Polypedilum* (*Tripodura*) *scalaenum* group (1 morphospecies), *Goeldichironomus fluctuans* Reiss, *Tanytarsus mendax* Kieffer, *Tanytarsus* cf. *confusus* Malloch, *Ablabesmyia* (*Sartaia*) *metica* Roback, *Labrundinia maculata* Roback, *Paramerina anomala* Beck & Beck, and *Djalmabatista pulchra* (Johannsen). All of these are new records for the Bahamas, with *Tanytarsus mendax* and *Paramerina anomala* new for the Neotropical region.

Key Words: aquatic insects, taxonomy, biogeography, diversity, metapopulation, exuviae

Resumen

Chironomidae (Diptera) se encuentran entre los más diversos y generalizados insectos acuáticos, con aproximadamente 5500 especies descritas. Sin embargo, antes del presente trabajo, sólo se reportaron 4 especies de Chironomidae de las Bahamas. El objetivo de nuestro estudio fue proveer datos básicos sobre las especies de Chironomidae de la isla de San Salvador. En marzo del 2012, se tomaron muestras de las larvas y las exuvias de la pupa de los quironómidos en una gran variedad de hábitats acuáticos que representan aguas frescas y aguas salinas. Se encontraron doce especies: *Chironomus* Meigen (3 morfoespecies), *Dicrotendipes* sp. A sensu Epler, *Polypedilum* (*Tripodura*) grupo *scalaenum* (1 morfoespecies), *Goeldichironomus fluctuans* Reiss, *Tanytarsus mendax* Kieffer, *Tanytarsus* cf. *confusus* Malloch, *Ablabesmyia* (*Sartaia*) *metica* Roback, *Labrundinia maculata* Roback, *Paramerina anomala* Beck & Beck y *Djalmabatista pulchra* (Johannsen). Todos estos son nuevos registros para las Bahamas, con *Tanytarsus mendax* y *Paramerina anomala* nuevos registros para la región Neotropical.

Palabras Clave: insectos acuáticos, taxonomía, biogeografía, diversidad, metapoblación, exuvias

References Cited

Ashe, P., and O'connor, J. P. 2012. A world catalogue of Chironomidae (Diptera). Part 2. Orthocladiinae. Two volumes. The Irish Biogeographical Society, Dublin.

Bailey, R. C., Norris, R. H., and Reynoldson, T. B. 2001. Taxonomic resolution of benthic macroinvertebrate communities in bioassessments. J. North American Benthol. Soc. 20(2): 280-286.

Bass, D. 2003. A comparison of freshwater macroinvertebrate communities on small Caribbean islands. Bioscience 53(11): 1094-1100.

Beck, W. M., and Beck, E. C. 1966. Chironomidae (Diptera) of Florida I. Pentaneurini (Tanypodinae). Bull. Florida State Mus. 10(8): 305-379.

Coffman, W. P., and De La Rosa, C. 1998. Taxonomic composition and temporal organization of tropical and temperate assemblages of lotic Chironomidae. J. Kansas Entomol. Soc. 71(4): 388-406.

Crump, M. A., and Gamble, D. W. 2006. Hydroclimatic analysis of a carbonate island pond through the development of a hydrologic landscape unit model. Phys. Geogr. 27(6): 554-570.

Diehl, F., Mellon, D., Garrett, R., and Elliott, N. 1986. A field guide to the invertebrates of San Salvador. CCFL Bahamian Field Station, Fort Lauderdale, FL.

Ekrem, T., Sublette, M. F., and Sublette, J. E. 2003. North American *Tanytarsus* I. Descriptions and keys to species in the *eminulus*, *gregarius*, *lugens* and *medax* species groups (Diptera: Chironomidae). Ann. Entomol. Soc. America 96(3): 265-328.

Elliott, N. B., Smith, D. L., and Smith, S. G. F. 2009. Field Guide to the Insects of San Salvador, 3rd Edition. Gerace Research Centre, San Salvador, Bahamas.

Epler, J. H. 2001. Identification manual for the larval Chironomidae (Diptera) of North and South Carolina. Special Publ. SJ2001-SP13. North Carolina Dept. Environment and Natural Resources, Raleigh, NC and St. Johns Water Management District, Palatka, FL. 526 pp.

Ferrington, L. C., Berg, M. B., and Coffman, W. P. 2008. Chironomidae, pp 847-989 *In* R. W. Merritt, K. W. Cummins and M. B. Berg [eds.], An Introduction to the Aquatic Insects of North America, 4th ed. Kendall/Hunt Publishing Company, Dubuque, IA.

Ferrington, L. C., 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. J. Kansas Entomol. Soc. 66(2): 167-180.

Ferrington, L. C., Blackwood, M. A., Wright, C. A., Crisp, N. H., Kavanaugh, J. L., and Schmidt, F. J. 1991. A protocol for using surface-floating pupal exuviae of Chironomidae for rapid bioassessment of changing water-quality. IAHS Publication 203: 181-190.

Flint, O. S. 1992. New species of caddisflies from Puerto Rico (Trichoptera). Proc. Entomol. Soc. Washington. 94(3): 379-389.

GRAVES, A. M., AND COLE, E. S. 2007. A comparative distribution of marine invertebrates and freshwater insects over an intertidal saltwater gradient, pp 90-98 *In* B. J. Rathcke and W. K. Hayes [eds.], Proc. Eleventh Symp. Natural History of the Bahamas. Gerace Research Center, Bahamas.

HAYFORD, B. L., AND FERRINGTON, L. C. 2005. Biological assessment of Cannon Creek, Missouri by use of emerging Chironomidae (Insecta: Diptera). J. Kansas Entomol. Soc. 78(2): 89-99.

LENAT, D. R., AND RESH, V. H. 2001. Taxonomy and stream ecology - The benefits of genus- and species-level identifications. J. North American Benthol. Soc. 20(2): 287-298.

MASCHWITZ, D. E., AND COOK, E. F. 2000. Revision of the Nearctic species of the genus *Polypedilum* Kieffer (Diptera: Chironomidae) in the subgenera *P.* (*Polypedilum*) Kieffer and *P.* (*Uresipedilum*) Oyewo and Saether. Ohio Biological Survey Bull. New Series 12 (3). vii + 135 pp.

OLIVEIRA, C. S. N., FONSECA-GESSNER, A. A., AND NAVARRO SILVA, M. A. 2008. The immature stages of *Ablabesmyia* (*Sartaia*) *metica* Roback, 1983 (Diptera: Chironomidae) with keys to subgenera. Zootaxa 1808: 61-68.

REISS, F. 1974. Die in stehenden Gewassern der Neotropis verbreitete Chironomidengattung *Goeldichironomus* Fittkau (Diptera, Insecta). Stud. Neotrop. Fauna 9: 85-122.

ROBACK, S. S. 1987. The immature chironomids of the Eastern United States IX. Pentaneurini: Genus *Labrundinia* with the description of some Neotropical material. Proc. Acad. Nat. Sci. Philadelphia 139(1): 159-209.

ROBACK, S. S. 1983. *Ablabesmyia* (*Sartaia*) *metica*, a new subgenus and species (Diptera: Chironomidae: Tanypodinae. Proc. Acad. Nat. Sci. Philadelphia 135: 236-240.

ROBACK, S. S. 1972. The immature stages of *Paramerina smithae* (Sublette) (Diptera: Chironomidae: Tanypodinae). Proc. Acad. Nat. Sci. Philadelphia 124(2): 11-15.

ROBACK, S. S., AND TENNESSEN, K. J. 1978. The immature stages of *Djalmabatista pulcher* [=*Procladius (Calotanypus) pulcher* (Joh.)]. Proc. Acad. Nat. Sci. Philadelphia 130: 11-20.

SEALEY, N. 2006. Bahamian Landscapes: An Introduction to the Geology and Physical Geography of the Bahamas, 3rd Ed. Macmillan Publishers, Thailand.

SPIES, M., AND REISS, F. 1996. Catalog and bibliography of Neotropical and Mexican Chironomidae (Insecta, Diptera). Spixiana Suppl. 22: 61-119.

WIEDERHOLM, T. 1984. Responses of aquatic insects to environmental pollution, pp 508-557 *In* V. H. Resh and D. M. Rosenberg [eds.], The Ecology of Aquatic Insects. Praeger Publishers, New York, New York.