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HEAD MEASUREMENTS AND WEIGHTS OF THE BEAN LEAF ROLLER, *URBANUS PROTEUS* (HESPERIIDAE)[1]

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The bean leaf roller, *Urbanus proteus* (Linn.), is common on beans and other legumes in Florida during the fall of the year. Head widths and weights of newly molted larvae were determined to learn if larval instars could be accurately distinguished when making field observations.

Larvae were reared on Harvester variety snap bean leaves held in an insect rearing room with the temperature about 85°F. Larvae were kept individually on bean leaflets in round plastic dishes 2 cm deep by 10 cm in diameter with moistened filter paper to maintain leaf turgidity. Fresh leaves were supplied after each molt. Eggs were measured within five hours after oviposition and larval head widths were recorded soon after molting when the head became black. Pupal heads were measured two

[1] Florida Agricultural Experiment Stations Journal Series No. 3241.

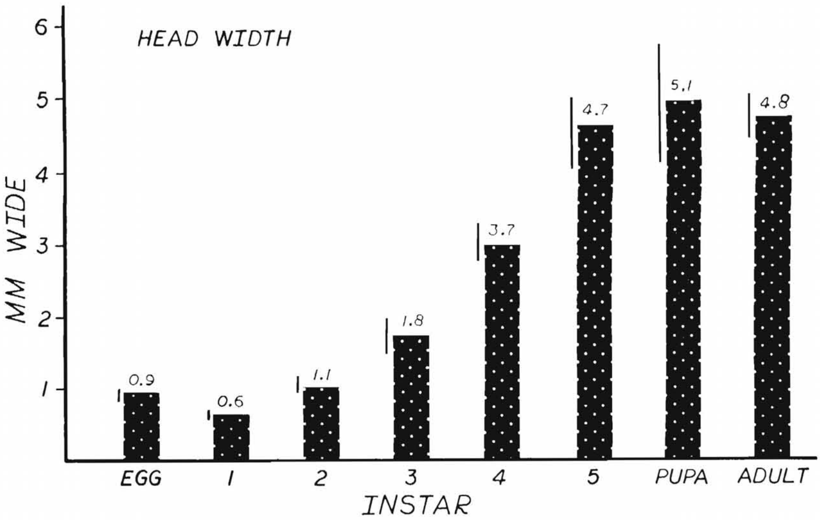

Fig. 1. Comparison of egg and head widths of the bean leaf roller, *Urbanus proteus* (Linn.). Bars and numbers represent means of 50 or more individuals and the lines connect the low and high measurement for each life stage.

days after pupation. All measurements were made on living specimens except for adults, which were killed in a cyanide jar following emergence and measured within one hour after death. Head measurements were made using a dissecting microscope with an ocular micrometer.

Data on the means and ranges of head widths (Fig. 1) demonstrate distinct differences between instars with none of the extreme measurements overlapping from instar to instar. The validity of field determination of instars based on head size is substantiated by these data. The results of these measurements agree with those reported by Quaintance (1898). His measurements, made on preserved specimens, were as follows: eggs 0.966 mm, 1st instar 0.566 mm, 2nd instar 0.866 mm, 3rd instar 2 mm, 4th instar 3 mm, and 5th instar 4.5 mm. Quaintance did not report the extremes or variation within each stage.

Heads of newly eclosed larvae filled approximately ⅔ of the egg interior. The 5th instar, pupal and adult head widths were similar (Fig. 1). When observing the changes during these stages it appeared that pupal heads would be wider than 5th instar larvae by a larger amount than was measured because the 5th instar head capsules split during pupation. The adult emerges from the pupal case without splitting the head covering, therefore its head cannot be wider than the pupal head. The extreme mea-

TABLE 1. Milligrams weight of eight life stages of the bean leaf roller, *Urbanus proteus* (Linn.) taken at the beginning of each stage.

	Egg[a]	1st[a]	2nd	3rd	4th	5th	Pupa	Adult[b]
Low individual	—	—	1	5	29	153	367	100
Mean	0.46	0.41	2.25	11.18	38.59	215.16	407.71	177.60
High individual	—	—	3.5	14	47	265	610	352
Weight change ratio[c]	—	0.9	5.5	5.0	3.5	5.5	1.9	0.4
No. of individuals weighed	170	120	126	117	96	90	85	25

[a] Weighed in groups of 10 per weighing because the balance used was only sensitive to tenths of a mg.
[b] Adults were killed with cyanide and weighed within a few minutes after emergence from the pupa. All other weights were made of living individuals.
[c] The figures are derived by dividing the weight of the indicated stage by the weight of the previous stage.

surements for the adult were much closer than they were for the 5th instar or pupa.

Comparing head measurements by dividing the head width of one instar into that of the preceding instar, ratios of .55, .61, .49, .79 and a mean of .61 were found. Dyar (1890) found ratios of .58 to .73 for 14 species having five larval stages, and the bean leaf roller falls within his range. A lower numerical ratio was expected in an insect with a large head such as a Hesperiidae, but this was not apparent with the bean leaf roller.

Dyar (1890) mentions the smaller size of head capsules from larvae which died after molting. Several bean leaf roller larvae which died were compared to the average of each instar. The first four instars which died had similar measurements to live specimens, but the dead 5th instar heads were much smaller than the average, and two which had not grown during the 4th instar had heads smaller than the previous instar. Measurements of live and preserved head capsules were very similar, even for 5th instar heads which had split during pupation.

In conjunction with head measurements larvae were weighed to record the weight increase from molt to molt. These weights were made just after molting rather than before molting to allow for uniform weighing. Weights just before molting would have been nearly impossible to make due to the difficulty of knowing when the larvae had completed their feeding. By weighing soon after molting, uniform weights were made for individuals of each instar and feeding or molting was not interrupted. Larvae had not begun to feed after molting when they were weighed.

The weights are given in Table 1 for the eight life stages. All weights

TABLE 2. Conversion of eaten leaf weight to bean leaf roller (BLR), *Urbanus proteus* (Linn.), weight for five life stages.

	Egg	1	2	3	4	5	Pupae
Leaf eaten (mg)	—	11	28	110	567	3343	—
BLR weight (mg)	0.46	0.41	2.3	11.2	38.6	215.2	407.7
BLR gain (mg)[1]	—	1.9	8.9	27.2	186.6	192.5	—
Conversion ratio[2]	—	0.17	0.32	0.24	0.33	0.06	—

[1] This figure derived by subtracting weight of one instar from the weight of next instar. The weight lost during molting is not included because weights were made after molting but before feeding resumed.

[2] Conversion ratio $= \frac{\text{mg BLR gain}}{\text{mg Leaf eaten}}$.

are of live specimens, except for adults, which were killed just before weighing. The ratio of gain was largest from 1st to 2nd and 4th to 5th instar and smallest from 5th instar to pupa. The 5th instar gained considerable weight, but lost much of the gain at pupation after which the weights were taken. The small loss of weight from egg to newly eclosed larva, only 10%, was a surprise, since newly eclosed larvae do not eat any of the egg shell and loss of fluids during eclosion was noted.

The conversion ratio of leaf weight to body weight of each larva was calculated by dividing the weight of leaf tissue eaten by the weight increase during each instar (Table 2). The efficiency of the 1st and 5th instar to convert leaf weight into body weight was low, whereas the efficiency of the other 3 instars was similar. The figure of 0.3 is close to the conversion ratios reported by Taylor and Bardner (1968) for the diamond back moth on a dry weight basis. The low conversion ratio for the 1st instar was unexpected since larval weight increased 5.5 times over the newly hatched larvae. After 5th instar feeding the transformation into the pupa results in considerable weight loss as indicated by the 0.06 figure in Table 1.

Przibram and Megusar (1912) concluded that the weight of each instar should double that of the preceding instar and Bodenheimer (1932) added latent divisions for holometabolic insects. Instar weights obtained for the bean leaf roller agree closely with those reported by Przibram and Megusar when the latent division calculations of Bodenheimer are used.

CONCLUSIONS

Measurements of bean leaf roller heads demonstrated that larval instars can be accurately distinguished. The head widths did not overlap from one instar to the next and the standard deviation was 0.4 mm for the 5th instar and pupae, 0.1 for adults and less than 0.1 for the other life stages. Head capsules which had been shed during molting were similar in width to live specimens.

Larval weight increased approximately 5 fold during each of the 2nd, 3rd, and 4th instar periods. The 5th instar increased in size and weight but lost much of the increase during pupation. Adults weighed 0.4 times as much as did the pupae, and 1st instar larvae averaged 0.9 times as much as the eggs. A greater proportion of weight was lost during the transformation from 5th instar to adult than during eclosion.

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WHAT'S YOUR COLLECTION WORTH

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In discussing the value of a collection of Lepidoptera we must first define "value" by some criterion. We can first consider its monetary value: the amount spent on materials, storage equipment, library, and the procurement of specimens; and also the fair market value if it were to be sold to a dealer, private collector, or institution. Next, there is the sentimental value to the collector. Most collectors probably value their collections far beyond a fair market value simply because of all the hours of sweating, searching, panting, itching, squinting, cursing, and joyful whooping that accompany the perfect avocation. Finally, we shall discuss the scientific value: what information useful in taxonomic and faunistic research is intrinsic in the collection? The scientific value can sometimes be related to monetary value; but, too often, institutional collections cannot afford to purchase highly desirable collections, and must rely upon donated material for research purposes.