CONSUMPTION INDEX (C.I.) AND GROWTH RATE (G.R.) OF THE BIGHEADED GRASSHOPPER, *AULOCARA ELLIOTTI* (THOMAS) FED ON CRESTED WHEATGRASS AND WESTERN WHEATGRASS.

by

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Abstract. *Nymphs of* Aulocara elliotti *(Thomas) were raised from the beginning of the first instar to the end of the final instar on the leaves of crested wheatgrass and western wheatgrass. The average C.I. of the male grasshoppers fed on crested wheatgrass and western wheatgrass were calculated to be* 0.9977 *and* 1.1094, *respectively. Among the females those feeding on crested wheatgrass a C.I. of* 1.0006 *was recorded compared to* 1.1733 *on western wheatgrass. During this period the average G.R. of male grasshopper was* 0.0848 *on crested wheatgrass and* 0.0813 *on western wheatgrass. Female grasshoppers demonstrated a better G.R. than males and the highest,* 0.0943 *was calculated for those fed on crested wheatgrass.*

Introduction. The nutritional adequacy of plant species is basic to the insect/food plant relationships and despite variation in chemical composition of plants there is a noteworthy similarity or "rule of sameness" of qualitative requirements among insects. Although these qualitative requirements provide a primary understanding of insect nutrition, the balance which is needed between the main classes of nutrients for adequate nutrition of insects imparts a basic significance to the quantitative aspects. The usefulness of a foodstuff depends first upon its digestibility and then how well the kinds and amounts of the nutrients made available meet the nutritional requirements of the animals. The nutritionist, therefore, uses criteria determined by feeding test to draw inferences about the food and nutritive values of the foodstuff. He recognizes that the animal concerned is the final judge of the matter and uses a number of measures for determining the usefulness of the food material. Each measure serves to evaluate some quality of the foodstuff. This study was attempted to calculate the following indices:

(1) The consumption index (C.I.)
(2) The relative growth rate (G.R.)

Materials and Methods. Newly hatched nymphs of *Aulocara elliotti* (Thomas) were reared singly in cages on one of two food plants and records were kept of the amount of food eaten, amount of faeces voided and the gain in weight of the insects obtained.

The grasshoppers were reared in plastic containers having two cutout openings of 2.5-5 Cm, each covered with saran screen. *Food*: Western wheatgrass (*Agropyron-smithii*

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Rydb.) and crested wheatgrass (*Agropyron cristatum*) were chosen as food plants on the basis of their being generally available in the insect's habitat and their relative suitability. (Pfadt, 1949; Anderson and Wright, 1952).

The insects were weighed and placed in the plastic containers within six hours of hatching and supplied immediately with food. Because it was impossible to handle more than 40 to 50 insects at one time during the early nymphal stages, the experiment was started with forty grasshoppers each treatment receiving 20 insects. The rearing was carried on in a room in which the temperature was controlled at 85 ± 3 °F and the relative humidity at 30 ± 5 percent. The room was lighted continuously by four 40 watt fluorescent tubes. The insects were reared for forty days or as much longer as necessary to bring them to the adult stage. Feeding was *ad libitum*. This is the most commonly used procedure in farm animals investigation (Maynard and Loosli, 1962) and in insects (Waldbauer, 1964); it gives unbiased results for direct practical application.

Old food and faeces were removed every 24 hours, and a known fresh weight of food was introduced at the same time. Food, faeces, and insects were weighed on a Mettler balance. An estimate of the dry weight of each nymph was calculated by using the mean percent dry weight of an aliquot of similar nymphs reared singly on each food, which had been killed by exposure in a freezer, weighed, and then dried to a constant weight in an oven at 60°C. Measurements of food consumption were made on a dry weight basis. The estimated dry weight of each meal was calculated from the percent dry matter of an aliquot. Left-over faeces and food were carefully separated and dried to a constant weight at 60 °C to avoid decomposition. The dry weight of food eaten was calculated by subtracting the dry weight of the leftover food from the estimated dry weight of food introduced to the insect.

Waldbauer (1962, 1968) has discussed the shortcomings of various indices proposed by recent authors and has suggested some new ones. In this study all the indices are adapted from Waldbauer (1968). The consumption index (C.I.) was calculated as:

$$(1)\quad \text{C.I.} = \frac{F}{TA}$$

F = dry weight of food eaten.
T = duration of feeding period (days)
A = mean dry weight of animal during feeding period.

(2) The relative growth rate (G.R.) was calculated as:

$$\text{G.R.} = \frac{G}{TA}$$

G = dry weight gain during feeding period.
T = duration of feeding period (days.)
A = mean dry weight of animal during the feeding period.

The data were obtained over a physiologically defined period. Waldbauer (1968) has stated that though physiologically defined period are less convenient, they are more likely to yield reproducible results which can be compared with the results of the other experiments. In this study the first period began with hatching and ended with the completion of the first moult. The second period began with the completion of the first period and ended with the completion of the second moult, and so on.

Results and Discussions. The data are summarized in table 1,2,3, and 4. The average C.I. of the male grasshopper fed on crested wheatgrass and western wheatgrass were calculated to be 0.9977 and 1.1094, respectively (table 1). The highest was recorded during the second instars. It fell gradually and the lowest value was obtained during the final stage. Using a "t" test there was no significant difference between the types of food during the first and 2nd instars. There was, however, a singificant difference between the third instar and adult stage. Grasshoppers fed on western wheatgrass exhibited a higher C.I. than those fed on crested wheatgrass.

Among the females, those feeding on crested wheatgrass had an average C.I. of 1.0006, while those feeding on western wheatgrass had 1.1733 (table 2). In both the cases the highest values were obtained during the second stage. The "t" test indicated a highly significant difference during all the stages of the insect. In general the C.I. decreased from the peak in the 2nd instar to a low in the adult life.

TABLE 1

Average† consumption index of male A. elliotti *fed on crested wheatgrass and western wheatgrass.*

Instar	Calculated dry weight of food eaten. (g)	Calculated mean dry weight of insect. (g)	Duration of instar. (days)	Food	C.I.	"t"
I	0.0278	0.0033	7.2857	Crested wheatgrass	1.1583	
	0.0337	0.0037	8.25	Western wheatgrass	1.1049	0.2754
II	0.0491	0.0059	6.2857	Crested wheatgrass	1.3235	
	0.0555	0.0064	6.25	Western wheatgrass	1.3875	0.7771
III	0.0884	0.0120	7.5714	Crested wheatgrass	0.9725	
	0.1144	0.0125	7.50	Western wheatgrass	1.2196	1.9677*
IV	0.1831	0.0237	9.7143	Crested wheatgrass	0.7954	
	0.2153	0.0241	10.25	Western wheatgrass	0.8717	1.4150

†average of 10 grasshoppers.
*Significant at 5% level.

TABLE 2

Average† consumption index of female A. elliotti *fed on crested wheatgrass and western wheatgrass.*

Instar	Calculated dry weight of food eaten. (g)	Calculated mean dry weight of insect. (g)	Duration of instar. (days)	Food	C.I.	"t"
I	0.0262	0.0034	6.80	Crested wheatgrass	1.1342	
	0.0369	0.0033	8.2857	Western wheatgrass	1.3516	2.3826**
II	0.0407	0.0060	5.40	Crested wheatgrass	1.265	
	0.0577	0.0059	6.0	Western wheatgrass	1.6299	1.2383
III	0.0696	0.0109	5.60	Crested wheatgrass	0.8480	
	0.1037	0.0110	7.0	Western wheatgrass	1.3468	2.4296**
IV	0.1585	0.0227	8.40	Crested wheatgrass	0.9230	
	0.1895	0.0224	7.8571	Western wheatgrass	1.0767	2.6276**
V	0.3534	0.0477	9.60	Crested wheatgrass	0.7718	
	0.4118	0.0418	11.0	Western wheatgrass	0.8956	3.9936**

†average of 10 grasshoppers.
**Significant at 1% level.

The average growth rate (G.R.) of males fed on crested wheatgrass was 0.0848 and of males fed on western wheatgrass was 0.0813 (Table. 3) The highest values of 0.1105 and 0.1125 were obtained in the second instar of males fed on crested wheatgrass and western wheatgrass, respectively. The rate declined gradually and reached its lowest point in the adult stage. Except for the 2nd instar males there was no statistical difference in G.R. of grasshoppers fed on two varieties of grasses.

The average growth rate of female grasshoppers fed on crested wheatgrass was 0.0943. The peak was obtained during the 2nd stage (table 4) and the lowest value was registered during the adult stage. The average G.R. of females fed on western wheatgrass was 0.0734. In this case too, the peak was attained during the 2nd stage and the lowest value during the adult stage. Statistical analysis of all the stages showed highly significant differences during the first and 5th instars. The G. R. of grasshoppers fed on crested wheatgrass were notably higher during these stages. In general the G.R. declined gradually from a peak acquired in the second stage to a low during the adult stage.

In this study it was observed that grasshoppers feed on western wheatgrass had a higher consumption index (C.I.) compared to those fed on crested wheatgrass, and that the

growth rate (G.R.) of grasshoppers fed on crested wheatgrass was greater than those fed on western wheatgrass. From these observations we draw these inferences:

(*a*) western wheatgrass is preferred to crested wheatgrass because it contains secondary plant substances which act as attractant.

(*b*) western wheatgrass did not support good growth because it either lacks the optimum quantity of a nutrient or is less digestible than crested wheatgrass.

TABLE 3

Growth† rate of male A. elliotti fed on crested wheatgrass and western wheatgrass.

Instar	Dry weight gain. (g)	Calculated mean dry weight of insect. (g)	Duration of instar. (days)	Food	G.R.	"t"
I	0.0011	0.0033	7.2857	Crested wheatgrass	0.0500	
	0.0008	0.0037	8.25	Western wheatgrass	0.0262	4.3636**
II	0.0041	0.0059	6.2857	Crested wheatgrass	0.1105	
	0.0045	0.0064	6.25	Western wheatgrass	0.1125	0.0357
III	0.0074	0.0120	7.5714	Crested wheatgrass	0.0814	
	0.0080	0.0125	7.50	Western wheatgrass	0.0853	0.9363
IV	0.0167	0.0237	9.7143	Crested wheatgrass	0.0725	
	0.0174	0.0241	10.25	Western wheatgrass	0.0704	0.4687

†average of 10 grasshoppers.
**Significant at 1% level.

TABLE 4

Growth† rate of female A. elliotti *fed on crested wheatgrass and western wheatgrass.*

Instar	Dry weight gain. (g)	Calculated mean dry of insect. (g)	Duration of instar. (days)	Food	G.R.	"t"
I	0.0010	0.0034	6.80	Crested wheatgrass	0.0433	
	0.0007	0.0033	8.2857	Western wheatgrass	0.0256	2.9636**
II	0.0041	0.0060	5.40	Crested wheatgrass	0.1265	
	0.0044	0.0059	6.0	Western wheatgrass	0.1243	0.4900
III	0.0059	0.0190	5.60	Crested wheatgrass	0.0848	
	0.0060	0.0110	7.0	Western wheatgrass	0.0779	1.7021
IV	0.0176	0.0227	8.40	Crested wheatgrass	0.0923	
	0.0168	0.0224	7.8571	Western wheatgrass	0.0955	0.5957
V	0.0325	0.0477	9.60	Crested wheatgrass	0.0710	
	0.0219	0.0418	11.0	Western wheatgrass	0.0476	5.2444**

†average of 10 grasshoppers.
**Significant at 1% level.

Smith (1959) observed that western wheatgrass was possibly nutritionally inadequate plant for *Melanoplus sanguinipes* because it did not support good growth and that the large amount of food processed was apparently used for energy. McGinnis and Kasting (1966) found that grasshoppers more than doubled their intake when the nutrient content of the diet was halved by replacing half of the lyophilized wheat sprouts with cellulose. It has been observed that nutritional requirements of grasshoppers vary according to the growth phase of the insect. Grasshoppers need and use more sugars during the period of somatic growth than at any other time (Mordue and Hill, 1970). It is unfortunate that we could not determine the sugar contents of the two varieties of grass, and it is hard to speculate whether this had any effect on the consumption index of the grasshoppers.

The plants used in this experiment contained 60-75 percent of water. No attempt was made to determine the effect of water on consumption and growth. Legay (1957) has stated that silkworm feeding on mulberry leaves retained much of the water they ingested. Waldbauer (1964) noted that larvae of tobacco hornworm feeding on tomoto leaves grew at a slower pace when the weather was exceptionally dry and warm, but he cautions that differences in the ability to utilize tomato leaves may not be simply due to differences in the water content of the leaves.

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