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THE TEMPORAL DISTRIBUTION OF *CHIRONOMUS DECORUS* (CHIRONOMIDAE) IN NORTHERN NEW JERSEY, 1979[1]

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Abstract.—The temporal distribution of *Chironomus decorus,* inhabiting a shallow, brackish pond, was determined over the course of one season. Data on larval abundance and adult flight activity were collected at regular intervals to study population trends. Initial population levels, following thaw of the winter ice cover, were relatively low. As temperatures rose throughout the spring and early summer, midge abundance gradually increased. Larval density peaked in mid-summer, averaging 700 third and fourth instar larvae per 0.02 m^2 of substrate. Population numbers decreased rapidly in late summer, prior to the onset of colder temperatures and winter weather conditions. Fluctuations in water level, salinity, and dissolved oxygen levels, are discussed in terms of their limiting affect on the aquatic environment and its inhabitants. Temperature appears to fill the primary role in regulating the population of *C. decorus* in the study area. Peaks in adult emergence and larval abundance suggest 5–6 generations were completed during 1979.

Introduction

Residents living adjacent to the Hackensack Meadowlands of New Jersey are plagued each spring and summer by tremendous swarms of the midge, *Chironomus decorus* Johannsen. The aquatic larvae develop in an area that was once salt marsh meadow, but is now a brackish, muck-bottomed pond. The habitat is subjected to daily tidal fluctuations, to a depth of one foot or less at ebb tide, and up to three feet at flood tide. Access roads and gas pipelines prevent a significant amount of water exchange, and organic materials are steadily introduced through garbage dump runoff and disposal plant effluents. The implementation of effective control measures for this chironomid is hampered by a relative lack of knowledge concerning the biology and habits of the species in this environment. Field investigations

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were undertaken to examine the temporal distribution of *C. decorus* during 1979, as measured by larval abundance and adult flight activity.

Materials and Methods

A quantitative survey of the larval populations was initiated in March of 1979, immediately following thaw of the winter ice cover. Three aquatic sampling stations were established along a transect running parallel to the southern shore of the study area (Fig. 1), and were permanently tagged with buoys. An airboat was used for transportation through the shallow water, to avoid disturbance of the upper 5 cm of bottom substrate, where 95% of the vertical distribution of chironomid larvae has been found to occur (Carter 1976; Mundie 1957). An Ekman dredge was employed as a sampling device to obtain 0.02 m^2 sections of mud, to an approximate depth of 7 cm. At each of the three stations, five samples were obtained, one from a central position at the buoy, and one taken 4–5 m from the buoy at each of the four cardinal directions. The sampling procedure consisted of first raising the sample from the bottom and immediately releasing the contents of the dredge into a bucket. The combined mud and water yield of each dredge sample was approximately four liters. The mud and water were whipped to a slurry, and a portion of the mixture funneled into a half-liter plastic container. The aliquots were transported to the laboratory for subsequent examination.

Larval sampling was conducted from early March through November. Collections were made on a semi-monthly basis in the spring and fall, and at weekly intervals during the summer. Environmental factors were monitored on each sampling date, including benthic mud and surface water temperatures, dissolved oxygen content, pH, and salinity of the water. Temperature measurements were taken with a mercury thermometer, and dissolved oxygen was determined in the field with a Hach kit.[3] A refractometer was used to ascertain salinity levels in ppt, and pH was periodically determined with commercially prepared indicator papers.[4] Daily sampling times were selected according to published tide tables, when water levels accommodated boat usage.

The larvae were separated from the mud slurry in the laboratory by rinsing each aliquot through a series of U.S. Standard Sieves, with screening ranging from 20 to 50 mesh. Head capsule width measurements were taken to determine the instar of the larvae (Ford 1959). Preliminary trial separations indicated that the first and second instars were often lost in the rinse water. Their recovery by flotation methods was inconsistent and hampered by

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[3] Model OX-10, Hach Chemical Co., Ames, Iowa.

[4] pHydrion Midget, Ward's, Rochester, New York.

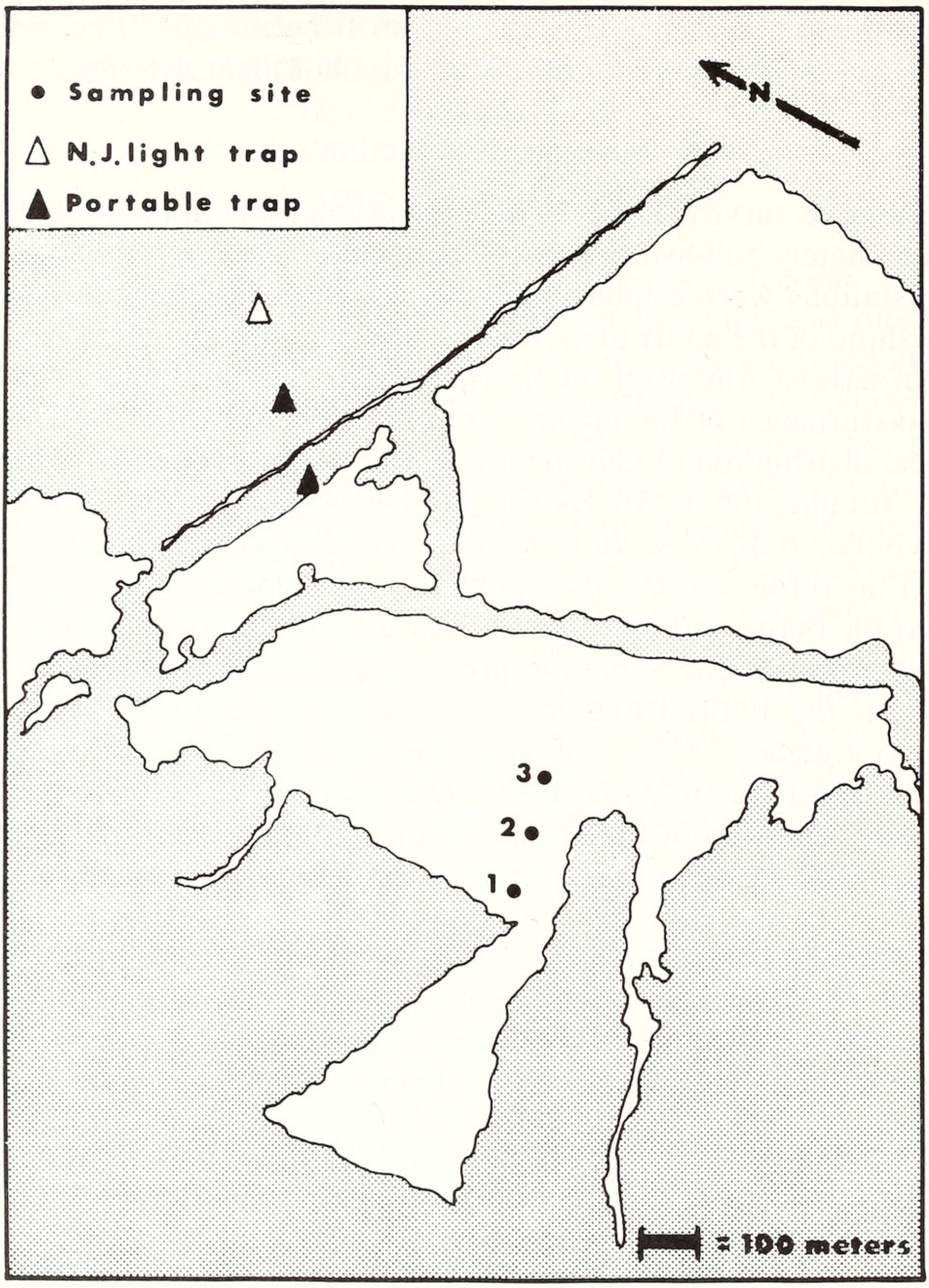

Fig. 1. Study site in the Hackensack Meadowlands, Bergen County, New Jersey, with locations of larval sampling stations and of adult traps (shaded, land; clear, water).

small detritus. Therefore, only third and fourth instar larval counts were used to assess population levels.

Light trap data gave an indication of seasonal adult emergence patterns. One New Jersey light trap, permanently established 600 m from the shore, was operated once weekly for a 24 hr period, from April to November. Two CDC portable traps were positioned closer to the shore, at 425 and 275 m distances. The portable traps were operated one evening a week, between 8:30 pm and 10:30 pm, from May to November. The time selected was based

Table 1. Head capsule width measurements for the four larval instars of *Chironomus decorus*, collected in the Hackensack Meadowlands, Bergen County, New Jersey.

	Head capsule width (mm)	
Instar	Range	Mean + C.I.
First	0.07–0.13	0.10 ± .0039
Second	0.14–0.20	0.17 ± .0029
Third	0.25–0.33	0.29 ± .0037
Fourth	0.40–0.61	0.50 ± .0108

upon a study (Ping 1917) reporting that peak flight activity of *C. decorus* occurs just after sunset. The weekly trap collections were synchronized with larval sampling dates, and the numbers of male and female adults were recorded.

Results

The range of head capsule width measurements for *C. decorus* was uniform for each instar (Table 1). As there was no overlapping of sizes, head capsule measurements were confirmed as a reliable means of determining the instar of field-collected larvae. The mean numbers of third and fourth instar larvae collected per 0.02 m^2 are presented on a weekly basis in Figure 2. The samples taken in early March contained only low levels of fourth instar larvae, and no individuals were detected in April. Third and fourth instar larvae suddenly appeared in May, and numbers increased as the summer progressed. A maximum density of 700 larvae per 0.02 m^2 was recorded in mid July. The population then declined in early August, and stabilized at comparatively low levels for the duration of the fall season.

Mean larval abundance per sample was different at the three stations (Site 1 = 208.6 ± 56.99; Site 2 = 180.5 ± 47.80; Site 3 = 141.4 ± 38.16), while the numbers of larvae collected from the five locations at any one station were statistically the same (5% level of significance). Duncan's multiple comparison test revealed that adjacent stations (1 and 2, 2 and 3) were the same, while larval numbers at stations 1 and 3 were significantly different. This indicates that a density gradient existed, with highest concentrations of larvae at station 1, and density decreasing toward station 3. The larval density gradient was accompanied by changes in substrate composition. Fine silt and ooze predominated at station 1, and shifted to a coarser mixture of muck and broken vegetation at station 3. Sublette (1957) and Whitsel et al. (1963) have also reported that *C. decorus* prefers to inhabit finer substrates.

Changes in the recorded environmental data reflected the seasonal time span of the investigation (Figure 3). Water temperatures gradually increased

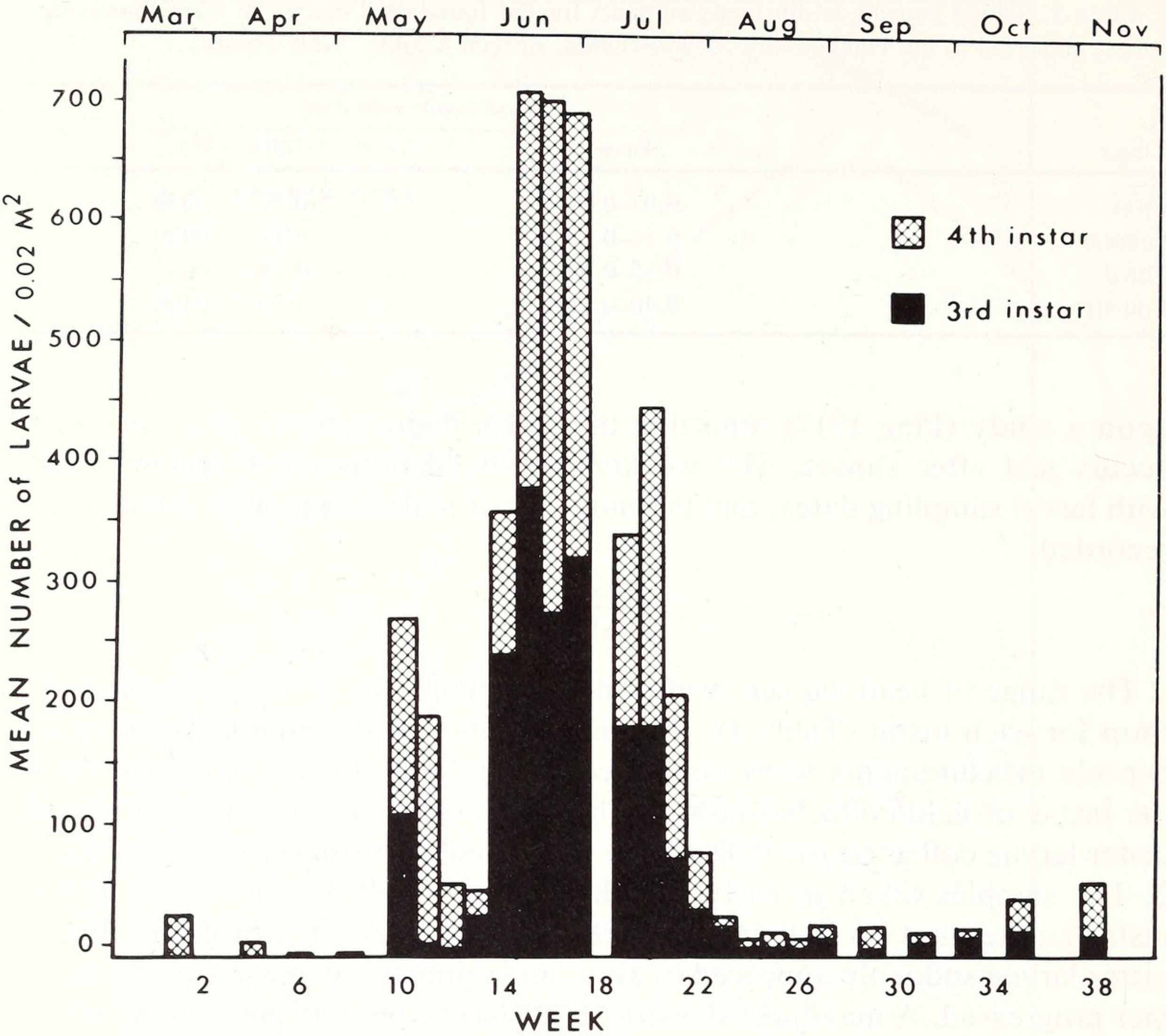

Fig. 2. Average number of third and fourth instar larvae of *C. decorus*, collected in the Hackensack Meadowlands, Bergen County, New Jersey, 1979.

from 6.5°C in early March, when larval numbers were lowest, to 24°C in May, when the larval population increased significantly. Throughout the summer months, temperatures oscillated from week to week, but exhibited an overall rising trend. A maximum of 33.5°C was attained in early August, when larval numbers began declining. Temperatures remained above freezing until late October. The dissolved oxygen content of the water was highest in early spring, when monitoring was initiated (12 ppm), and fell to relatively low levels (3–5 ppm) for the summer and fall seasons. The pH of the water was constant, between 6.8–7.0, throughout the study. The salinity of the water, during the spring precipitation period, was zero ppt. Salinity increased with the onset of dryer, warmer conditions, attaining a maximum of 13 ppt in August. Salinity readings averaged 9 ppt during the remainder of the season.

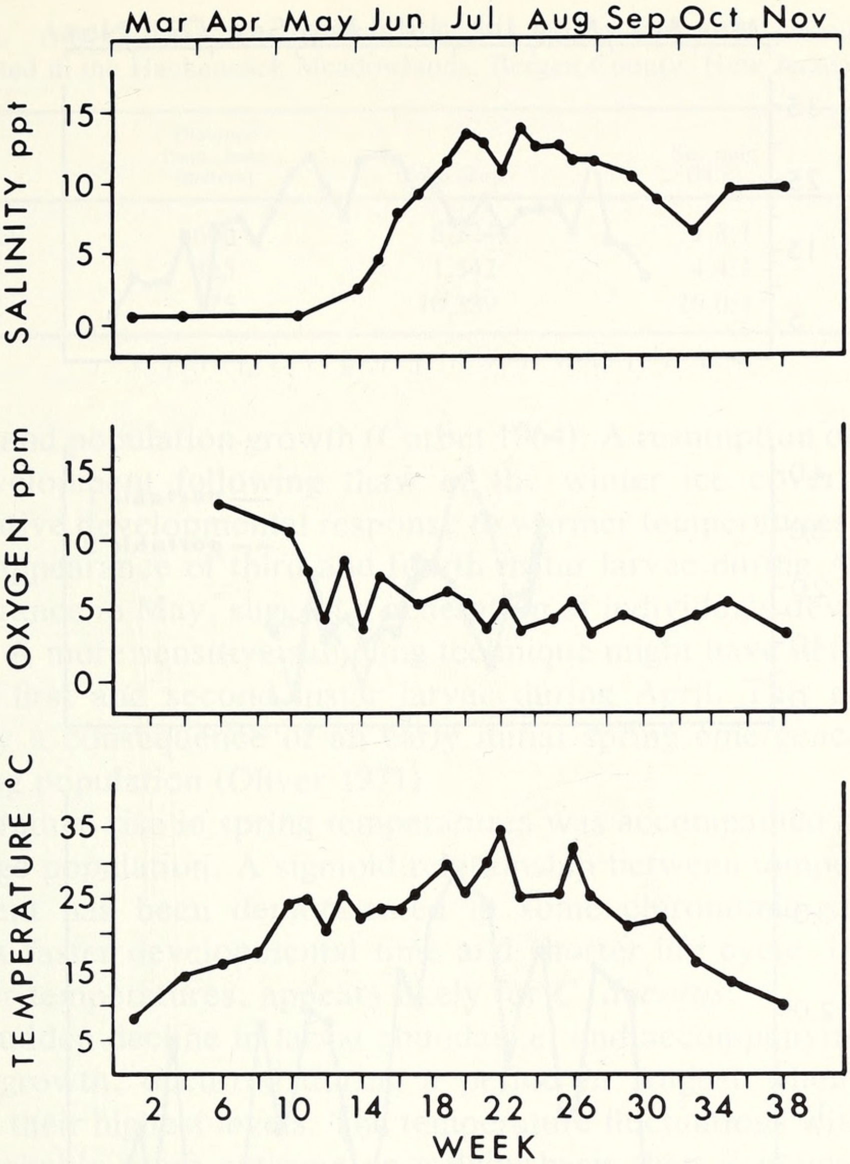

Fig. 3. Temperature, oxygen, and salinity levels recorded in the aquatic habitat of *C. decorus,* Hackensack Meadowlands, Bergen County, New Jersey, 1979.

The warm summer temperatures were accompanied by a proliferation of submergent vegetation, particularly the green algae *Cladophora* sp. and *Enteromorpha* sp. A vegetative mat had formed over the water surface by mid July. In late July the plant life rapidly diminished, and had nearly disappeared by mid August.

The numbers of adults collected from the N.J. light trap and the two portable traps are plotted on a logarithmic scale in Figure 4. The pattern of adult flight activity closely resembles the larval population trends. Adults were less active in the early spring and fall when lower temperatures prevailed, with emergence occurring primarily during June and July.

The use of different trap types prohibited averaging of data from the three trap locations, and limited statistical analysis. However, the overall fluc-

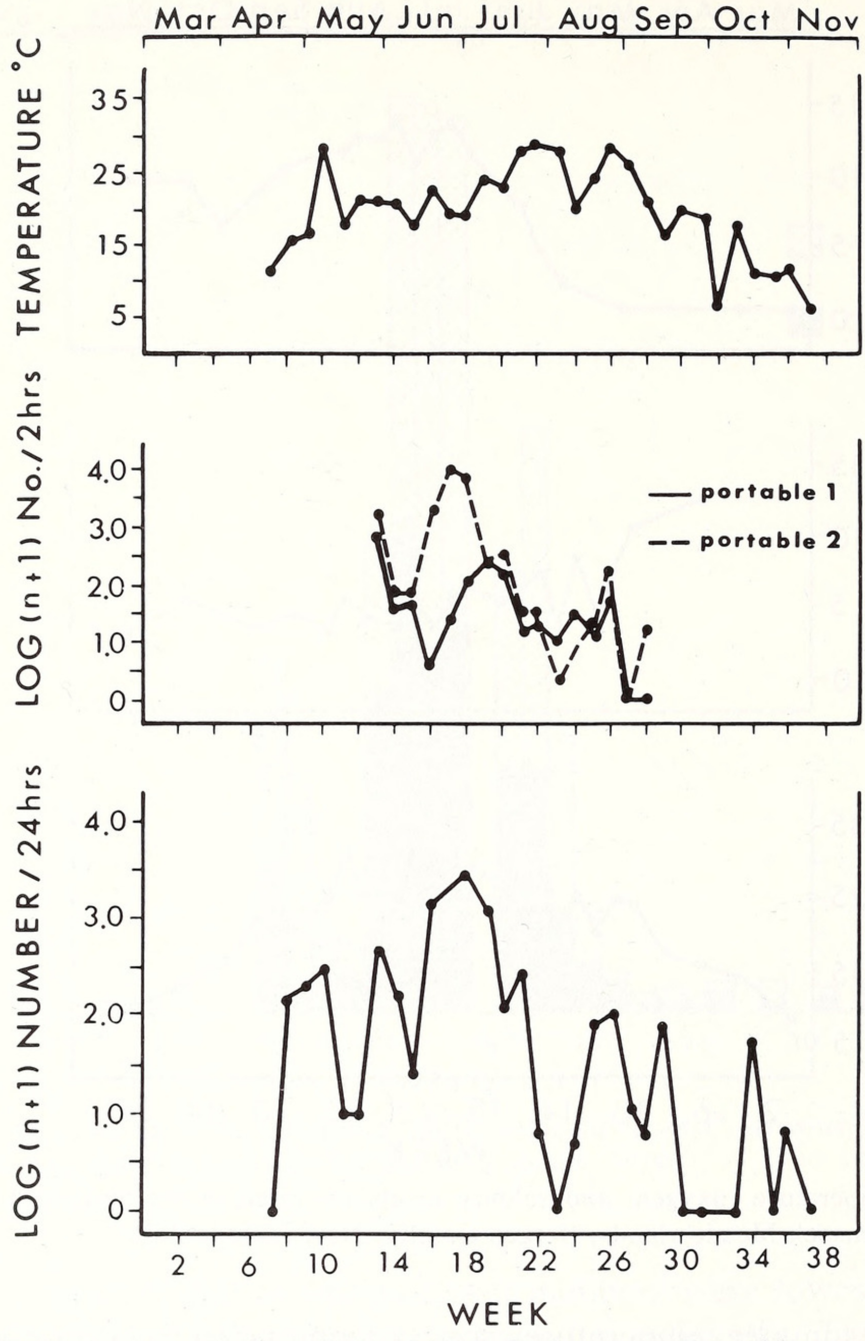

Fig. 4. Air temperatures and numbers of adult *C. decorus* collected in one N.J. light trap and two portable CDC traps, Hackensack Meadowlands, Bergen County, New Jersey, 1979.

tuations in abundance appeared similar among the three sets of data. The N.J. light trap and portable 2 exhibited the strongest correlation (Table 2), while the centrally located trap, portable 1, was weakly correlated with the other two traps. Males dominated the trap counts at portable 2, but the sex ratio became more equal with increasing distance from the shore.

Discussion

The population trend of *C. decorus* typifies that of an insect inhabiting a temperate region, where temperature is the dominant regulator of insect

Table 2. Adult *Chironomus decorus* collected during a 15 week period from three light traps located in the Hackensack Meadowlands, Bergen County, New Jersey.

Light trap	Distance from shore (meters)	Total adults	Sex ratio (M:F)	Correlation coefficient (R) with N.J. trap
New Jersey	600	8,324	1.8:1	
Portable 1	425	1,542	4.4:1	0.48
Portable 2	275	10,339	26.0:1	0.85

activity and population growth (Corbet 1964). A resumption of larval growth and development following thaw of the winter ice cover is considered a facultative developmental response to warmer temperatures (Oliver 1971). The disappearance of third and fourth instar larvae during April, and their reappearance in May, suggest a generation of individuals developing in synchrony. A more sensitive sampling technique might have detected the presence of first and second instar larvae during April. This generation was probably a consequence of an early initial spring emergence of the overwintering population (Oliver 1971).

The gradual rise in spring temperatures was accompanied by increases in the midge population. A sigmoid relationship between temperature and development has been demonstrated in some chironomid species (Biever 1967). A faster developmental time and shorter life cycle, in the presence of higher temperatures, appears likely for *C. decorus*.

The sudden decline in larval abundance, and accompanying drop in vegetative growth, occurred during a period in August when temperatures reached their highest levels. The temperature fluctuations within the habitat were probably more extreme on a daily basis than is indicated by the recorded data. Local wind and tidal effects reduced the water level at ebb tide to a few centimeters or less, exposing a great deal of the benthic mud surface. On a hot day, with ebb tide occurring at midday, the maximum daily temperatures attained would have been greater than those recorded during the high tide sampling situation. Temperature may have surpassed the tolerance levels of *C. decorus* and the aquatic life (Brauner 1979), and directly influenced survival.

Dense growths of algae and vegetation, such as were present in the study site, have been attributed with causing mid summer declines in chironomid populations (Bay and Anderson 1965). Plant respiration, and decomposition of an organic aggregate derived from the death of a large algal bloom, can reduce oxygen tension in the water (Cole 1975). Therefore, vegetation as well as temperature could have produced an oxygen deficit, detrimental to the larvae.

The variability in the number of adults collected by the three light traps was partially due to the use of different types of trap, and the length of the sampling interval for each type. Undefined differences in light trap efficiency, and local environmental factors, could have caused the weak correlation observed between the centrally located trap and the other two traps. The distance between the traps and the source would also be expected to affect the number of adults trapped. The decreasing male sex ratio in traps located further from the shore indicates that distance did influence light trap reliability to some extent. The male swarming behavior, in which assemblages form over stationary points (Downes 1969) may have limited dispersal of males. A differential flight ability between the sexes, where the female is the stronger flyer, would also result in fewer males reaching points further from the source.

The overwintering status of the study population in New Jersey was not clearly defined by the data collected. However, it was presumed that population growth of *C. decorus* was minimal after November, when larval sampling and adult trapping were discontinued. Previous research has indicated that populations of chironomids, located in temperate regions, generally overwinter as larvae in a state of suspended growth and development (Oliver 1971). Laboratory reared larvae, of a species closely related to *C. decorus,* ceased feeding and became inactive at temperatures of 50°F (10°C) or lower (Biever 1967). Adults become lethargic at 5°C or lower (Ping 1917).

The number of generations completed by *C. decorus* can be estimated by counting the number of apparent peaks in larval abundance and adult flight activity. Highest levels were attained at points in mid May, June, July, August, September, and late October. As the season progressed, and generations began overlapping, the peaks were less distinct and more difficult to distinguish. Five to six generations may have been completed by *C. decorus* in northern New Jersey, during the 1979 reproductive season. This finding is similar to that of Ping (1917) for a source located in Ithaca, New York.

Summary and Conclusions

Data obtained from larval sampling and trapping of adults indicated that the highest levels of *C. decorus* were attained in midsummer, 1979. Abundance during the spring and fall seasons was relatively low, apparently being regulated by environmental factors. The initial rise in spring temperatures resulted in a resumption of larval growth and development, and emergence of overwintering individuals. Population accrual continued to accompany rising temperatures throughout the summer, with the highest numbers occurring in July. A sudden drop in larval abundance in late summer may have been a result of extreme temperatures. In terms of nuisance potential, emergent adults reached peak levels during a limited interval of the reproductive season. Larval and adult data indicated that *C. decorus* can complete 5–6 generations in this habitat in a single year.

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