The Diversity of Chironomidae Associated with Hydrilla in Florida, with Special Reference to Cricotopus lebetis (Diptera: Chironomidae)

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THE DIVERSITY OF CHIRONOMIDAE ASSOCIATED WITH HYDRILLA IN FLORIDA, WITH SPECIAL REFERENCE TO *CRICOTOPUS LEBETIS* (DIPTERA: CHIRONOMIDAE)

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Hydrilla verticillata (L.f. Royle) (Hydrocharitales: Hydrocharitaceae) – hereafter hydrilla – is an aquatic plant that is widely distributed in the Old World. A dioecious form of hydrilla was introduced into Florida in the 1950s, and has since spread across the southern USA (Schmitz et al. 1991; Langeland 1996). Hydrilla is a highly aggressive weed which is known to displace native vegetation (Haller & Sutton 1975; Hofstra et al. 1999; Van et al. 1999), impede boat traffic and disrupt water movement (Schmitz et al. 1991).

In 1992, the chironomid *Cricotopus lebetis* Sublette (Diptera: Chironomidae) was discovered in Crystal River, Florida attacking the apical meristems of hydrilla, and may have potential as an augmentative biological control agent (Cuda et al. 2002, 2011). The origin of the midge is unknown (Epler et al. 2000), and its distribution in Florida has not been determined. The midge damages hydrilla by mining in the apical meristem, which causes tip abscission (Cuda et al., 2002). The objectives of the current study were to examine the distribution and abundance of *C. lebetis*, and more generally of chironomid midges, associated with hydrilla in Florida.

Six water bodies in Florida were surveyed to examine the distribution and abundance of chironomids associated with hydrilla; Lake Rowell (Bradford Co.) and Wacissa Springs (Jefferson Co.) in North Florida, Lake Tohopekaliga (Osecola Co.) and Bulldozer Canal (Brevard Co.) in central Florida and Lake Istokpoga (Highlands Co.) and Lake Okeechobee (Okeechobee Co.) in south-central Florida. Each location was sampled quarterly from Jan, 2011 to Jun, 2012 for a total of 6 samples from all locations except Wacissa Springs, which was sampled 5 times. On each sampling occasion, a 4-pronged steel hook attached to a rope was thrown into the water and dragged along the hydrosoil to collect hydrilla. Hydrilla plants were removed from the hook and placed in plastic bags (46 × 61 cm, ~16 liter capacity) partially filled with water from the corresponding sample site. Sufficient hydrilla was collected on each sampling occasion to fill two bags approximately two-thirds full. A separate plastic container was filled with water from the corresponding site. Bags were placed in a cooler and transported to the laboratory. Apical portions (5-8 cm) of 300 intact hydrilla tips were haphazardly selected from each sample and placed in open plastic containers (34 × 28 × 15 cm, L × W × H) in water collected from the corresponding site. Containers were placed individually in fine mesh emergence cages (50 × 50 × 50 cm) and aerated with an aquarium pump. Cages were monitored daily for 14 days for midge emergence. Adults were collected daily by aspirator and placed in vials containing 95% ethanol. Specimens were initially sent to J. H. Epler for authoritative identification, but once a reference collection was assembled, most midges were locally identified.

Species richness at each location was determined as the total number of midge species recovered. Diversity was calculated using the Shannon Index, which combines aspects of species richness and evenness (how equally individuals are distributed among species) (Shannon 1948). The Shannon index measures the predictability that an individual selected in a sample will be a given species. Higher values of the Shannon index indicate that individuals are more evenly distributed among species, whereas low values indicate that some species are much more common than others.

The Shannon Index was calculated for each sampling location as follows:

$$H = -\sum_{i=1}^{s} \rho_i \ln \rho_i$$

Where ρ_i = number of species i collected at a location/total number of midges collected at the location. The index was computed for each water body and compared between water bodies with a t-test (Hutcheson 1970). The probability level of t-tests (0.05) was adjusted for the number of tests with the Dunn-Sidak correction (Ury 1976). The density of larvae per hydrilla apical stem was de-

TABLE 1. CHIRONOMID SPECIES REARED FROM APICAL MERISTEMS OF *HYDRILLA VERTICILLATA* COLLECTED IN SIX FLORIDA WATER BODIES FROM JAN 2011 TO JUN 2012.

Species	Diet/reference	Lake Tohopekaliga	Lake Istokpoga	Lake Okeechobee	Bulldozer Canal	Lake Rowell	Wacissa Springs	Total
Ablabesmyia rhamphe Sublette	Predator (Bass, 1986)	0	1	0	1	1	0	3
Apedilum elachistus Townes	Unknown	3	1	2	36	0	0	42
Chironomini sp.	—	3	27	2	1	8	8	49
Cricotopus bicinctus (Meigen)	Detritus, algae (Bishop Museum 2010)	1	0	3	5	0	0	9
Cricotopus lebetis Sublette	Plants (Cuda et al. 2002)	9	12	0	3	0	0	24
Cricotopus politus (Coquillett)	Unknown	0	0	0	0	0	1	1
Cricotopus sylvestris (Fabricius)	Detritus, diatoms, algae, crustaceans (Mackey 1979)	2	3	53	25	30	5	118
Dicrotendipes sp.	—	26	11	7	20	3	12	79
Glyptotendipes sp.	—	11	0	0	6	0	0	11
Larsia decolorata Malloch	Predator of aquatic annelids (Balci and Kennedy 2002)	7	0	2	3	2	0	14
Nanocladius alternantherae Dendy and Sublette	Predator (chironomid eggs and larvae), aufuchs (Dendy 1973)	1	2	0	0	0	0	3
Parachironomus hazelriggi Spies	Unknown	32	17	15	9	0	8	84
Pentaneura inconspicua (Malloch)	Predator of chironomid larvae (Hershey 1987)	5	0	0	0	0	5	10
Pseudochironomus richardsoni Malloch	diatoms, algae (Powers 1991)	5	1	0	5	0	0	11
Tanytarsus buckleyi Sublette	Unknown	10	3	0	7	9	17	46
Tanytarsini sp.	—	17	2	2	6	94	17	138
Species richness		14	11	8	13	7	8	
Shannon-Weaver index (±SE)		2.27 ± 0.22	1.89 ± 0.24	1.27 ± 0.29	2.11 ± 0.22	1.13 ± 0.12	1.89 ± 0.14	

termined for each midge species by dividing the number of individuals of each species recovered on each sampling occasion by 300 (the number of plant tips sampled on each occasion). The average density of each species across all sampling occasion was calculated.

A total of 16 species of chironomids were reared from hydrilla, including predators, herbivores and detritivores (Table 1). This is only a small portion of the chironomids reported from Florida (Epler 2013), likely because our sampling was narrowly targeted to the apical meristems of hydrilla. Species richness ranged from 8-14 species per location. Richness was highest in Bulldozer Canal and lowest in Lake Okeechobee, Wacissa Springs, and Lake Rowell. Species diversity, measured by the Shannon index, ranged from 1.13-2.27, but was not different between water bodies ($P > 0.05$). The densities of all midge species were low and ranged from 0.0001 ± 0.0001 (mean ± SE) larvae/hydrilla tip to 0.0152 ± 0.009 larvae/tip for *Cricotopus politus* and *Tanytarsini* sp., respectively (Fig. 1). *Cricotopus lebetis* was recovered in Lake Tohopekaliga, Lake Istopkoga and Bulldozer Canal (Table 1). The density of *C. lebetis* was intermediate compared with other species and had a mean of 0.0026 ± 0.001 larvae/tip. There did not appear to be a seasonal influence on the occurrence of *C. lebetis* as it was found in the winter, spring, summer and fall, albeit not within the same water body (data not shown). Due to the low abundance of *C. lebetis*, the lack of recoveries in Lake Okeechobee, Wacissa Springs and Lake Rowell should be interpreted with caution, particularly considering that it was found in to be widely distributed in the central and southern peninsula (Lake Istopoga, Lake Tohopekaliga and Bulldozer Canal), and has previously been found at Crystal River in the northern peninsula (Cuda et al. 2002). The wide distribution of *C. lebetis* in Florida, in conjunction with previous reports from Louisiana (Subette 1964), suggests that the midge is adapted to a range of climatic and water quality conditions, and thus may have value as an augmentative biological control agent of hydrilla.

Summary

The chironomid community associated with hydrilla tips in Florida was diverse, including 16 species of herbivores, detritivores and predators. *Cricotopus lebetis*, an herbivore of hydrilla, was found in 3 of 6 sampled water bodies, but its abundance, and that of the other midge species, was low.

Key Words: abundance, biological control, distribution, herbivores, Shannon Index, species richness

Resumen

"La comunidad de quironómidos asociada con los brotes de hydrilla fue diversa, e incluyó 16 especies de herbívoros, detritívoros y predadores.

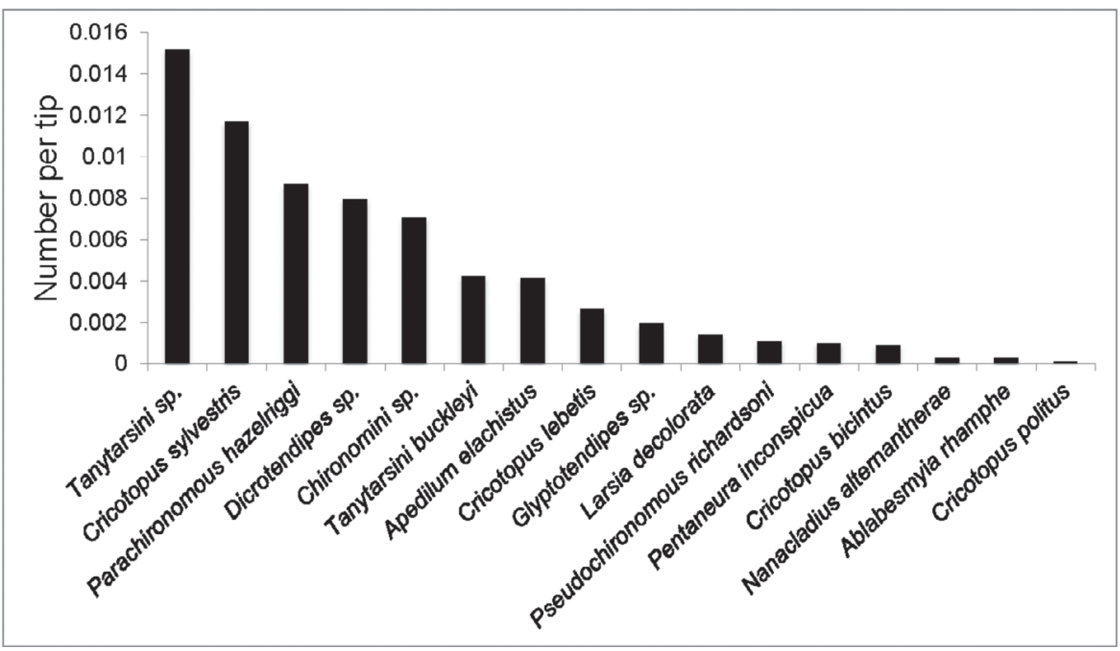

Fig. 1. Abundance of chironomid midges reared from apical meristems of hydrilla collected in six Florida water bodies from Jan 2011 to Jun 2012.

Cricotopus lebetis, un herbívoro de hydrilla, fue encontrado en tres de seis cuerpos de agua muestreados, pero su abundancia, y la de otras especies de quironómidos, fue baja.

Palabras Clave: abundancia, control biológico, distribución, herbívoros, Índice de Shannon, riqueza de especies

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