FEEDING POTENTIAL OF *CASSIDA CIRCUMDATA* HERBST (CHRYSOMELIDAE : COLEOPTERA) ON *IPOMOEA REPTANS* (LINN.) (CONVOLVULACEAE)[1]

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(*With one text-figure*)

Key words: *Cassida circumdata*, Coleoptera, *Ipomoea reptans*, Convolvulaceae

The tortoise beetle *Cassida circumdata* Herbst feeds on the aquatic plant *Ipomoea reptans* (Linn.) (Family: Convolvulaceae), which grows profusely in the tropical wetlands. This plant species was found invading the open water area and changing the proportion of habitats available for aquatic birds and fishes. The different larval instars and adults of the tortoise beetle were noticed feeding on the leaves and tender stems of *Ipomoea reptans*, one of the abundant aquatic plants in Keoladeo National Park, Bharatpur, Rajasthan, which is among the major protected wetlands in India.

To assess the impact of *Cassida circumdata* on its main host plant *I. reptans*, consumption of the leaves in terms of area fed by different larval and adult stages were studied under laboratory conditions (30 ±2 °C and 50-70% relative humidity). The first to fifth instar larvae and adult differed widely in their consumption of host plant leaves. The area consumed was in the order 1st <2nd <3rd <4th <5th instars > adult. Significant correlation could be obtained between the growth of the larvae and their food consumption. The different rates of food consumption indicate the varying energy requirements of the various larval stages of the beetle.

INTRODUCTION

Recently, much attention has been given to the herbivore-plant relationship, with reference to its ecological and evolutionary impacts (Denno and McClure 1983). Such studies demand a knowledge of the actual consumption of the host plant parts by the herbivore and its growth rate. The quantitative assessment of consumption of host plants by its pest may help us to assess the impact of the pest on the growth of the plant and thereby the possible use of that pest as an agent of biological control.

The tortoise beetle *Cassida circumdata* Herbst feeds on the aquatic plant *Ipomoea reptans* (Linn.), which grows profusely in tropical wetlands. About 91 species of wetland macrophytes have been identified from the Keoladeo National Park of which the most dominant species is a grass, *Paspalum distichum*, that covers a major part of the aquatic area. The rest is mostly covered with *Ipomoea reptans*, an important amphibious herb. *Ipomoea reptans* floats in water, usually appears as a trailing herb and changes the proportion of the habitat available for aquatic birds and fishes (Ali and Vijayan 1986). In the Park, *I. reptans* remains in a dormant stage during winter (December-February).

In summer (April-June), as the water level drops and the stem makes contact with the ground, it produces leaves in large numbers. After monsoon and when the level of water rises, *I. reptans* spreads and attains maximum growth. This paper reports the result of the study carried out in the field and under laboratory conditions, to determine the feeding potential of *C. circumdata*.

The life-cycle of *C. circumdata* includes 5 larval stages and a pupal stage. The eggs were laid on the ventral side of *I. reptans* leaves. Under

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laboratory conditions (30 ±2 °C), the eggs hatched within 4 days. The duration of the 5 larval instars was 2, 1-2, 2, 2 and 4 days respectively. The pupal stage lasted for 4 days.

Study area

The present study was carried out in the well-known protected wetland, the Keoladeo National Park, Bharatpur (27° 7.6' to 27° 12.2' N and 77° 29.5' to 77° 33.9' E), Rajasthan, India.

Methodology

Both sexes were almost alike, the male being slightly smaller than the female. To study the feeding and oviposition, experiments were carried out in plastic containers (height = 8 cm and diameter = 3 cm) with screw top having holes for ventilation. Discs of filter paper were placed at the bottom of the containers to absorb excess moisture and facilitate cleaning. Mating pairs were collected from the field and kept in these containers. The leaf-area fed by the adult and the eggs laid after 24 hrs were recorded. The adults, when kept in containers laid eggs on the leaves of *I. reptans*, and the eggs hatched within 4 days.

Newly emerged larvae were placed one in each container and provided with fresh leaves of *I. reptans* daily. The body length and breadth were measured every 24 hrs using a compound microscope with a calibrated ocular micrometer. When fresh leaves were freely available, the larvae and adults fed upon the fresh area. The leaf area consumed and removed at one meal (leaf area fed at a stretch) was measured by placing the leaf on graph paper and tracing the leaf area fed, and then counting the squares of the leaf area fed, as suggested by Simmonds (1949). As the early instars fed very little and made circular holes, the radius of the circular path fed was measured with graph paper and by a calibrated, ocular micrometer. To estimate the quantity of food consumed by the adult and grub of *Lema lacordairei* (Chrysomelidae), Visalakshi and Nair (1987) used similar methods.

Along with the experimental studies in the laboratory, an attempt was made to quantify the feeding impact of different instars of the beetle on the host plant. This was carried out by collecting the plant and different stages of the beetles from randomly placed quadrats of 100 x 100 sq. cm. Collections were made from 6 study plots. Once the quadrat was placed, all the leaves above water were plucked and transferred into plastic bags (harvest method). The adults that flew off on being disturbed were also counted. In the laboratory, all the leaves were carefully examined and the different instars and adults counted. The leaf area was measured using the same method as above. The leaf biomass was quantified using an electrical monopan balance of sensitivity 0.1 mg. The samples were taken once in seven days and monthly averages were calculated.

Results and discussion

Lab experiment: The average leaf area of *Ipomoea reptans* consumed and the average growth (length and breadth) of the larvae of *Cassida circumdata* for each day are summarized in Table 1. The maximum leaf area was consumed on the eighth day by the 5th instar larva (59.33 sq. mm). The maximum increase in the larval stage was noted on the seventh and eighth day. On the ninth day, the larvae slowly decreased their rate of feeding and entered pupation. The 5th instar larva fed about 101.16 sq. mm leaf area within 3 days. The maximum area was fed upon by the two day old 5th instar larva. This study showed that the 5th instar larvae can consume almost 4 times more than the 4th instar and about 100 times more than the 1st instar (Table 1).

A single larva from the 1st through the 5th instar consumed about 145.95 sq. mm leaf

TABLE 1
FOOD CONSUMPTION AND GROWTH OF THE LARVAE OF *C. CIRCUMDATA* REARED ON *I. REPTANS* IN THE LABORATORY (30±2°C)

Days	1	2	3	4	5	6	7	8	9	10	11
Stage (instar)	1st	2nd	3rd	3rd	4th	4th	5th	5th	5th	Pupa	Pupa
Increase in length (mm)	0.15	0.28	0.3	0.2	0.45	0.45	0.75	0.58	0.18	-0.08	0
Increase in breadth (mm)	0.08	0.17	0.15	0.13	0.37	0.17	0.38	0.55	0	0	0
Area fed (sq. mm)	1.86	5.01	4.68	9.83	9.65	16.79	30.25	59.33	11.58	0	0

area of *I. reptans* within 9 days (Table 1). The average leaf area collected during July-October was 17.55 sq. cm. The study showed that two larvae from the 1st instar through 5th instar can completely eat and skeletonise a single leaf.

To study the feeding behaviour of the beetle, the host plant leaves were observed when there was less attack. Of the total holes fed and made by the larvae and the adult (N = 5,265 holes) 95.5% of the holes indicated only one feeding. This indicates that the larvae and adults preferred to feed on fresh area when the host plant leaves were plentiful.

The leaf area fed and removed at one meal (in a stretch) by each instar larva and adult are summarized in Table 2. The result showed that the 5th instar larvae consumed greater leaf area at a single meal and the first instar the least.

The adult *C. circumdata* pair under captivity (N=15) fed on 56.81 ±12.53 sq. mm leaves and laid 12.6 ±6.1 eggs within 24 hrs. The mating pairs fed 17.1 ±4.8 times within 24 hrs. The area fed upon by the mating pairs was less compared to the 5th instar larva, as more time was utilized for mating and laying eggs. No significant correlation was noticed between the area fed and the number of eggs laid.

Simmonds (1949) assessed the leaf area consumed each day by the larvae of *Physonota alutacea* (Cassidinae). The leaf area consumption was seen to increase with the growth of the larvae each day, the maximum consumption of leaf area

TABLE 2
LEAF AREA OF *I. REPTANS* CONSUMED (SQ. MM) BY THE LARVAE AND ADULT *C. CIRCUMDATA* AT 30 ±2°C (N=80)

1st instar	0.21 ±0.13
2nd instar	0.35 ±0.19
3rd instar	0.80 ±0.37
4th instar	1.86 ±0.82
5th instar	5.32 ±3.41
Adult	3.77 ±1.72

was noted on the 16th day. In *Aspidomorpha miliaris*, the adult consumed seven times more leaf area than the 5th instar (Manjunatha *et al.* 1987). *Bombyx mori* and *Protoparce sexta*, both lepidopterous leaf feeders, eat about 97% of their total intake during the last two instars and about 99% during the last three instars respectively. In *Bombyx mori*, it was noticed that the efficiency of storage of metabolizable energy increases with age, reaching its peak in the 5th instar. The large amount of energy stored during 5th instar is, of course, needed to support the non-feeding pupa and adult (Waldbauer, 1968).

Field experiments: Field observations revealed that the beetle appears in the study area during March (mean min. temp. = 19 °C). The host plant was available only along the dykes. The population of *C. circumdata* remained almost constant during the peak summer months. With the onset of monsoon and the release of water from Ajanbund, an inundation reservoir situated 0.5 km south of the Park, the plant spread over the area by vegetative reproduction. There is spatial variation in the abundance of this plant in the Park. By this time, the beetle had settled in different areas. The adults mainly concentrated in certain areas, fed and laid eggs. There was wide fluctuation in the population of different stages of the beetle among the different study plots. After laying eggs, the adults move to other less infected areas. The adult beetles prefer to lay eggs on the underside of fresh young leaves. Eggs were never laid on skeletonised leaves, to ensure enough food for the emerging larva.

The average maximum number of different stages of the beetle was noted during September (Fig. 1). The leaf area of the host plant was found following the same trend as that of the beetle. Thus, a significant positive correlation was obtained between biomass and leaf area of the plant with the population of the beetle ($r = 0.821$, $p = 0.001$; $r = 0.8472$, $p = 0.0001$, $n = 60$).

It was observed that the host plant compensated for the leaf area fed upon by the larval and adult *C. circumdata* by producing larger leaves. Leaves with greater surface area were noticed in August and September during 1985, when the population of the beetle was at its peak (Fig. 1). But in a later study during 1986-87, a similar response of the host plant could not be observed due to low population of the beetle (George 1988). The maximum population (468/ sq. m) and leaf area (17.8 sq. mm) during 1986, was noticed in September.

Kolodny-Hirsch and Harrison (1982) conducted field and field cage studies to compare larval injury by the tobacco bud worm, *Heliothis virescens* and corn ear worm, *Heliothis zea* (Lepidoptera: Noctuidae). Their observations showed that the plant compensated for leaf loss by increasing the laminal area of the damaged leaves.

The population of *C. circumdata*, in the Park, reached a peak in September, and as a result the leaf area and biomass declined. In the end, only leaf skeletons remained in the infested areas. Thus, leaf biomass became zero towards the onset of winter. In winter, both the plant and its pest remained dormant. The beetles were found hibernating, in the Park, on terrestrial plants, namely *Salvadora persica*, albeit in small numbers (George 1988). This formed the breeding stock for the next population during February-March, and by this time the host plant also starts producing smaller leaves. Thus, the interrelated life-cycles of the host and pest continue.

The study unravels a unique relationship between the plant and the beetle. Though the beetle controls the biomass of the host plant, it

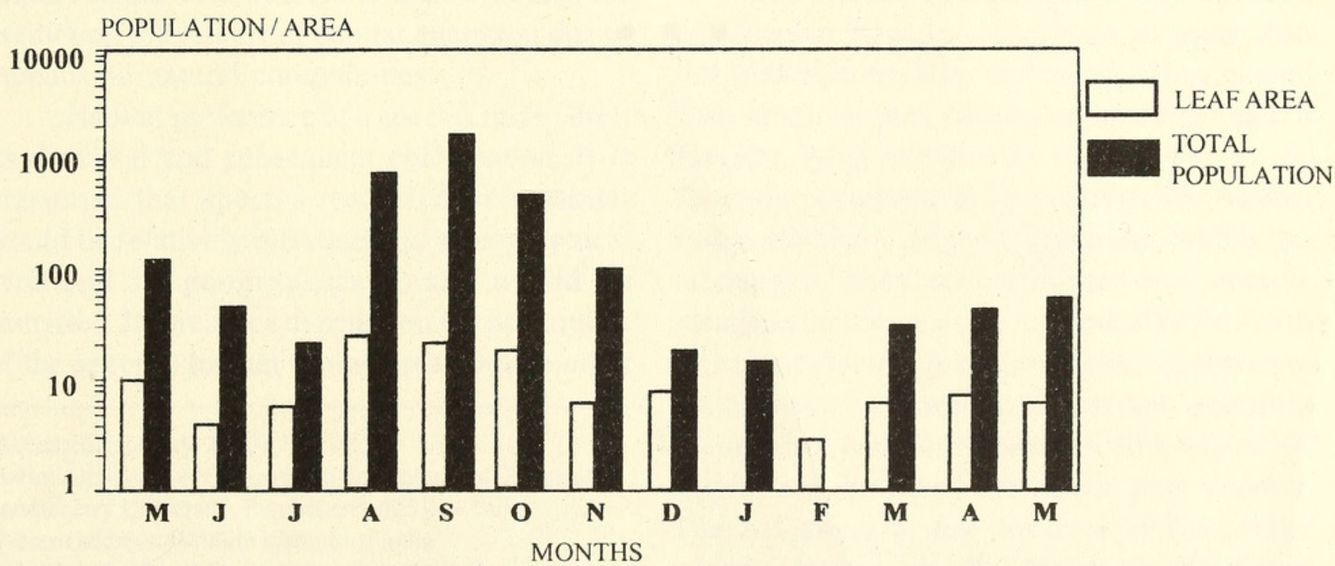

Fig. 1: Leaf area (sq. mm) of *I. reptans* and population of *C. circumdata*

does not completely destroy them, thereby ensuring its own survival. The most important barriers which prevent the beetle from destroying the plant entirely are the ability of the plant to survive under water and low ambient temperatures (average minimum temp. in December-February 8 °C).

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