LIFE HISTORY OF *CALLOSOBRUCHUS CHINENSIS* (L.) (COLEOPTERA, BRUCHIDAE)

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Abstract

Until now no wild host legume for the azuki bean weevil, Callosobruchus chinensis, has been recorded. When bred on the azuki bean, the life cycle of the weevil is 21 days and adult longevity is as short as 10 days at 30°C. There may be four generations a year under favorable storage conditions. In autumn many weevils are found in bean fields, where they lay their eggs on the growing pods. The beans are harvested and the weevils are carried to the storage site together with the beans. Until now it has been believed that there is a compulsory movement of weevils to and from the bean fields and storage sites every year.

In 1984 the ripe pods of many wild legumes were collected and rearing experiments were carried out on the beans. The weevil fed and developed on four legumes. In 1985 many of the weevils were found to visit wild legumes during the flowering and fruiting season. The legume pods were collected and the beans were incubated under favorable laboratory conditions. Many adult weevils emerged from the beans. Longevity of weevils kept at 18°C and 75% r.h. and supplied with food was extended to 200 days. The females laid their eggs even at that age. In the field the weevils are seen to visit and feed on colonies of fungi. The weevils which fed on the fungi had greater longevity and increased fecundity. It is concluded that weevils emerge from the wild legumes in spring, exist on nectar, pollen and/or fungi throughout summer, and in autumn visit the legumes to await their flowering and fruiting. Eggs are laid on the pods. There is probably one generation a year for the wild population of the azuki bean weevil.

Introduction

In Japan the azuki bean weevil, Callosobruchus chinensis (L.), is the most common and destructive pest of the azuki bean, Vigna angularis Ohwi, and the cow pea, Vigna unguiculata Verdc., in farm storage and on the growing plants.

During very hot weather a generation will mature in 21 days (eggs, 4 days; larvae 13 days; pupal stage, 4 days). During cooler weather the period is prolonged and approximates 6 or 8 months and more. The insect lays eggs on the seeds and is capable of breeding indefinitely in the

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dried seeds in storage. There are 4 generations a year under favorable conditions in storage. In autumn many weevils are found in the bean fields. The beans infested by weevils in the field are harvested and carried into storage. So far it has been belived that there has been a compulsory movement of weevils to and from the bean field and storage sites every year.

In 1985 a huge weevil population was found on wild legume plants in Okayama. Thus it would appear that some weevils spend one generation a year on wild legumes without returning to the storage.

1. The incidence of azuki bean weevils in the cultivated bean fields.

The weevils attack the pods of growing legume plants cultivated in the field. The incidence of the weevils in a field of Natu-azuki (the azuki, V. angularis, cultivated in summer in Japan) and cow peas in north Okayama was recorded from mid-July to mid-September. The weevils laid eggs on the pods of the azuki and cow pea between the end of July and the end of August. About 10% of the Natu-azuki beans harvested was infested by the weevil. Occurence of the weevils in the Aki-azuki (the azuki cultivated in autumn) field was recorded from mid-August and continued for about three months. The weevils laid eggs on the pods between mid-September and mid-October in the field. In consequence about fourteen per cent of the beans were infested by the weevils before harvest.

2. The possibility of development of the weevils on wild beans.

So far no wild host legume for the azuki bean weevil has been recorded in Japan. To determine the weevil wild host range in the field the ripe pods of fifteen common species of wild legumes were collected in Okayama and the rearing experiments on these beans were carried out in the laboratory. The results of the experiments showed that among the species tested the weevil feeds and develops on the following four wild legumes: Amphicarpaea edgeworthii Benth, Pueraria lohata (Willd), Dubaria villosa (Thunb.) and Vigna trilobata Verdc. (V. angularis var. nipponensis (Ohwi)). Among these the survival rate of weevils bred on the last two species was 88.5 and 94.1% respectively.

3. The incidence of the weevils on the wild legume plants.

Colonies of the two wild legume plants, D. villosa and V. trilobata, were found alongside a stream in Okyama. A census of weevils was carried out on these wild legumes during their flowering and fruiting season. Fig. 1 shows the seasonal trend of the number of azuki bean weevils found on the wild legumes. The weevils visit the wild plants from early August to the latter part of October. During this period the pods of the legumes come to maturity; and on these pods the weevils lay their eggs.

Many of the weevils actually visit the two wild legumes, D. villosa and V. trilobata, that constitute a well distributed and dense colony alongside the stream.

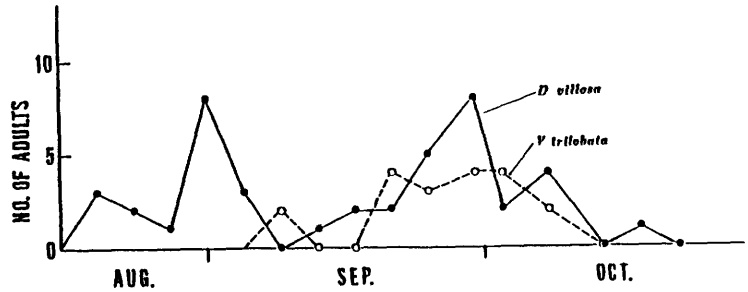

Fig. 1. Seasonal trend of the adult number of the azuki bean weevils and on the wild legume plants, D. villosa and V. trilobata.

4. Emergence of weevils from wild beans collected in the field.

To verify whether the weevils deposit on the pods of wild plants and the larvae burrow into the beans and develop within them, pods of the two legumes, D. villosa and V. trilobata. were collected from different places in the field on different days in 1984 and 1985. The beans taken from the pods were incubated at 25°C and 75% r.h. The number of the weevils that emerged from the beans were counted. Table 1 shows the number of beans collected, the number of weevils that emerged from the

TABLE 1 NUMBER OF THE ADULT AZUKI BEAN WEEVIL EMERGING FROM THE WILD BEANS COLLECTED AT THE FIELD

Places	Dates of Collection	Colony Area (m^2)	No. Beans Collected (Weight g)	No. Adults Emerged	Beans Infested (%)
Vigna trilobata					
Akasaka Y	15 Oct. 1984		1928 (48.5)	16	0.8
Tsushina	29 Oct. 1984	6	390 (9.8)	19	4.9
Dunbaria villosa					
Akasaka A	15 Oct. 1984	18	714 (34.0)	9	1.3
Akasaka A	18 Oct. 1984	18	278 (10.0)	32	11.5
Akasaka B	13 Oct. 1985	10	541 (19.2)	2	0.4
Sanyoo	13 Oct. 1985	6	372 (14.0)	1	0.3
Akasaka C	25 Oct. 1985	2	320 (11.9)	2	0.9
Akasaka D	27 Oct. 1985	16	417 (15.0)	11	2.6
Akasaka E	27 Oct. 1985	11	311 (11.2)	0	0.0
Akasaka F	27 Oct. 1985	5	90 (2.9)	0	0.0
Akasaka G	3 Nov. 1985	20	231 (8.3)	0	0.0
Akasaka H	3 Nov. 1985	5	186 (6.7)	0	0.0
Akasaka I	9 Nov. 1985	5	417 (15.0)	8	1.9
Akasaka J	9 Nov. 1985	2	63 (2.4)	0	0.0

beans and levels of infestation in both the legumes at each of the sites according to date.

5. Adult longevity under favorable laboratory conditions: moderately low temperature, high relative humidity and a food supply.

In storage or laboratory condition longevity of the adult azuki bean weevil is about 10 days. For weevils that emerge from the wild bean in spring no host plants are available in the field from spring to autumn. Thus for the weevils to attack the host plants in the field they must continue to survive until autumn: this necessitates longevity must be five months and more long. It is well known that at low temperature, moderately high relative humidity and by taking food, the longevity of the weevil increases. A temperature of 18°C and a r.h. of 75% are moderate and common. In the field the weevils may readily find their food such as nectar, pollen and fungi. Then the possible longevity of the weevil was evaluated in under laboratory conditions of 18°C and 75% r.h. with a supply of five per cent solution of sacharose and yeast as food. The results of the experment are shown in Fig. 2 as survivorship curves of the males and females. The average longevity of males was 120 days (maximum 240 days) and that of females was 223 days (maximum 408 days). The females exhibited prolonged longevity and some survived for more than one year under these favorable conditions.

This suggests that in nature the weevils may live until October when they can find wild host plants for laying eggs in the field.

6. Fecundity of weevils with prolonged longevity.

In orgder to verify whether weevils can lay eggs throughout their

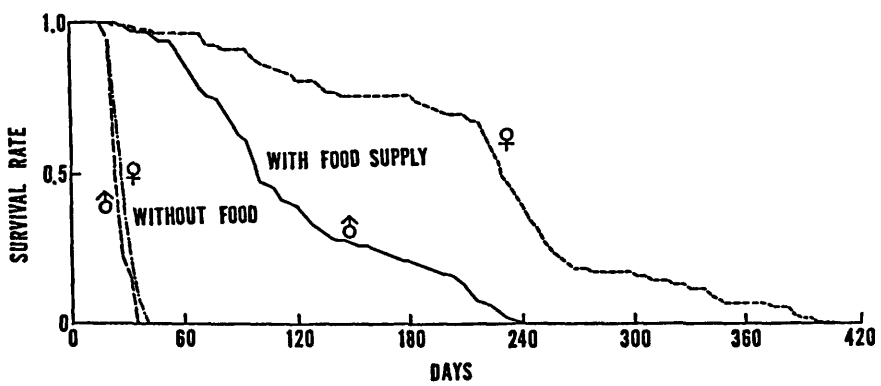

Fig. 2. Longevity of the adult bean weevils at 18°C and 75% r.h. with and without food.

life weevils reared on food and kept at 18°C and 75% r.h. were transfered to 25°C and permitted to oviposite on the azuki beans at 0, 7, 30, 60, and 180 days after emergence. Fig. 3 shows the age-specific survival rate, l_x, curve and the age-specific fecundity, m_x, curve in each of the experiments.

From this data it can be seen that weevils are able to oviposit even after 200 days.

7. The effect of fungal feeding on fecundity.

In the field azuki bean weevils are found occasionally to visit colonies of fungi on leaves and eat them. It was considered possible that fungal feeding increases their fecundity. The following experiment was carried out to clarify this point. The weevils were introduced into vessels containing leaf covered with the powdery mildew, Uncinula necator (Schweinitz) Burrill; one with both the powdery mildew and the rust, Phakopsora ampelosidis Dietel et Sydow; and one in which leaf was not

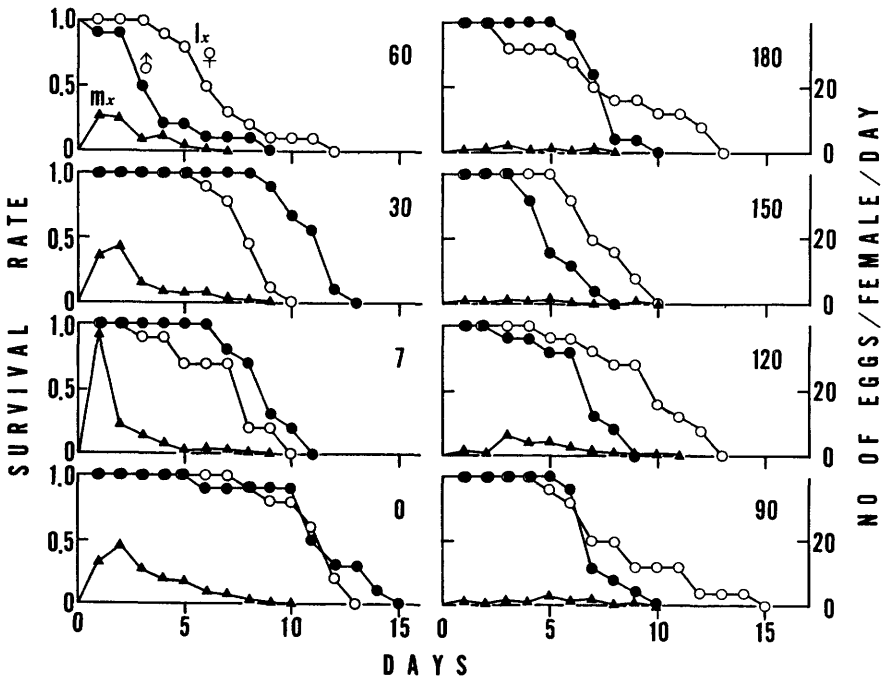

Fig. 3. Fecundity of azuki bean weevils in which longevity was prolonged by holding them at 18°C and 75% r.h. with food. Number in each graph represents age of adults at time of transfer to oviposition experiment.

contained with fungi (control); and without a leaf (control). Fig. 4 shows l_x and m_x curves for each of the experiments.

These results reveal that longevity of the weevils is prolonged and fecundity increased by feeding on fungi.

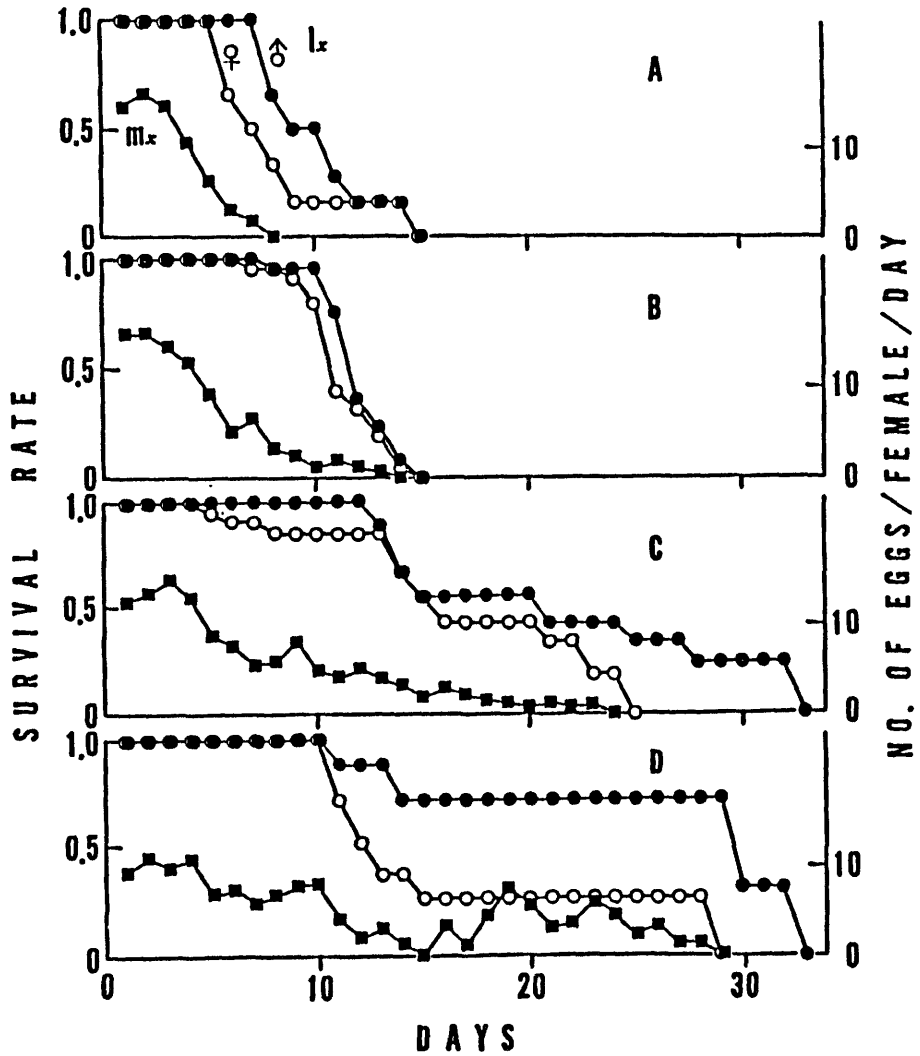

Fig. 4. Effect of fungal feeding on longevity and fecundity.
A: without food, B: providing leaf only, C: leaf covered with the powdery mildew, D: leaf covered with the powdery mildew and the rust.

Conclusions

The conclusions derived from the above study are that the azuki bean weevil probably develops in the field on the wild legumes, *D. villosa* and *V. trilobata*: weevils emerging from the wild beans in spring probably survive on nectar, pollen and/or fungi, taking shelter in the moist and cooler places throughout the summer. In autumn they probably visit the legumes waiting for the flowering and fruiting and then lay eggs on the pods. There would appear to be one generation a year for the wild population of the azuki bean weevil.