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Biometrical analysis of growth in the larvae of *Heliothis armigera* Hubner

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Abstract. Measuring the width of the head capsule of *Heliothis armigera* Hbn. at different stages of development larvae fall into five well defined group each characteristic of an instar, when reared on alfalfa (*Medicago sativa*) leaves and sorghum earhead (*sorghum vulgare*) at a constant temperature of 26 ± 1°C. Przibram's rule cannot be applied to increase in the linear dimensions of larva in its successive stages. However, variations in the value of the linear progression factor show that Przibram's progression principle is of doubtful significance in the case of this pest.

Keywords. Biometrical analysis; *Heliothis armigera*.

1. Introduction

The gram pod borer, *Heliothis armigera* Hbn. is a serious and polyphagous pest feeding on many important crops of the Marathwada region. Dyar (1890) established a criterion to determine the correctness of the instars observed. He asserted that the ranges of variation in the width of the head capsule in the successive developmental stages characterise an instar, which follow a geometrical progression. According to Przibram and Megusor (1912), the weight of an insect is doubled during each instar and at each moult all linear dimensions are increased by the ratio of 1·26. Mohan Rao and Tonapi (1970) stated that Przibram's rule may be safely applied for the increase in weight of the larvae in successive stages. However, the principle of linear progression is of doubtful significance. Keeping this in view, an attempt is made to study the ideals of these well established formulae in the case of *Heliothis armigera* larvae when reared on alfalfa and sorghum.

2. Materials and methods

A laboratory culture of *H. armigera* was used for this study. Known number of male and female pairs were kept for laying eggs in a cage (30 × 30 × 30 cm) prepared with white muslin cloth. These eggs were collected using wet camel hair brush and kept for hatching. Immediately after hatching, the tiny larvae were carefully collected by hair brush and released in plastic boxes (5 × 5 cm) containing alfalfa leaves (*Medicago sativa*) and small pieces of sorghum earhead (*Sorghum vulgare*). The food was changed everyday. Dry sieved soil of 2·5 cm in thickness was provided in the boxes to make them enter the soil for pupation. The pest was reared for two successive generations on respective hosts and in the third generation the data were recorded for thirty larvae on the head width, body length and body width in different instars, by using ocular micrometer.

Partial regression and multiple correlation on the variables viz., head capsule width, larval body length and larval body width were calculated to test the reliability in the case of individual larva. The equation used was, $Y=b_0+b_1x_1+b_2x_2$; where $Y=$ width of head capsule, $x_1=$ larval length, $x_2=$ larval width, $b_0=$ regression constant and b_1 and b_2 coefficient of partial regression. Values of b_0, b_1 and b_2 were calculated by the method of least squares. For the purpose of assigning single individuals to their respective instars, regression relationship between instar and the mean head capsule width of the larvae was calculated. The regression equation used was, $\log Y=a+bx$ where, $Y=$ width of head capsule, $a=$ constant, $b=$ logarithm of growth ratio, and $x=$ number of instar.

3. Results and discussion

The mean value of head width of the larvae in their successive instars was calculated when reared on alfalfa leaves and sorghum earhead using the regression equation mentioned earlier. These measurements fall into five well defined groups, each characteristic of an instar. By the method of least squares, values of a and b were found which gave an equation for the straight line best fitting the observed head widths. These equations are $\log y=-0{\cdot}72079+0{\cdot}22966_x$ and $\log y=-0{\cdot}78231+0{\cdot}24751_x$, for alfalfa and sorghum, respectively. The agreement of the data with Dyar's law is illustrated by the regression line (figures 1 and 2) Peterson and Haeussler (1928),

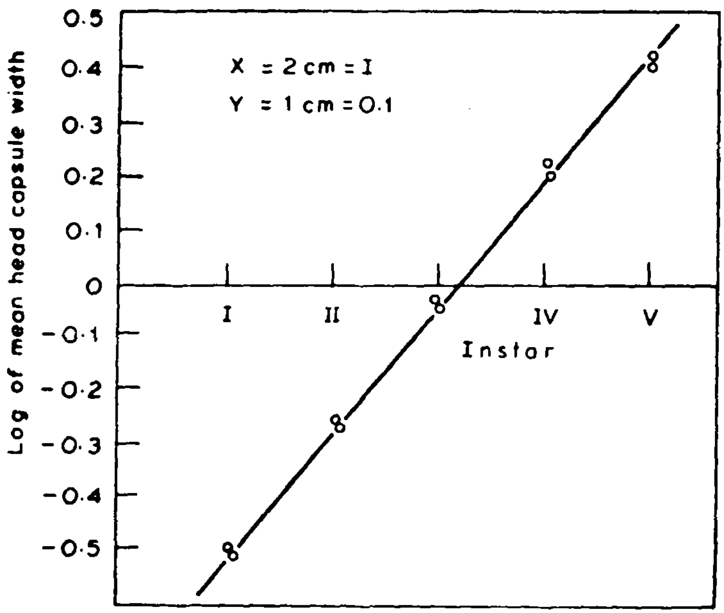

Figure 1. Regression of instar on mean head capsule width. When reared on alfalfa.

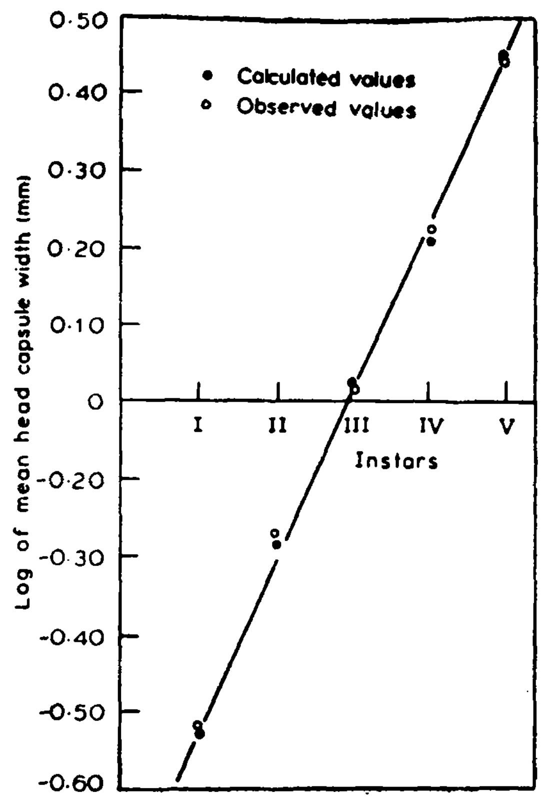

Figure 2. Regression of instar on mean head capsule width when reared on sorghum on alfalfa.

opined that in the case the larvae of oriental fruit moth, the measurements of the head of the larvae fall into groups which evidently characterise a specific instar. Taylor (1931) stated that an analysis of measurements in 46 species of sawflies and 28 species of Lepidoptera upheld Dyar's generalisation. In the present experiment, the mean value of the observed and calculated head widths and the progression factors are very close to indicate that the width of head capsule of *H. armigera* is more or less constant for any instar when larvae reared on alfalfa and sorghum. Harries and Henderson (1938) concluded that Dyar's principle is generally of a descriptive value but exceptions to the rule are common. Dyar's rule is not applicable in the case of *Henosepilachna vigintioctopunctata* Fabr. (Rathore and Verma 1977) but is useful to serve the purpose of knowing the number of instars.

The values of the larval length in its successive stages when larvae reared on alfalfa and sorghum are shown in figures 3 and 4. The theory that successive growth stages of an insect are determined by a single division of cells implies that a series of stages may be recognised which follow a geometrical progression having a value of 1·26 for a linear growth. The values of a and b when larvae reared on alfalfa and sorghum were calculated by the least square method ($\log Y = -0{\cdot}00520 + 0{\cdot}28414_x$ and $\log Y = -0{\cdot}12079 + 0{\cdot}30056_x$) and the values obtained here are not close to the observed values of body length in successive stages as well as the progression factors since linear growth has shown a deviation from the value as required under

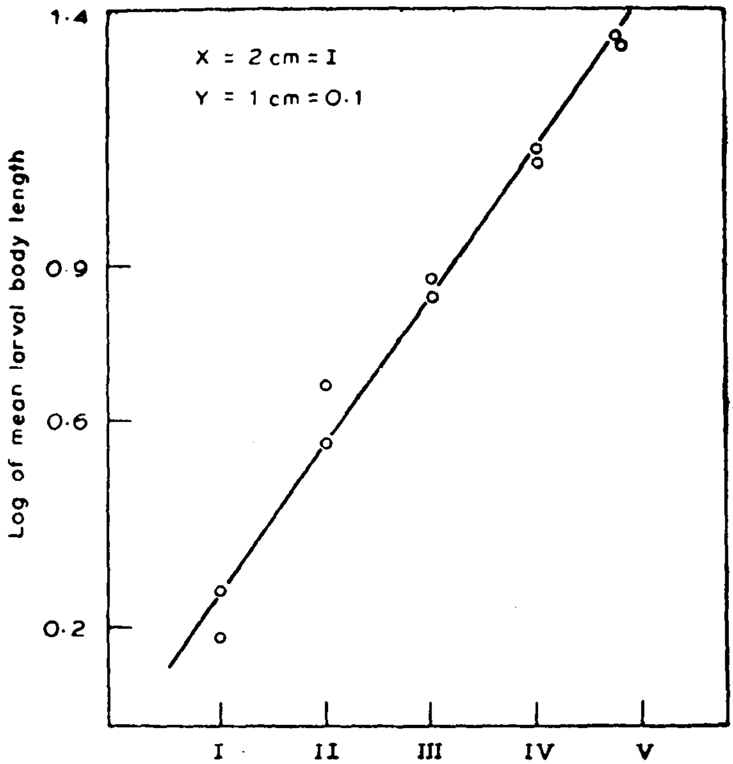

Figure 3. Relative growth in length of larvae of different instars.

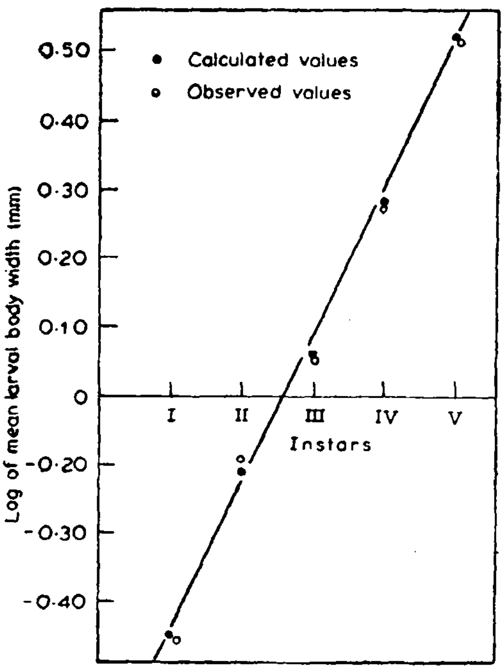

Figure 4. Relative growth in length of larvae of different instars on sorghum on alfalfa.

Przibram's rule. Harries and Henderson (1938) concluded that 'the variation shown in the value of the progression factor is too great to provide any support for the theory that the constant has the same value (1·26) for different species.' In the present studies, the data for linear growth for body length do not support the theory.

The values of width of larval body and its expected calculated values are presented in figures 5 and 6. The equations obtained by the method of least square were $\log Y = -0{\cdot}69358 + 0{\cdot}25735_x$ and $\log Y = -0{\cdot}70151 + 0{\cdot}24541_x$ for respective hosts. The mean values of observed and calculated progression factors for alfalfa and sorghum were 1·8456, 1·8087, 1·8037 and 1·7597, respectively. These values show a marked tendency to exceed the value required by Przibram's theory. The values of multiple correlation coefficients of head width, body length and body width were 0·989 and 0·977 for alfalfa and sorghum respectively. The high values of multiple correlation coefficient show that the regressions are good fits. The regression equations obtained were $Y = 0{\cdot}0865 + 0{\cdot}0202x_1 + 0{\cdot}557x_2$ and $Y = 0{\cdot}0549 + 0{\cdot}8737x_1 + 0{\cdot}0368x_2$.

The values when larvae reared on sorghum indicated that the mean larval and pupal durations were 16·15±0·84 and 12·70±1·07 days, respectively. However, the female adult emerged earlier (12·03±0·88 days) than the male (13·36±0·92 days). The life cycle of male and female was completed within 34·70±1·20 and 32·96±1·03 days respectively. The mean fecundity of female was 746·40±122·18 eggs during its life time. However, the highest contribution of eggs in the life cycle was made by the female on the fifth day of oviposition.

During our investigations on sorghum, it was noted that 88·89% of larvae formed into pupae and 87·50% pupae emerged into adults. Partial regressions and multiple

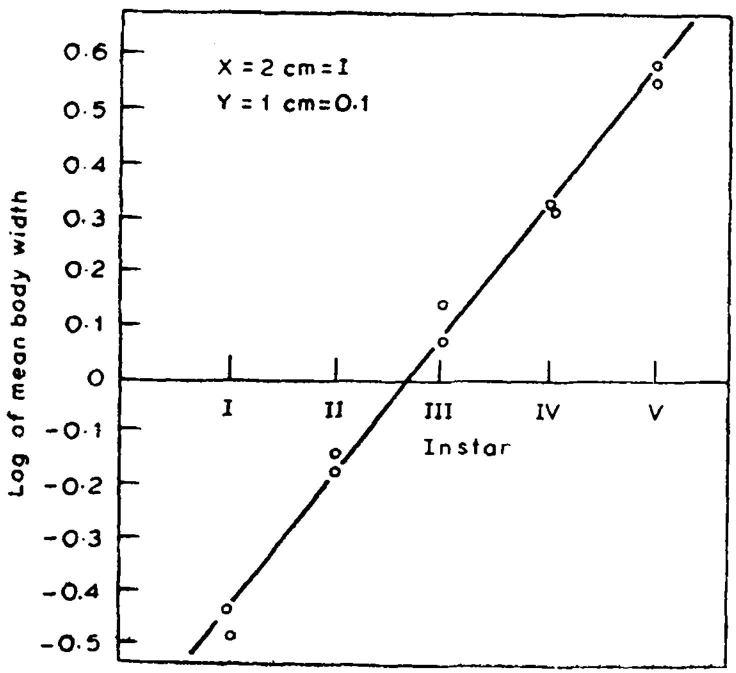

Figure 5. Relative growth in width of larvae of different instars.

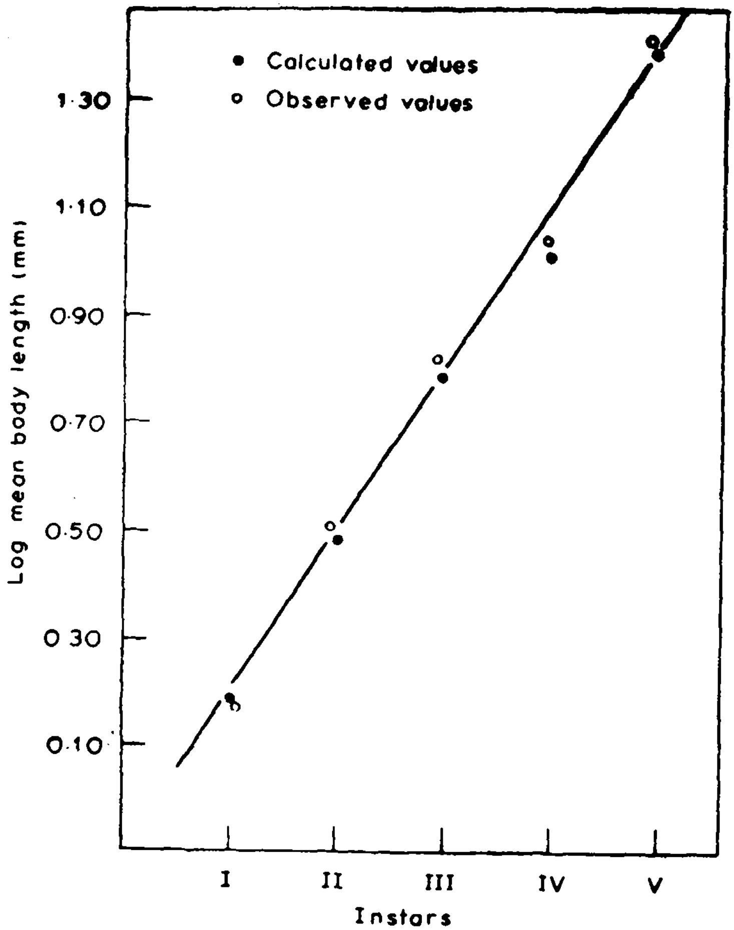

Figure 6. Relative growth in width of larvae of different instars on sorghum.

correlation on the variables viz pupal length, pupal width and pupal weight (male and female) were calculated in accordance with the regression equation. The mean values of multiple correlation coefficient in male and female pupae were 0·696 and 0·789, respectively. The length, width and weight of the male and the female pupae were 17·30 mm, 4·84 mm, 214·21 mg and 17·85 mm, 4·86 mm and 219·20 mg respectively.

References

Dyar H G 1890 The number of moults of lepidopterous larvae; *Psyche* **5** 420-422

Harries W and Henderson T 1938 Growth of insects with reference to progression factors for successive growth stages; *Ann. Entomol. Soc. Am.* **31** 557-572

Mohan Rao H N and Tonapi G T 1970 A biometrical analysis of growth in the larvae of *Dineutes indicus* Aube (Gyrinidae: Coleoptera); *Indian J. Ent.* **32** 39-50

Peterson A and Haeussler G J 1928 Some observations on the number of larval instars of the oriental peach moth, *Laspeyresia molesta* Busck; *J. Econ. Entomol.* **21** 843-854

Przibram H and Megusor F 1912 Waschstumsmessungen au *Sphodromantis bioculata* Burm.; *Ann. Entomol. Soc. Am.* **31** 572

Rathore Y S and Verma J K 1977 On the application of Dyar's rule to the larvae of *Henosepilachina vigintioctopunctata* Fabr.; *Curr. Sci.* **46** 420-421

Taylor R L 1931 On Dyar's rule and its application to sawfly larvae; *Ann. Entomol. Soc. Am.* **24** 451-466