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FOOD CONSUMPTION, PARTITIONING AND ECOLOGICAL EFFICIENCIES IN ADULT *POECILOCERUS PICTUS* FABR. (ORTHOPTERA: ACRIDIDAE)

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INTRODUCTION

A quantitative study of feeding may help establish relationships between food consumption, assimilation and tissue growth, as well as it may provide insight into the success of the organism in an ecosystem (Wiegert 1965, Mukerji and LeRoux 1969, Latheef and Harcourt 1972). Ecological efficiency ratios (Odum 1971) are useful in comparing the apportionment of energy resources by different animal populations (Kozlovsky 1968, Reichle 1971) and may form a basis for the assessment of canopy consumption (Van Hook and Dodson 1974).

In the present communication a quantitative study of food consumption and tissue growth, and related efficiencies has been made for *Poecilocerus pictus*. Fabr which is a serious pest of *Calotropis* spp. The distribution of this species follows that of its food plant which thrives in the drier portions of India from the north of Punjab to the southern extremity of Madras (Maxwell-Lefroy and Howlett 1909). Recently Khurana (1975) has reported that this insect also defoliates *Luffa acutangula* Roxb., *Lagenaria sinceraria* Ser., *Benincasa hispida* Cogn., *Citrullus vulgaris* Schrad. ex Eckl. & Zeyuh., *Capsicum frutescens* Linn., *Medicago sativa* Linn. and *Clerodendrum inerme* Gaertn. Thus *P. pictus* seems to have the potentiality of becoming a serious vegetable pest.

MATERIALS AND METHODS

Adult male and female specimens of *P. pictus* were collected from *Calotropis procera* R. Br. plants growing within the campus of Kurukshetra University during October 1975 and were kept in a glass cage (77x30x30 cm) covered at the top with a fine mesh wire gauge. This stock culture was maintained at room temperature (25-28°C) and the insects were fed upon the fresh leaves of *C. procera*, which were changed twice a day.

After a 3-day period of acclimatization, the male and female insects were randomly divided into five groups, with three insects of each sex in each group. Separate cages were provided for each insect. Before the start of the feeding trial, the food was withheld for varying periods of time: 0 hr, 6 hr, 12 hr, 18 hr and 24 hr. At the end of the respective starvation period, the insects were individually weighed on an analytical balance, and were supplied with abundant, preweighed, fresh

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leaves of *C. procera*. In an identical set preweighed leaves were kept without insects to determine the weight loss in the food material due to respiratory activity. After a 24-hr feeding period, the insects, remaining leaves, and egesta were collected separately, weighed, overdried at 60°C and reweighed. The initial dry weights of insects and of food material were arrived at by ovendrying preweighed male and female insects and fresh leaves at 60°C and reweighing, thus establishing the fresh/dry weight relationships. All the calculations were done on dry weight basis.

Food consumption was calculated as the difference between initial weight of food supplied and the final weight of the remaining plant material at the end of the feeding period, after correcting for the weight loss in food due to respiration. Food consumption minus egesta yielded the value for assimilation, while tissue growth was directly measured as increase in the body weight of the insects in the 24-hr period.

Various ecological efficiencies were calculated using the following expressions:

(*a*) $\text{Assimilation efficiency} = \dfrac{\text{Assimilation}}{\text{Consumption}} \times 100$

(*b*) $\text{Tissue growth efficiency} = \dfrac{\text{Tissue growth}}{\text{Assimilation}} \times 100$

(*c*) $\text{Ecological growth efficiency} = \dfrac{\text{Tissue growth}}{\text{Consumption}} \times 100$

RESULTS AND DISCUSSION

Food Consumption and Utilization

The female adult insects were on an average three times heavier than the male adult insects (Table 1). Food consumption varied from 821 ± 191 to 1144 ± 426 mg.g^{-1} day^{-1} in male insects and from 367 ± 79 to 920 ± 274 mg.g^{-1} day^{-1} in female insects. Thus food consumption per unit dry weight was much higher in males. On the other hand, the difference in the egesta values per unit weight were not statistically significant in males and females, although mean values were generally higher in the case of female insects (Table 1). Consequently assimilation of food per unit weight was greater in the male insects (636 ± 208 to 942 ± 324 mg.g^{-1} day^{-1} in males against 178 ± 27 to 694 ± 212 mg.g^{-1} day^{-1} in females). Weight specific tissue growth as represented by increase in body weight was not statistically different for the two sexes. This would indicate a higher metabolic activity in males and thus greater respiratory consumption as compared to more sluggish female insects. Further, there was no profound effect of starvation except for the fact that in the treatment involving 24-hr of food withdrawal the values for consumption, egesta, assimilation and tissue growth were higher as compared to no starvation treatment.

When data for all the replicates and treatments were considered together certain relationships became apparent between initial dry weight of insects and metabolic functions. Thus food consumption was inversely related ($r = -0.595$, $P < 0.05$) to initial dry weight in female insects according to:

TABLE 1. *Initial dry weight, food consumption, food partitioning and tissue growth in* Poecilocerus pictus *fed on* Calotropis procera *leaves* (*Mean* ± 1 *S.E.*)

Period for which food was withheld before 24 hr feeding	Initial dry weight (mg)		Consumption (mg g^{-1} day^{-1})		Egesta (mg g^{-1} day^{-1})		Assimilation (mg g^{-1} day^{-1})		Tissue growth (mg g^{-1} day^{-1})	
(hr)	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
0 ..	542±11	1553±26	911±299	367±79	172±42	189±62	739±246	178±27	47±19	126±38
6 ..	493±37	1622±37	821±191	456±57	185±30	144±31	636±208	312±35	105±23	102±42
12 ..	444±24	1192±191	969±97	673±44	184±13	101±37	785±92	572±22	78±36	98±43
18 ..	588±51	1539±151	873±141	605±243	156±59	188±131	717±129	417±144	175±37	210±113
24 ..	506±67	1306±245	1144±426	920±274	202±77	226±79	942±348	694±212	251±81	307±103

Y=1864.308—0.874 X, where Y=food consumption ($mg.g^{-1}$ day^{-1}) and X=initial dry weight (Fig. 1), However, in the case of meal insects this relation was not significant.

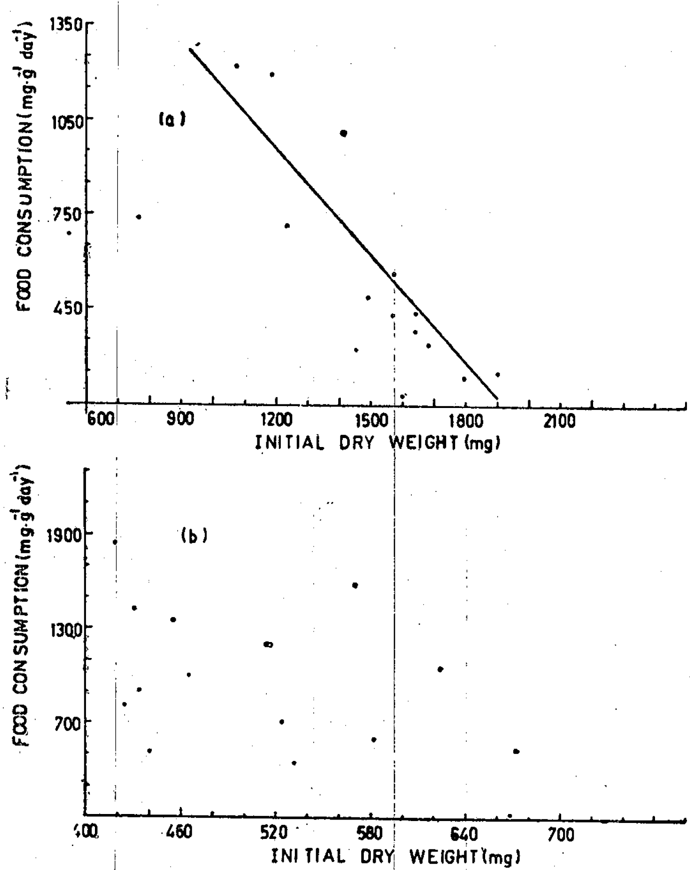

Fig. 1. Relationship between food consumption and initial dry weight of (*a*) female and (*b*) male individuals of *P. pictus*.

Both in males and females, egesta was inversely related to body weight according to the following regressions (Fig. 2):

(Female) Y = 115.842—0.201 X : ($r = -0.56$, $P < 0.05$)

(Male)Y=518.118—0.654 X : ($r = -0.61$, $P < 0.01$)

where Y=egesta ($mg.g^{-1}$ day^{-1}) and X =initial dry weight (mg) of insects.

Weight specific assimilation also declined with increase in the body weight in both male and female insects (Fig. 3). The assimilation was related with the body weight in females according to:

Y=944.468—0.354 X : ($r = -0.61$, $P < 0.05$) and in male insects according to :

Y=769—1.38 X : ($r = 0.52$, $P < 0.05$).

In the above relations Y=assimilation ($mg.g^{-1}day^{-1}$) and X =Initial dry weight (mg) of insects.

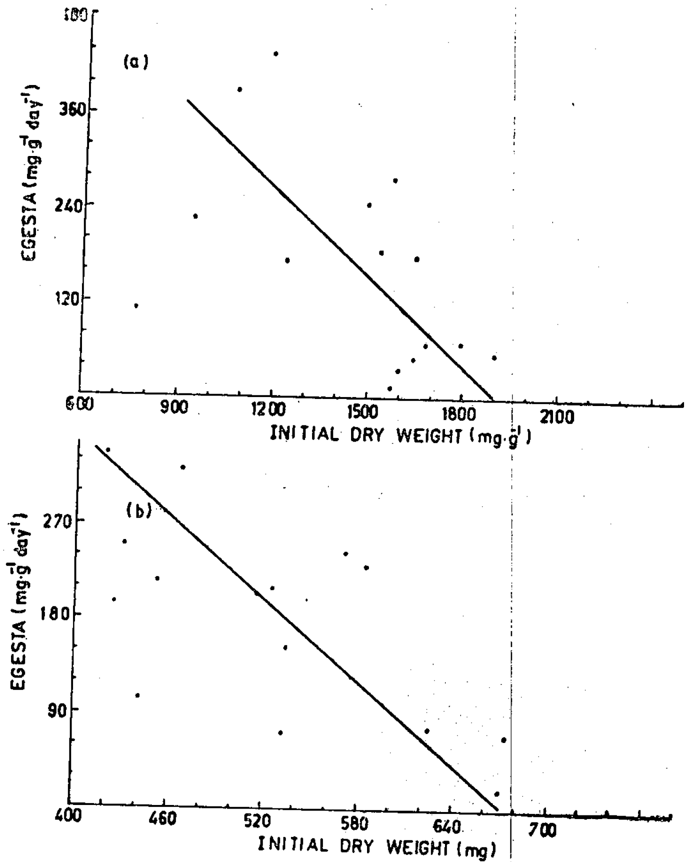

Fig. 2. Relationship between egesta and initial dry weight of (*a*) female and (*b*) male individuals of *P. pictus*.

Assimilation and food consumption were found to be positively related in both the sexes (Fig. 4) according to the following regressions:

(Female) $Y = -46.56 + 0.76\,X$: ($r = 0.979$, $P < 0.01$)

(Male) $Y = -76.16 + 0.89\,X$: ($r = 0.953$, $P < 0.01$)

where Y=assimilation ($mg.^{-1}$ day^{-1}) and X=food consumption ($mg.^{-1}$ day^{-1})

Tissue growth was also positively related with consumption (Fig. 5) according to the following regressions:

(Female) $Y = -50.95 + 0.233\,X$: ($r = 0\ 56$, $P < 0.05$)

(Male) $Y = 9.22 + 0.129\,X$: ($r = 0.51$, $P < 0.05$)

where Y=tissue growth ($mg.^{-1}$ day^{-1}) and X = consumption ($mg.g^{-1}$ day^{-1}). Working on *Podisus maculiventris* Say, Mukerji and LeRoux (1969) have also reported a positive relation between the mean daily food consumption and the mean daily growth in various instar nymphs. Latheef and Harcourt (1972) while working on *Leptinotarsa decemlineata* Say have also recorded a direct relation between food consumption and larval growth.

Although the tissue growth and assimilation were found to be directly and significantly related in female insects (Fig. 6) according to;

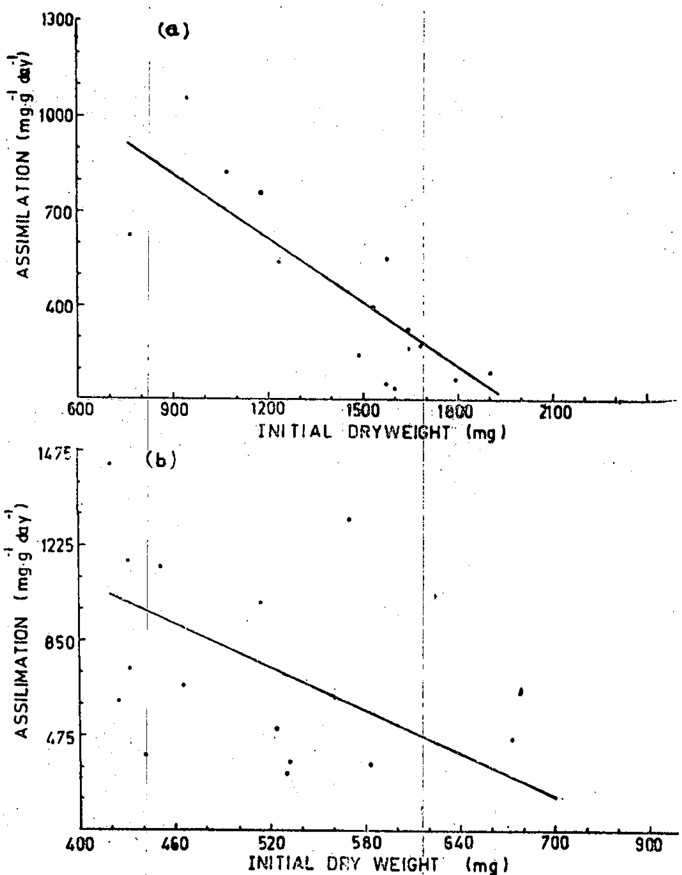

Fig. 3. Relationship between assimilation and initial dry weight of (*a*) female and (*b*) male individuals of *P. pictus*.

$Y = -69.37+0.312\ X : (r=0.51,\ P<0.05)$, where

Y=tissue growth ($mg.g^{-1}\ day^{-1}$) and X= assimilation ($mg.g^{-1}day^{-1}$) this relationship was not statistically significant in the case of male insects. That is perhaps because of high activity level in males which increases the respiratory cost.

Ecological Efficiencies

The values for assimilation efficiency, tissue growth efficiency and ecological, growth efficiency are set in Table 2. The assimilation efficiency, in general, represents approximate digestibility of the food, while the tissue growth efficiency represents the efficiency of conversion of digested food into body substance (Waldbaner 1968, Latheef and Harcourt 1972). The ecological growth efficiency reflects the proportion of ingested food available to be passed on to the next trophic level (Phillipson 1966, Van Hook and Dodson 1974).

The mean value of assimilation efficiency varied from 77.4% to 82.3% in the case of male insects and from 48.5% to 85% in the case of female insects. These

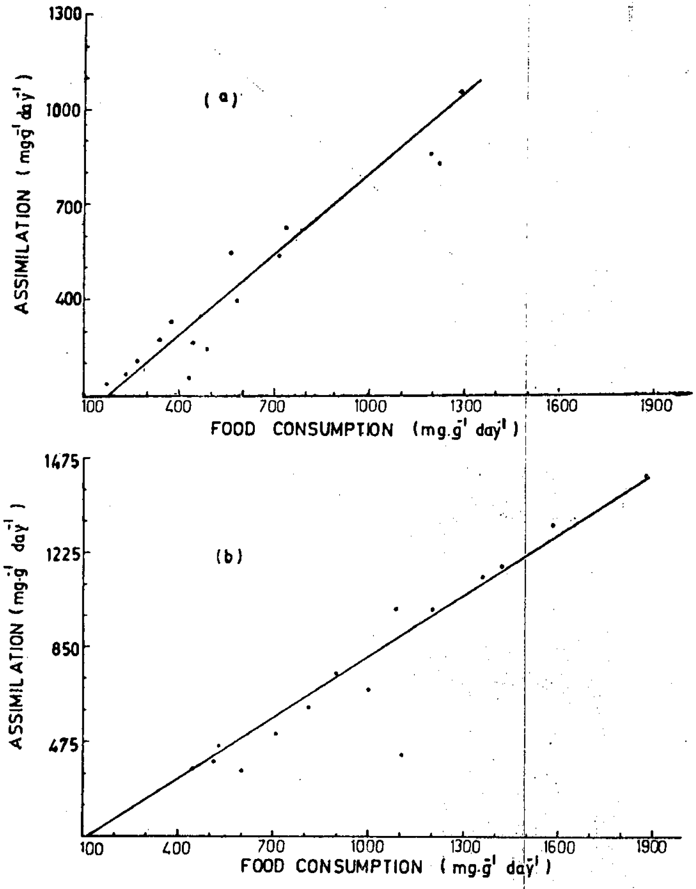

Fig. 4. Relationship between assimilation and food consumption of (*a*) female and (*b*) male individuals of *P. pictus*.

TABLE 2. *Ecological efficiencies in* Poecilocerus pictus *fed on* Calotropis procera *leaves* (*Mean* ± 1 *SE*)

Period for which food was withheld before 24-hr feeding	Assimilation Efficiency (%)		Tissue growth Efficiency (%)		Ecological growth Efficiency (%)	
(hr)	Male	Female	Male	Female	Male	Female
0	81.1±3	48.5±9	6.3±3.5	70.8±8	5.2±3	34.3±4
6	77.4±5	68.4±5	16.5±3	32.7±10	12.8±3	22.3±4
12	81.0±2	85.0±5	9.9±3	17.1±7	8±3	14.6±5
18	82.1±4	68.9±6	24.4±5	50.3±13.2	20±2	34.6±7
24	82.3±1	75.4±3	26.6±16	44.2±5	21.9±2	33.3±3

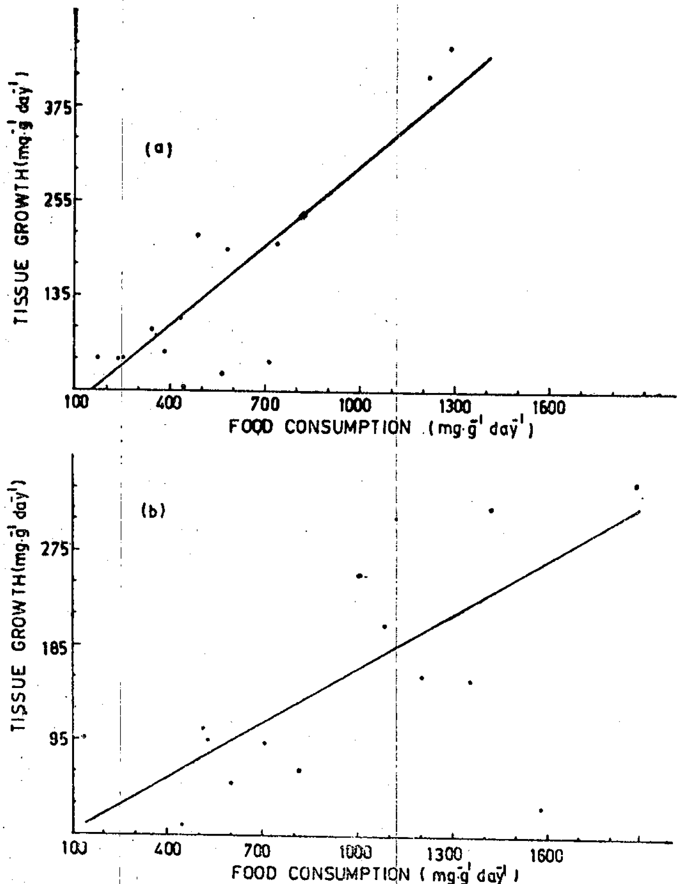

Fig. 5. Relationship between tissue growth and food consumption of (*a*) female and (*b*) male individuals of *P. pictus*.

values indicate good digestibility of the food and reflect the compatibility of the insect and its host. The assimilation efficiency for insects is quite variable depending upon the nutrition value of the food (Odum 1971). Latheef and Harcourt (1972) have reported assimilation efficiency of 73% to 97% for the potato and tomato leaves being consumed by the larvae of *Leptinotarsa decemlineata*, while Van Hook and Dodson (1974) have found assimilation efficiency of 54% for *Odontopus calceatus* Say feeding on *Liriodendron tulipifera*.

The tissue growth efficiency of adult *P. pictus* males varied from 8.3% to 26.6% and for females from 17.1% to 70.8%. Thus the females are more efficient in conversing the digested material into body tissue. Apparently the cost of maintenance (respiratory metabolism) is lower in females, which are significantly heavier than the male insects. Latheef and Harcourt (1972) have found large variability in the tissue growth efficiency of larvae of *Leptinotarsa decemlineata* fed on different food sources; the values ranged from 7.4% to 63.7%. For *Odontopus calceatus*, Van Hook and Dodson (1974) found this efficiency to be 19%. Phillipson (1966)

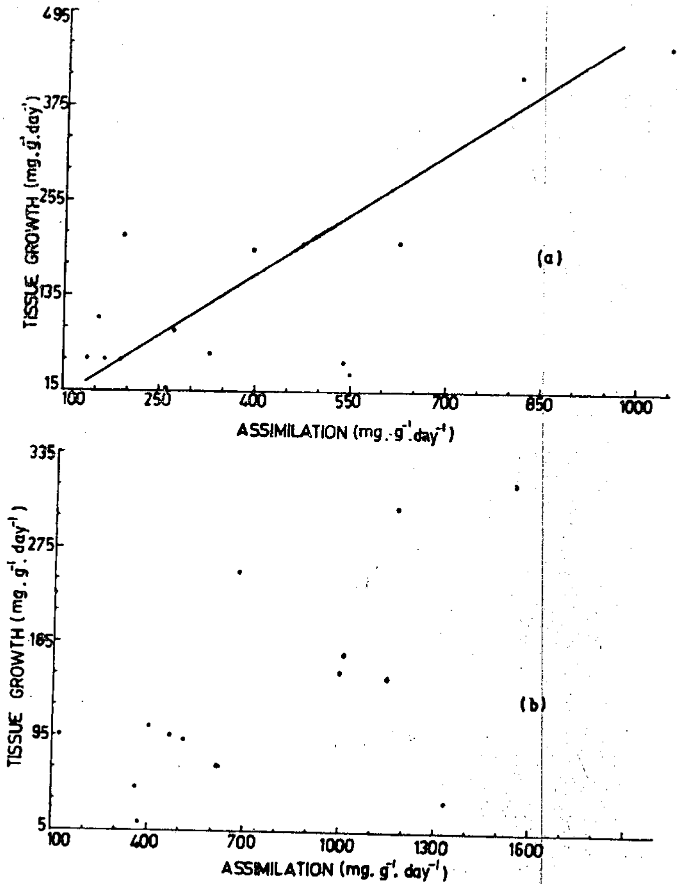

Fig. 6. Relationship between tissue growth and assimilation of (*a*) female and (*b*) male individuals of *P. pictus*.

has observed that the tissue growth efficiency in animals could vary from 5% to 60%.

The ecological growth efficiency in the present case varied from 5.2% to 21.9% in the case of male insects and from 14.5% to 34.6% in the case of female insects. These values are thus within the range reported for invertebrate herbivores (Kozlovsky 1968, Phillipson 1966, Reichle 1971, Van Hook 1971, Latheef and Harcourt 1972, Van Hook and Dodson 1974).

The tissue growth efficiency was found to be inversely related with the assimilation efficiency (Fig. 7) according to the following regressions:

(Female) $Y = 438.5 - 4.98\ X$: ($r = -0.71$, $P < 0.01$)

(Male) $Y = 52.25 - 0.439\ X$: ($r = -0.61$, $P < 0.05$)

where Y=tissue growth efficiency (%) and X=assimilation efficiency (%). This inverse relationship in animals has been earlier reported by Odum and Smalley (1957), Welch (1968) and Latheef and Harcourt (1972). There was no statistical significant relationship among other combinations of ecological efficiencies. Fur-

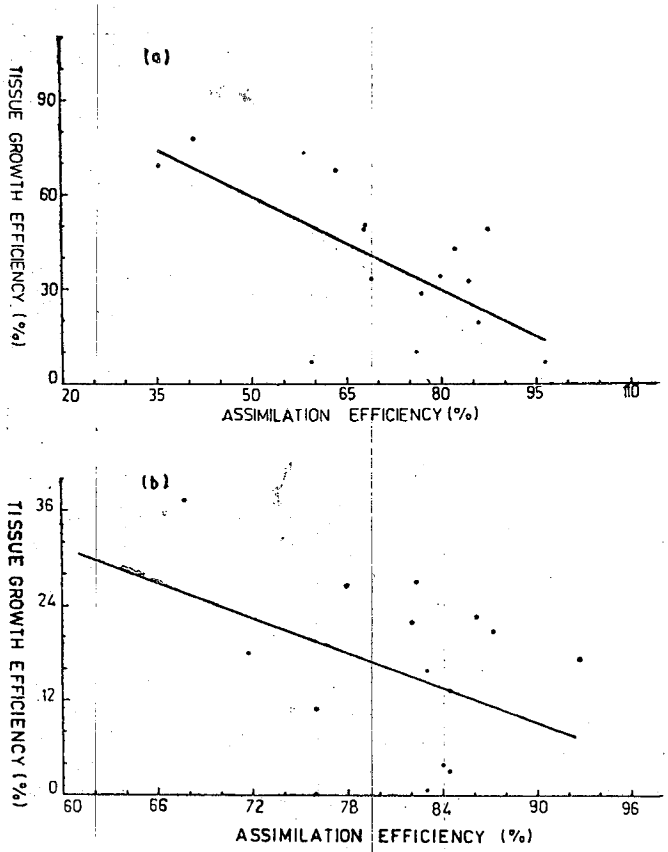

Fig. 7. Relationship between tissue growth efficiency and assimilation efficiency of (*a*) female and (*b*) male individuals of *P. pictus*.

ther, withdrawal of food for varying periods of time had no consistent influence on the ecological efficiencies.

SUMMARY

The food consumption, assimilation, tissue growth and ecological efficiencies of the male and female *Poecilocerus pictus* Fabr. fed on *Calotropis procera* leaves have been worked out under laboratory conditions. All the calculations were done on dry weight basis. The food consumption (♀, 367±79 to 938±311 $mg.g^{-1}day^{-1}$ and ♂, 821±191 to 1144±426) and assimilation (♀, 178±27 to 694+212 $mg.g^{-1}$. day^{-1} and ♂, 603±21 to 943±35 $mg.g^{-1}$ day^{-1}) per unit weight were higher in male than in female insects. However, tissue growth was not statistically different for the two sexes. The food consumption was inversely related to initial dry weight in female, whereas, in male insects this relation was not significant. Egesta and assimilation were also inversely related with initial dry weight of insects. Assimilation and tissue growth were positively related with the food consumption.

Tissue growth efficiency varied from 8.2% to 23.9% in male and 16.4%

to 66% in female insects indicating that female insects were more efficient in converting the digested material into body tissue and had lower maintenance cost. The ecological growth efficiency varied from 6% to 20% in male and 13.9% to 33.3% in female insects. Starvation had no consistent influence on the ecological efficiencies.

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