Journal of the American Mosquito Control Association, 10(1):24–28, 1994

OVIPOSITION, HATCHING, AND AGE COMPOSITION OF A PESTIFEROUS MIDGE, *GLYPTOTENDIPES PARIPES* (DIPTERA: CHIRONOMIDAE)[1]

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ABSTRACT. Field-caught gravid female *Glyptotendipes paripes* in central Florida laid a single egg mass each during onset of photophase in laboratory cages. Egg masses averaged 626 and 942 eggs/mass during summer and spring, respectively. Oviposition preference in water was not detected when provided from different sources (i.e., distilled, tap, ponds and a lake). However, the percentage of egg hatch/mass was significantly ($P < 0.05$) higher in the lake water than in water from the other 3 sources. Observations on follicular development in the ovaries indicated presence of ½–¾ yolk within 2 days, full yolk at ≥2 days, and parity at ≥4 days postemergence. Age composition of field-collected *G. paripes* populations from June to December 1992 was 29% at <2, 48% at ≥2, and 23% at ≥4 days old, and parity 23%. Adult abundance was correlated with prevailing air temperatures in the study area.

INTRODUCTION

In recent years, adult chironomid midges emerging from some urban natural or man-made aquatic habitats have increasingly posed a variety of nuisance, economic, and, in some situations, medical problems to human populations worldwide (Ali 1991). In central Florida, the city of Sanford has been plagued by *Glyptotendipes paripes* Edwards and *Chironomus crassicaudatus* Malloch midges for many years (Ali 1980). It has been documented that Sanford suffers an annual economic loss of $3–4 million because of phenomenal midge swarms frequently emerging from adjacent Lake Monroe (Anonymous 1977[2]). Because of the recurring economic loss and nuisance posed by adult midges, chironomid research in the Sanford area is being continually conducted and the results have been reported in several recent publications discussed by Ali (1991). We present here laboratory observations on *G. paripes* oviposition behavior, fecundity, egg hatch in different water types, and follicular development. Also reported are age composition and parity of adult *G. paripes* collected from the Sanford area. Such biological and ecological understanding is essential for the overall development of criteria for midge control.

[1] This is Florida Agricultural Experiment Stations Journal Series No. R-03290.

[2] Anonymous. 1977. Economic impact statement, blind mosquito (midge) task force. Sanford Chamber of Commerce, Seminole County, FL.

MATERIALS AND METHODS

Adult *G. paripes* were collected on multiple occasions during June 1992 and May 1993 from the Lake Monroe Marina area of Sanford using a hand-held sweep net. A battery-operated aspirator was also used to capture adults resting on lakefront walls and other structures. Collections were usually made between 1300 and 1600 h EDT and the captured adults were released into a screened cage (56 × 56 × 56 cm) and were transported to the laboratory. After acclimating the caged adults for 1–2 h in a control room (air temperature 25–27°C and 14:10 h light : dark), 100 females were collected with a mouth aspirator and released into a standard mosquito cage (31 × 31 × 31 cm). A plastic cup (15 cm diam × 4 cm high) containing about 300 ml tap water was left in the middle of the cage for the gravid females to oviposit into. For the next 3 days the cups were examined daily and any egg masses laid were removed with a dropper and the number of egg masses recorded. Each egg mass was transferred to a Sedgwick-Rafter counting cell containing 2–3 drops of distilled water and dissected to count the number of eggs.

To observe oviposition behavior of *G. paripes* in the laboratory, 20 field-collected gravid females were placed individually in labeled 250-ml glass beakers containing 100 ml distilled water. The mouth of each beaker was covered with a 1-mm nylon mesh secured with a rubber band to confine the adult to the beaker. Each adult was examined through the mesh hourly for the first 24 h and subsequently at 3–4 h intervals until its death. The study was repeated 3 times.

Table 1. Mean number (±SD) of eggs/egg mass laid by field-collected[1] *Glyptotendipes paripes* under caged laboratory conditions (25–27°C, 14:10 h light : dark). Eggs were laid in tap water.

Season	Mean ± SD	Range	*n*
Summer (June–July 1992)	626 ± 219	295–1,150	24
Spring (April–May 1993)	942 ± 229	420–1,400	52

[1] Adults collected from lakefront structures (Lake Monroe), Sanford, Seminole County, FL.

Oviposition preference of *G. paripes* in water derived from 4 sources (distilled, tap, experimental ponds [Ali et al. 1993], and Lake Monroe) was studied in the laboratory. These were the candidate water types for future laboratory rearing of *G. paripes*. All water types were aged for 24 h before use. Four labeled paper cups (7 cm diam × 4 cm high) containing about 75 ml of each water type were placed in the middle of the mosquito cage containing 100 field-collected female *G. paripes*. The females in each cage were allowed to lay their egg masses in the cups for a period of 24 h after which each cup was examined for egg masses. The study was repeated 4 times and each time the site of a cup containing a water type was changed so that it occupied all 4 positions. Water pH, dissolved oxygen, salinity, and conductivity of each water type in the cups were determined prior to placement of the cups in the cage.

The number of eggs hatching in each of the 4 water types was studied for 72 h in 1 cm diam × 10 cm long test tubes. The incubation period for most chironomids is 2–5 days depending upon the water temperature (Branch and Wichita 1923). One freshly laid (within 12 h) egg mass was placed in each tube to which water of one type was added to bring the total volume to 5 ml. Each treatment was replicated 6 times. After 3 days, the contents of each tube were examined at 40× using a binocular microscope fitted with a Whipple ocular grid. The contents were examined by taking small portions in a Sedgwick-Rafter cell. The hatched larvae and the unhatched eggs in each tube were counted. Percent egg hatch was calculated by the following expression:

$$\%\ \text{hatch} = \frac{\text{TLH}}{\text{TLH} + \text{NHE}} \times 100$$

where: TLH = total larvae hatched; NHE = nonhatched eggs

The parity percentage and primary follicle stage of nulliparous females was determined by dissecting field-collected *G. paripes* to remove the ovaries, which were then examined under 100× of a compound microscope. Stage of follicular development and nulliparous and parous status of the ovaries were classified according to Detinova (1962) and Seward (1980[3]).

Age composition of female *G. paripes* field populations was determined by collecting adults on a monthly basis from June to November 1992, from lakefront locations in Sanford. One hundred to 300 randomly selected females were examined monthly in the laboratory to determine parity status and yolk development. To confirm the female age in these populations, field-collected larvae of *G. paripes* from Lake Monroe were reared to the adult stage in the laboratory (Biever 1965). The adults were dissected at 1, 1.5, 2, 3, 4, and 5 days postemergence to observe presence of yolk in primary follicles (Fischer 1969) and compared with that of the field populations. Laboratory-determined monthly percent parity of field-collected *G. paripes* was compared to *G. paripes* population abundance in the field estimated by utilizing 2 New Jersey light traps permanently placed at 2 separate lakefront locations and monitored weekly from June to December 1992. Air temperature and rainfall data in the area were collected from June to December 1992 at a weather station at the University of Florida's Central Florida Research and Education Center, Sanford.

The collected data in various experiments were analyzed by chi-square and ANOVA. A log(n + 1) transformation was used where deemed necessary.

RESULTS

Field-collected female *G. paripes* laid only one egg mass during its adult life in laboratory cages. The mean number of eggs/mass was 626 and 942 during summer and spring, respectively (Table 1).

The gravid females contained in beakers laid egg masses only in the morning within a few minutes of the onset of photophase in the laboratory. These females rested on the glass wall

[3] Seward, R. M. 1980. A study of fecundity in the Chironomidae, with emphasis on intra- and inter-specific variability in primary follicle number. Ph.D. dissertation, University of Pittsburgh, PA.

Table 2. Oviposition of field-collected[1] *Glyptotendipes paripes* in the laboratory (25–27°C, 14:10 h light : dark) in water obtained from different sources (types), and selected chemical parameters of each water type. Means in columns followed by the same letter are not statistically different ($P > 0.05$).

	Mean values ± SD				
		Selected water parameters			
Water type	% oviposition[2]	pH	D.O. (ppm)	Salinity[3] (‰)	Conductivity[4] (μmhos/cm)
Distilled	23 ± 4.7	6.35 ± 0.2	8.7 ± 1.1	0.0 ± 0.00 a	10.4 ± 0.90 a
Tap	15 ± 1.4	6.50 ± 0.4	7.2 ± 0.7	0.4 ± 0.13 b	368 ± 52.0 b
Pond	26 ± 4.1	6.98 ± 0.5	3.8 ± 1.2	1.1 ± 0.11 c	1,590 ± 195.0 c
Lake Monroe	16 ± 2.2	7.70 ± 0.7	7.5 ± 0.5	1.0 ± 0.00 c	1,340 ± 89.0 d

[1] Adults collected from lakefront structures (Lake Monroe), Sanford, Seminole County, FL (June–August 1992).
[2] $\chi^2 = 4.79$, df = 12, $P > 0.05$.
[3] F = 123, df = 3 and 12, $P < 0.01$.
[4] F = 160, df = 3 and 12, $P < 0.01$.

or the water surface and within 1 min gradually released all the eggs in one mass. The brownish eggs were enclosed in a translucent gelatinous substance and the entire mass was *ca.* 3 mm when freshly laid. Some females with egg masses had to fly vigorously for shaking their abdomen to separate the egg mass from the abdomen tip. The laid egg masses settled onto the beaker bottom within a few seconds and after about 5 min enlarged from 3 mm to *ca.* 1.2 cm. The parous females died within 2–3 days of oviposition.

Glyptotendipes paripes laid egg masses in water derived from all 4 sources (types) (Table 2). Percent oviposition in water from experimental ponds was the highest as compared to the other 3 water types, but this difference was not statistically significant ($P > 0.05$). In general, this species had rather low oviposition rates in the laboratory. This was most likely due to large proportions of parous females in the field-collected populations that could not be separated. Chemical parameters of water, particularly salinity and conductivity were significantly ($P < 0.01$) different for the different water types (Table 2), but apparently had no influence on oviposition of *G. paripes.*

The eggs hatched in all 4 water types. Percent egg hatch/mass was significantly higher ($P < 0.05$) in the lake water than in the other 3 water types at 72 h (Fig. 1). The range of percent egg hatch/mass varied from a minimum of 25% in distilled water to a maximum of 44% in the lake water. This range of egg hatch at 72 h was rather low. It is likely that eggs of *G. paripes* hatch beyond 72 h postoviposition.

Follicular development in laboratory-reared *G. paripes* indicated presence of ½–¾ yolk within 2 days, full yolk at ≥2 days, and parity at ≥4 days postemergence. Based on laboratory observations, the age composition of total field-col-

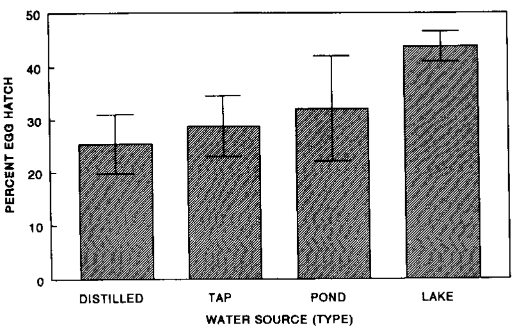

Fig. 1. Percent egg hatch/egg mass of field-collected *Glyptotendipes paripes* laying egg masses in the laboratory (25–27°C air temperatures and 14:10 h light : dark) in water derived from 4 different sources (types). Bars indicate SD values ($\chi^2 = 9.16$, df = 3, $P < 0.05$).

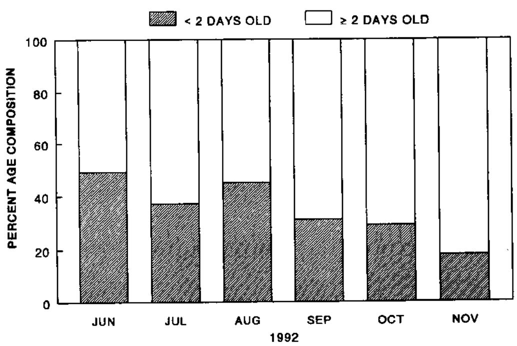

Fig. 2. Percent age composition of nulliparous *Glyptotendipes paripes* (June–November 1992) occurring at lakefront, Lake Monroe, Sanford, FL ($\chi^2 = 20.25$, df = 6, $P < 0.01$).

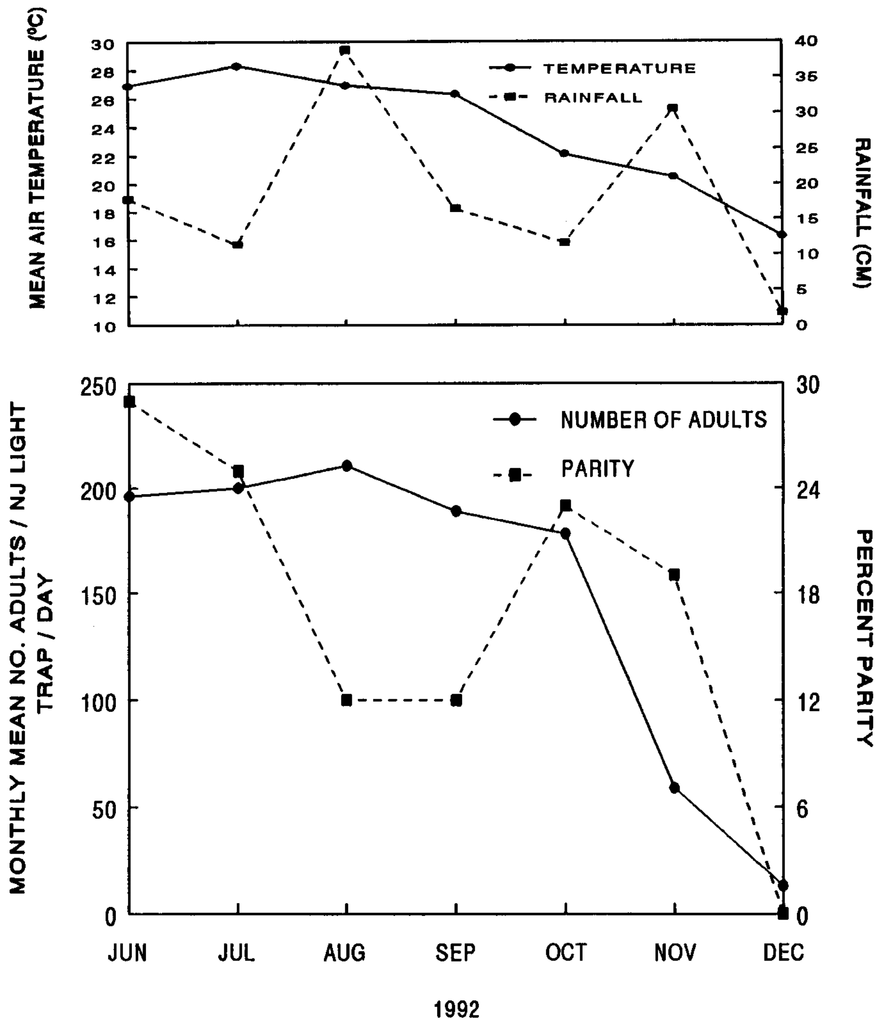

Fig. 3. Adult abundance and parity of *Glyptotendipes paripes* (June–December 1992) occurring at lakefront, Lake Monroe, Sanford, FL (Parity $\chi^2 = 44.23$, df = 6, $P < 0.01$). Mean air temperatures and monthly mean rainfall in the Sanford area from June to December 1992 are also shown.

lected female *G. paripes* from June to November 1992 was 29% at <2 days, 48% at ≥2 days, and 23% at ≥4 days old. In this population, nulliparous *G. paripes* were 38% at <2 days and 62% at ≥2 days old. Monthly age composition of <2 days old nulliparous field populations of *G. paripes* changed from 49% in June to 19% in November (Fig. 2).

Monthly percent parity of field-collected *G. paripes* observed from June to November 1992 ranged from a maximum of 29% (June) to a minimum of 12% (August) (Fig. 3); the mean percent parity for the 6 months amounted to 23%. During this period the mean number of adult *G. paripes* in the New Jersey light traps fluctuated from 178 to 211/trap/day during June through October, declining rapidly in November and December.

DISCUSSION

Details concerning fecundity, oviposition behavior, egg hatch, and age composition of field populations of *G. paripes* were previously lacking, although cursory observations on the life history (Lieux and Mulrennan 1956) and oviposition (Nielsen 1962) of this species have been reported. Nielsen (1962) observed that *G. paripes* laid egg masses in the field at the end of civil twilight. In our laboratory observations, *G. paripes* did not lay eggs in the evening or in the dark. However, it laid eggs within a few minutes of the

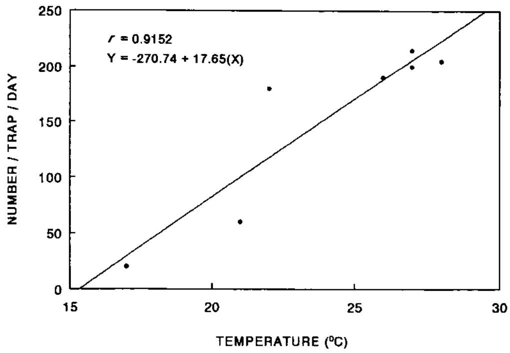

Fig. 4. Relationship between *Glyptotendipes paripes* abundance and air temperatures at lakefront, Lake Monroe, Sanford, FL (June–December 1992).

onset of light in the laboratory. The cause of this difference in observations is unknown. However, based on our observations we suggest that change in light intensity is a stimulating factor for oviposition activity of this species.

The number of egg masses laid by a female chironomid and the number of eggs/mass may vary by species and strains (Branch and Wichita 1923, Morrow et al. 1968). Female *Pseudodiamesa arctica* (Malloch) and *Heterotrissocladius subpilosus* (Kieffer) group successfully completed the development of 2 ovarian cycles without feeding, although neither oviposited (Oliver 1971); however, in some midge species a 2nd egg batch is produced after deposition of the first batch (Fischer 1969). In our observations, laboratory-reared and field-collected *G. paripes* laid only a single egg mass. The field-collected females were mostly nulliparous. No traces of a second oviposition were observed despite indications of development of some 2nd follicles.

The selection of water type for oviposition by *G. paripes* was not previously elucidated (Nielsen 1962). Our observations indicate that *G. paripes* generally may not have an oviposition preference for a certain water type, but the survival and hatching of eggs may depend upon the water type, essentially water quality. The maximum hatch in the present study was recorded in the lake water, which was perhaps chemically more suitable for survival and hatching of eggs of *G. paripes* than the other 3 water types tested.

Among environmental factors, temperature is the most obvious factor that affects seasonal cycles and abundance of chironomids (Ali et al. 1977). In the present study, air temperature had a highly significant ($r = 0.91$, $P < 0.01$) relationship with the adult populations (Fig. 4). Rainfall did not seem to have any influence on the adult populations or on percent parity rates in this short-term study (Fig. 3).

Age composition of adult Diptera may be used as an index for estimating longevity and survival of the populations (Detinova 1962). Our observations indicated that >2-day-old adult female *G. paripes* predominated in the field and these females were ready to reproduce. The life span of adult *G. paripes* is rather short—from 4 to 6 days (Nielsen 1962).

Although the adult life span of *G. paripes* is much shorter than most mosquito species, the severe nuisance problem posed by the phenomenal numbers in which these insects emerge, swarm, and congregate in urban water fronts necessitates implementation of control measures. The present findings suggest that adult control of spring populations is warranted because of their higher reproductive potential. Adulticiding conducted in the evening hours should prevent gravid females from laying eggs the following morning and thus reduce the development of potential future populations as well as existing ones of this pestiferous midge.

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