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Brief report

Heritability estimates of morphological traits in *Gerris odontogaster* (Zett.) (Heteroptera; Gerridae)

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Water striders (Heteroptera: Gerridae) represent a group of predatory insects, inhabiting water surfaces of various aquatic habitats. Though the evolutionary biology and ecology of water striders have received increased attention (e.g., HAYASHI 1984; RUBENSTEIN 1984; ZERA 1984; FAIRBAIRN 1988; ARNQVIST 1989), very little effort has been made to assess the degree of inheritance of morphological variation (but see VEPSÄLÄINEN 1974a; ZERA et al. 1983; ARNQVIST 1989). In this paper, I report significant estimates of heritability for several morphological traits in *Gerris odontogaster* (Zett), one of the most widely distributed palearctic species (VEPSÄLÄINEN 1973).

Methods

G. odontogaster overwinters on land as adult in a prereproductive state. The reproductive activities start in spring after a period of gonad maturation lasting 1–2 weeks (VEPSÄLÄINEN 1974b). The population investigated in the current study is univoltine and monomorphic macropterous and inhabits the Gimonäs pond SE of Umeå in northern Sweden (63° 48′N, 20° 19′E). Immature (virgin; females laid only unfertilized eggs prior to the experiment) individuals were captured on May 17–18, 1987. These individuals were used in a laboratory breeding experiment in order to perform heritability estimates of various morphological traits.

Pairs of water striders (N=20) were isolated in plastic containers, and the eggs from each pair were subsequently hatched in the laboratory. All offspring were reared in 30 cm diameter plastic containers under identical conditions in the laboratory and fed daily with 3 frozen *Drosophila melanogaster* each. All offspring reaching adult stage were preserved in 70 % ethanol. All individuals (parental and offspring generation) were subsequently coded, and 22 morphological traits (Table 1) were measured with a micrometer eyepiece. Heritability estimates were made using a regression of mid-offspring on mid-parental values (FALCONER 1981). Since *G. odontogaster* is sexually dimorphic in size of all traits (whereas the variances do not differ), male measurements were adjusted to female equivalents so that the means were the same in males and females (FALCONER 1983). This was made simply by adding the intersexual difference in mean values of each specific trait to each individual male measurement.

Results and discussion

Offspring reaching adult stage was produced by 18 pairs. Each pair produced on average 2.39 (SD=1.49) offspring. Mid-offspring values correlated significantly with mid-parental values in 7 of the 22 measured traits (Table 1). The heritability estimates of these traits ranged between 0.44 and 1.02 (Table 1).

Several morphological traits have been found to be related to fitness in natural populations of water striders, e.g., body size (RUBENSTEIN 1984; FAIRBAIRN 1988), size of fore femur (RUBENSTEIN 1984), length of midlegs (HAYASHI 1984), wing length (e.g., ZERA 1984), and secondary sexual characteristics (ARNQVIST 1989). In this study, seven traits relating to body size and form, leg lengths, and pigmentation were found to have significant heritability estimates. However, the fact that the correlation coefficients and regression coefficients of all 22 traits were positive (see Table 1) suggests that more than these seven traits may have considerable additive genetic components in their phenotypic trait variation. Estimates of heritabilities from parent-offspring regressions often suffers from large standard errors (FALCONER 1981). One general problem is

Table 1. Heritibility estimates of morphological traits in *Gerris odontogaster*. Correlation coefficients for mid-offspring mid-parent correlations are given, as are the P-values for *t*-test of H_0: $\beta = 0$ in regressions of mid-offspring on mid-parent. NS = P>0.05,* = P<0.05,** = P<0.02,*** = P<0.01, N = 18 in all cases

Trait	h^2	±SD	*t*-test (P-value)	r
Body length	0.27	0.20	NS	0.320
Length of pronotum	0.59	0.22	0.016	0.560**
Width of pronotum	0.29	0.18	NS	0.368
Form of pronotum (length/width)	0.52	0.23	0.036	0.497*
Width of anterior lobe of pronotum	0.22	0.15	NS	0.348
Length of head	0.31	0.22	NS	0.340
Width of head	1.02	0.38	0.017	0.555**
Width of eyes	0.31	0.21	NS	0.349
Length of eyes	0.26	0.28	NS	0.224
Length of first (basal) antennal segment	0.32	0.20	NS	0.375
Length of fore femur	0.24	0.29	NS	0.200
Length of fore tibia	0.53	0.21	0.023	0.531**
Length of middle femur	0.24	0.23	NS	0.248
Length of middle tibia	0.30	0.24	NS	0.298
Length of middle tarsal segment1	0.61	0.21	0.010	0.592***
Length of middle tarsal segment 2	0.63	0.24	0.018	0.550**
Length of hind femur	0.22	0.22	NS	0.241
Length of hind tibia	0.14	0.23	NS	0.151
Length of hind tarsal segment 1	0.39	0.19	NS	0.451
Length of hind tarsal segment 2	0.05	0.11	NS	0.115
Length of pronotal patch	0.44	0.14	0.007	0.611***
Distance between lateral tips of seventh abdominal segment	0.01	0.17	NS	0.021

the fact that the lower the heritability of a trait is (regression coefficient), the more difficult it becomes to obtain a statistically significant heritability estimate (significant correlation coefficient).

Lengths of middle tarsal segments 1 and 2 had a significantly higher degree of inheritance than had lengths of middle femur and tibia (*t*-test of difference between slopes (b); P<0.01 in all four cases). This suggests that the lengths of tarsal segments may be less influenced by various mechanisms during the ontogeny (notably during moulting processes) than the lengths of femur and tibia, which would result in generally low heritabilities for total leg lengths. It is further worth noting that the extention of the light dorsal patch on pronotum was heritable,demonstrating that traits which are not size-related, such as pigmentation, may be heritable.

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