CHAPTER V.

FEEDING AND OVIPOSITION IN DINARMUS BASALIS.

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CHAPTER V.

FEEDING AND OVIPPOSITION IN DINARMUS BASALIS.

Introduction:

Pteromalids are entomophagous insects of special interest, as they feed on the host not only as the larva but also as the adult, and because they are able to locate, assess the size and suitability of the host and feed and oviposit on it, though the host is inside a hard encasement. Habits of pteromalids have been studied by some earlier workers. The study of Edwards (1954) is specially notable in this context. There is, however no previous record of habits of Dinarmus basalis.

Material and Methods:

Adults of D. basalis from cultures on Callosobruchus analis on gram (Cicer arietinum) have been kept along with some infested seeds in "observation chambers", which had been made by holding together six square cover-glasses by applying a little "Quickfix" to the edges of the
cover-glasses. Behaviour of the insects have been observed under magnification.

**Observations:**

On approaching an infested seed a female of *D. basalis* mounts the seed, and moves about, holding the flagella of its antennae vertically (fig. 1A), and moving the antennae up and down repeatedly touches the seed surface. Such movements have been referred to as 'drumming' by Edwards (1954). Perhaps by drumming the female is able to perceive the surface vibrations, and is thus able to locate the position of the bruchid cavity close beneath the surface. But perhaps the significance of drumming should be expressed in more general terms, because very much similar behaviour is on record for *Mormoniella vitripennis* (Edwards, 1954) and *Ptermomalus* (Doten, 1911 and Doutt, 1964), which parasitize muscoid and peirid pupae respectively. Drumming seems to be with the purpose of locating a suitable site for drilling. The drumming continues for a few minutes, as the female moves over the uncovered surface of the
seed in the heap, or, after drumming the surface of one seed for a shorter period, she moves to another seed.

After drumming has stopped, the female bends her abdomen, and applies the tip of the abdomen to the seed surface (fig. 1B), and, by repeatedly lifting and lowering the abdominal tip, she taps the seed surface. Edwards (1954) has referred to this part of the oviposition behaviour as 'tapping'. Tapping is confined to a limited area. Perhaps during tapping she learns about the nature of the seed surface and of the hard layer, which the ovipositor shaft has to penetrate, with the help of the sense organs at the abdominal tip, specially those on the third valvulae and those on the median and exposed portion of the ninth tergum. Next the tip of the ovipositor shaft is applied to the seed surface, and the abdomen is lifted and is made horizontal again, so that the ovipositor shaft is seen coming out almost vertically from the venter of the abdomen. Now starts the 'drilling' phase in oviposition (fig. 1C). During this phase the abdomen shows pulsating movements, which indicate rhythmic contractions of ovipositor muscles. Total
drilling time varies from 1 to 5 minutes. It is perhaps determined by the thickness of the solid layer of seed to be penetrated. During penetration the ovipositor shaft moves in slowly with back and forth vibrations. Then suddenly the shaft moves swiftly. Obviously the former phase in drilling is through the solid roof of the bruchid cavity, and the latter through the cavity. Most of the total time of drilling is occupied by the former phase. During drilling at times, due to lateral bending of the abdomen on the two sides alternately, the shaft makes rotatory movements.

After penetration (fig. 1D) the ovipositor is withdrawn partially, and pushed in again repeatedly with swiftness. These movements may be called 'stabbing movements', as they seem to be with the purpose of reaching the host larva and making an wound on it. Perhaps it is at this time that a paralyzing fluid is injected into the prey.

Next comes the phase of formation of a feeding tube. A fluid, viscid and transparent, flows out from the base of the ovipositor shaft, and flows along its length. This happens when the shaft has become partly withdrawn, and its tip is
still inserted. As the fluid flows along the length of the shaft, the shaft is moved back and forth slowly, but during such movements it is never fully withdrawn. At the same time, due to sideway bending of the abdomen alternately on the two sides, the shaft performs rotatory movements through considerably less than 180° in opposite directions. The back and forth and rotatory movements are apparently for shaping the tube from inside. The tube, resulting from hardening of the viscid fluid, is parchment-like and nearly solid. It extends for a short distance into the host body, perhaps through the wound made by the female during the stabbing movements. When the tip of a black fibre pen was applied to the outer end of the tube, the ink of the pen was sucked into the tube by capillarity. When the seed was dissected open, not only the tube showed a blackened lumen, but also there could be seen a small black patch immediately beneath the skin of the bruchid larva around the point of contact with the tube.

After thus making the tube the insect turns around, and applies its mouth, and feeds
(fig. 2). During feeding the abdomen swells up. After feeding for sometime (feeding time is variable; usually it is 2 to 5 minutes), the ovipositor is reintroduced into the tube slowly, kept inside the tube for sometime, withdrawn, and again feeding is done. In one case the feeding took place for 3 minutes; then the female reintroduced the ovipositor shaft into the feeding tube and kept it there for another 3 minutes. After withdrawing the ovipositor shaft she again fed for four and a half minutes. After this she again introduced the ovipositor, and moved it in and out, as if in stabbing movements, several times at somewhat different angles. Perhaps the latter movements were for destroying the feeding tube. Then she withdrew the ovipositor shaft, and retracted it into the abdomen. From the tip of the abdomen a droplet was seen coming out, and the abdominal tip was applied to the outer end of the feeding tube. Perhaps this was for closing the feeding tube. Then the female moved away.
It may be noted that stabbing movements following feeding, apparently to destroy the tube, do not always appear. Closure of the outer end of the feeding tube with a milky secretion, emerging from the abdominal tip, is seen in most but not in all cases. Perhaps this is because the female has not found the prey inside suitable for oviposition, and has not laid any egg on it. In some cases feeding took place with the formation of a feeding tube, and immediately after it, on dissection of the seed, a parasite egg was seen on the bruchid larva. From this it has been inferred that, before formation of the feeding tube and feeding, oviposition had been done. On several occasions it was found that, soon after feeding tube formation and feeding, when the seed was dissected, there was a dead and partly shrunken larva, and there was no egg on it. In a number of cases it was also observed that the ovipositor was inserted into the seed, and was later withdrawn, but no feeding tube was formed, and no feeding took place. Even then, on dissecting the seed an egg was found on the bruchid larva. Thus oviposition is not necessarily accompanied by feeding. Sometimes after drilling, the ovipositor
is withdrawn, without performing stabbing movements. Apparently this was because the female did not find the prey fit for either oviposition or feeding.

Normally only one parasite egg is laid on one bruchid larva. But in one case three D. basalis females were kept with only two infested seeds. In this case even after oviposition the females were moving about restlessly. When after one hour the seeds were broken open, on one bruchid larva 3 D. basalis eggs were found, and in the other seed the larva was very small, and, though D. basalis normally does not oviposit on such a small host, this small bruchid larva showed an egg on it.

Usually D. basalis eggs are laid on nearly mature or mature bruchid larvae. In some cases the parasitoid eggs have been found on bruchid pupae also. In still other cases fairly well sclerotized adults of the bruchid have been dissected out from seeds with elytra elevated and a D. basalis larva/pupa on the concave dorsum of the shrunken abdomen (fig. 10 of chapter VII).
It may be inferred from this that D. basalis may oviposit also on a young adult bruchid, which is still inside the seed.

The normal sequence of behaviour during oviposition and feeding has been shown through solid arrows in fig. 3. Deviations from the normal sequence have been indicated through broken arrows, and they are the following.

(i) After drumming the surface of an infested seed, the female may not take to tapping; instead she dismounts the seed and moves. But, as has been pointed out by Edwards (1954) in case of Mormoniella vitripennis, in this case also it has been noted that tapping is always followed by drilling.

(ii) After drilling, instead of stabbing, there may be withdrawal of ovipositor. Perhaps this happens on finding the host unsuitable for feeding/oviposition.

(iii) After stabbing the female may form a feeding tube and feed without ovipositing. Perhaps this happens when the female is a freshly ecloded adult, and she is in need
of feeding, but is not in position to oviposit.

(iv) After oviposition the female closes the aperture, and there is no feeding. Sometimes such bruchid larvae could be dissected out from seeds, after the female parasitoid had moved away, as were nearly paralyzed, showing some movements, plump and obviously not fed upon, and showing an egg of the parasitoid on the body surface.

(v) At any stage in the sequence of behaviour, shown in fig. 3., if the female is disturbed by another parasitoid adult or by an adult bruchid, the further sequence is arrested, and the female, withdrawing its ovipositor, if drilling phase has been reached, moves away. She may keep moving close to this seed, or may simply move away.

Discussion:

Simmonds (1956) in his study of Spalangia drosophilae noted that the feeding tube was formed by coagulation of host body fluids,
seeping out from the wound in the body of the pupa and hardening around the ovipositor shaft. In the present material, however the formation of the feeding tube has been repeatedly observed to take place by a viscid secretion flowing out at the base of the ovipositor shaft and spreading over the surface of the shaft from the base distally. Thus the tube in *D. basalis* is a product of certain glands associated with the base of the ovipositor, and does not result from coagulation of host's blood. Thus these observations are similar to those of Fulton (1933), Faure and Zolstorewsky (as quoted by Clausen, 1940) and H.D. Smith (1930).

Fulton (1933) and Faure and Zolstorewsky (as quoted by Clausen, 1940) have reported that the secretion emerges mostly through the tip of the ovipositor, and the ovipositor tip is used as a spatula for shaping the feeding tube. Present observations are, however somewhat different. The secretion for formation of the feeding tube emerges at the ovipositor base, flows around the shaft and
hardens. The shaft thus behaves as an internal mould for the tube. The slow back and forth movement and the rotatory movement of the shaft also seem to help in shaping the tube. These observations come quite close to those of H. B. Smith (1930).

Details of drumming, tapping and drilling are very much similar to those given by Edwards (1954) for Mormoniella vitripennis. As to the mode of feeding tube formation this author says, "After laying her eggs the female removes all but the tip of the ovipositor and then slowly inserts it again, at the same time exuding a colourless fluid around it. The surface of the pupa is probed by the tip of the ovipositor for several seconds and is then held motionless until fluid hardens. The ventral valves are jabbed several times into the pupa before the ovipositor is carefully withdrawn leaving a tube connecting the pupa with the exterior." A very much similar procedure for feeding tube formation seems to be followed by the species under study.
According to Edwards (1954) *M. vitripennis* feeds on very young puparia but does not oviposit in them. In the present study too it has been observed that developmental stages of *D. basalis* are not found on young bruchid larvae, though sometimes such bruchid larvae have been found dead, shrunken and apparently fed upon by the parasitoid.

About male feeding Edwards (1954) says, "Cousin (1933) claims that males follow the females to find the end of a tube and feed on host fluids, but this was never seen during the present work." In the present study also *D. basalis* male has never been observed to behave this way. Infact male *D. basalis* has not been found to feed by any method, except when it is offered an artificial diet of honey.

According to Edwards (1954) the number of eggs laid per female varies much in *M. vitripennis* and that the female tries to adjust the number of eggs according to size of the host. In *D. basalis* normally only one egg is laid per bruchid larva.
References:


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Key to lettering of figures:

BA - bruchid adult.
BC - bruchid cavity.
DL - bruchid larva.
DP - D. basalis pupa.
FT - feeding tube.
OV - ovipositor shaft.
S  - seed surface.

* * * * *
Mounts an infested seed
↓
Drumming
↓
Tapping
↓
Drilling
↓
Stabbing
↓
Oviposition
↓
Formation of feeding tube
↓
Feeding
↓
Closing the feeding tube/ aperture at the site of drilling
↓
Moves away

Withdrawal of ovipositor

Dismounts and moves away

FIG. 3