EGG-LAYING OF THE RICE WEEVIL, CALANDRA ORYZAE LINN.

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The Rice Weevil, *Calandra oryzæ* Linn., is well known throughout the United States as a stored grain pest. It is especially destructive in the South, however, where it is known chiefly because of its injury to corn (1, 4). In fact, it is often locally called the Corn Weevil.

While studying the pest, the writer was impressed by its highly adaptive method of oviposition, and the belief that a study of the habit would be interesting and of some economic importance led to the observations included in this paper.

The work was performed at Clemson College, South Carolina, during the winter of 1912-1913, under the direction of Professor A. F. Conradi, State Entomologist, to whom the writer is indebted for valuable suggestions and assistance. The cuts are used through courtesy of the South Carolina Experiment Station.

WHERE THE EGGS ARE DEPOSITED.

Each egg is deposited singly in a cavity previously dug in the grain by the female beetle. Preparatory to oviposition, the weevil moves over the surface of the corn several times, examining it thoroughly by means of the tip of the proboscis and the antennæ before a suitable place is decided upon. When the place has finally been chosen, the excavation of the cavity is immediately begun by gnawing the material with the mandibles. Unless disturbed, the weevil will usually finish the cavity when once started, but its completion is by no means certain, for the weevil often becomes apparently dissatisfied with the location even after the cavity is well started, and a new location is sought.

The place selected is usually near the edge of the corn, and, when in position to excavate, the weevil is almost invariably straddling the edge of the kernel. Nearly all of the eggs observed were deposited in the soft starch or in the germ. Only rarely was one placed in the horny starch, while a favorite location was at the junction of the germ with the soft starch, and also at the junction of the soft starch with the horny starch.

In order to facilitate observation, the weevils were provided with grains of corn that had previously been cut in two longitudinally. The eggs were deposited on the broken surfaces of these half-grains, except in a few cases where they were deposited in the germ at the point where it had been attached to the cob. The outer, horny surface of dry corn is apparently too hard for the weevils to penetrate, for no eggs were observed in this region, and, even when only whole grains were provided, the eggs were deposited either in the germ or in the soft starch at the outer end of the kernel.

EXCAVATING THE CAVITY.

While excavating the cavity, the insect retains a firm attachment to the corn by clasping the surface, chiefly with the spines on the distal ends of the tibiæ. During the entire process, one of the fore legs is in almost constant motion as though endeavoring to obtain a better foothold. The operation of digging is accomplished by giving an oscillating motion to the thorax on the first pair of legs as an axis, which results in an up-and-down movement of the proboscis. At the same time, the head is turned from side to side, thus adding a rotary motion to the proboscis. This operation continues until the hole is partially dug, when the proboscis is lifted nearly to the surface, after which the sides are

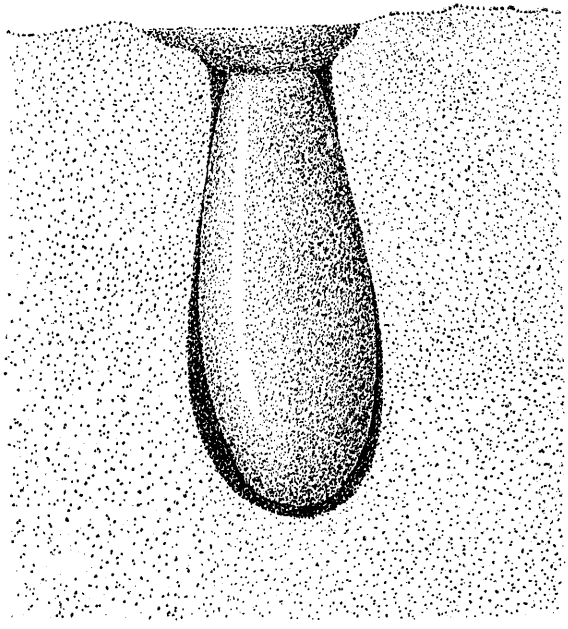

Figure 1. Longitudinal section of cavity showing egg and plug in place.

cut down, enlarging the excavation. When the bottom is again reached, the former movements are resumed. These movements often end with sharp jerks as though pieces of the material were being broken off. The work of excavating is continued until the depth of the cavity is equal to the length of the proboscis, when the weevil stops digging, and prepares to deposit the egg. During the process of digging, that part of the proboscis that extends into the cavity is clean, but chewed material collects about the mouth of the cavity and on the portion of the proboscis above.

The insects are quite easily disconcerted. They discontinue operations and remain still a few moments when disturbed by noise or by the movement of a nearby object, and frequently quit the place entirely. This sensitiveness abates as the cavity deepens, until, during the operation of depositing the egg, the grain on which the weevil is at work may be handled without disturbing the insect.

The time required in making the cavities varies greatly. Out of six operations of which the time was taken, the shortest was thirty two minutes, while the longest period observed was one hour and forty five minutes, and this time was spent in completing a cavity which was apparently one-half finished when observation began.

DEPOSITING THE EGG.

When the cavity is finished, the proboscis is slowly and hesitatingly withdrawn. The weevil then turns around over the opening, and walks slowly forward a few steps, at the same time swinging the abdomen from side to side, thus searching for the mouth of the cavity. When the tip of the abdomen comes in contact with the opening, the weevil stops, and places the ovipositor in position. During egg-laying, the ovipositor may be observed somewhat distended by the passage of the egg. There is a slight movement of the tip of the abdomen, probably aiding in forcing the egg into the cavity.

In one instance it was observed that a weevil, when the cavity was finished, turned about as usual, but failed to find the opening with the ovipositor. The insect then moved backward until the proboscis was over the cavity, facing in the opposite direction from that when the cavity was dug. After a little additional digging, the weevil successfully inserted the ovipositor, and deposited the egg.

The time consumed in depositing the egg varies from three to seven minutes, the average being 4.3 minutes. The average number of eggs laid per day by a single weevil was found to be 1.2. This was determined from records including twenty weevils laying a total of 378 eggs. The largest number of eggs deposited by a weevil in one day was 9, while 63 eggs in 46 days was the greatest total number of eggs deposited by one weevil. This does not represent the total number of eggs laid during the life of the insect. The rate of oviposition as well as the total number of eggs deposited varies with the conditions under which the eggs are laid. Probably the most important factors are the degree of hardness of the corn and the temperature and moisture conditions. Hinds and Turner (3) found that a single weevil is capable of laying as many as 417 eggs during a period of 110 days.

The act of preparing the cavity and depositing the egg apparently requires considerable energy, for, after depositing an egg, the weevil requires a period of rest before repeating the operation.

SEALING THE CAVITY.

After the egg has been deposited, but before the ovipositor has been withdrawn, the substance with which the cavity is sealed may be seen flowing through the translucent ovipositor into the cavity. The ovipositor is then withdrawn, and its trowel-like tip is used to work the fluid into place. This consists of a thorough tamping of the material and smoothing of the surface, and continues until the fluid solidifies. This process being completed, the weevil, without changing position, usually deposits a second

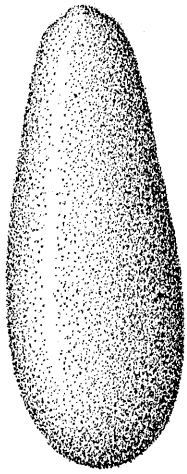

Fig. 2. Egg.

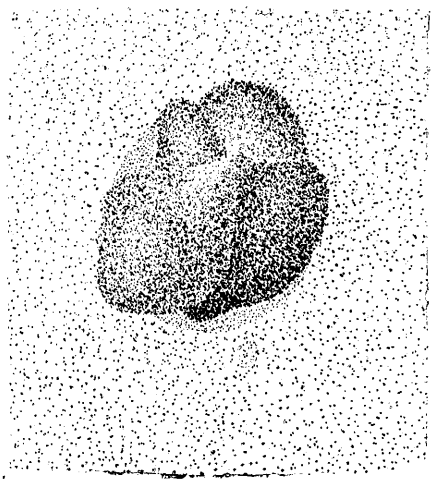

Fig. 3. Plug with two or more discharges of material, viewed in normal position in corn.

mass of material over the first. The second discharge is much less plastic than the first, and is not usually very thoroughly worked with the ovipositor, except when the surface of the first discharge lies below the surface of the corn. Frequently a third mass of material similar to the second, but much smaller, is discharged. This is rarely tamped. After this, the weevil pays no further attion to the egg, but immediately abandons the place.

DESCRIPTION OF THE PLUG.

The plug that seals the cavity may be described as a rather uneven disc-shaped body about .12 mm. thick, the diameter corresponding to the diameter of the mouth of the cavity. The inner surface is somewhat hemispherical, with a minute pit in the centre

into which the tip of the egg extends. In some cases there is also a depression in the outer surface. As the second and third discharges are usually not well tamped, they are seen as rough and uneven masses above the first discharge. When the latter discharges are not present, the surface of the plug has a smooth appearance, and in the rather exceptional cases when the other discharges are well tamped, they also present a fairly smooth surface.

The top of the first discharge usually lies even with the surface of the corn. However, it not infrequently happens that the egg is set so far into the cavity that the top of the plug lies some distance below the surface of the corn, but it never extends much above the surface unless more than one discharge has been added.

Fig. 4. Plug showing pit in inner surface.

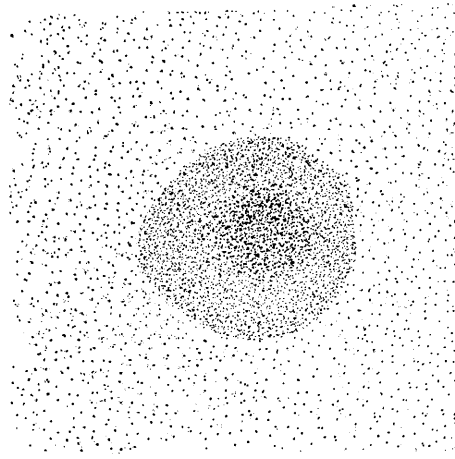

Fig. 5. Plug consisting of a single discharge of material, viewed in normal position in corn.

The plug may readily be picked from the corn by means of a needle. The several discharges are usually very loosely coherent, but, if the second and third discharges have been thoroughly tamped down upon the first, all are more or less firmly united. Usually it is not difficult to separate the plug from the egg, but frequently they are so firmly joined that the egg is torn in separating the two.

The material of the first discharge is colorless and translucent, while that of the second and third discharges is opaque, and varies in color from greenish or yellowish to a starchy white, and closely resembles fœcal material. Hence, if the plug consists of only the first discharge, its apparent color varies with the color of the part of the corn in which it is situated. There often appears to be a dark area in the center of such a plug, which is no doubt caused

by the dark cavity beneath. The plug often so closely resembles the surrounding surface as to be very difficultly distinguished, and some practice is required to locate these eggs. If more than one discharge is present, however, the plug is easily seen.

DESCRIPTION OF THE EGG.

The egg is a small, glistening, opaque, somewhat "pear-shaped" body of a creamy white color. The size varies somewhat, but the average dimensions are about .643 mm. long by .289 mm. in diameter at the largest part. It consists of an outer, comparatively tough membrane, filled with an opaque, sticky fluid. The large end of the egg is placed toward the inner end of the cavity, while the small end is attached to the plug in the mouth of the cavity, which does not agree with the observations of Hinds and Turner (3) who describe the egg as having the "larger end outward as it rests in the grain." On the small end of the egg is a small protuberance that fits into the pit in the inner surface of the plug.

DESCRIPTION OF THE CAVITY.

The cavity is somewhat larger than the egg, there being an unoccupied space around the sides and bottom. The bottom is evenly rounded, the sides drawing gradually together at the mouth, the diameter of which is smaller than at any other part of the cavity. The mouth of the cavity being smaller than the larger end of the egg, it is necessary to enlarge the opening in order to remove the egg.

SIGNIFICANCE OF THE HABIT.

It is interesting to conjecture the uses of this careful and laborious method of oviposition. The point of prime importance is that the eggs are placed in such a position that the larvæ produced are surrounded by an abundance of food, and are in a position where they are protected during the helpless period of life. By being deposited beneath the surface of the corn, the eggs are protected to a large extent from external injury, from excessive drying, and from sudden changes in temperature. While serving to increase the protection from external injury, excessive drying, and change in temperature, the sealing of the cavity is undoubtedly useful as a protection against predaceous and parasitic enemies. Incidentally, this, probably, is quite effective as a protection to the eggs and larvæ against gases used in fumigation.

As a protection against natural enemies, the plug is no doubt serviceable, but it is not an absolute, and possibly not a very highly efficient safeguard, for, while making these observations, the writer noted numerous instances in which the predaceous mite, *Pediculoides ventricosus* Newport (2), successfully attacked and

destroyed the eggs and larvæ as well as the adult weevils. The method by which the mites gained access to the eggs was by burrowing between the plug and the surrounding corn, which, apparently, was not a difficult task.

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