Sexual size dimorphism in a natural population of Callicorixa vulnerata (Hemiptera: Corixidae)

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Sexual size dimorphism occurs in many species. Differences between males and females, in size or other characteristics, may result from sexual selection, fecundity selection, natural selection, non-adaptive processes or a combination of these pressures (Darwin 1874; Selander 1966; Trivers 1976; Slatkin 1984; Shine 1989). In insects, females with large body size often produce more eggs than smaller females and female-biased sexual size dimorphism is commonly attributed to such fecundity selection (e.g. Preziosi and Fairbairn 1997; but see Leather 1988). Water boatmen are detrivorous or zoophagous semi-aquatic insects often inhabiting small ponds of the Northern Hemisphere (Hungerford 1977; Nosil and Reimchen in press). Female water boatmen are generally larger than males. In this note, I quantify the nature and magnitude of a previously undescribed sexual size dimorphism in a natural population of the water boatmen *Callicorixa vulnerata* Uhler (Hemiptera: Corixidae). I test for differences between males and females in mean trait size (body length, body weight, mid-leg tarsal length, mid-leg tarsal spine number) and also test for sexual dimorphism in allometric relationships between tarsal traits and body length.

During July 1999 adult *C. vulnerata* (males, n = 211, females, n = 156) were captured from Rithet's bog in Victoria, British Columbia (48°25'N 123°19'W) using dip nets. Specimens were scored for sex, body length, wet weight, dry weight, mid-leg tarsal length and mid-leg tarsal spine number (see Nosil and Reimchen 2001 for morphometric procedures). Measurement error was assessed using replicate measurements of each linear trait (body length, left tarsus length, left tarsal spine number) on 50 individuals. Repeatabilities for body length, tarsal spine number and tarsal length respectively were 0.98, 0.97, 0.93 for males and 0.99, 0.98, 0.95 for females (all P < 0.001; Model II ANOVA; Yezerinac *et al.* 1992 for details). To reduce bias, all measurements were done blind, without knowledge of length, weight or sex and were carried out by one individual (P. Nosil). Tarsal length and tarsal spine number were calculated as the average of the right and left measurements. The coefficients of variation for trait size were calculated as the ratio of standard deviation to the mean.

Differences in morphology between the sexes were tested using independent sample ttests and logistic regression. Storer's (1966) dimorphism index (DI) = (mean female size – mean male size) / [(mean female size + mean male size)/2] x 100 was also calculated. ANCOVA was used to test for differences between the sexes in allometric relationships between tarsal morphology and body length.

Body length ranged from 3.98 to 11.53 mm and dry weight ranged from 0.80 to 9.54 mg. Males and females differed in the size of the traits measured, but had similar coefficients of variation (Table 1). Females were heavier and longer (wet weight, $t_{172} = 5.54$, P < 0.001; dry weight, $t_{172} = 4.53$, P < 0.001; length, $t_{365} = 5.64$, P < 0.001, t-tests) and exhibited greater tarsal spine number and tarsal length ($t_{351} = 2.47$, P < 0.05; $t_{350} = 2.67$, P < 0.01 respectively) than did males.

There was no sexual dimorphism in allometric relationships between body length and tarsal morphology (Fig. 1). The regression of log tarsal length versus log body length did not differ between the sexes in slope or elevation (males: y = -0.75x + 0.82; females: y = -0.73x + 0.79; slopes $F_{1,351} = 0.09$, P = 0.77, intercepts $F_{1,351} = 1.47$, P = 0.23; ANCOVA). Likewise, the regression of log tarsal spine number versus log body length did not differ between the sexes in slope or elevation (males: y = 0.34x + 0.79; females: y = 0.30x + 0.84; slopes $F_{1,351} = 0.04$, P = 0.84, intercepts $F_{1,351} = 0.12$, P = 0.73). This indicates differences between sexes in tarsal length and tarsal spine number are scaled to differences in body length. When partial associations among morphological variables were accounted for in a multivariate analysis, overall differences

between the sexes were detected and 70.3% of water boatmen were classified correctly according to sex by a logistic regression model (Model $\chi^2_4 = 23.47$, P < 0.001). As suspected, body length explained the greatest amount of variability between the sexes and was the only morphological variable correlated with sex after removal of partial associations among morphological traits (P < 0.05; Table 2).

Thus males and females differed in mean trait size, but not in allometric relationships between tarsal morphology and body length. This suggests body size per se, rather than tarsal morphology, has diverged between the sexes (Tseng and Rowe 1999). Potentially this reflects fecundity selection favoring large overall body size in females (Darwin 1874; but see Leather 1988). In a water strider (*Aquarius remigis*), female abdomen length, rather than total length, is the direct target of fecundity selection (Preziosi and Fairbairn 1997). Further work is required to determine which, if any, components of female size are under direct fecundity selection for increased size in natural populations of *C. vulnerata*.

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Table 1. Mean \pm SD and coefficients of variation for morphometric traits in male (n = 211) and female (n = 156) *Callicorixa vulnerata* from a natural population. D.I. is a dimorphism index (Storer 1966) where D.I. = (mean female size – mean male size) / [(mean male size + mean female size)/2]

Variable		Males			Females		
	Mean	SD	CV	Mean	SD	CV	D.I.(%) [#]
number of spines per tarsus	10.6	2.1	0.20	11.2	2.3	0.20	5.5
tarsal length (mm)	0.92	0.10	0.11	0.94	0.10	0.11	2.2
body length (mm)	7.33	0.66	0.09	7.73	0.68	0.09	5.3
dry weight (mg)	3.32	1.10	1.33	4.29	1.72	0.40	25.5
wet weight (mg)	11.6	3.5	0.30	15.3	5.3	0.35	27.5

[#] see text for details on calculation of this index

Table 2. Logistic regression analysis of morphology with sex (female = 0, male = 1) of *Callicorixa vulnerata* as the dependent variable. The overall model is significant at P < 0.001 (d.f. 5). Significance levels for individual variables are from the Wald statistic (β / SE β)². For details on morphology refer to Table 1.

Variable	В	SE B	Wald	Р	R
length (mm)	-1.02	0.46	4.88	< 0.05	-0.11
dry weight (mg)	-0.27	0.16	2.86	0.09	-0.06
number of tarsal spines	0.08	0.08	1.06	0.30	0.00
tarsal length (mm)	-0.18	2.21	0.01	0.93	0.00
Constant	8.16	2.66	9.34	< 0.01	

Figure caption

Figure 1. Allometric relationships between tarsal morphology (A - tarsal length; B - tarsal spine number) and body length in male and female *C. vulnerata*. The slope and intercepts of each regression did not differ between the sexes, indicating no sexual dimorphism in allometry (see results).