Seasonal emergence of chironomids (Chironomidae, Diptera) in Delta Marsh

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Introduction

Numbers and biomass of emerging insects have been examined in various habitat types, including lakes and wetlands (Welch 1973; Welch *et al.* 1988a; Wrubleski 1984). Seasonal emergence of chironomids from wetlands provides a major food source for passerine birds that nest, often at high density, in adjacent habitats (*e.g.*, Goossen and Sealy 1982), and constitutes a significant transfer of biomass from the aquatic to the terrestrial environment (Wrubleski 1987). Emergent chironomid abundance has been positively correlated to total primary productivity of phytoplankton (Davies 1980), and negatively correlated with intensity of fish predation (Thorp and Bergey 1981; Bohanan and Johnson 1983) and extent of littoral vegetation (Wrubleski 1984). Delta Marsh comprises a diverse array of wetland habitats that vary in many of these environmental parameters, including turbidity, water depth, water chemistry, sediment characteristics, and biotic community composition (macrophytes, invertebrates, and fish) and density (Hann and Zrum 1998).

Various sampling devices have been used in evaluating chironomid emergence patterns (reviewed in Davies 1984), but there has been little previous work comparing different types of traps. Two primary trap types have been used most commonly. Submerged traps sample chironomid pupae as they move toward the water surface to metamorphose into flying adults. Floating traps capture adults as they emerge from the water surface. Numbers and biomass of chironomids caught with the two types of trap would be expected to be comparable within a sampling site when corrected for surface area. It was also predicted that the numbers of chironomids emerging from Blind Channel would be fewer than in Crescent Pond due to higher predation pressure by fish in Blind Channel. Fish feed on chironomids either in the larval stage associated with macrophytes and in the benthic sediments, or in the pupal stage in the water column as they rise to the surface to emerge as adults.

The large chironomid species assemblage in wetlands, including Delta Marsh, comprises many species for which the bulk of the population emerges within a few days, and others that emerge more continuously throughout the open-water season (Wrubleski 1984). Therefore, a large sampling effort at considerable cost is required to monitor seasonal emergence patterns for the many species of chironomids in the marsh. Different trap designs permit a sampling interval of variable duration. The effectiveness of 1-day versus 7-day sampling was examined in terms of how representative each regime was of the changing emergence patterns over the season.

The purpose of this study was to compare the estimates of the numbers and biomass of emerging chironomids (a) in two types of wetland habitats, (b) collected using two different types of traps, and (c) collected on a 1-day and a 7-day sampling regime. The effectiveness of the traps was evaluated in terms of numbers and biomass, as well as types of insects trapped in order to assess their possible use in future programs involving the trapping of emerging insects at Delta Marsh.

Materials and Methods

Study sites

Chironomid emergence patterns were examined in two sites in Delta Marsh, Manitoba. West Blind Channel is a larger body of water that remains connected to Lake Manitoba through the year. Crescent Pond is a small oxbow remnant of a former channel of the Assiniboine River and is densely vegetated. The habitats differed in water depth and the type and number of fish present. West Blind Channel was shallower (mean depth = 0.82 m, S.D. = 0.09 m) and had planktivorous, piscivorous and detritivorous fish present. Crescent Pond was deeper (mean depth = 0.90 m, S.D. = 0.10 m) and had fewer, mainly planktivorous, fish present. The type and abundance of submerged and emergent vegetation present also differed between the two sites.

Trap design

Two floating traps, based on a design by Lesage and Harrison (1979), were constructed with modifications (described in Rosenberg and Wiens 1983; Wrubleski 1984). The floating traps (Fig. 1) consisted of a wooden frame with styrofoam float, mesh screening, and a collecting head with attached jar containing 70% ethanol as preservative. The frame was covered with wire mesh to prevent damage by muskrats, and plastic to protect from rain. The base of the trap covered 0.5 m^2 of water surface area. Insects trapped in the collecting jar were removed for analysis by exchanging the bottom jar attached to the collecting head with another containing fresh preservative. The floating trap collects adults after they have metamorphosed because as they fly up from the water surface they are funneled into the collecting head and into the collecting jar.

The submerged traps (Fig. 2), based on a design by Davies (1984), are widely used (Davies 1980; Welch 1973; Welch *et al*. 1988a). They consist of a funnel, weighted on its lower edges with lead weights, with a collecting jar at the apex of the cone. The bottom of the cone had a surface area of 0.25 m^2. These traps were suspended from a wooden frame. Insects were collected by unscrewing the partially submerged collecting jar and capping it with a lid while inverted. The submerged trap collects chironomid pupae that rise to the surface to emerge into adults. Those insects that are funneled up into the collecting jar emerge inside the jar. Because these traps could not be used with preservative, they could not be set for prolonged periods as decomposition of the trapped insects would occur.

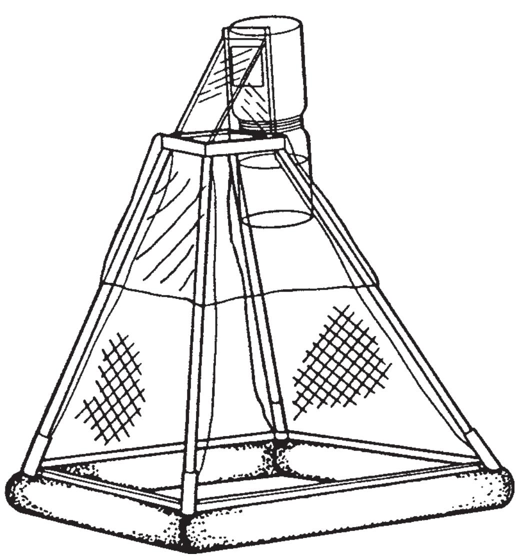

Figure 1. Diagram of the floating trap used to sample emergent chironomids in Delta Marsh (Davies 1984).

Sampling

Two submerged traps and one floating emergence trap were set in each of two sampling areas for the period of June 19 to August 28, 1996. The sampling locations in West Blind Channel and Crescent Pond were chosen on the basis of accessibility, known differences in fish abundance (Kiers and Hann 1996), and variation in depth and vegetation. Submerged traps were set for one 24-hour period per week. Floating traps were sampled after one 24-hour period and one 6-day period each week.

Samples were sorted and counted in the lab, using a dissecting microscope, then preserved in 70% ethanol. The samples were later dried at 60ºC for 24 hours and weighed. No correction of dry weights was applied to account for specimen weight loss due to the preservative.

Results

Chironomid abundance: one-day totals

Seasonal patterns in chironomid emergence in floating traps differed between sampling sites. In Blind Channel, emergence increased steadily throughout late June and July, whereas emergence in Crescent Pond was relatively steady through the summer. Numbers in submerged traps were too low to be useful in describing seasonality of chironomid emergence.

The mean number of chironomids which emerged in floating traps was substantially higher than in submerged traps on all sampling dates in both Blind Channel (Fig. 3) and Crescent Pond (Fig. 4), so trends are described based on floating trap data only. Chironomid emergence was considerably higher in

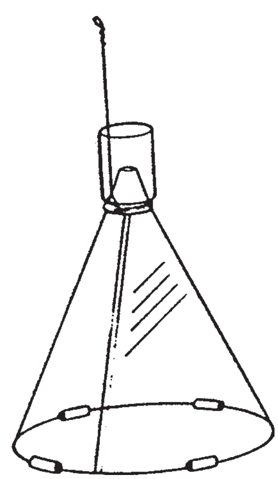

Figure 2. Diagram of the submerged trap used to sample emergent chironomids in Delta Marsh (Davies 1984).

Blind Channel than in Crescent Pond throughout the season. In Blind Channel, abundance of chironomids averaged >200 ind. per m^2 per day from 20 June to 25 July after which numbers declined to ~ 50 ind. per m^2 per day from 8 August to 22 August (Fig. 3). Crescent Pond showed far lower abundance of chironomids (< 40 ind. per m^2 per day) than Blind Channel for all but the second and third weeks of sampling (Fig. 4). The chironomid emergence in Crescent Pond exhibited three small peaks of approximately 80-90 ind. per m^2 per day on 27 June to 4 July, 1 August, and 22 August (Fig. 4).

Chironomid abundance: seven-day totals

Patterns in chironomid emergence in floating traps paralleled those observed in the 1-day totals for both sampling sites. Chironomid emergence displayed a late July-early August peak in Blind Channel in contrast with a pattern of steady emergence in Crescent Pond.

Consistently higher abundances were observed in Blind Channel than in Crescent Pond. In Blind Channel, emergence increased from mid-June to the end of July (~ 250 ind. per m^2 per day), after which abundance declined by the end of August to ~ 125 ind. per m^2 per day (Fig. 5). Emergence in Crescent Pond averaged ~ 40 per m^2 per day, and showed three small peaks in the number of chironomids trapped (~ 85-115 ind. per m^2 per day), in late June, late July, and late August (Fig. 6).

Chironomid biomass: one-day totals

The seasonal pattern of biomass of chironomids emerging into floating traps differed between sites, with the majority of emergence occurring throughout July in Blind Channel (Fig. 7), whereas emergence was relatively constant in Crescent Pond (Fig. 8). Mean seasonal chironomid biomass was four times higher In Blind Channel than in Crescent Pond. In Blind Channel, chironomid biomass was elevated from 4 July to 1 August (mean biomass ~ 0.05 g/m^2 per day), and biomass peaked at 0.064 g/m^2 per day on 11 July (Fig. 7). The maximum biomass in Crescent Pond occurred in August, with a peak of 0.032 g/m^2 per day on 8 August (Fig. 8), half the peak biomass in Blind Channel.

Submerged traps showed far smaller biomass values compared to the floating traps in Blind Channel (Fig. 7). In contrast, in Crescent Pond, there was a closer correspondence between biomass estimates from floating and submerged traps (Fig. 8).

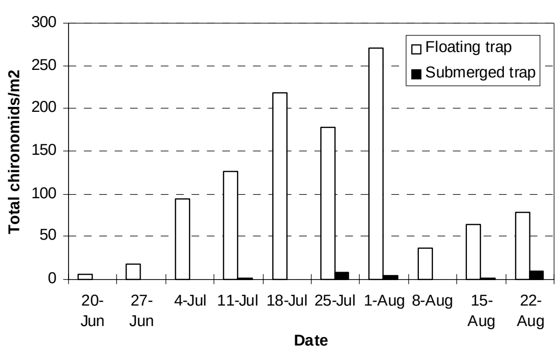

Figure 3. One-day total chironomid catches in floating and submerged traps in Blind Channel, 1996.

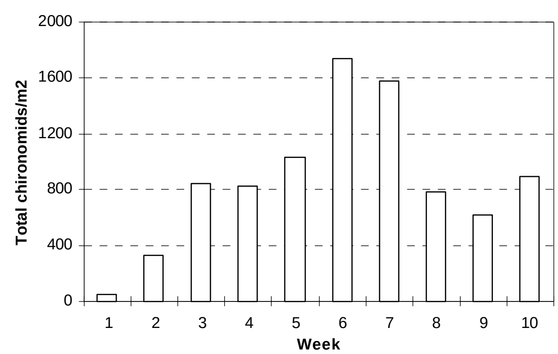

Figure 5. Weekly total chironomid catches in floating traps in Blind Channel, 1996.

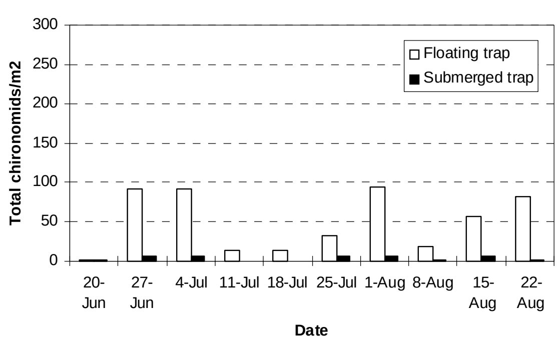

Figure 4. One-day total chironomid catches in floating and submerged traps in Crescent Pond, 1996.

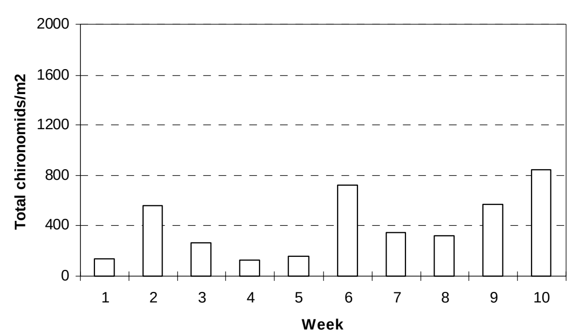

Figure 6. Weekly total chironomid catches in floating traps in Crescent Pond, 1996.

Chironomid biomass: seven-day totals

Biomass in Blind Channel was elevated above that in Crescent Pond throughout July and August, and was generally 2-4 times higher than in Crescent Pond (Fig. 9, 10). Biomass averaged ~ 0.04 g/m^2 per day throughout July in Blind Channel (Fig. 9). In Crescent Pond, biomass was low (~ 0.01 g/m^2 per day) throughout the sampling period, with a slight increase through August (Fig. 10).

Discussion

Numbers and biomass of chironomids emerging from a sparsely vegetated area of Blind Channel were substantially higher than from a densely vegetated area in Crescent Pond. In a study using similar floating traps in a different part of Delta Marsh, Wrubleski (1984) found that numbers of emerging chironomids ranged from around 30 per m^2 to over 1000 per m^2 per day, and that emerging numbers were greatest in sites with the lowest emergent macrophyte abundance.

Abundance and biomass of emerging chironomids were substantially higher in the presence of abundant fish in Blind Channel than in virtually fishless Crescent Pond. This suggests that fish predation may not be as important a factor influencing chironomid emergence in wetlands as was predicted. Although the presence of fish may reduce the biomass of emerging chironomids in the open water of lakes, this may not be the case in shallow, spatially complex habitats with abundant submersed macrophytes. In the presence of dense macrophytes, insects may be able to avoid predation by taking refuge among the submerged plants. Thorp and Bergey (1981) determined that spatial heterogeneity decreased predation efficiency in the littoral zone of freshwater lentic environments with soft bottoms. Bohanan and Johnson (1983) similarly concluded that fish effects are less likely in habitats with macrophytes in their study of a shallow dimictic eutrophic reservoir. Gilinsky (1984) also found that fish predation was not effective in reducing macroinvertebrates that occurred on macrophytes.

The submerged traps consistently trapped far fewer insects than the floating traps. Morgan *et al.* (1963) concluded that submerged funnel traps caught fewer insects than floating box traps covering the same area. Insects caught in the submerged traps might die and fall to the water surface where they would be subject to predation by fish or simply sink out of the trap. This might be avoided if modifications of the traps as described by Welch *et al.* (1988b) were made to the

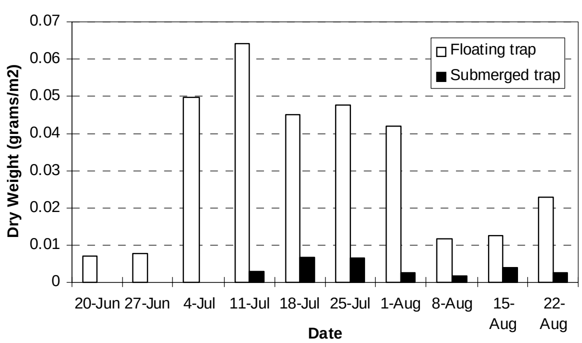

Figure 7. One-day total chironomid dry weight in floating and submerged traps in Blind Channel, 1996.

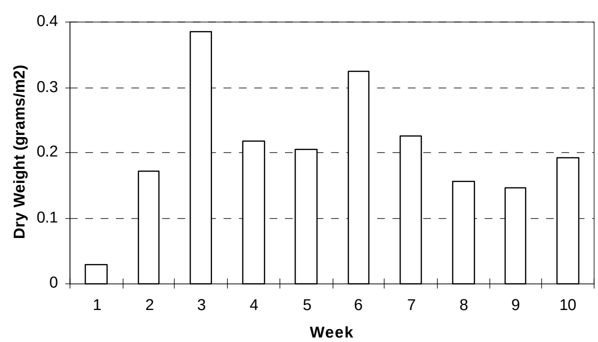

Figure 9. Weekly total chironomid dry weight in floating traps in Blind Channel, 1996.

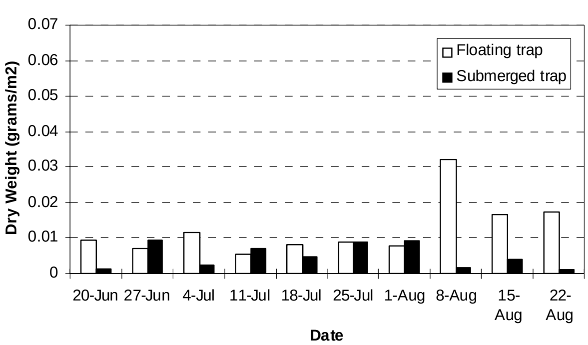

Figure 8. One-day total chironomid dry weight in floating and submerged traps in Crescent Pond, 1996.

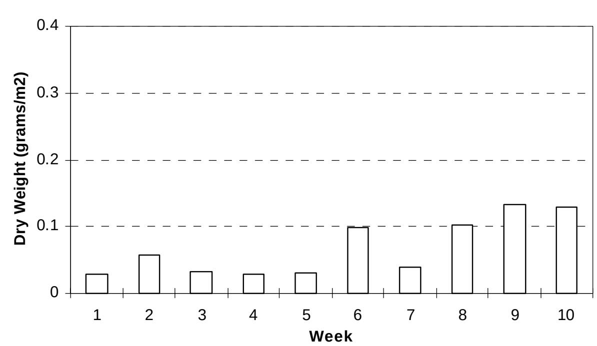

Figure 10. Weekly total chironomid dry weight in floating traps in Crescent Pond, 1996.

traps. These modifications include a small funnel inside the collecting jar which prevents dead insects falling out of the trap.

Despite vastly different amounts of sampling effort, the 1- and 7-day samples showed similar seasonal chironomid emergence patterns. In addition, mean abundances (individuals per m^2 per day) and mean biomass (g/m^2 per day) of chironomids emerging into floating traps were remarkably similar between the 1-day and 7-day sampling protocols in both Blind Channel and Crescent Pond.

The 1-day samples, taken weekly, provided a narrower sampling window, and hence a more detailed picture of the numbers of emerging chironomids than the general, integrated picture of changing abundance observed from the 7-day cumulative sampling regime.

Recommendations

1. Sampling weekly versus daily in future sampling programs at Delta Marsh might be considered depending on the precision required in terms of an estimate of temporal changes in emergent chironomids. If interest lies in the estimation of abundance of emergent biomass available for higher trophic levels, weekly samples may be sufficient. Weekly samples are far less labor intensive and samples are already preserved, so no further work has to be done with them immediately after collection. Daily sampling, on the other hand, provides much more detailed information about the temporal pattern of chironomid emergence, since peaks may occur in a single 24-hour period.
2. Different information can be obtained from numbers of insects caught and the biomass of samples so both measurements should be made. Greater information could be obtained if insects were identified to genera or divided into size classes.
3. A larger number of floating traps should be used to allow replication at a site and the sampling of more sites. Sampling should begin as early as possible in the spring to assess adequately seasonal total emergent biomass.

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