2005. The Journal of Arachnology 33:870–872

SHORT COMMUNICATION

ALLOMETRY OF GENITALIA AND FIGHTING STRUCTURES IN *LINYPHIA TRIANGULARIS* (ARANEAE, LINYPHIIDAE)

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ABSTRACT. Allometric scaling is a powerful approach for studying the relationship between size, shape and function. We studied allometric slopes in *Linyphia triangularis*, measuring two male and one female genital characters and several male and female non-genital characters including male chelicerae that are used for fighting. As predicted from theory, genitalia had the lowest allometric values, fighting structures the highest.

Keywords: Copulatory organs, sexual selection, *Linyphia*, allometry

''Mr. Locket tells me that, from preliminary investigations . . . of males of the species *Linyphia triangularis* . . . he does not believe that large specimens have relatively larger jaws than smaller specimens'' (Bristowe 1929: 339).

In most animals studied, structures used as weapons or display devices show steeper regression slopes (higher allometric values) than other body parts in relation to body size (Tatsuta et al. 2001; Eberhard 2002a; further references in Eberhard 2002b). This may result from small individuals having relatively little to gain from investing in such structures (Baker & Wilkinson 2001). In contrast, genitalia often have remarkably low slopes (Eberhard et al. 1998; Palestrini et al. 2000; Tatsuta et al. 2001; Kato & Miyashita 2003), presumably resulting from selection to fit all variants of the opposite six ('one-size-fits-all' model, Eberhard et al. 1998). This short note focuses on the relationships between chelicerae (fighting structures), genitalia and body size in *Linyphia triangularis* (Clerck 1757).

Adult males and females of the holarctic *L. triangularis* appear from July to late August with males molting to maturity about 1–3 weeks earlier than females (Toft 1989; Stumpf & Linsenmair 1996). First male sperm precedence has been documented in closely related species (Watson 1991; Stumpf & Linsenmair 1996) and this probably explains mate-guarding of penultimate females (Toft 1989; Stumpf & Linsenmair 1996). Despite the existence of an alternative male mating strategy, where the smaller male attempts to induce the dominant male to leave the female by chasing him out of the web ('interference strategy', Nielsen & Toft 1990), observations on this and a related species (Rovner 1968; Stumpf & Linsenmair 1996; Watson 1990) suggest that fighting ability largely predicts reproductive success. *Linyphia triangularis* males use their chelicerae in aggressive interactions (Rovner 1968) leading to the prediction that these should be under strong directional selection.

Our measurements are based on a sample of 33 adult cohabiting male/female pairs collected in Austria (Upper-Austria, Walding, 48°21′N, 14°12′E, 4 August 2003). The spiders are deposited at the Zoological Research Institute and Museum Alexander Koenig (ZFMK), Bonn. We measured male and female carapace length and width, abdomen length and width, tibia 1 length, paturon and cheliceral fang lengths, as well as epigynum width and the length of two bulbal structures, lamella and tegulum (Figs. 1–5). Measurements were to the nearest 0.01 mm (genitalia)–0.03 mm (legs). Statistical analysis was made with SPSS 11.0, using both ordinary least squares (OLS) and reduced major axis (RMA) regressions of log-transformed data. Carapace width was taken as an indicator of body size, i.e. all OLS regression values are of the respective structure on log carapace width. Both regression techniques supported the same conclusions, so we will present OLS values only.

Our data clearly show the dichotomy between fighting structures and genitalia. The slopes of male chelicerae (paturon: 1.740, fang: 2.319, both $P < 0.001$) were high in comparison to the slopes of tibia and opisthosoma measures (0.607–0.973, $P < 0.003$). Interestingly, female chelicerae also had rel-

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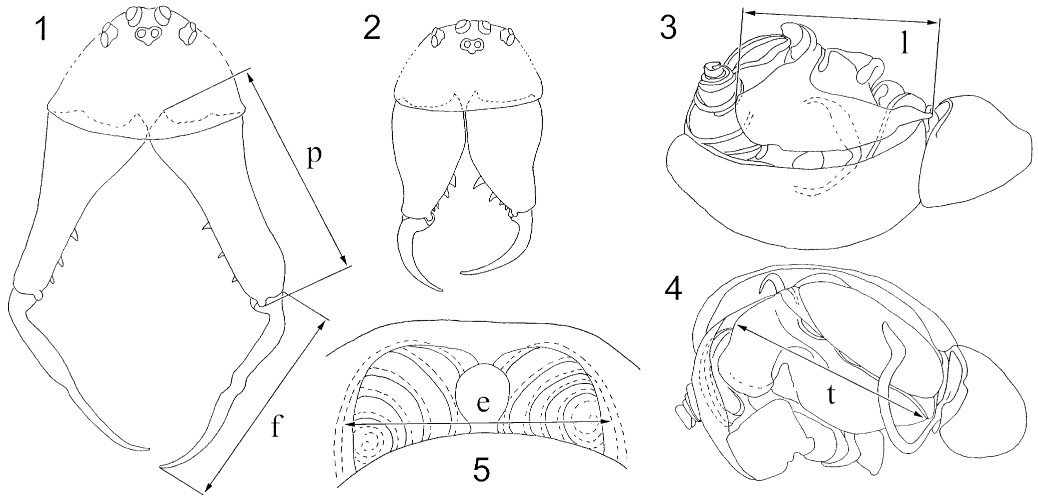

Figures 1–5.—*Linyphia triangularis*, illustrations of some of the characters measured. 1, 2. Frontal views of large male and medium size female, drawn at same scale. 3, 4. Left genital bulb, prolateral (3) and retrolateral (4) views. 5. Epigynum, posterior view. e = epigynum width, f = fang length, l = bulbal lamina length, p = paturon length, t = tegulum length.

atively steep slopes, though much lower than in males (paturon: 1.070, fang: 1.410, both $P < 0.001$). Genitalia, on the other hand, showed very low slopes for both bulbal structures (lamella: 0.296, $P < 0.001$, tegulum: 0.257, $P = 0.004$), and for the epigynum (0.422, $P = 0.016$). Evidently, there is stabilizing selection on standard size genitalia in *L. triangularis* like in many other arthropods (Eberhard et al. 1998).

Apart from these main results, we incidentally found a surprising relationship between male and female sizes: males (carapace width) in our sample were not larger than females (paired t-test, $P = 0.30$). Lång (2001), working on Swedish populations of the same species, reported that males were on average 5–22% larger than females in 11 out of his 12 samples. We suggest that the absence of body size dimorphism in our sample might be explained by a bias in our sample. We collected only cohabiting adult pairs, i.e. females that were probably non-virgin. If *L. triangularis* has first male sperm precedence like its close relatives (Watson 1991; Stumpf & Linsenmair 1996), then the females in these pairs had a lower reproductive value than virgin females. Large, dominant males might rather invest in searching for virgin females, so we might have missed them. Apart from explaining the absence of a sexual size dimorphism in carapace width in our sample, this finding hints to yet another alternative mating strategy of smaller males: small males might employ a post-copulation cohabitation strategy to profit from the residual female reproductive value that is left for second males in *Linyphia*.

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Manuscript received 10 March 2004, revised 10 June 2004.