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WEB-MONITORING FORCE EXERTED BY THE SPIDER *WAITKERA WAITAKERENSIS* (ULOBORIDAE)

The purpose of this study is to determine if the resting force expressed by the primitive, orb-weaver *Waitkera waitakerensis* (Chamberlain 1946) is similar to that of the orb-weaver *Uloborus glomosus* (Walckenaer 1841) and less than that of the triangle-weaver *Hyptiotes cavatus* (Hentz 1847) (Opell 1987a). This is important because Opell (1987a) used *U. glomosus* to represent orb-weavers in a study which concluded that triangle-web spiders exert more force on a horizontal resting line than do orb-weavers.

I chose the monotypic genus *Waitkera* for this study because it is one of the two most primitive members of the uloborid clade that is a sister clade of the larger assemblage that includes *Uloborus, Hyptiotes*, and *Miagrammopes* (Coddington 1990). Unlike members of the other primitive orb-weaving genus *Tangaroa*, which are very small (Opell 1983), *W. waitakerensis* is similar in size to the aforementioned genera (Table 1). Like members of these genera, this species has a well developed tracheal system, characterized by tracheae that pass through the pedicel and enter the legs (Opell 1979, 1987b), a pattern considered plesiomorphic for the family Uloboridae. Like *U. glomosus, W. waitakerensis* hangs beneath the hub of its web with legs extended, while it waits for prey to strike its web (Opell pers. obs.). Therefore, although *U. glomosus* and *W. waitakerensis* are phylogenetically distant, there are no morphological or behavioral features that suggest their resting forces should greatly differ.

Following the methods described by Opell (1987a), I used a glass needle strain gauge to measure the resting forces expressed by adult female *W. waitakerensis*. This species is found only on New Zealand's north island (Opell 1979), where I studied two populations, one in a city park in Hamilton (sample size 36) and another from the Waitakere Mountains near Piha (sample size 19). I recorded the temperature at which each force measurement was taken and the live weight of each spider. These data were compared with those of adult female *U. glomosus* and *H. cavatus*, as measured by Opell (1987a).

Using a Shapiro-Wilk W-statistic, I first determined if the resting forces of each population or species were normally distributed. If they were, I used a *t* test (*t*) to compare means; if they were not, I used a Wilcoxon 2-sample test (W). Except for the temperature at which force measurements were taken, all values from the Hamilton and Piha populations of *W. waitakerensis* were similar (Weight: *t*, $P = 0.178$; Force: *t*, $P = 0.267$; Force/weight: W, $P = 0.212$). Mean temperatures were very similar (22.44 ±1.44 °C and 23.00 ±0.00 °C, respectively) and their statistical difference (W, $P = 0.031$) is attributable to the uniform temperature at which the Piha population was measured. Therefore, the following comparisons combine the values of the two *W. waitakerensis* populations.

Table 1 compares the absolute and weight-specific resting forces of the three species. The mean resting force of *W. waitakerensis* is greater than that of *U. glomosus* (*t*, $P = 0.016$) but did not differ from that of *H. cavatus* (*t*, $P = 0.052$). The weight-specific resting force of *W. waitakerensis* was 0.25×10^{-5} N/mg greater than that of *U. glomosus* (W, $P = 0.004$) and 0.77×10^{-5} N/mg less than that of *H. cavatus* (W, $P = 0.0001$). The mean temperatures at which the resting force of *U. glomosus* and *H. cavatus* were measured were nearly identical (Table 1) and that at which *W. waitakerensis* was measured was only 2.5 °C lower. Therefore, it is unlikely that temperature

Table 1.—Comparison of the weights and resting forces of three uloborid species. Mean ± standard deviation (sample size is indicated by boldface).

	Uloborus glomosus	*Waitkera waitakerensis*	*Hyptiotes cavatus*
Live weight (mg)	9.93 ± 4.65 (**45**)	8.92 ± 2.52 (**55**)	6.76 ± 3.05 (**42**)
Resting force (10^{-4} Newtons)	1.07 ± 0.30 (**40**)	1.21 ± 0.26 (**57**)	1.34 ± 0.37 (**42**)
Resting force/live weight (10^{-5} N/mg)	1.21 ± 0.29 (**40**)	1.46 ± 0.41 (**55**)	2.23 ± 0.69 (**42**)
Temperature (°C)	25.0 ± 0.7 (**45**)	22.6 ± 1.2 (**57**)	25.2 ± 0.9 (**42**)

differences had a major influence on the observed differences in resting forces.

The weight-specific resting force expressed by *W. waitakerensis* is intermediate between and statistically different from those of the orb-weaver *U. glomosus* and the triangle-weaver *H. cavatus*. However, the weight-specific forces of the two phylogenetically distant orb-weaving uloborids are more similar to one another than either is to that of *H. cavatus*. This upholds Opell's (1987a) conclusion that triangle-web uloborids that actively monitor their webs express more web-monitoring force than do orb-weaving uloborids that hang from the hubs of their webs while waiting for prey to strike. However, the fact that *W. waitakerensis* expresses greater weight-specific resting force than *U. glomosus* may indicate a trend toward the reduction of web-monitoring forces within orb-weaving uloborids. Support for this is found in the reduced tracheal systems of members of the higher orb-weaving uloborid genera *Daramuliana, Octonoba, Philoponella, Ponella, Purumitra*, and *Zosis* (Opell 1979, 1987b).

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