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MORPHOLOGICAL STUDIES ON GRAM POD BORER, *HELICOVERPA ARMIGERA* (HUBNER) (LEPIDOPTERA : NOCUTIDAE)

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The head capsule width of *Helicoverpa armigera* (Hb.) larvae falls into six groups, each of which could be considered an instar. In addition to the head capsule width, an increase in the length and width of other head and body appendages also followed a geometrical progression confirmity with Dyar's law.

INTRODUCTION

Dyar (1890) seems to have been the first to point out that there is some relationship between the head capsule width of successive instars of lepidopterous larvae. According to him the successive measurements are in a geometrical progression, bearing a constant ratio to one another. Results varifying Dyar's law for determining the number of instars in different insects have been discussed by Forbes (1934), Rao & Tonapi (1970), Sorensen & Thompson (1979) and Goel & Kumar (1982). The present study, thus is a basic analysis of the morphometrics of the head and body appendages of immature stage of *Helicoverpa armigera* (Hubner).

These studies shall be of great importance in applied research in determining the larval instars correctly with much ease.

MATERIAL AND METHODS

Larvae collected from gram field were reared in the laboratory on semi-synthetic diet (Sharma *et al.*, 1987). The brood completed its life cycle in 36.0 ± 1.62 days. The exuviae and a few stock caterpillars of each instar were dissected under a stereoscopic research microscope to disarticulate the head and its different appendages. The balsam mounts together with body appendages were prepared and the metrical measurements were made by using ocular and stage micrometer combinations. The mean value of 20 replicates for 33 characters at each instar stage were calculated. To ascertain the nature of growth for each variable, the instars were recorded on X-axis. Assuming the linear growth, the relation $Y = a + bx$, was used to evolve growth equation. The regression equation so obtained further assisted in plotting best fit regression line for all variables taken into consideration. Also to varify relationship between the observed and calculated values, χ^2 (Chi-square) test was applied. An average ratio for each variable obtained dividing the succeeding instar value by the preceeding one has been described as the 'growth ratio' between each moult, whereas the average growth ratio for each variable has been the progression factor.

RESULTS

The measurements of the larval head and its appendages together with thoracic legs in *H. armigera* for the separate instar are distinguished (Table 1). The width of head capsule is always

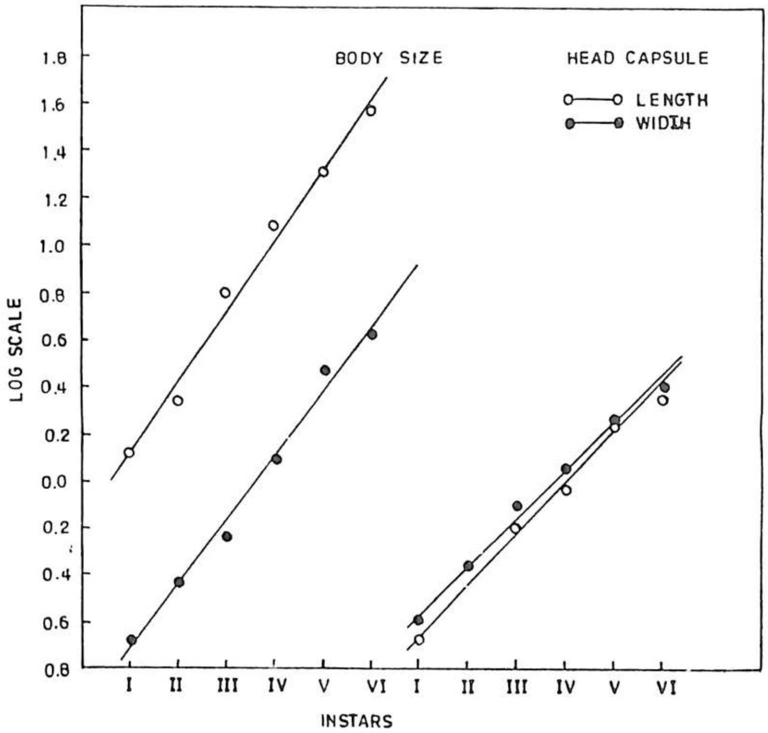

Fig. 1. Best fit regression line based on mean observed value at each instar level for metrical data plotted on different abscissa.

greater than the length in all the instars except the second instar, whereas width is almost equal to the length of the head capsule (Fig. 1).

In labrum and antenna, the difference between length and width is less in the first instar, comparatively to the later instars. With each instar the labrum, mandible and maxilla increased proportionately both in their length and width. Similarly the setal gap on the postmental sclerite also increase at each moult but the scatter of points plotted for caterpillars are comparatively distant from regression line. The length and width of the hypopharyngeal premental lobe converge approaching the sixth instar stage. There was not much of deviation between the proportionate growth of the width corresponding to the length of each podomere of the three pairs of thoracic legs except prototibia, mesotibia and metatibia.

Insignificant values of χ^2 at 5 and 1 per cent levels, between the observed and calculated values support a perfect linear relationship. The slop of regression line with an angle greater than 45° at the abscissa also indicated a better growth.

DISCUSSION

According to Dyar (1880) the width of the head capsule of a larva in its successive stages follows a regular geometrical progression. Like the findings of Harries & Handerson (1938), Rao & Bucker (1975), Majeed & Aziz (1979) and Sorensen & Thompson (1979), the head width of *H. armigera* also falls into six groups each of which is considered as an instar stage (Fig. 2). Not only the width of the head capsule but an increase in length and width of the head and body appendages followed a geometrical progression. A slight variation in scatter of points from the regression line of different

Table I. Biometrical measurements and regression equation of head and appendages during successive developmental stages of *H. armigera* (Hb.) with χ^2 between observed and calculated values being insignificant.

Characters (mm)	Mean values of larval stages						Progression factor	Regression equation	χ^2
	I	II	III	IV	V	VI			
Body length	1.330	2.200	6.400	12.080	20.830	38.200	2.000	$\log Y = -0.17367 + 0.29987X$	1.208696
Body width	0.208	0.362	0.538	1.270	3.080	4.170	1.861	$\log y = -0.98797 + 0.27537X$	0.209322
Head capsule length	0.212	0.430	0.625	0.925	1.773	2.281	1.632	$\log Y = -0.88353 + 0.22047X$	0.097053
Head capsule width	0.262	0.431	0.777	1.170	1.836	2.593	1.586	$\log Y = -0.75616 + 0.20124X$	0.032510
Labrum length (Anteroposteriorly)	0.085	0.120	0.188	0.248	0.330	0.491	1.422	$\log Y = -1.21017 + 0.14990X$	0.002170
Labrum width (laterally)	0.091	0.144	0.205	0.329	0.451	0.618	1.469	$\log Y = -1.18664 + 0.16721X$	0.004663
Mandible length	0.087	0.141	0.211	0.353	0.590	0.875	1.587	$\log Y = -1.26104 + 0.20249X$	0.001867
Mandible width	0.058	0.096	0.150	0.250	0.394	0.574	1.583	$\log Y = -1.42485 + 0.20111X$	0.002989
Maxilla length	0.075	0.114	0.190	0.316	0.539	0.808	1.541	$\log Y = -1.34909 + 0.21162X$	0.002544
Maxilla width	0.054	0.073	0.125	0.194	0.308	0.522	1.579	$\log Y = -1.50234 + 0.19999X$	0.002315
Antenna length	0.025	0.044	0.068	0.197	0.154	0.246	1.583	$\log Y = -1.76858 + 0.19289X$	0.000638
Antenna width	0.022	0.025	0.056	0.087	0.119	0.187	1.536	$\log Y = -1.81728 + 0.18274X$	0.000780
Hypopharyngeal premental lobe length	0.054	0.088	0.131	0.205	0.251	0.323	1.439	$\log Y = -1.37662 + 0.15642X$	0.010243
Hypopharyngeal premental lobe width	0.034	0.071	0.121	0.171	0.223	0.302	1.569	$\log Y = -1.55954 + 0.18336X$	0.013760
Postmental setae (Gap in between)	0.028	0.051	0.103	0.157	0.200	0.276	1.603	$\log Y = -1.67564 + 0.19806X$	0.019318

Prothoracic femur length	0.083	0.118	0.208	0.307	0.494	0.778	1.568	log Y = – 1.29258 + 0.19697X	0.001233
Prothoracic femur width	0.067	0.104	0.165	0.278	0.428	0.640	1.571	log Y = – 1.37268 + 0.19897X	0.001921
Prothoracic tibia length	0.061	0.092	0.154	0.238	0.496	0.640	1.601	log Y = – 1.38997 + 0.19557X	0.003023
Prothoracic tibia width	0.045	0.071	0.119	0.202	0.342	0.572	1.663	log Y = – 1.58373 + 0.22282X	0.000233
Prothoracic tarsus length	0.079	0.106	0.157	0.232	0.382	0.580	1.492	log Y = – 1.31190 + 0.13625X	0.003214
Prothoracic tarsus width	0.041	0.059	0.079	0.117	0.172	0.273	1.451	log Y = – 1.55924 + 0.16002X	0.001035
Mesothoracic femur length	0.083	0.118	0.221	0.308	0.486	0.778	1.572	log Y = – 1.28451 + 0.19565X	0.003307
Mesothoracic femur width	0.067	0.108	0.163	0.278	0.436	0.642	1.573	log Y = – 1.36860 + 0.19878X	0.002036
Mesothoracic tibia length	0.058	0.098	0.158	0.253	0.408	0.659	1.625	log Y = – 1.43631 + 0.20971X	0.00146
Mesothoracic tibia width	0.044	0.077	0.140	0.229	0.355	0.587	1.676	log Y = – 1.55501 + 0.22207X	0.003061
Mesothoracic tarsus length	0.079	0.116	0.188	0.244	0.379	0.594	1.501	log Y = – 1.27430 + 0.17247X	0.002614
Mesothoracic tarsus width	0.041	0.062	0.079	0.129	0.207	0.308	1.502	log Y = – 1.59725 + 0.18007X	0.001932

Metathoracic femur length	0.083	0.118	0.226	0.316	0.498	0.765	1.569	log Y = – 1.28014 + 0.19555X	0.004942
Metathoracic femur width	0.067	0.108	0.173	0.283	0.436	0.651	1.576	log Y = – 1.36353 + 0.19912X	0.001810
Metathoracic tibia length	0.058	0.106	0.163	0.253	0.402	0.660	1.629	log Y = – 1.41618 + 0.20595X	0.000991
Metathoracic tibia width	0.046	0.084	0.143	0.223	0.363	0.571	1.657	log Y = – 1.52406 + 0.21655X	0.002375
Metathoracic tarsus length	0.079	0.124	0.188	0.231	0.382	0.584	1.499	log Y = – 1.26065 + 0.16874X	0.003819
Metathoracic tarsus width	0.044	0.071	0.086	0.129	0.211	0.312	1.487	log Y = – 1.52493 + 0.16704X	0.002980
Ratio between the mean of each instar and one next preceding	1.646	2.037	1.765	1.714	1.646	1.581			

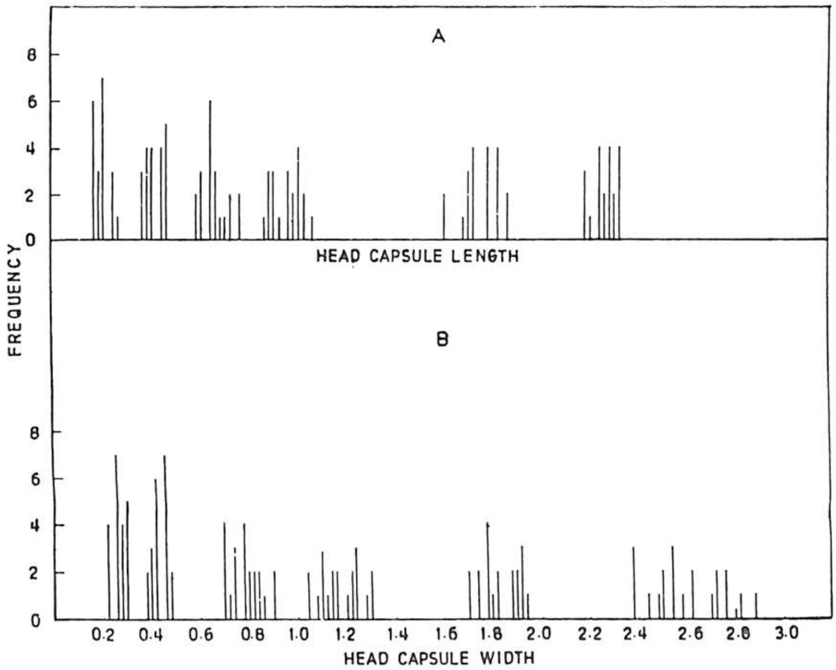

Fig. 2. Frequency distribution of head measurements of *Heliothis armigera* (Hubner).

parameters is probably an effect of the environmental changes and of the possible differences between the two sexes, which remained unfeasible because of lack of information on sexual dimorphism at larval stages in Lepidoptera.

The growth ratio between preceding and succeeding instars for *H. armigera* lies in between 1.581 to 2.037 against an average progression of 1.422 to 2.000, thus very much in consistent to Dyar (1890) and Gains & Campbell (1935) observations and can be generalized for Lepidoptera in particular. Further very poor values of calculated χ^2 compared at 5% and 1% levels, respectively also supported an insignificant differences between the observed and the theoritical values for a perfect relationship. Also the slop of the regression line with angles greater than 45° at the abscissa indicated a better growth. Thus the equation $Y = a + bx$ depicts the growth pattern in the larvae of *H. armigera*. The inverse relationship between the 'a' and 'b' *i.e.* if 'a' increases 'b' decreases and vice versa a hypothesis (Matsuda, 1961) found to a good hold in present study.

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REFERENCES

DYAR, H.G. 1890. The number of moults of lepidopterous larvae. *Psyche.* **5** : 420-422.

FORBES, W.T.M. 1934. A note on Dyar's law (Lepidoptera : Larvae). *Bull. Brooklyn ent. Soc.* **29** : 146-149.

GAINS, J.C. & CAMPBELL, F.L. 1935. Dyar's rule as related to the number of instars of the corn ear-worm, *Heliothis obsoleta* (F.) collected in the field. *Ann. entomol. Soc. Am.* **28** : 448-461.

GOEL, S.C. & KUMAR, A. 1982. Application of Dyar's rule to the head appendages of *Diacrisia obliqua* (Walk.) (Arctiidae). *Geobios new reports*. **1** : 26-31.

HARRIES, W. & HANDERSON, T. 1938. Growth of insects with reference to progression factor for successive growth stages. *Ann. entomol. Soc. Am.* **31** : 557-572.

LUDWIG, D. & ABERCROMBIE, W.F. 1940. The growth of the head capsule of Japanese beetle larva. *Ibid.* **24** : 8-10.

MAJEED, Q. & AZIZ, S.A. 1979. Application of Dyar's law of different hopper instars of *Gastrimargus transversus* Thunb. *Indian J. Ent.* **41** : 240-243.

MATSUDA, R. 1961. Studies of relative growth in Gerridae (Hemiptera : Heteroptera) I-III. *Ann. entomol. Soc. Am.* **54** : 578-598.

RAO, H.N.M. & TONAPI, G.T. 1970. A biochemical analysis of growth in the larvae of *Dineutes indicus* Aube (Gyrinidae : Coleoptera). *Indian J. Ent.* **32** : 39-50.

RAO, P.V.S. & BUCKER, A.H.A. 1975. Application of Dyar's law to the larvae of two lepidopterous insects. *Ibid.* **37** : 95-96.

SHARMA, S.P., GOEL, S.C. & SAINI, M.L. 1987. Mass breeding of gram pod borer, *Heliothis armigera* Hubner on semi-synthetic diet and its biological studies. *Uttar Pradesh J. Zool.* **7** : 26-31.

SORENSEN, K.A. & THOMPSON, H.E. 1979. The life history of the buffalo-grass webworm, *Surattha indetella* Kearfolt in Kansas. (Lepidoptera : Pyralidae). *J. Kansas Ent. Soc.* **52** : 282-296.