A STUDY OF RELATIVE GROWTH OF LEG AND ANTENNAL SEGMENTS IN TWO SPECIES OF *ORTHOTYLUS* (HETEROPTERA : MIRIDAE)*

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The species dealt with in this paper are two of three closely allied species of the genus *Orthotylus* that have been studied from the ecological and evolutionary viewpoints by Professor O. W. Richards and his associates at Silwood Park, Berks., England. They are *O. adenocarpi* (Perris) and *O. virescens* (Douglas and Scott).

Waloff and Southwood (1960) have discussed the recognition of nymphal stages of these species. The present paper attempts to clarify further the distinction of their nymphal stages by studying the relative growth of leg and antennal segments. While the comparison of growth pattern is itself of interest, the work has another aim, namely that of testing hypotheses that have been put forward by the author in connection with the study of relative growth in Gerridae (1961). The hypotheses were: (1) when the growth ratio (slope) or the initial growth index (Y-intercept) varies for a segment among a group of related species, the ratio or the index for other segments varies in a parallel fashion; and (2) among a group of related species, the growth patterns (growth ratio or initial growth index or both) of segments with higher growth ratios are more similar than those of the other segments with lower growth ratios.

Material and Methods

The material consisted of ten individuals of each stage of each species. Measurements were made under the binocular microscope. Each leg and antenna was removed from the body and laid flat on the bottom of a syracuse watch glass in 80 per cent. alcohol. The formula used was $Y = bX^k$, where Y is the allometrically growing segment; b is the theoretical value of Y when the standard measurement X equals unity and is called the initial growth index; k is the constant at which Y grows in relation to the standard measurement X and is called the growth ratio. The width of the head was chosen as the standard measurement, for it is the most solid part of the body and is therefore subject to the least change in size because of the physiological condition of the individual. As may be seen from figures 1 and 2, there is a strong tendency for almost all segments to grow more slowly from the first to the second stage, and to grow very rapidly at the final stage of development into the adult. In all there are three rather well defined phases of development. The calculation of the growth ratio and the initial growth index was therefore made for the second phase, which lasts longest. Correlation coefficients in all calculations here were over 0·99. The formula therefore should suffice for describing growth patterns.

Results and Discussion

The growth ratios and initial growth indices for both species are shown in Table I. The growth ratios of all segments in *O. virescens* are consistently greater than those for homologous segments in *O. adenocarpi*, and the differences between homologous segments are all statistically significant ($P < 0{\cdot}01$). The initial growth indices in

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O. virescens are, however, smaller than in *O. adenocarpi* in all segments, and the differences are statistically significant ($P < 0{\cdot}01$). Hypothesis (1) in this comparison of growth patterns thus holds without exception.

The growth ratios of some segments with relatively high growth ratios (second antennal segment, middle femur, middle tibia, hind femur and hind tibia) are more similar than some segments with lower growth ratios (front tarsus, middle tarsus).

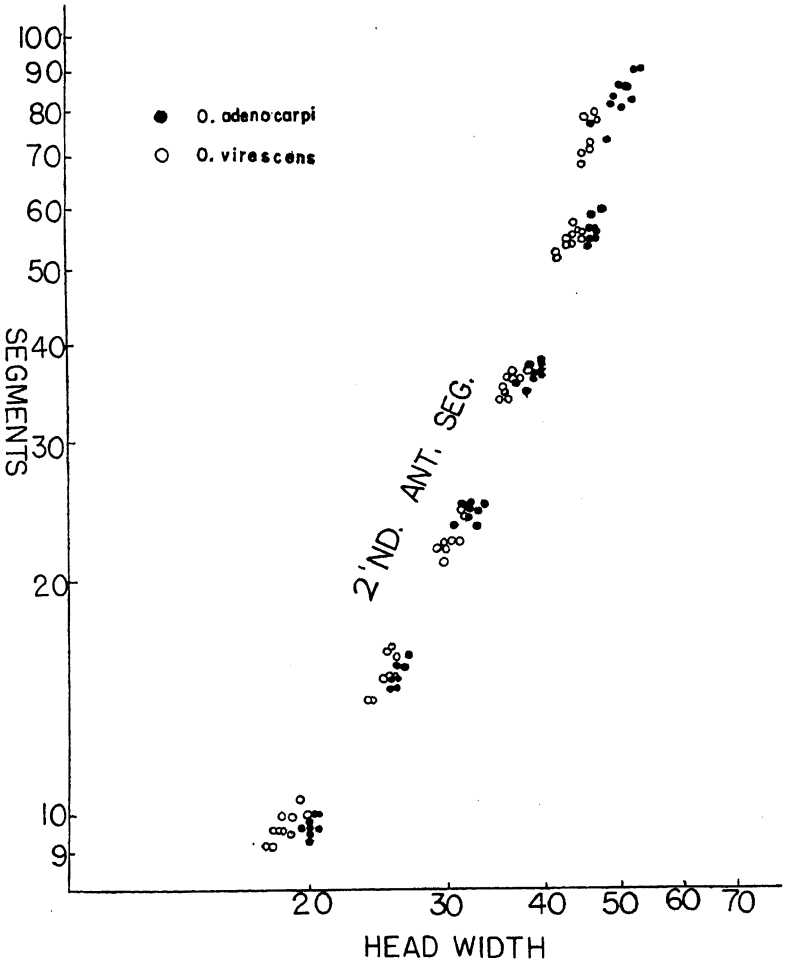

FIG. 1.—Relative growth of second antennal segments (length of segment compared with width of head).

There are, however, exceptions to this general tendency. For instance the difference in growth ratio between such rapidly growing homologous segments in the two species as the third antennal segment is relatively great as compared with that between such slowly growing segments as the fourth antennal. As one way to visualise the tendency stated under hypothesis (2), the correlation coefficient between the differences in angle of two comparable slopes (growth ratios) and the mean values of growth ratios of homologous segments was calculated. If there is a tendency for the growth ratios in rapidly growing segments to be more similar than those in more slowly growing segments, a negative correlation would be expected to exist. The correlation coefficient obtained here was $-0{\cdot}385$, which is not statistically significant. This value is not comparable with the one obtained in the comparison

of two populations of *Trepobates trepidus* in the Gerridae ($r = -0{\cdot}832$, $P < 0{\cdot}01$, Matsuda, 1962) or with the one obtained in the comparison of two species of *Trepobates* ($r = -0{\cdot}547$, $0{\cdot}1 > P > 0{\cdot}05$, Matsuda, 1962). It can be said that the tendency stated under hypothesis (2) is not pronounced when these two species of *Orthotylus* are compared. There is also no strong tendency for the initial growth

TABLE I.—*Comparison of growth patterns between* O. adenocarpi *and* O. virescens

	Growth ratio (k)		Initial growth index (b)	
	O. adenocarpi	*O. virescens*	*O. adenocarpi*	*O. virescens*
2nd ant. seg. . .	2·286	2·379	−2·063	−2·164
3rd ant. seg. . .	1·885	2·183	−1·585	−1·842
4th ant. seg. . .	0·873	0·949	−0·048	−0·130
Front femur . .	1·415	1·550	−0·722	−0·904
Front tibia . .	1·504	1·700	−0·802	−1·053
Front tarsus . .	0·948	1·180	−0·315	−0·620
Middle femur . .	1·495	1·569	−0·805	−0·882
Middle tibia . .	1·571	1·659	−0·835	−0·914
Middle tarsus . .	0·945	1·077	−0·298	−0·457
Hind femur . .	1·700	1·836	−1·030	−1·186
Hind tibia . .	1·755	1·852	−0·960	−1·048
Hind tarsus . .	1·098	1·180	−0·960	−1·048

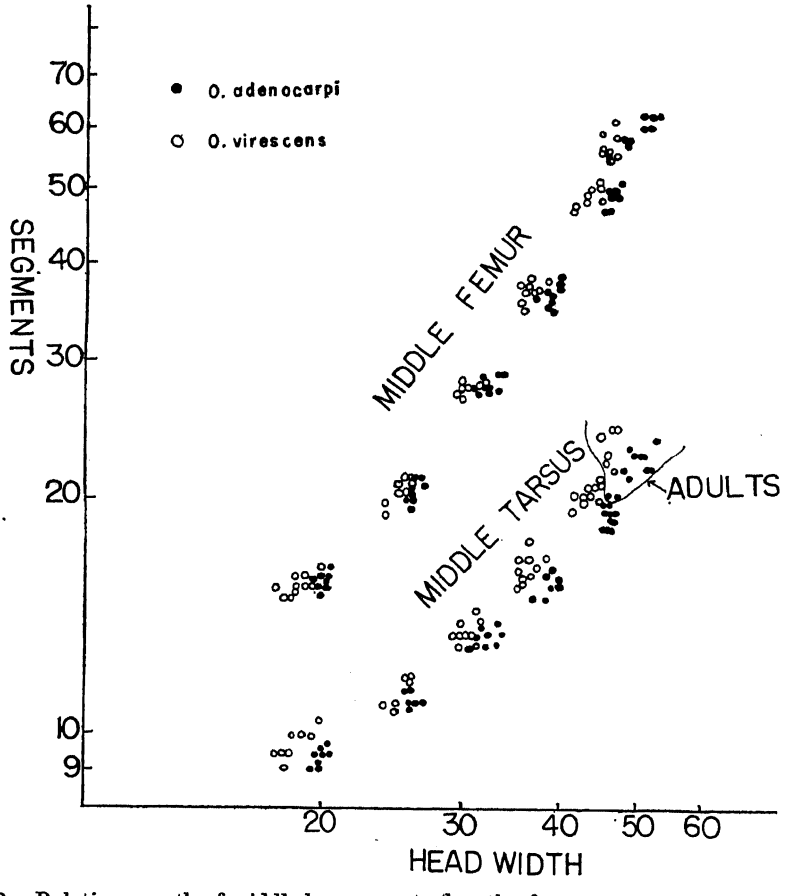

FIG. 2.—Relative growth of middle leg segments (length of segment compared with width of head).

index to be more similar between the segments with higher growth ratios. As already suggested by Matsuda and Rohlf (1961), hypothesis (2) would hold better the lower the taxonomic units compared (*e.g.* population, subspecies, very closely related species, etc.).

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