

OCCURRENCE OF SEXUAL SIZE DIMORPHISM IN *BELOSTOMA ELEGANS* (HETEROPTERA: BELOSTOMATIDAE)¹

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ABSTRACT: Sexual size dimorphism (SSD) is detected in *Belostoma elegans* for the first time in a multivariate framework. Females are usually bigger than males in Heteroptera species; size is frequently associated with reproductive success. Following this general trend we found that maximum width of the head and interocular distance are biased towards females. Components of body size involved in paternal care and mating behavior did not follow that general rule. Therefore, SSD is not detected in total length without head and maximum width, presumably a consequence of the male egg-laying area which offers a proportional major surface for the clutch. SSD biased to males is found in middle and hind leg segments, used during mating and brooding behavior.

KEY WORDS: Male brooding behavior, giant water bugs, Belostomatinae, morphometry, paternal care

Male brooding behavior is a distinctive trait of giant water bugs of the subfamily Belostomatinae (Heteroptera: Belostomatidae) wherein females alternate copulation with egg laying on the male dorsal surface. This should assure male paternity as the last copulating male fertilizes most of the eggs (Smith, 1980). It seems well documented that paternal care behavior increases offspring survival (Munguía-Stayer et al., 2008), but it is energetically expensive for males (Smith, 1980). Males utilize their hind legs to carry, aerate, and protect the eggs, performing movements, namely brood pumping, stroking, patting, kicking, and sawing (Smith, 1976a, 1976b, 1980). The male also holds the female throughout the mating period using his hind legs (Schnack et al., 1990).

Structures involved in sexual interactions frequently are dimorphic, but many selective processes that produce sexual dimorphism are expressed as dimorphic size structures, requiring a morphometric analysis in order to be detected (Iglesias and Crespo, 2008; Tseng and Rowe, 1999).

Nonbrooding males and females of Belostomatinae species are morphologically and behaviorally cryptic (Smith, 1980), but it would be expected that those characteristics involved in mating interactions and paternal behavior could show sexual size dimorphism (SSD).

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In the present paper, using *Belostoma elegans* as a representative species of Belostomatinae, we document and discuss the sexual differences in size of structures used in mating and paternal care, presumably exhibited in several different studied structures, such as body, head and legs, in order to detect convincing sexual size dimorphism.

METHODS

All specimens were collected in the “Greater Buenos Aires” area, Argentina, with a fine mesh water net and light-traps, and preserved in 70% ethyl alcohol. Both classification and sex determination of specimens follow Schnack (1976). Measurements were taken on 128 specimens using a Leica stereomicroscope with a graduate ocular. All measurements are in millimeters. The following ten measurements are indicated in Fig. 1 A-D: total length without head (TLwH), maximum width (MW), head width (MWH), interocular distance (IOD), length of femur and tibia of the fore (Fe 1, Ti 1), middle (Fe 2, Ti 2) and hind legs (Fe 3, Ti 3). The measurements are based on all available *B. elegans* specimens.

In order to study the existence of SSD, two statistical analyses (multivariate discriminant analysis and Hotelling’s T-squared) were conducted using statistics software package PAST version 1.78 (Hammer et al., 2001). We also analyzed SSD in structures associated (or not) with mating interactions and parental care using a Mann Whitney U-test. Then we constructed hypotheses about mechanisms that presumably have determined the SSD patterns observed.

RESULTS AND DISCUSSION

Through the multivariate discriminant analysis and Hotelling’s T-squared, significant differences ($p < 0.01$) between sexes with a correct reclassification of 84.5% in their respective groups are here obtained for the first time.

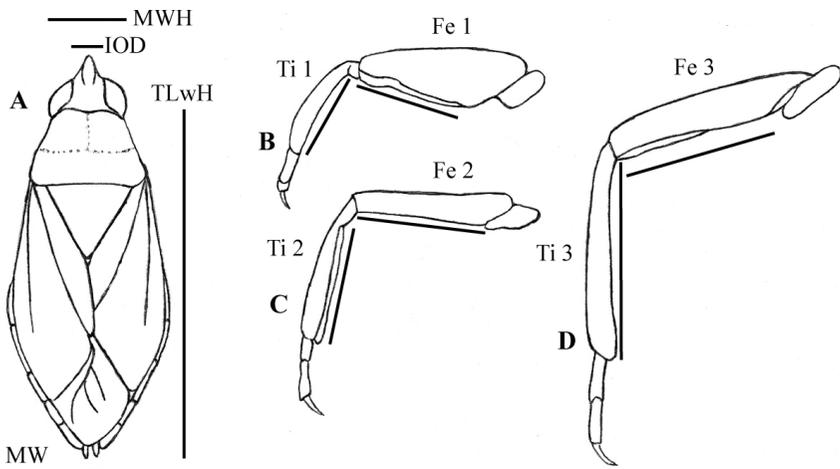


Fig. 1. Measurements selected of *Belostoma elegans* are shown with bars in the schemes. A) Dorsal aspect. B) Fore leg. C) Middle leg. D) Hind leg.

Clutch size on the male dorsum depends both on the quantity of mature ova inside a female and on the available area for egg-laying of the male. The quantity of mature ova and the available area for egg-laying are, in turn, related to female size (Andersson, 1994; Blanckenhorn, 2005) and male dorsal area, respectively. Female reproductive success in insects is almost unanimously related to female-biased body size, and the MWH and IOD here taken seem to follow this generalized trend (Table 1). Paternal care can affect the general size trend of insects and Belostomatinae males with a wider dorsum presumably offer a major surface for egg laying (Schnack et al., 1980), so the particular reproductive system of the Belostomatinae now incorporates a new component to analyze, the male egg-laying area, even though SSD was not detected in TLwH and MW (Table 1).

Table 1: Sexual size dimorphism patterns of *Belostoma elegans*.

	MALES ($n = 63$)		FEMALES ($n = 65$)		S^*
	<i>mean</i>	<i>SD</i>	<i>mean</i>	<i>SD</i>	
TLwH	19.62	0.88	19.90	0.94	<i>ns</i>
MW	9.31	0.48	9.40	0.39	<i>ns</i>
MWH	4.06	0.14	4.18	0.18	** ? F
IOD	1.59	0.06	1.63	0.08	* ? F
Fe 1	3.75	0.23	3.80	0.21	<i>ns</i>
Ti 1	2.54	0.17	2.56	0.17	<i>ns</i>
Fe 2	4.77	0.29	4.75	0.24	<i>Ns</i>
Ti 2	4.58	0.28	4.49	0.24	* ? M
Fe 3	5.55	0.35	5.42	0.28	** ? M
Ti 3	6.36	0.38	6.20	0.32	** ? M

Note. TLwH, total length without the head; MW, maximum width; MWH, maximum width of the head; IOD, interocular distance; Fe 1–Fe 3, lengths of the femur of the fore, middle and hind legs, Ti 1–Ti 3, lengths of the tibia of the fore, middle and hind legs; n , sample size. Measurements are in millimeters. S^* , significance according to the Mann–Whitney U test: **, highly significant ($p < 0.01$); *, significant ($p < 0.05$); *ns*, not significant; ?, biased towards; M, male; F, female.

On the other hand, as expected, we confirmed SSD in hind leg segments biased towards males (Table 1). Similar biases in structures involved in sexual interactions have been detected in other insects (Iglesias and Crespo, 2008). A male holds a female putting his hind legs on her back during mating and using the middle legs to orient her during egg-laying (Schnack et al., 1990), so SSD in Ti 2 is reported with significant values in *B. elegans* specimens herein studied. As both appendages are involved in swimming, it is expected that the selection on the hind leg could drive an associated response in the middle one (Table 1). Male-biased SSD of the hind leg appears to be modulated by several selective processes and constraints. The reproductive success is linked to paternal care where hind legs have a leading role; meanwhile there are signals that indicate that the trait involved is sexually selected. Although selection is affecting overall body size, the target or targets of selection are often specific components of body size (Presiozi and Fairbairn, 2000).

Finally and perhaps most significantly, our research is an attempt to explain the adaptive significance of the sexual size dimorphism detected. We suggest that paternal care and mating behavior are involved in evolution and maintenance of SSD in Belostomatinae.

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