

THE EFFECT OF THE AMPUTATION OF HEAD
APPENDAGES ON THE OVIPOSITION OF THE BEAN WEEVIL,
ACANTHOSCELIDES OBTECTUS SAY
(COLEOPTERA: BRUCHIDAE)

by

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The oviposition behaviour of amputated bean weevil females were investigated, providing different oviposition stimuli (chemical and tactile). All the head appendages have chemosensory functions, however, the maxillary palpi seem to be most significant. The ovipositor is also able to perceive chemical stimuli. Its preliminary morphological examination showed different types of hairs on it, some of them with possible chemosensory functions.

INTRODUCTION

The selection and recognition of the oviposition site and the induction of oviposition in most insects is the result of different reflex mechanisms in which chemical and tactile stimuli play an important role. Different oviposition-behavioural patterns can be observed among insect species regarding the importance of head appendages and/or the ovipositor, in selecting the oviposition site.

In some insects the choosing of the oviposition site is a function of head appendages only, and the malfunction or removal of the antennae will result inadequate responses in oviposition as it has been shown in *Manduca* by Yamamoto and Fraenkel (1960). It is probable that if there are any chemoreceptors on the tip of the abdomen they do not play any role in the oviposition behaviour in *Manduca*.

However, many other insects need the simultaneous performance of the antennae, palpi and the ovipositor during this process. Stimuli, received by the ovipositor, will modify the information entering the central nervous system throughout the sensors of head appendages. There are some good examples in parasitic Hymenoptera, where the role of the ovipositor is equally important with that of the antennae. The localization of the host is the function of the antennae, but egg laying is evoked by stimuli perceived by the ovipositor on the tip of which different types of chemoreceptors were found (van Lenteren, 1972; Hawke et al., 1973). Scanning electron microscope examination showed the presence of chemoreceptors on the ovipositor of *Musca autumnalis*, too (Hooper et al., 1972).

Salama and Ata (1972) refer to the oviposition site selection of *Culex pipiens*, where neither the head appendages, nor the ovipositor play any significant role, because their removal did not cause any loss in sensitivity. It is probable that receptors on the legs guide the selection of oviposition site.

There are several stimuli originating from the host-plant and influencing oviposition in the bean weevil. It has been shown by Labeyrie (1961)

that there are two strains in respect to oviposition response. One of them lays eggs only in the presence of bean. Pouzat (1970) examining the role of head appendages in the oviposition of the bean weevil found the maxillary palpi as the most important ones in affecting egg laying. When the antennae were amputated, there was a high oviposition response. This was explained by the author as the release of oviposition from an inhibitory state. However, Nakamura (1971) did not observe any significant effect on egg laying after cutting off the antennae of the females in two *Callosobruchus* species.

Not only contact, but air-borne stimuli originating from the host-plant elicit searching, locomotion, attraction toward the direction of the odour source in inseminated bean weevil females (Halstead, 1973; Pouzat, 1974), while in a choice experiment using dry bean odour as stimulus and glass beads as substrate for oviposition egg laying occurred anywhere randomly (Jermy, unpublished).

Besides chemical stimuli from the bean (pod, seed) tactile stimuli are supposed to be also important. Inseminated females of *Ceutorrhynchus maculaalba* will not lay eggs on the flattened strips of poppy capsule, but there is an immediate ovipositional response if the strips are bent (Sáringér, 1975, in this volume). Similar behaviour was shown in pea weevil (*Bruchus pisorum*) where females preferred laying eggs on normal pea pods to flattened ones (Jermy, 1972). Shape sensation is supposed to be an important element in the complex oviposition behaviour in the bean weevil, too. The perception of shape stimuli is probably a function of antennae or palpi, or some proprioceptors possibly localized on the legs.

In order to analyze the importance of different stimuli and to find out what sort of receptors are involved and where they are localized in the bean weevil in relation to oviposition behaviour, amputation and oviposition inhibition experiments as well as SEM examinations have been carried out.

MATERIAL AND METHODS

Amputation experiments

One to three days old bean weevil females originating from the laboratory mass rearing (Szentesi, 1972) and immobilized at low temperature (+0.5 to +4 °C) were amputated to different degrees. After cutting off the antennae or the palpi or all of them, the females were kept individually in 6 ml glass vials with one male in each until their deaths at 23 °C. In the vials: (1) white dry beans (complete oviposition stimuli), (2) glass beads, 5 mm in diameter (tactile stimuli only), and (3) ground dry bean pods (chemical stimuli only), respectively, were provided as oviposition sites. The replicates of the series of amputations were 50. After the death of all adults the number of eggs was counted.

Oviposition inhibition in normal and amputated females

White dry beans were dipped into 0.05 M CuSO_4 solution for a few minutes then taken out and dried immediately in warm airstream. Dry beans treated with water in the same way served as control. The bottoms of

10 cm petri dishes were divided into four sections by paraffin wax walls: two sections for the untreated and two for treated beans. Equal number of bean seeds was placed into each petri dish. There were 5 replicates in each of the following treatments: (1) females without amputation (control), (2) females having only maxillary palpi, (3) totally amputated females. After 20 days the number of eggs laid into the treated and untreated sections was counted. The experiment was conducted at 23 °C, and at about 50% rel. hum.

*Morphological investigations on the ovipositor of female
bean weevil using scanning electron microscope*

The ovipositor of freshly emerged virgin bean weevil females was used. By slightly pressing the abdomen of a female, the ovipositor protruded and was cut off, dried in desiccator above conc. sulphuric acid and prepared for SEM examination. Ovipositors were stuck to a specimen holder with conductive silver paint and coated with gold in high vacuum evaporator. The examinations were carried out by a JEOL JSM 50A SE microscope at 20 kV.

RESULTS AND DISCUSSION

Amputation experiments

Sandner and Pankanin (1973) observed an increasing rate of oviposition in normal, inseminated bean weevil females when introducing them to gradually increasing amounts of dry beans. On the contrary, there was a high difference in the number of eggs laid if only indifferent stimuli (empty box, glass beads) were present.

In our experiments the oviposition behaviour of normal and amputated females showed unambiguous preference to bean seeds (Fig. 1). The number of eggs laid was the highest, because the stimuli provided were complete and complex. The ovipositional response was weaker, though the difference was not significant, if only one of the stimuli was provided. In case of normal, inseminated females the importance of shape and chemical stimuli, respectively, seems to be equally necessary and important. There was a considerable number of eggs laid even without any oviposition stimuli present. This finding may refer to the possible occurrence of individuals ovipositing in the absence of bean (Labeurie, 1961).

Any other combination of the amputation gave results similar to one another, and the most preferred oviposition site was the dry bean. However, the tendency of oviposition showed that the maxillary palpi had the most important role in chemical sensation, while the antennae may function both in chemical and shape recognition, though to a smaller extent. These results are in good accordance with those of Pouzat (1970).

There were some ovipositional responses in the case of total amputation. We concluded that both spontaneity in oviposition and the role of ovipositor were involved in this reaction.

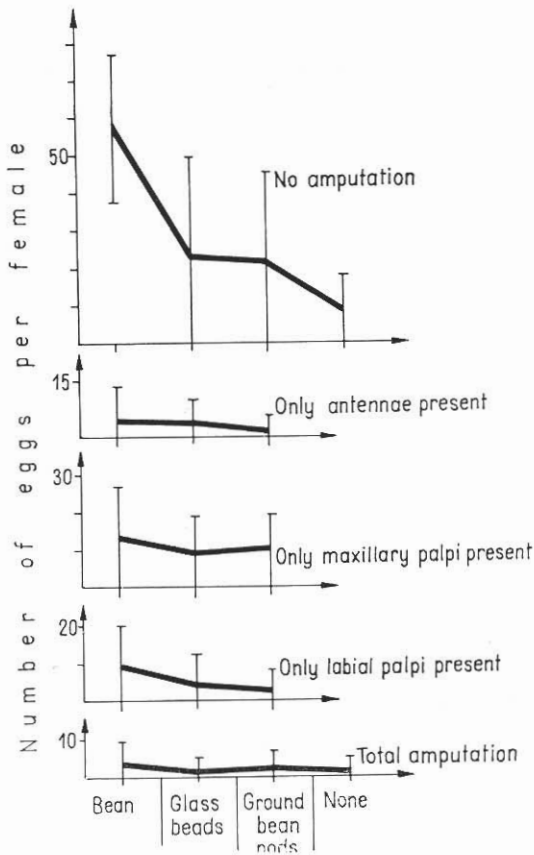


Fig. 1. Ovipositional responses given by normal and amputated bean weevil females in the presence or absence of different egg-laying stimuli

Oviposition inhibition experiment

In order to clear the importance of the ovipositor in the egg-laying behaviour, attempts were made to examine its role alone. Head appendages were cut off in different degrees while the ovipositor always remained intact. CuSO_4 has a definite and strong inhibitory effect on oviposition, disturbing the perception of the natural stimulating effect of dry bean. It was supposed that after a total amputation there would be no perception of stimuli either positive or inhibitory unless the ovipositor had chemoreceptors. According to the results (Table 1) amputated females could distinguish treated and untreated surfaces, and this fact indicated the presence of chemoreceptors on the tip of the ovipositor.

Morphological examinations on the ovipositor

By morphology the bean weevil ovipositor is a dorsoventrally flat organ. Its tip bears a great number of hairs of different lengths (Fig. 2). Pre-

TABLE 1

Oviposition preference of amputated bean weevil females

Degree of amputation	Percentage of eggs laid on		S.D.
	untreated	0.05 M CuSO ₄ treated	
	beans		
No amputation	90.48	9.51	1.5 ^a
Antennae + labial palpi cut off (only maxillary palpi present)	70.96	29.05	12.0 ^b
Total amputation	70.42	29.57	11.5 ^c

a-b: $P < 0.1\%$.a-c: $P < 0.1\%$.

b-c: N.S.

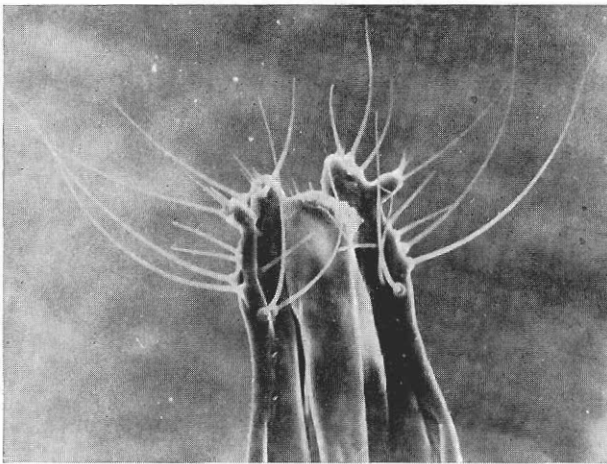


Fig. 2. General view of the tip of the ovipositor of *Acanthoscelides obtectus* Say showing different types of hairs. SEM photo ($\times 300$)

liminary investigations showed that most of them are long mechanoreceptor hairs, greatly varying in length and with probable tactile functions. They may play an important role in sensing distance between adjacent dry beans or the position and size of small holes gnawed on dry bean pods. Their functions may be responsible for the spatial distribution of eggs laid.

Besides the mechanoreceptors, scattered among them, there are shorter hairs with the shape of sensilla chaetica (Flower and Helson, 1971; Schafer, 1971; Steinbrecht and Müller, 1971).

There are two small warts on the lateral-distal parts of the ovipositor (Fig. 3). There are three or four (?) hairs raising from each. Two of them, though varying in size, must be a pair of long tactile hairs, the others rooting side by side seem to be a pair of sensilla chaetica type chemoreceptors.

Hairs distributed around the warts and in general on the surface of the ovipositor having different length are supposed to have similar functions.

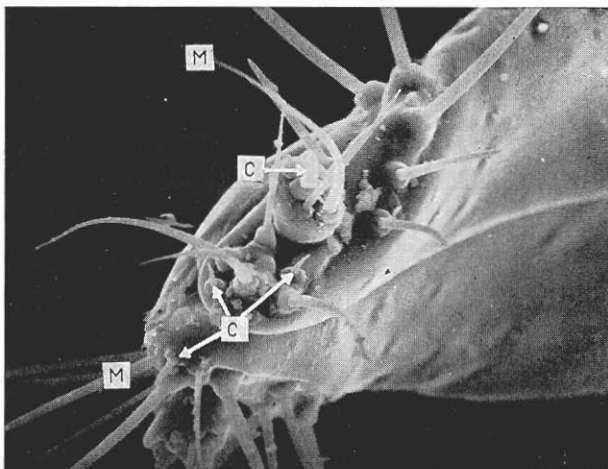


Fig. 3. The lateral-distal part of the bean weevil's ovipositor. One of the warts can be seen holding hairs thought to be mechanoreceptors (M) and chemoreceptors (C). SEM photo ($\times 1000$)

CONCLUSIONS

Studying the oviposition behaviour of the bean weevil it was proved:

1. Chemical and tactile (shape and mechanical) stimuli play a decisive role in choosing the oviposition site. Untreated females show the strongest oviposition response.

2. Dry beans are the most preferred oviposition site. There were fewer eggs laid if only chemical or only shape (tactile) stimuli were supplied.

3. In spite of the importance of the antennae and palpi in the recognition of the oviposition site, the role of the maxillary palpi seems to be the most significant.

4. In the oviposition inhibition experiment combined with the amputation of head appendages, it was proved that there must be chemoreceptor(s) on the tip of the ovipositor. These receptors take part in selecting the oviposition site. The oviposition behaviour is the result of a physiological state influenced, among others, by information given by the receptors on the head appendages and the ovipositor in the bean weevil.

5. Preliminary morphological investigations showed the presence of chemosensory sensilla on the ovipositor, however, further histological and physiological experiments are needed to clarify their exact functions.

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