Preliminary Findings on the Biology of *Autoserica rufocuprea* (Blanchard) *sensu* Brenske (Coleoptera: Melolonthinae) in Singapore

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Abstract

Autoserica rufocuprea, a species of Melolonthinae and a night flying beetle, has been found to attack many ornamental plants and shade trees in Singapore. Thirty two species of its food plants were revealed by field observations at night. A survey showed that in a park developed on clayey reclaimed land, about 8% of the total plant population was damaged. The level of infestation of the beetle in different parts of the park and the susceptibility of its host plants are discussed. The damage patterns made on plants, and preliminary observations on the life cycle and seasonal flights of the beetle are briefly described.

Introduction

The cockchafers, which include night-feeding beetles in the subfamilies Rutelinae and Melolonthinae (Dammerman, 1929), have long been known to be serious plant pests in many parts of the world including Southeast Asia. According to various reports, many economic crops, some forest trees, shade trees, turf and pastures have been damaged (Swaine, 1971; Britton, 1979; Borror & Delong, 1966; Ritcher, 1966). Some ornamental plants have also been named as host plants (Dammerman, 1929; Yunus & Ho, 1980).

In Singapore it had often been observed that many ornamental plants and shade tree saplings suffered serious foliar damage similar to those made by a few species of cockchafers on economic crops (Kalshoven, 1951; Lever, 1953). Studies were therefore carried out from November 1979 to February 1980 by the Entomology Unit of Parks & Recreation Department to confirm these suspected pest attacks. The host range of these night flying beetles at Botanic Gardens & East Coast Park was investigated. The extent and severity of damage made on plants at East Coast Park was also assessed. Subsequently, laboratory studies and field observations were conducted to gather more information about the life cycle and seasonal flights of these beetles. This paper reports the findings and preliminary observations made by the author on *Autoserica rufocuprea*, one of the cockchafers.

Study Sites

The surface area of the Botanic Gardens (BG) is about 32 hectares. Apart from the orchids and the plants in the Gardens' jungle, it accommodates nearly a thousand species of native and introduced plants scattered over some 20 lawns. Most of these species are represented by only one to a few individuals. The garden was first established in 1859 and most of the trees here are old.

The East Coast Park (ECP) is a park newly developed on clayey reclaimed land. It has about 100 hectares of green area, which were planted up between 1973 and 1978. It is divided by monsoon drains into 6 sections, namely areas E, C, D, B, A, F and AA, listed in chronological sequence of development. A peculiar feature of the park was that certain areas, namely areas F, E and parts of AA were often waterlogged due to poor drainage. At the time the studies began, the park had about a hundred species of plants. These included mainly ornamental and shade trees and some shrubs. Here plants of the same species mostly occur in distinct stands which vary from a few to hundreds in number.

Materials and Methods

1. *Collection of the cockchafers*

The adult cockchafers are known to shelter in the soil during day time and only emerge after sunset. Therefore most collections were obtained between 7.00pm and 10.30pm. The cockchafers on host plants were revealed in torch light. They were either picked by hand or shaken directly into plastic bags or vials.

In day time, the grubs, pupae and adults were obtained by digging into the turfed areas near the host plants.

2. *Identification of A. rufocuprea*

The pinned adults were sent to the Commonwealth Institute of Entomology and the National University of Singapore for identification.

3. *Survey on host plants*

The host plants of *A. rufocuprea* and the damaged plant parts were observed at the two study sites at night. The damage patterns made on host plants were also carefully noted during the visits.

4. *Survey on pest status of A. rufocuprea at ECP*

The two aspects of the survey were the relative infestation levels of *A. rufocuprea* in different areas of ECP and the extent of damage made on individual species of host plants. The entire park was systematically combed for 3 months starting from mid-November 1979 so that all the plants were examined as far as possible.

At each area of ECP, records were made of the number of plants examined, which also was, or almost equalled, the total plant population of the area. The total number of host plants and of those with typical damage symptoms were also noted. The percentage of plants attacked in each area was then worked out. These percentages were used to indicate the relative level of infestation of *A. rufocuprea* in the different areas.

The extent of damage made on 19 species of host plants was quantified by two indices, namely the % incidence of attack and the severity of damage.

The % incidence of attack of any species is determined by the formula :

$$\frac{\text{No. of plants (of the species) attacked}}{\text{No. of plants (of the species) examined}} \times 100\%$$

The severity of damage was a visual assessment of the percentage of the foliage or canopy of a plant eaten up by the insect. It was arbitrarily categorised into 5 degrees, as follows:

% of foliage eaten	*Severity of damage*	*Denotation*
<10%	very slight	+
10 – 30%	slight	++
31 – 50%	moderate	+++
51 – 70%	severe	++++
>70%	very severe	+++++

The severity of damage given in the results for a particular species of plant is the assessment rated for the majority of plants examined.

5. *Observations on life-cycle and seasonal flights*

The adults collected during the mating season were reared at room temperature (about 28°C) in rectangular perspex cages. Each cage measures 50 x 50 x 60 cm and has one side made of white organdi. Young *Peltophorum pterocarpum* (DC.) K. Heyne seedlings grown in polythene bags were placed in the cage as food plants. The soil in the polythene bags was checked for the presence of eggs at intervals of 3 to 4 days. The eggs and newly hatched grubs were transferred to small bottles containing soil and vegetative litter. The grubs were later reared on roots of cowgrass in pots until they pupated. The pupae were kept in bottles filled with slightly moist soil until they hatched into adults.

The seasonal flight periodicity of *A. rufocuprea* was determined by monthly visits of ECP at night, the duration of the study being from February, 1981 to April, 1982. When the population was high, visits were conducted more frequently, at fortnightly or weekly intervals. During each visit the abundance of the beetles on the host plants was noted and their mating activities were observed.

Results & Discussions

1. *The identification of A. rufocuprea*

The cockchafer under study was identified by the Commonwealth Institute of Entomology as *Maladera* sp. It was later identified by Mr. D.H. Murphy of the National University of Singapore as *Autoserica rufocuprea* (Blanchard) *sensu* Brenske 1894. He believes this to be of the same species as one recorded from Ceylon but in the British Museum, it is placed under *Aserica mollis* (Walker).

It appears that the controversy over the placing of this insect under the genera *Autoserica, Maladera,* or *Aserica* is merely a matter of difference of opinion. Kalshoven (1951), for instance, had included *Aserica, Autoserica* and *Microserica* in his description of the genus *Serica.*

2. *Damage patterns and feeding habits*

A. rufocuprea often feeds gregariously (Pl. 1). This can lead to severe defoliation of saplings or new transplants bearing new leaves (Pl. 2). Leaves which are many

Plate 1. *Autoserica rufocuprea* feeding gregariously on leaves of *Cassia nodosa.*

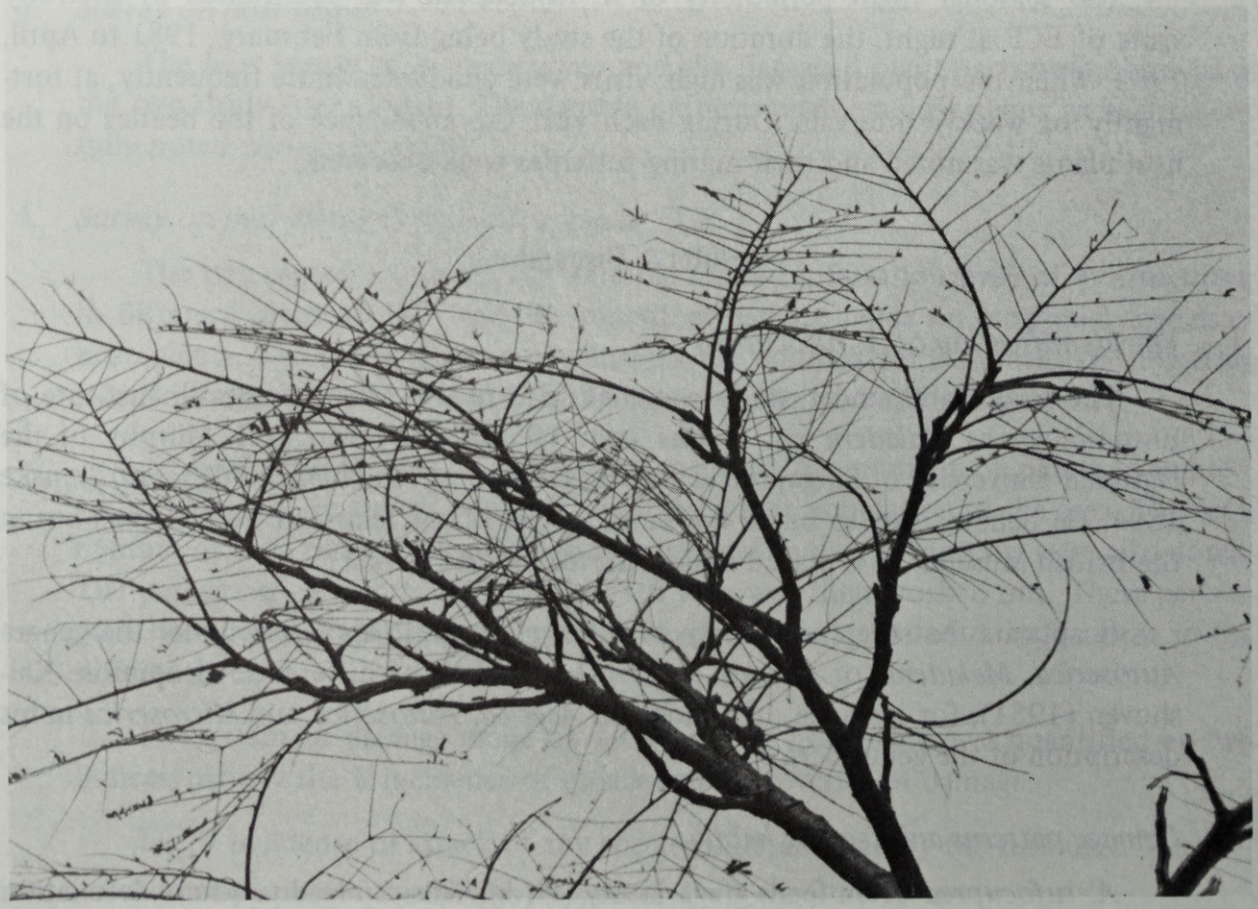

Plate 2. Branches of *Cassia nodosa* defoliated by *Autoserica rufocuprea.*

Plate 3. Leaves of young *Gardenia carinata* skeletonised by *Autoserica rufocuprea.*

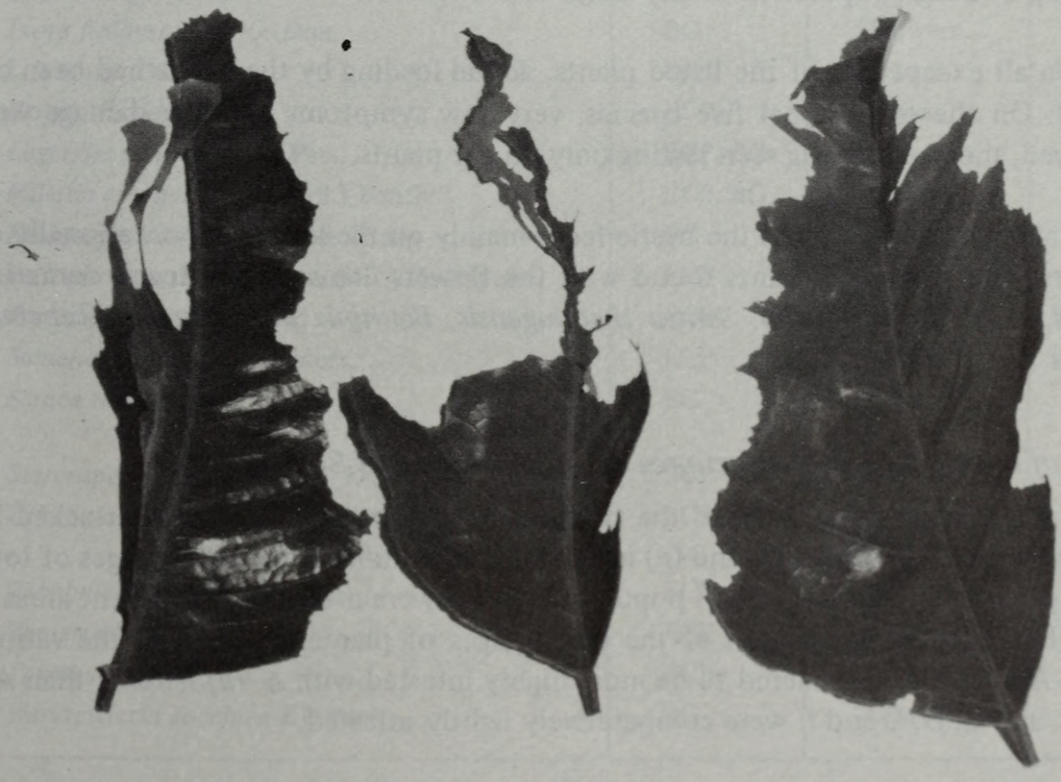

Plate 4. Leaves of *Erythrophleum suaveolens* with gnaw-marks of *Autoserica rufocuprea.*

times the size of the beetle can be skeletonised to side veins or just the midrib (Pl. 3). Those less severely attacked will have big, irregular cuts at the leaf edges (Pl. 4). Flower petals and buds can also be badly gnawed (Pl. 5). The damage pattern on individual leaves is quite similar to that caused by *Apogonia cribricollis* Burm., another Melolonthinae (Lever, 1953); it is quite distinct from that caused by species of *Adoretus,* a Rutelinae, which make holes in leaves (Kalshoven, 1951).

A. rufocuprea has the habit of clinging to the edges of leaves while feeding; but it would drop instantly to the ground at the slightest touch of the leaf on which it is feeding. It would respond in similar fashion while being approached or shone on abruptly. Occasionally, female *A. rufocuprea* may be seen to feed whilst mating (Pl. 6).

A. rufocuprea only damages young, tender leaves in contrast with *Adoretus compressus* Weber which feeds on older leaves. The difference in their food preference could be the reason why *A. rufocuprea* and *A. compressus* can co-exist in the same location and can sometimes be found on the same plant, though seldom on the same leaf.

3. *Host plants*

Table 1 lists the host plants of *A. rufocuprea* at ECP and BG.

Of these, 26 species were recorded at ECP and 12 species at BG. Many of the host plants at BG are not attacked because they do not occur in pure stands which provide ample food for the pest, unlike those at ECP. Moreover, the much more complex ecological community at BG has attained a stable equilibrium which resists the build up of a high population of any single insect species.

On all except five of the listed plants, actual feeding by the beetle had been observed. On the exceptional five species, very few symptoms of foliar damage were observed, the beetle being seen resting only on the plants.

Table 1 also shows that the beetle feeds mainly on the leaves and occasionally on flowers. The species of plants found with the flowers damaged are *Acacia auriculaeformis, Ixora finlaysoniana, Saraca thaipingensis, Bauhinia purpurea* and *Tabebuia pallida.*

4. *Level of infestation of A. rufocuprea at different areas of ECP*

Table 2 shows that 8.0% of the total plant population at ECP was attacked by *A. rufocuprea.* Columns (d) and (e) in the table also indicate the percentages of total plant population and host plant population which were attacked at different areas in ECP. Based on a comparison of the percentages of plants attacked in the various areas, A could be considered to be more highly infested with *A. rufocuprea* than AA and B, and C, D, E and F were comparatively lightly infested.

Observations of the different areas at night also revealed that the *A. rufocuprea* population was high in areas A, B and AA, and low in the others. The beetle popula-

Table 1.
Host plants of *A. rufocuprea* at East Coast Park and Botanic Gardens

Host plant	*Location*	*Parts damaged*	*+ Date observed*
Acacia auriculaeformis Bth.	ECP	Flowers	Sept. 81
Actinorhytis calapparia (Bl.) Scheff.	BG	*	
Andira inermis (Wight) HBK	ECP	Leaves	
Antidesma bunius (L.) Spreng.	ECP	Leaves	
Bauhinia purpurea L.	ECP	Leaves, Flowers	Apr. 82
Canna Primrose	BG	*	
Cassia fistula L.	ECP	*	Apr. 82
C. nodosa Roxb.	ECP	Leaves	Jul. 81
C. spectabilis DC.	ECP	Leaves	
Cochlospermum religiosum (L.) Aston	ECP	*	
Cola acuminata (Beauv.) Schott & Endl.	BG	Leaves	
Delonix regia (Hk.) Raf.	ECP	Leaves	
Erythrina fusca Lour.	ECP	Leaves	
E. variegata L.	ECP	Leaves	
Erythrophleum suaveolens (Guill. & Perr.) Bren.	ECP	Leaves	
Eucalyptus pellita F. Muell.	BG	Leaves	
Eugenia grandis Wight	ECP	Leaves	Feb. 81
E. polyantha Wight	ECP	Leaves	
Gardenia carinata Wall.	ECP	Leaves	
Hopea sangal Korth.	BG	*	
Ixora finlaysoniana G. Don.	BG	Flowers	
I. javanica DC.	BG	Leaves	
Kopsia flavida Bl.	ECP	Leaves	
Lagerstroemia speciosa Pers.	ECP, BG	Leaves	
Milletia atropurpurea (Wall.) Benth	ECP, BG	Leaves	
Paulownia taiwaniana Hu & Chang	BG	Leaves	
Peltophorum pterocarpum (DC.) K. Heyne	ECP	Leaves	
Pterocarpus indicus Willd.	ECP	Leaves	
Samanea saman (Jacq.) Merr.	ECP	Leaves	
Saraca thaipingensis Prain	BG	Leaves, Flowers	
Stereospermum fimbriatum DC.	ECP	Leaves	
Tabebuia pallida (Lindl.) Miers	ECP	Leaves, Flowers	
Tabebuia rosea (Bertol) DC.	ECP	Leaves	
Tamarindus indicus L.	ECP	Leaves	
Terminalia catappa L.	ECP	Leaves	Feb. 82
Warszewiczia coccinea Klotzsch	BG	Leaves	

* *A. rufocuprea* was only seen resting on this species, no feeding was observed.

\+ Where unstated, date observed is November–December 1979.

tion was generally high where the host plants were young and where the activities of the beetle were least disturbed by nocturnal park users, and, it seemed low where the area was frequently waterlogged, e.g. at area F.

As it is neither entirely satisfactory to relate pest population to the level of pest damage (Southwood, 1966) nor to assess pest population visually, future assessment of the pest infestation level is best determined with methods like trapping and sampling of pest populations from plants.

Table 2
The number of plants in different areas of East Coast Park with the number and percentage attacked by *A. rufocuprea* indicated.

*Area**	*(a) Total plant population*	*(b) Host-plant population*	*(c) No. of host plants attacked*	*(d) % of plants attacked* $\frac{c}{a} \times 100\%$	*(e) % of host plants attacked* $\frac{c}{b} \times 100\%$
AA	544	99	59	10.8	59.6
F	679	142	29	4.3	20.4
A	2,757	589	399	14.5	67.7
B	2,829	627	259	9.1	41.3
D	3,980	1,722	250	6.2	14.5
C	3,274	881	187	5.7	21.2
E	3,158	744	194	6.1	26.1
Total	17,221	4,804	1,377	8.0	28.6

* The areas are listed in time sequence of development. AA is the most recently planted area.

5. *Extent of damage on the host plants at ECP*

Table 3 indicates the extent of damage made by *A. rufocuprea* on 19 species of host plants at ECP in terms of % incidence of attack and severity of damage.

Of the listed plants, 5 species were localised in only one or two areas of ECP. Of these 5 species, *Antidesma bunius* and *Cassia spectabilis* were located only in area A. Since the pest population was high in area A and the plants here were young, the % incidence of attack of these 2 species were very high.

Considering the pest population at the location of the trees together with the severity of damage and % incidence of attack, *Gardenia carinata* is probably only slightly less susceptible than *A. bunius,* but *Erythrina fusca* could be as vulnerable as or even more vulnerable than *A. bunius* because it was extensively and severely damaged despite the fact that it was located outside highly infested areas. Of the 5 species, *Erythrina variegata* was most resistant to the beetle attack.

Table 3.

The extent of damage made by *A. rufocuprea* on 19 species of host plants at East Coast Park in term of % incidence of attack and severity of damage

Host species	*Areas*			*Number of plants damaged/examined*	*% incidence of attack*	*Severity of damage*
	highly infested	*moderately infested*	*lightly infested*			
*1. *Antidesma bunius* (L.) Spreng.	A	–	–	10/10	100	++++
2. *Cassia spectabilis* DC.	A	–	–	15/16	93.7	++
3. *Erythrina fusca* Lour.	–	–	C,E	24/26	92.3	+++
4. *E. variegata* L.	–	B	D	7/29	24.1	+
5. *Gardenia carinata* Wall.	A	–	C	41/53	77.3	+++
+6. *Andira inermis* (Wight) HBK	A	AA, B	C,D,E,F	30/337	8.9	+
7. *Delonix regia* (Hk.) Raf.	A	B	C,D,E	5/51	9.8	+
8. *Eugenia polyantha* Wight	A	B	C,D	99/460	21.5	++
9. *Erythrophleum suaveolens* (Guill. & Perr.) Bren.	A	–	C,E	28/113	24.7	++
10. *Samanea saman* (Jacq.) Merr.	A	AA, B	D,E	193/1474	13.1	++
11. *Kopsia flavida* Bl.	A	B	C	81/97	83.5	++
12. *Lagerstroemia speciosa* (L.) Pers.	A	B	C,E	43/54	79.6	++
13. *Milletia atropurpurea* (Wall.) Benth.	A	AA, B	C,D	66/173	38.1	+
14. *Peltophorum pterocarpum* (DC.) K. Heyne	A	B	C,D,E,F	158/502	31.4	++++
15. *Pterocarpus indicus* Willd.	A	AA, B	C,D,F	191/712	26.8	+++
16. *Stereospermum fimbriatum* DC.	A	AA, B	C,D,E	108/143	75.5	++
17. *Tabebuia pallida* (Lindl.) Miers	A	AA, B	C,D,E,F	98/148	66.2	+++
18. *Tabebuia rosea* (Bertol.) DC.	A	AA, B	C,D,E,F	253/331	76.4	+
19. *Tamarindus indicus* L.	A	AA	C,D,E,F	33/67	49.2	++
Severity of damage % of foliage damaged	+ <10%	++ 10% – 30%	+++ 31% – 50%	++++ 51% – 70%	+++++ > 70%	

* species no. 1–5 are localised in one or two areas of ECP

\+ species no. 6–19 are well dispersed throughout ECP

Of the remaining 14 host species which were well dispersed throughout ECP, *Andira inermis* and *Delonix regia* were only slightly affected by *A. rufocuprea.* Compared to them, *Eugenia polyantha, Erythrophleum suaveolens, Samanea saman, Milletia atropurpurea* and *Tamarindus indicus* were more prone to attack. Species like *Kopsia flavida, Lagerstroemia speciosa, Stereospermum fimbriatum* and *Tabebuia rosea* had an even higher percentage incidence of attack although the degree of damage was generally slight. The three species of plants that were very severely damaged when they had plenty of young flushes were *Peltophorum pterocarpum, Pterocarpus indicus* and *Tabebuia pallida.*

6. *Life cycle*

The eggs are laid in groups within a hollow surrounded by compacted clayey soil (Pl. 7). They are found at a depth of 1½ to 2 inches. When laid under laboratory conditions, each group of eggs varies from three to six in number. Each egg is white and elongate-oval in shape, measuring 1.2 mm to 1.4 mm in length and about 1.0 mm in breadth. As the embryo develops, the egg turns creamy in colour and swells slightly.

The larva hatches in about a week. It is initially white and 2 mm long. As the grub grows, its body becomes creamy in colour while the mandible turns yellowish. The length of the full-grown larva (Pl. 8) is about 19 mm. The entire larval period lasts about 10 weeks. The prepupal and pupal stages last about 11 days. The pupa is ivory coloured and often has a lump of earth attached to the abdomen (Pl. 9). The total period of development from the time eggs are laid to the emergence of adults is about 3 months.

The newly emerged adult is about 9 mm long and has a soft, pale yellow elytra. The elytra later darkens in colour to become golden brown. In the laboratory, an adult survived for 23 days after its emergence although it hardly fed on the young leaves supplied.

7. *Seasonal flights*

The adult *A. rufocuprea* was observed to be abundant and active in flight from late July to September, from mid-November to early February, and from late March to May. During the other months of the year, its adult population was low or almost nil. The flights appeared to be triggered off by rains at the end of dry periods. The flight periods also coincided with the emergence of new leaves of most host plants. These new flushes provided ample food for the adult beetles.

Mating was observed to start around end March and end July. This activity lasted about 3 to 6 weeks, and was most intense on dry nights in April and August. The dissection of adult females indicated that some matured eggs had already been formed in their ovaries when mating occurred. Caging of the females which were caught mating showed that oviposition may occur a few days after mating.

Based on the observations made on the life cycle of *A. rufocuprea* and on its seasonal flights, it is deduced that the beetle has at least two generations in a year. One generation begins its egg stage in April during which mating and oviposition occur. By July, the beetle has already gone through the larval and pupal stages to

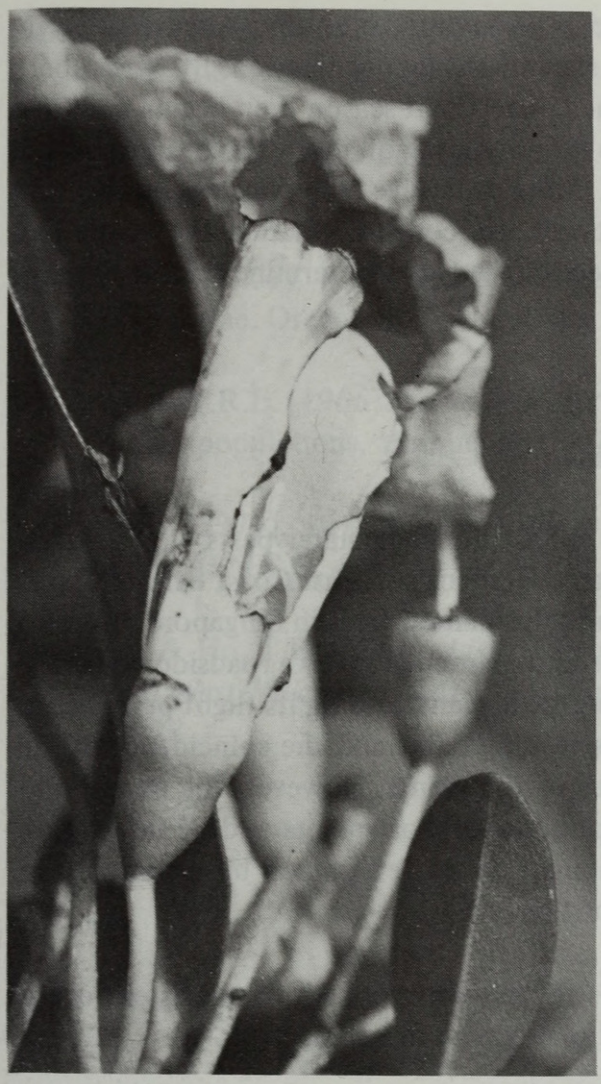

Plate 5. A flower of *Tabebuia pallida* attacked by *Autoserica rufocuprea*.

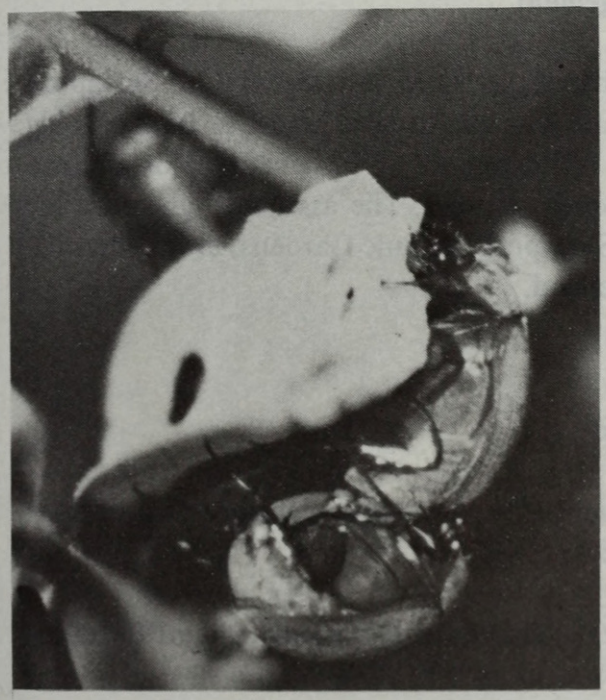

Plate 6. A pair of *Autoserica rufocuprea* mating on a leaf. Note that the female is feeding at the same time.

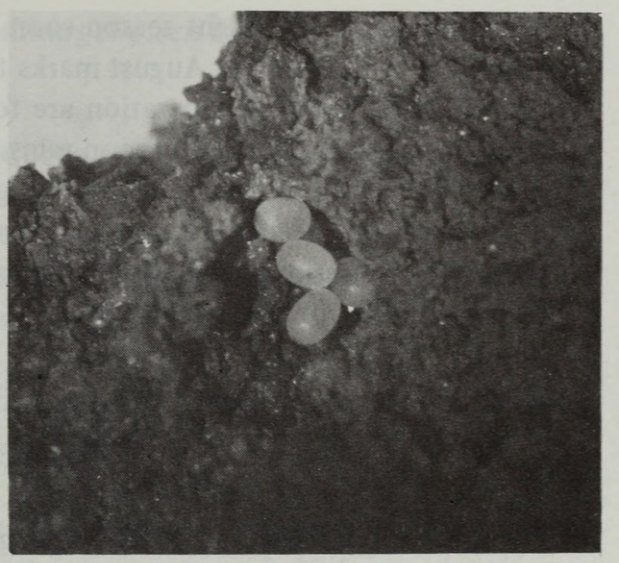

Plate 7. A batch of eggs of *Autoserica rufocuprea* inside a hollow made by the adult female in the soil.

Plate 8. A full-grown grub of *Autoserica rufocuprea*, 19 mm long.

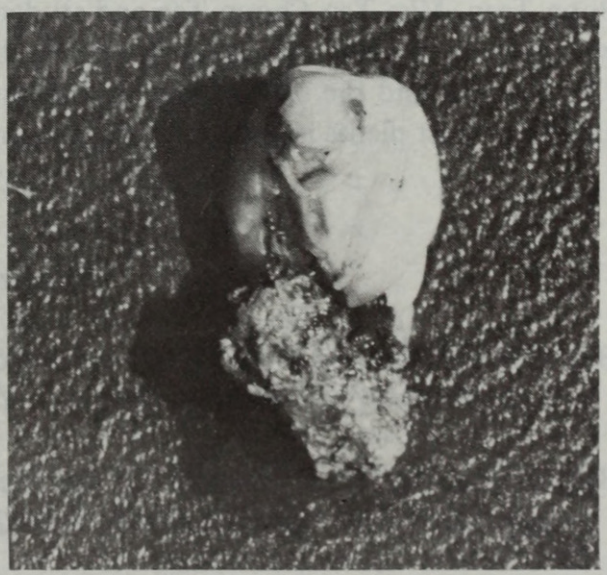

Plate 9. A pupa of *Autoserica rufocuprea*, 8 mm long.

become adults. The flight season soon occurs. Adults mate around August and oviposit. The oviposition in August marks the start of another generation. By November, the adults of this new generation are formed. The flight season then begins with the arrival of the north east monsoon rains. So far no mating of adults has been observed during the November – February flight. More intensive observations during this flight period is needed to confirm this. It will also confirm whether the beetle has three generations in a year. More studies are also needed to determine the life span of each generation of the beetle.

Conclusion

The studies confirm that *A. rufocuprea* is one of the cockchafer pests which attack many ornamental plants and shade trees at Botanic Gardens and East Coast Park in Singapore. As its food plants include the most commonly planted trees in Singapore, it is also expected to occur in most other parks, gardens and planted areas like roadside nurseries. The amount of foliar damage it incurs on young host plants during its flight periods can be fairly great. This is because of its gregarious feeding habit and the coincidence of the flight periods with the emergence of new leaves of the plants. However, the extent and severity of damage also varies with the susceptibility of host plants and its infestation level. The infestation level of the beetle is thought to be determined by a complex of ecological factors which has to be investigated further.

The studies have also revealed the beetle's flight seasons which, if consistent every year, may determine the times for spraying host plants with insecticides.

Acknowledgement

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