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RELATIONSHIP BETWEEN WING LENGTH AND FECUNDITY OF A PESTIFEROUS MIDGE, *GLYPTOTENDIPES PARIPES* (DIPTERA: CHIRONOMIDAE)

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ABSTRACT. The relationship between body size and fecundity of adult female *Glyptotendipes paripes* collected along southern shore areas of Lake Monroe, Sanford, FL, was studied by measuring wing length and examining ovaries, follicular development, and number of eggs/egg mass. Wing length of nulliparous, as well as parous females, had a significant ($P < 0.01$) linear relationship with dry body weight. Large females had a significantly ($P < 0.01$) higher number of follicles and eggs/egg mass than small females. No correlation existed between wing length and parity nor between wing length and age composition of field populations sampled between January and June 1993.

INTRODUCTION

The relationship between intraspecific variation in adult body size and fecundity in many insects has been studied because of its biological importance (Honek 1993). A large number of such studies have focused on mosquitoes, relating female body size variation to fecundity (Packer and Corbet 1989), parity (Nasci 1987), and survivorship (Landry et al. 1988). To date, no such information is available on aquatic nonbiting chironomid midges. In many situations throughout the world, adult midges emerge in very large numbers and pose severe nuisance, economic, and, in some cases, medical problems to the human populations residing within the dispersal range of these insects (Ali 1991).

In central Florida, *Glyptotendipes paripes* Edwards is one of the major pest species of midges (Ali 1991). According to an economic survey (Anonymous 1977[1]), businesses and tourism-related industry of the city of Sanford along the southern shore of Lake Monroe, Seminole County, FL, suffer an annual loss of $3–4 million because of midge nuisance problems requiring control attempts and frequent washing and maintenance of properties and other areas invaded by adult midges. Research in the Sanford area on midges is conducted to understand the biology, behavior, and ecology of the pestiferous species and develop criteria for their control. In the present study, female body size and fecundity of *G. paripes* field populations were investigated; specifically, the intraspecific distribution of wing length in females, the relationship between female wing length and dry body weight, and the relationship between wing length, the number of follicles, and the number of eggs per female. Also, we studied the relationship of wing length to parity and midge age composition.

MATERIALS AND METHODS

Wing length and dry body weight: Adult *G. paripes* were collected on multiple occasions during January and June 1993. Resting adults on waterfront structures along the southern shore of Lake Monroe, Sanford, FL, were collected with a mouth aspirator. The adults were killed in the laboratory by freezing, and the wing length (axial incision to apical margin of R1 vein) of individuals was measured under 40× using a binocular microscope fitted with a Whipple ocular grid. The wings were not measured from axial incision to the apical tip (beyond R1 vein) because the tips were often broken in the field specimens. Wing length of male and female *G. paripes* was recorded separately and the wings discarded, and the corresponding bodies of females were dried in an oven (65°C) for 24 h, and weighed with a Mettler AC 100 balance. Wing length and dry body weight were compared for parous and nulliparous females. A linear regression analysis was used to determine the relationship between dry body weight and wing length.

Wing length, follicles, and eggs: Wing lengths of field-collected females were measured individually in the laboratory and then each female was dissected in a drop of distilled water on a glass slide to remove the ovaries. One ovary from each dissected female was transferred to a Sedgwick-Rafter counting chamber containing distilled water, dissected, and examined at 40× using a binocular microscope. The bottom of the counting chamber was marked with a 2-mm grid. The number of follicles in each ovary were counted and multiplied by 2 to derive the total number

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

Table 1. Wing length and dry body weight of nulliparous and parous *Glyptotendipes paripes* collected along southern shore areas of Lake Monroe, Sanford, FL (May–June 1993).

	Nulliparous			Parous		
Collection date	Wing length[1] (mm) (mean/female) (±SD)	Dry wt.[2] (mg) (mean/female) (±SD)	*n*	Wing length[1] (mm) (mean/female) (±SD)	Dry wt.[2] (mg) (mean/female) (±SD)	*n*
May 5	4.25	2.580	20	4.22	0.854	35
May 17	3.93	2.626	66	3.93	0.670	15
May 19	3.55	1.773	30	3.55	0.629	17
May 28	3.82	2.359	32	3.72	1.080	13
June 3	3.60	2.140	20	3.60	0.840	35
June 23	3.34	2.007	95	3.25	0.539	13
Total	3.75 ± 0.32	2.248 ± 0.335	263	3.71 ± 0.33	0.769 ± 0.196	128

[1] $t = 0.19$, $P > 0.05$.
[2] $t = 9.34$, $P < 0.01$.

of follicles per female. One hundred and one females were examined between January and June 1993.

To obtain eggs, 20 gravid field-collected *G. paripes* were placed individually in 250-ml glass beakers containing 100 ml distilled water. The mouth of each beaker was covered with nylon mesh and tied with a rubber band to confine the female to the beaker. The egg mass, usually laid the following morning, was removed with a dropper, transferred to a Sedgwick-Rafter counting chamber with a 2-mm bottom grid, and examined at 40× using a binocular microscope after incising the gelatinous mass enclosing the eggs. The wing length of each female was measured at postoviposition death. A regression analysis was used to determine the relationship between wing length and number of follicles/ovary as well as wing length and number of eggs/egg mass. This experiment was repeated 3 times between January and June 1993.

Wing length and parity: More than 400 field-collected *G. paripes* females were examined between January and June 1993 for parity status and wing length measurement. Most nulliparous females could be readily distinguished by eye from the parous ones due to their distended abdomen prior to oviposition; parous females had a shrunken abdomen within 2 days postoviposition. When doubted, some females (<10%), were dissected and ovaries examined under a microscope to confirm parity using the method of Detinova (1962).

Wing length and age composition: Age composition of female *G. paripes* field populations was determined by randomly selecting 25–40 adults/month from January to June 1993, and examining the ovaries by the method described in Xue et al. (1994), after taking the wing length measurement. Briefly, follicles developed 50–75% yolk in <2 days, full yolk at ≥2 days, and eggs were laid (parity) at ≥4 days postemergence.

Wing length and parity, and wing length and age composition data were analyzed by chi-square, Student's *t*-test, and ANOVA as needed.

RESULTS

Wing length and dry body weight: Nulliparous *G. paripes* had mean (±SD) wing length of 3.75 ± 0.32 mm and mean dry body weight of 2.248 ± 0.335 mg. Parous females had mean wing length of 3.71 ± 0.33 mm and mean dry body weight of 0.769 ± 0.196 mg. There was no significant difference between wing length of nulliparous and parous females; however, dry body weights of nulliparous *G. paripes* were significantly higher than those of parous females ($t = 9.34$, $P < 0.01$) (Table 1). There was a linear relationship ($r = 0.44$, $P < 0.01$, $n = 95$) between wing length and dry body weight of nulliparous individuals. A similar linear relationship ($r = 0.38$, $P < 0.01$, $n = 100$) existed between wing length and dry body weight of parous females (Fig. 1). Thus, wing length of female *G. paripes* is a reliable measure of their body size.

A total of 794 female and 392 male *G. paripes* were measured for wing length. The mean (±SD) wing length values for female and male midges were 3.89 ± 0.29 mm (range = 3.00–4.56 mm) and 3.34 ± 0.20 mm (range = 2.76–3.84 mm), respectively. The frequency distribution of female wing length was skewed to the right, but that of male wing length was almost normal (Fig. 2). Female wing-length distribution essentially consisted of 2 size classes: 57% with short wings (≤3.72 mm) and 43% with long wings (≥3.73 mm).

Wing length, follicles, and eggs: A highly significant linear relationship existed between fe-

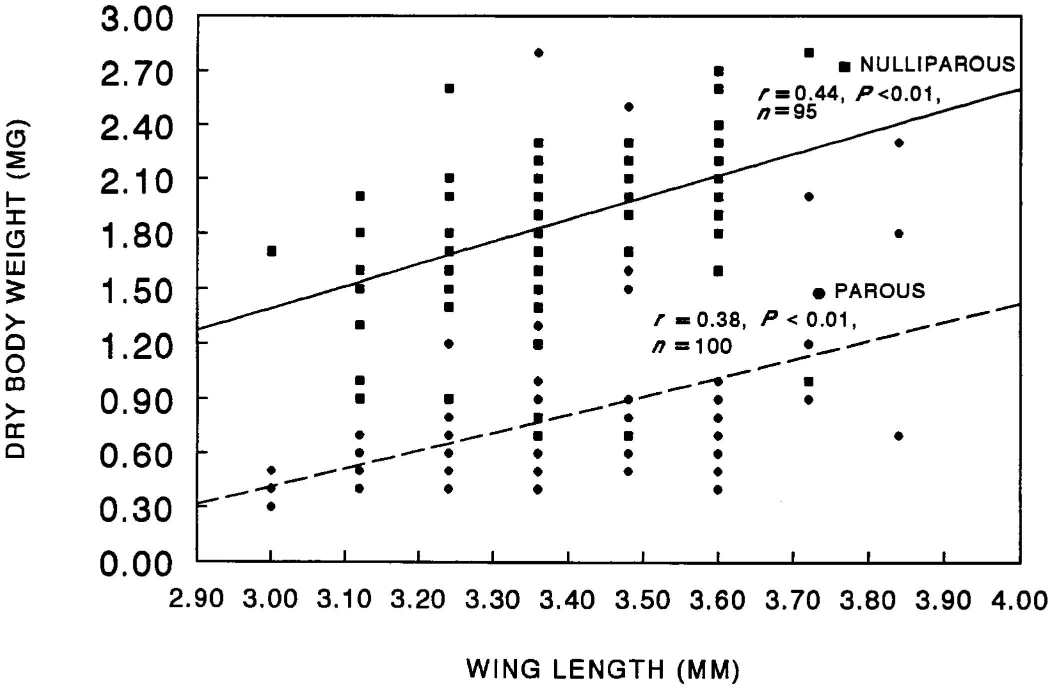

Fig. 1. Relationship between wing length and dry body weight of nulliparous and parous *Glyptotendipes paripes* collected from southern shore areas of Lake Monroe, Sanford, FL (May–June 1993).

male wing length and number of follicles (r = 0.69, P < 0.001, n = 101) (Fig. 3). The mean (±SD) number of follicles was 909 ± 243 (range = 412–1,525 follicles) in field-collected *G. paripes*. Females with long wings (≥3.73 mm) had 1,085 ± 238 follicles (range = 620–1,525 follicles), and females with short wings (≤3.72 mm) contained 827 ± 200 follicles (range = 412–1,320 follicles).

The relationship between female wing length and the number of eggs/mass is also shown in Fig. 3. This relationship was highly significant (r = 0.72, P < 0.001, n = 53). Long-winged females (≥3.73 mm) laid more eggs (mean = 1,100 ± 205 eggs/mass and range = 420–1,400 eggs/mass), and short winged females (≤3.72 mm) laid fewer eggs (mean = 794 ± 131 eggs/mass and range = 520–980 eggs/mass).

Wing length and parity: No significant correlation was found between wing length and parity. Percent parity in long-winged and short-winged females was 17.5 and 16.2, respectively (Table 2).

Wing length and age composition: Field populations of long-winged and short-winged females did not differ in percent age composition (Table 2). However, females of both wing size classes contained significantly more adults ≥2 d old than adults ≥4 d old (F = 15.26, P < 0.05) (Table 2).

Table 2. Wing length, parity and age composition of female *Glyptotendipes paripes* collected along southern shore areas of Lake Monroe, Sanford, FL (January–June 1993).

Wing		Parity status			Age composition (%)[1]			
Size	Length (mm)	Nulliparous	Parous	% parity[2]	<2 days	≥2 days	≥4 days	n
Large	≥ 3.73[3]	22	104	17.5	32.5	50.0	17.5	126
Small	≤ 3.72[3]	16	83	16.2	42.4	41.4	16.2	99

[1] F = 15.26, P < 0.05 (between ≥2 d and ≥4 d).
[2] χ^2 = 0.006, P > 0.05.
[3] t = 1.53, P > 0.05 (wing length).

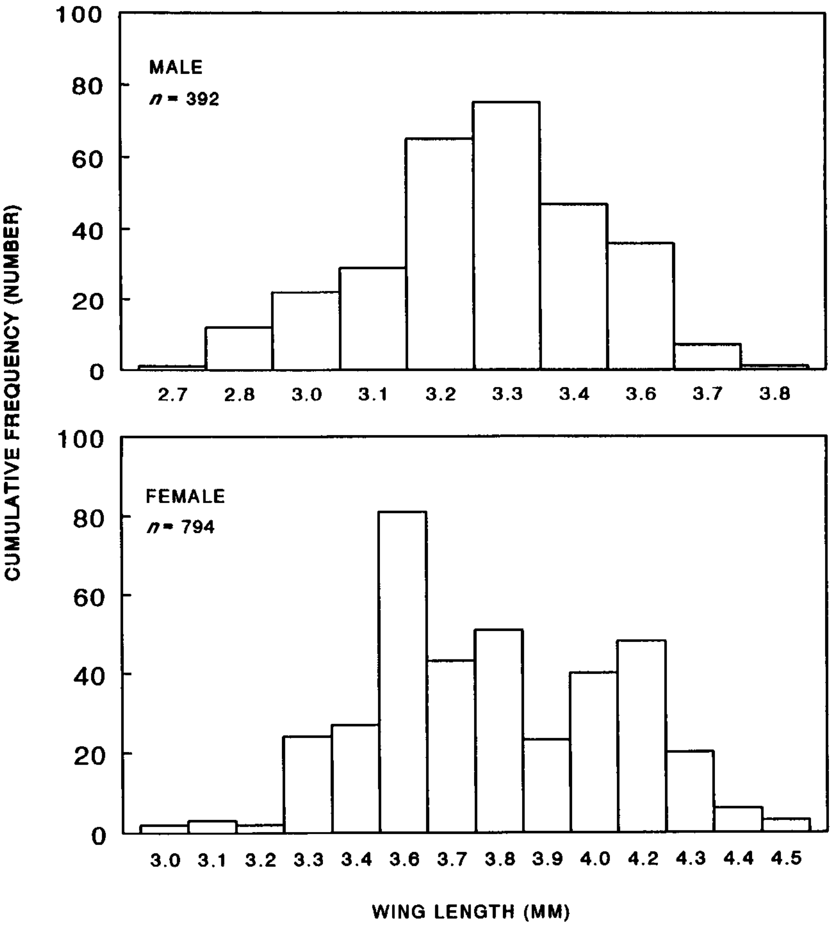

Fig. 2. Wing length distribution of adult male and female *Glyptotendipes paripes* collected from southern shore areas of Lake Monroe, Sanford, FL (January–June 1993).

DISCUSSION

Limited chironomid data exist for comparisons with the present study. However, numerous studies on female mosquito body size relationship to wing length, fecundity, parity, and survivorship have been reported (Nasci 1987, Landry et al. 1988, Packer and Corbet 1989).

The lack of normal distribution in the female wing-length in the present study was similar to the wing-length distribution in the mosquito *Aedes triseriatus* Say (Haramis 1983). The linear relationship between wing length and dry body weight of nulliparous and parous *G. paripes* found in the present study was similar to the relationship found in laboratory-colonized and wild-caught mosquito of the species *Culiseta melanura* (Coquillett) (Lorenz et al. 1990). However, the relationship between wing length cubed and dry body weight at adult emergence differed among mosquito species, between sexes within species, and may even differ within the same sex of a species (Nasci 1990).

In our studies, females with long wings (large body size) had higher fecundity than females with short wings (small body size). These results were similar to those reported for mosquitoes and other insects (Briegel 1990, Honek 1993). In midges, a significant intraspecific difference in primary follicle numbers was detected for populations of *Diamesa nivoriunda* (Fitch) and *Procladius bellus* (Loew); these differences were explained due to variations in body size of the emerging female (Seward 1980[2]). The body size of mosquitoes is influenced by water temperature (Day et al. 1990),

[2] 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.

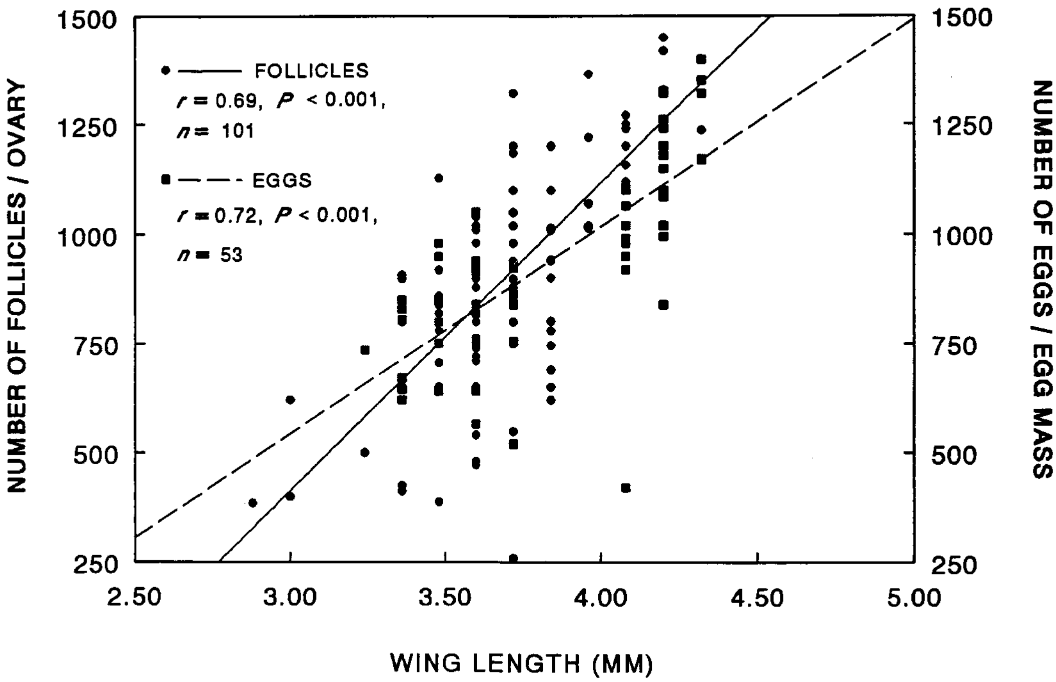

Fig. 3. Relationship between wing length and number of follicles/ovary, and wing length and number of eggs/egg mass of *Glyptotendipes paripes* collected from southern shore areas of Lake Monroe, Sanford, FL (January–June 1993).

larval nutrition (Briegel 1990), and, in part, photoperiod (Lanciani 1992). These factors may also influence body size of chironomid midges and, in turn, fecundity, which in mosquitoes and other insects increases with body weight and body size (Briegel 1990, Honek 1993).

Our results indicating the lack of relationship between wing length and parity of *G. paripes* were similar to those reported for *Cs. melanura* (Lorenz et al. 1990). However, parity was positively correlated with large body size in several mosquito species (Haramis 1983, Nasci 1987) and parous rates have been frequently utilized to analyze the age structure of mosquito populations (Detinova 1962).

The age composition of long-winged and short-winged classes of female *G. paripes* did not differ. Therefore, adult female body size and survivorship of this midge may not be related. Similar observations were reported for the mosquito *Ae. triseriatus* by Landry et al. (1988). However, the adult life span of *G. paripes* is only 4–6 days (Nielson 1962) and, thus, is much shorter than that of most mosquito species.

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