

# Elytron length and sexual dimorphism in *Zonocerus elegans* (Thunb.), (Orthoptera: Pyrgomorphidae)

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Adults of the African pyrgomorphid grasshopper, *Zonocerus elegans* Thunberg, exhibit strong alar polymorphism, especially in the male sex, with wings either vestigial or fully developed. Analysis of body and elytron lengths of about 400 insects revealed sexual dimorphism, females being larger than males, and showed a bimodal distribution for wing length. The difference in average wing length between long-winged and short-winged forms was 14 mm. Since the two distributions (short and long) do not overlap, they would correspond closely to the subsidiary infra-subspecific categories *f. brachyptera* and *f. macroptera*, respectively, although even wings of the lower *macroptera* range seem to be vestigial, i.e. imperfectly developed and useless for flight. *S. Afr. J. Zool.* 1985, 20: 147 – 149

Volwassens van die Afrikaanse stinksprinkaan, *Zonocerus elegans* Thunberg, vertoon 'n groot mate van vlerkdimorfisme, veral in mannetjies, met die vlerke óf rudimentêr óf volledig ontwikkel. 'n Ontleding van liggaams- en elytronlengtes van omtrent 400 insekte het 'n seksuele dimorfisme openbaar in dié opsig dat wyfies groter as mannetjies is, en het verder 'n bimodale distribusie vir vlerklengte vertoon. Die verskil in gemiddelde vlerklengte tussen lang- en kortvleuelige individue was 14 mm. Aangesien die twee distribusies (kort en lank) nie oorleuel het nie, sou hulle baie nou met die aanvullende infra-subspesifie kategorieë *f. brachyptera* en *f. macroptera*, onderskeidelik, ooreenstem, alhoewel selfs vlerke van die laer *macroptera*-reeks rudimentêr blyk te wees, d.w.s. onvolmaak ontwikkel en nutteloos vir vliegdoeleindes. *S. Afr. Tydskr. Dierk.* 1985, 20: 147 – 149

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The African grasshopper genus *Zonocerus* comprises two species, *elegans* (Thunb.) and *variegatus* (L.), which both sporadically become pests, mostly of introduced crops (Hill 1975). Many recent publications deal with various aspects of the biology of *Z. variegatus* but little is known about *Z. elegans*. Its general biology has been described by Van der Merwe & Kent (1925) from the Natal coast and more briefly by Kaufmann (1972) from central Tanzania. *Zonocerus* is herbivorous and feeds on various plants. We studied *Z. elegans* from 1981 – 83 on the Ubizane Ranch near Hluhluwe and showed that it is attracted to pure pyrrolizidine alkaloids, which it ingests (Boppré, Seibt & Wickler 1984). These alkaloids are secondary substances of many plants and can act as anti-predator poisons when eaten and sequestered by the insects. *Zonocerus* feeds on *Heliotropium*, among other plants, which contains these alkaloids; and *Z. elegans* is the first insect shown to search directly for the alkaloids and ingest the pure crystalline substance. During these studies we collected adults both with fully developed or rudimentary elytra and investigated whether this was correlated with sex or body size.

## Methods

We collected a total of 407 insects (212 males, 195 females) between 1 – 12 March 1983 from an area of 0,5 km<sup>2</sup> and marked them for further observation. We measured the length of their elytra from base to tip and body length from anterior dorsal border of pronotum to the tip of abdomen, before releasing them. These data were then analysed.

Body length is normally measured from the frons to the apex of the abdomen in Acridoidea; we, however, did not want mate-guarding pairs in precopula to separate or to squirt their defensive fluids, and therefore avoided touching their heads. Also, as a quantitative means of expressing wing length, taxonomists (e.g. Kevan 1957) have used the ratio length of elytron over length of hind femur (E/F ratio); however, we asked whether males prefer long-winged females which, according to Chapman, Page & Cook (1979) seem to lay more eggs. We did not use the E/F ratio because it is unlikely that male grasshoppers are influenced by it.

## Results

### Elytron length

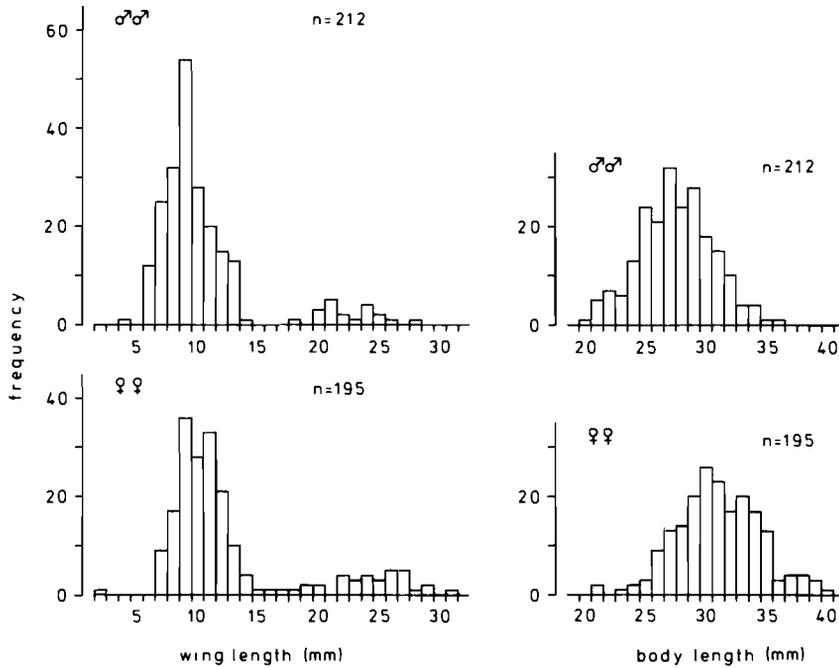
Ranges and frequency distributions of wing length of males and females are shown in Figure 1 (left). The distributions are bimodal in both sexes and when separated into  $\leq 17$  mm and  $> 17$  mm gave two normal distributions for each sex. The lower range will be called SW (short wing), the upper LW (long wing).

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**Figure 1** Ranges and frequency distributions of males (above) and female (below) wing lengths (left) and body lengths (right).

The difference between the average wing length for LW and SW was 11,3 mm in males, and 14,2 mm in females, or 14,0 mm for all individuals regardless of sex. Ten per cent of all males and 17% of all females (or 13% of all individuals) were LW individuals.

According to Kaufmann (1972) the elytra of *Z. elegans* are far shorter than those of *Z. variegatus*. He found in central Tanzania, as did Bevis (1964) in the Orange Free State, only 5% of adult *Z. elegans* with 'fully developed' wings, but neither author gives a critical measurement for the separation of reduced and fully developed wings. The term 'wings vestigial' (i.e. not usable for flight) seems to apply not only to the SW range but also to the lower LW range, leaving 'fully developed' to apply to only 5% of the population in the upper range of LW.

There were more SW than LW insects in our sample: 90% of 212 males and 83% of 195 females were short winged. The sex ratio we found did not differ significantly from 1:1.

### Body length

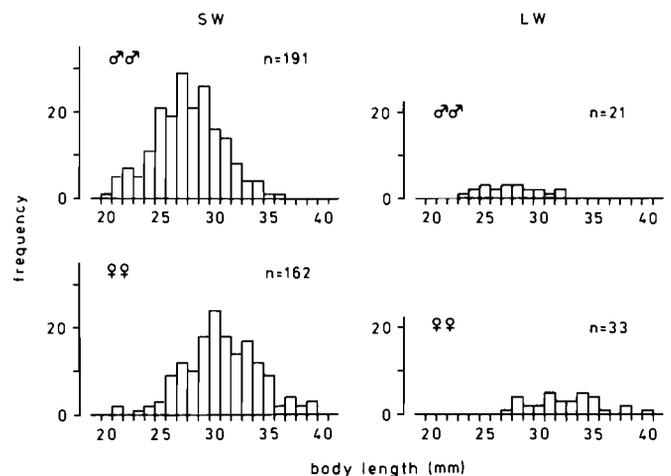
Because of shrinkage or extension, especially in connection with egg development in females, body length may be an unreliable taxonomic character, but it is used by males in choosing a mate. Ranges and frequency distributions of body lengths of males and females are shown in Figure 1 (right). Means of 27,5 mm ( $s=3,0$ ) for males and 31,0 mm ( $s=3,4$ ) for females differed significantly ( $p < ,001$ ). Females are, on average, slightly larger than males, as is the case with many grasshoppers. Also differing significantly are the means for LW and SW categories with both sexes (Table 2), except between LW males and SW males ( $t=0,04$ ;  $p > ,9$ ). (Means were used since frequency distributions of body lengths of male and female LW and SW individuals were normal in all cases; Figure 2).

### The elytron length/body length relation

Wing length is plotted against body length in Figure 3A for males, in Figure 3B for females. All correlations are positive and significant ( $p < ,05$  for LW females,  $p < ,01$  in all other cases). Regression coefficients are also positive and significant

**Table 1** Wing-length data for LW and SW males and females

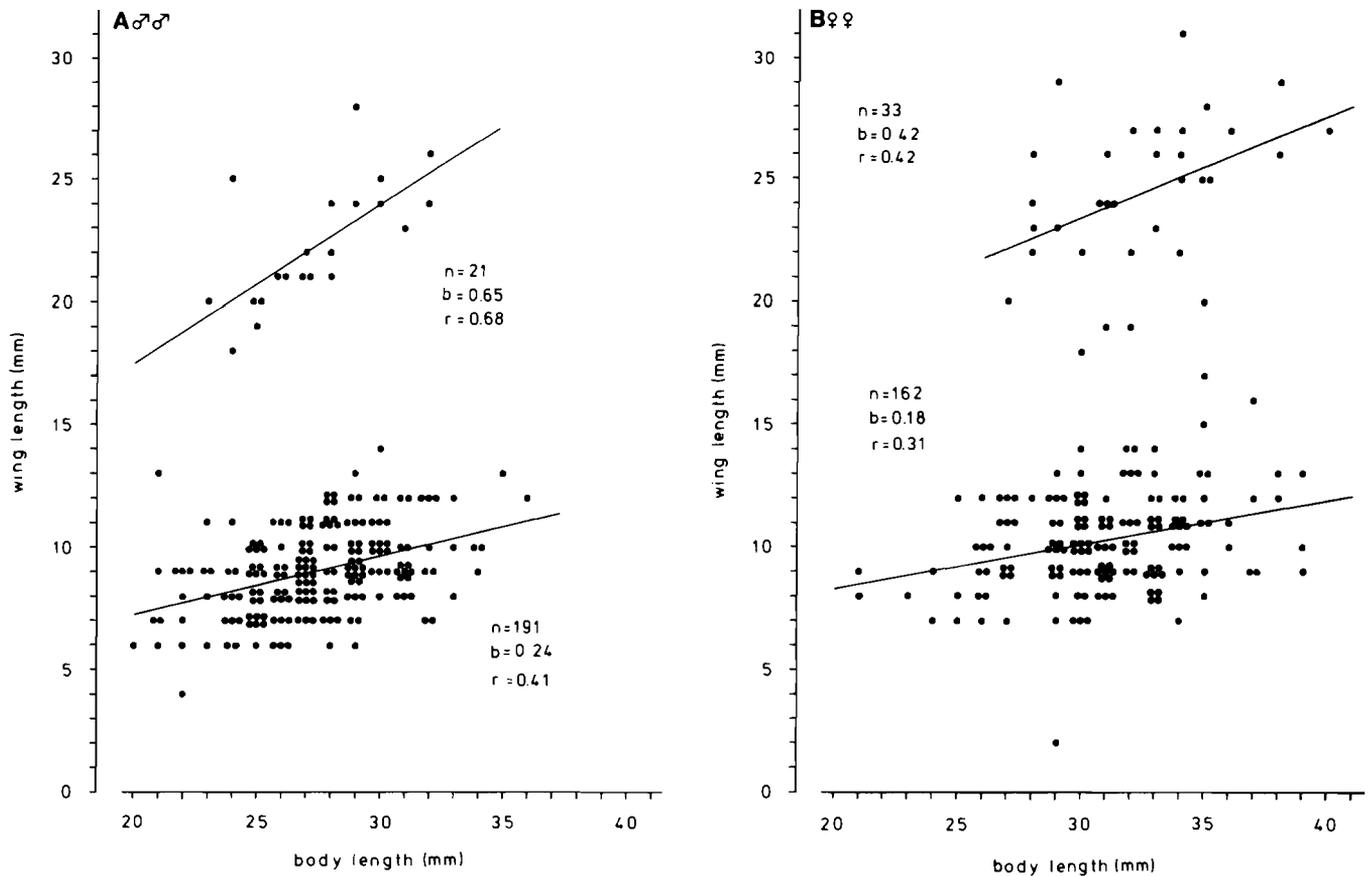
Number of individuals	Mean wing length (mm)	
191 SW males	9,0 (SD = 1,7)	} $p < ,001$ ( $t=5,88$ )
162 SW females	10,2 (SD = 2,0)	
33 LW females	24,4 (SD = 3,1)	} $p < ,02$ ( $t=2,57$ )
21 LW males	22,3 (SD = 2,5)	



**Figure 2** Ranges and frequency distributions of male (above) and female (below) body lengths separated according to SW (left) and LW (right).

in all cases. We calculated regressions from both natural and log-transformed data, thus checking allometric growth. Standard deviations were smaller for natural data, indicating a linear rather than allometric correlation between wing length and body length.

The regression coefficients of LW and SW differed significantly ( $p < ,01$ ) in both sexes and thus the LW-SW separation stands out strikingly. Having larger wings is not only the consequence of being larger. Long and short wings do occur in the



**Figure 3** Wing length plotted against body length for males (A) and females (B). Regression lines calculated for SW and LW;  $b$  = regression coefficient,  $r$  = Pearson correlation coefficient.

**Table 2** Body-length data for LW and SW males and females

Number of individuals	Mean wing length (mm)	
191 SW males	27,5 (SD=3,0)	} $p < ,001$ ( $t=9,33$ )
162 SW females	30,7 (SD=3,4)	
33 LW females	32,4 (SD=3,2)	
21 LW males	27,4 (SD=2,6)	

whole range of body sizes in both sexes. The growth rates of wings in relation to body length differed significantly even between LW and SW males (Figure 3A) though their mean body sizes did not (Table 2). Thus the LW/SW dimorphism seems most clearly expressed in males. According to Kevan (1959) only about  $\frac{1}{3}$  out of 100 genera of Pyrgomorphidae are exclusively fully alate. In the primitive families of Acridoidea, wing reduction is very common, more especially in the female sex.

We found significantly more SW than LW individuals among males compared to females. This, however, is a side-effect of the females' tendency to outgrow males.

Separation of the frequency distributions for SW and LW (Figure 1) is not due to a sampling error but to a sex-independent dimorphism in elytron growth-rate (Figure 3), thus validating the infra-subspecific distinction between *f. brachyptera* (Saussure) and *f. macroptera* (Dirsh). This does not mean, however, that all individuals belonging to *f. macroptera* will have fully developed wings usable for flight.

The distinction between 'fully developed' and 'reduced' (vestigial) wings from the functional point of view does not necessarily coincide with the dimorphism stated here.

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