it may be internal discrimination in *G. japonicum* ovipositing parasitized *R. clavatus* eggs that is responsible for parasitoid pupation.

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Preadaptation of a Wild Bean Weevil,
Kytorhinus sharpianus BRIDWELL
(Coleoptera: Bruchidae), for Infesting
the Storage Green Gram, *Vigna*
radiata (L.) WILCZEK (Leguminosae)^{1,2}

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Bruchids have been ecologically classified into 2 groups, the field and cross (or storage) types (KIRITANI, 1956; SOUTHGATE, 1979; UMEYA, 1981). The cross-type bruchids are recognized as distinct from the field-type in ecological habits such as ovipositing without feeding after adult emergence and laying eggs and developing in dry mature beans (KIRITANI, 1956). These habits should be indispensable for the cross-type bruchids infesting dry beans in storage. However, WATANABE (1985) found that *Sulcobrachus sauteri* (PIC.), which is not a pest and not classified as a cross-type bruchid,

could oviposit and develop in dry mature beans of its host. SHIMADA (1988) also reported the same ecological habits in a wild multivoltine bruchid, *Kytorhinus sharpianus* BRIDWELL, attacking the seeds of *Sophola flavescens* AITON (Leguminosae) in the field. Furthermore, he found that *K. sharpianus* could lay vital eggs without adult feeding. The oviposition and feeding habits in dry beans might make *K. sharpianus* a potential stored bean pest. SHIMADA (1988) emphasized preadaptation of a wild bruchid to infest dry stored beans of its host.

The cross-type bruchid as a stored bean pest has another distinct ecological habit. Its larvae can develop in beans of wide-ranging species. Almost all of the field-type bruchids are entirely or mostly monophagous (WATANABE and SUGIMOTO, 1988). If a wild bruchid can develop in beans of commercial legumes which are not related to its wild host plant, we can consider that it has acquired an infesting ability on beans of the secondary hosts as preadaptation in the field. I therefore conducted an experiment to examine if *K. sharpianus* can infest some commercial legumes. In this study I show that *K. sharpianus* larvae can develop into adults in dry beans of the commercial green gram, *Vigna radiata*.

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Table 1. *K. sharpianus* hatched larvae survivorship in dry beans of 3 *Vigna* species under 30°C, 70% r.h. and 16L-8D

Bean species	n	Time after parental introduction	No. of larvae died		No. of final instar larvae alive	No. of pupae alive	No. of adults emerged
			young ^a stage	old ^b stage			
<i>V. angularis</i>	20	2 months	20	—	—	—	—
<i>V. unguiculata</i>	20	2 months	20	—	—	—	—
<i>V. radiata</i>	40	2 and 6 months	25	9	4	0	2
<i>S. flavescentis</i>	22	40 days	2	0	6	11	3

Results in the wild host, *S. flavescentis*, are also shown for comparison with those in *Vigna*.

For time of inspection in each legume, see text.

^a 1st and 2nd instars.

^b 3rd instar or later.

MATERIALS AND METHODS

Dry beans of 3 commercial legumes of the genus *Vigna* were introduced into each compartment of a four-compartment Petri dish (Falcon No. 1009; 90 mm dia). The legumes were the azuki bean, *Vigna angularis* (WILLD.) OHWI and OHASHI, the black-eyed bean (cowpea), *Vigna unguiculata* ssp. *unguiculata* (L.) WALP., and the green gram (mung bean), *Vigna radiata* (L.) WILCZEK (for scientific names, ALLEN and ALLEN, 1981; DUKE, 1981; FUJII, 1988). Five pairs of *K. sharpianus* adults were obtained from a stock culture with adult feeding. They were introduced into the Petri dish, which was placed in a growth chamber controlled at 30°C, 70% R.H. and 16L-8D. They were allowed to oviposit in the Petri dish, without feeding, until they died.

Two months after introduction of adults, I sampled beans with 1 or 2 egg shells in *V. radiata* and those with a maximum of 3 egg shells in *V. angularis* and *V. unguiculata*. Egg shells were removed with binoculars to judge larval hatching. I investigated 20 larvae in the beans. Larval stages were determined from the width and morphology of head capsule. If living larvae were found during the procedures, the remaining beans were kept in the growth chamber until adult emergence. The inspection procedures were then carried out again.

A similar developmental experiment was conducted with dry mature beans of (wild) *S. flavescentis*, under the same physical conditions, in order to compare results with those of 3 *Vigna* species. Inspection in *S. flavescentis* was carried out for beans bearing 1 hatched egg after 40 days post-ovi-

position.

RESULTS AND DISCUSSION

K. sharpianus oviposited on all 3 *Vigna* legumes and died in ca. 10 days. Eggs hatched in ca. 1 week. All 20 hatched larvae died at the young larval stage (the 1st and 2nd instars) in *V. angularis* and *V. unguiculata* beans in the inspection 2 months after parental introduction (Table 1). Most hatched larvae in *V. radiata* beans also died in the young stage, but some lived until the 3rd instar or beyond. Since I found 1 final instar (possibly, the 4th) larva alive in a *V. radiata* bean during the inspection (Fig. 1), the remaining *V. radiata* beans were kept in the growth chamber.

Two adult males emerged from those remaining

Fig. 1. Final stage *K. sharpianus* larva living in the green gram, *V. radiata*.

Fig. 2. Two *K. sharpianus* males which emerged from *V. radiata* beans. "E": eggs deposited, and "H": emergence holes. A bar shows 5 mm.

V. radiata beans which were kept in the growth chamber ca. 4 months after the first inspection (Fig. 2). The developmental period of these males was markedly longer than that of the males developing in *S. flavescens* beans (41.6 days on average; SHIMADA, 1988) under the same physical conditions. Fresh weight of the males from *V. radiata* averaged 5.3 mg, which was lighter than that of the males from *S. flavescens* (7.8 mg on average; SHIMADA, unpub.). Three living final instar larvae were observed anew in *V. radiata* beans in the subsequent inspection. The number of larvae which were inspected in *V. radiata* was increased to a total of 40. Results of 2 inspections in *V. radiata* are summarized in Table 1.

Results in *S. flavescens* are also shown in Table 1. Only 2 out of 22 hatched larvae died at the young stage and the remainder grew to the final instar or beyond up to 40 days after parental introduction. Thus, the survivorship and developmental rate in the larval stage was much lower in *V. radiata* than in *S. flavescens*. These results suggest that undernourishment and/or some toxic factors (FUJII et al., 1939) might have influence on *K. sharpianus* larvae in *V. radiata*.

The present results show that *K. sharpianus* can infest dry beans of the commercial green gram, *V. radiata*, though *K. sharpianus* completes its life cycle on *S. flavescens* in the field and currently is not known

to infest stored *V. radiata* beans. These facts indicate that *K. sharpianus* has already potentially acquired the ability to infest dry beans of wide-ranging secondary hosts in storage. This may be termed as preadaptation in the field.

Recently, WATANABE and SUGIMOTO (1988) proposed a scheme that an ancestral bruchid which is now recognized as a stored bean pest invaded the storage together with a primary host legume which was infested in the field and thereafter expanded its host range to the secondary hosts accessible in that environment. However, they did not explore whether this ability for infesting previously alien, stored and secondary hosts evolved in the storage or had been already acquired in the field before storage infestation. The present study supports the latter hypothesis of preadaptation. We should pay more attention to the host range of bruchids in the field for understanding the establishing process of wild bruchids as stored bean pests.

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