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On the growth rate of the ovary of *Eyprepocnemis alacris alacris* (Serville) during post embryonic development (Orthoptera: Acrididae)

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Abstract. Variation in the ovariole number appears significant in providing indices between the total body length of the females and the number of ovarioles. Studies on the post embryonic development of ovaries in acridids being very much restricted, an attempt has been made to correlate the changes in weight of the ovary during post embryonic development, with the stage of development, as well as to establish the correlation coefficient between the weight of the ovary and length of the ovarioles, in *Eyprepocnemis alacris alacris* (Serville).

Keywords. Variation; ovariole number; weight; post embryonic development; correlation coefficient; *Eyprepocnemis alacris alacris* (Serville).

1. Introduction

Variations in the ovariole number have often been considered significant to the extent that an index between the total body length of the female and the number of ovarioles could be arrived at (Waloff 1954). Available information relating to the structure and number of ovarioles in acridids pertains to those of Waloff (1954), Bryantseva (1958), Kaufmann (1959), Phipps (1949, 1950, 1959a,b, 1962) and Robertson and Chapman (1962). As information on the post embryonic development of the ovaries and the impact of different physiological conditions of them appears to be very limited, an attempt has been made to correlate the changes in weight of the ovary with the stages during post embryonic development.

2. Materials and methods

In the rearing of the hoppers the method of Hunter Jones (1961) was suitably modified and adopted. Freshly etherised adults and nymphs were dissected in insect ringer (pH 6). Permanent mounts of ovaries were prepared after staining with safranin and counter staining with eosin and the weights of ovaries were taken with a Metler's semi-micro balance.

3. Observations and discussion

Rudiments of the ovaries are evident even from the earliest instar (Nelson 1934), but even after the final moult, the ovarioles are small, thread-like, with individual ovariole not clearly separated. In the early instars the ovary lies beneath the alimentary canal and after the V instar the ovary moves on to its dorsal side.

The primitive panoistic ovaries of acridids possess variable number of ovarioles. In adult *Eyprepocnemis alacris alacris* the number of ovarioles may vary from 38-46. Usually the ovariole number remains constant on both sides, rarely showing differences of 2-8 as against equal number on both the sides as described for *Melanoplus sanquinipes* (Smith 1964). Among the instars (laboratory reared as well as those obtained from the field) also, the number of ovarioles differs (similar to the range observed in the adults). The individual ovariole is not clearly evident in the III, IV, V instars and the 'O' day adult, while in the fully mature forms they become distinctly separate. However, the ovariole number is fixed even in the newly hatched ones, though they may be small and thread-like. During post embryonic development, the ovariole length steadily increases from 79 μ as in the III instars to 381·8 μ as in the adult-after-copulation, showing an average rate of increase of 4·83 except for a fall in length during the growth period—V instar to the 'O'-day adult.

Though there is a gradual increase in the length of the ovariole from the III instar to the adult, the growth rate falls gradually with the advancement of an instar stage, indicating more or less the same pattern as in the rate of increase in weight of *E. alacris alacris*. Though the growth rates of different parts of the body of *E. alacris alacris* appear irregular throughout (Muralirangan 1970; Muralirangan and Ananthakrishnan 1977), the rate of growth of ovarioles appears to be gradual (table 1). In the mature adult, the oviduct increases in width considerably to accommodate the discharged eggs.

A distinct correlation between the general body weight with the stage of ovarian development in *E. alacris alacris* is evident and the increase in the weight of the ovary indicates more or less doubling from the III instar to V instar (table 1). The adult ovary reaches a weight of 0·01045 gm on the 'O'-day and subsequently increases to 0·0662 gm at the time of maturation. The rate of increase in weight of the ovary

Table 1. Increase in length and weight of the reproductive organs and the body in different instars of *Eyprepocnemis alacris alacris* (Serville).

Stage	Average length of ovarioles in μ	Weight of the ovary in gm	Total/ width of the oviduct (near the basal (oocytes) in μ	Total body weight in gm	Oocyte length in μ
III	79	0·00115	—	44·48	180
IV	168·3	0·00265	34·5	257·10	260
V	326·4	0·00595	69·0	503·70	468-492
Adult 'O'-day	220·0	0·01045	75·9	674·00	1071-1172
Adult-after copulation	381·8	0·06620	184·0	938·00	420-480
Adult-Starved	204·6	0·00810	—	—	—

also shows an increase from one instar to the next. Present observations indicate a striking increase in the ovarian weight (including the rate of increase) which is mainly due to the increase in the oocyte size and number as indicated in table 1. The growth in the size of the oocytes as well as the rate of increase of the length of the oocyte are also gradual (figure 1).

A distinct correlation between the ovariole length and the weight of the ovary was also noted. A correlation coefficient between the weight of the ovary and the length of the ovarioles was calculated (table 2). The data thus obtained were fitted in the formula

$$r = \frac{\Sigma (X_r - \bar{X})(Y_r - \bar{Y})}{n\, \sigma_x\, \sigma_y}.$$

Table 2. Correlation between length of the ovariole and weight of the ovary.

Average length of ovariole X	$X-220$	$(X-220)^2$	Weight of ovary Y	$Y-0{\cdot}01045$	$(Y-0{\cdot}01045)^2$	$\frac{(X-220)}{(Y-0{\cdot}01045)}$
79	−141	19881	0·00155	−0·0089	0·00007921	1·2549
168·3	− 52	2704	0·00265	−0·0078	0·00006086	0·4056
326·4	106	11236	0·00595	−0·0045	0·00002025	0·4770
220	0	0	0·01045	0	0	0
381·8	162	26344	0·06620	+0·0558	0·00311364	9·0398
204·6	− 15	225	0·00810	0·0024	0·00000576	0·0360
	60	60390		0·0332	0·00327972	11·2151

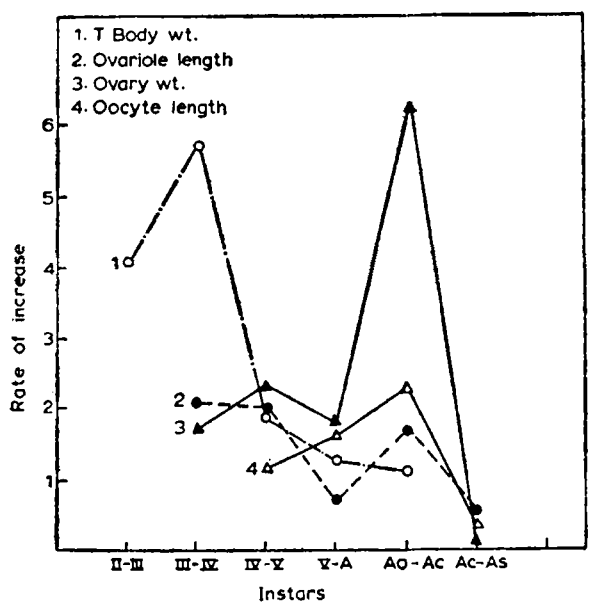

Figure 1. Rate of increase in length and weight of different parts of the body in instars of *E. alacris alacris*.

and the value of r was calculated. When the data were fitted in the above formula, r=0·91 indicates more or less a perfect correlation between the growth in length of the ovarioles and the weight of the body. Starving the adults for 2½ days caused a sharp fall in the ovariole length and ovary weight.

Comparison of the rate of increase of the total body weight with the rate of ovarian weight indicates an increase in the body weight upto the IV instar, followed by a fall in the rate and subsequently remaining more or less equal, although from the V instar to the mature adult, there is a fall in the rate. On the contrary, the rate of increase in weight of the ovary increases steadily and the rate never falls.

The total ovarian weight in the adult *E. alacris alacris* can be correlated with the total body weight and there is a clear agreement even with respect to the rate of growth, initially higher, but falling with the advancement of the instar as in *Paracomacris centralis centralis* (Phipps 1959). The rate of growth falls for all parts studied here when the V instar moults to adult. The results herein presented agree with that of Richards and Waloff (1954) and indicate that the development of the ovary is one of the main causal factors for the increase in the total body weight of the insect. Richards and Waloff (1954) also have shown that during maturation, changes take place both externally and internally and during this period colour changes were noticed in some British grasshoppers. But such colour changes are not evident in *E. alacris alacris*.

Fully developed oocytes, vary in length from 1071–1172 μ and the ovarioles of the ' O '-day female contained 10-12 differentiated egg rudiments with an undifferentiated mass of germarium, the length of which increases during development and falls during starvation. The rate of increase in the length of the oocyte, shows an increasing trend as in the case of the weight of the ovary, while the rate falls in the case of the length of the germarium as it differentiates to form new oocytes.

The rate of the total body weight increases till IV instar and then a fall is noticed, whereas in the case of the weight of the ovary, the rate steadily increases and the maximum rate of increase is reached in the mature adult in relation to the development of the eggs.

Starvation has a deleterious effect on the ovarioles with a sharp fall in the ovarian weight as well as in the ovarian length, possibly due to the absorption or loss of reserve food.

Comparison of the rate of growth of the total weight, ovary weight and the ovariole length indicated that (i) the correlation coefficient between the weight of the ovary and the ovariole length indicates more or less a perfect correlation in growth, (ii) the growth rate steadily increases upto the IV instar and then the rate falls for all the parts noted except in the case of the length of the ovarioles and the width of the oviduct where no fall is noticed, suggesting that it may be due to the developing and maturing eggs, there should be a steady increase whereas other body parts remain constant.

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