

through continuous progressive specialization to more and more differentiated structure with correspondingly increased functional powers, or larger or different fields of work. At other times it may lead us in a wave line, which follows a devious course, rising part of the time through progressive specialization, and then falling for another period of time through specialization by reduction. If the animals under consideration be parasites, they may continue on this descending plane both in the growth of the individual and the evolution of the group. Nevertheless the resulting adult is not necessarily of "low grade" in any scientific scheme of arrangement founded upon the principles of evolu-

tion. It is, however, farther removed from the primitive type, and is extremely specialized. The use of the aesthetic terms "low" and "high" have come from a period in the history of our science when nature was made to assume a rigidly progressive aspect, each division of the animal kingdom representing a finger-post pointing towards the so-called perfect animal, man, each rising higher and higher in the scale of perfection whose standard was the human organization. Such artificial ideas revenge themselves, and words become their ready instruments, first to express what is false, and then to help in binding the mind with the conservative fetters of habit.

ON THE LIFE HISTORY OF DIABROTICA 12-PUNCTATA, OLIV.

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(Concluded from p. 30.)

THE INJURY TO CORN.

The larva of this insect works much like its congener, *D. longicornis*, commonly destroying the roots, but often also working on the underground part of the stalk. The larva of *D. longicornis* often makes a longitudinal burrow in a root leaving little outward trace of its presence. The larval *D. 12-punctata* has not been observed to work in this manner, the roots being mined and channeled irregularly, often bored

through from side to side, or even completely devoured where the worms are abundant. Very few fields in Kentucky are entirely free from injury, and many are affected very injuriously, the damage being perceptible to casual observation in the retarded growth, and, as the seasons advance, in the prostration of infested corn by the winds. As a rule the injury is greatest on land that retains moisture longest. On high and well-drained land it is not so prevalent. In

all these respects it agrees with the related corn root-worm of the North.

I have not observed thus far that its abundance has any relation to the land having been previously in corn. The northern species, it will be remembered, is commonly most abundant on old corn land. Two of the worst infested fields examined in 1889 were, one in tobacco, and the other in oats, in 1888. A third field, in corn in 1887 and 1888, was in oats in the spring of 1889, these to be followed the same season by a late planting of corn. This difference in the injuries of the two corn root-worms is to be attributed to the fact that *D. longicornis* hibernates in the egg state in the earth of corn fields, whereas *D. 12-punctata* hibernates, at least in great part, as an adult beetle which wanders actively about in fall and spring in search of food. Still, the observation reported in Insect life concerning injury to orchard trees planted on corn land renders it probable that in some cases beetles which develop in corn land hibernate there. This would certainly be the case at any rate if the corn was very late.

D. 12-punctata seems to be the only corn root-worm of Kentucky, and certainly is the only generally injurious one. During two seasons' collecting I have not found a single specimen of *D. longicornis* within the limits of the State.

LIFE-HISTORY (FOR KENTUCKY).

Young larvae noted on the 15th of July, 1889, were mostly grown, and some had pupated in small cells in the

earth by the 29th of the same month. Adult beetles dissected at this time contained numerous ova of relatively large size. On August 3 of that summer an examination of infested corn showed that most of the larvae had pupated or were ready to do so. No very young worms were seen. One adult was taken from an earthen cell where it had recently changed from a pupa. From the abundance of females with well developed ova about fields at this time it seemed probable there was to be a second brood. Subsequent search in the fields did not reveal young larvae there, and towards the end of August the females disappeared, and none were observed with developed eggs during the remainder of the season.

The eggs of these females were certainly not deposited freely among corn that was damaged by the early brood of larvae. What then became of them?

Several larvae and pupae, perhaps from eggs laid by these females, were found among injured corn late in summer, but thorough search at different times showed them to be rare, and I was for a time led to think the species might be single brooded like the related *D. longicornis*. But on the first of November, 1889, the discovery in a field of late-planted corn of numerous larvae together with pupae and recently transformed adults, gave unquestionable proof of at least two annual broods of the insect for this locality. The examples collected at this time were chiefly grown larvae, contracted and ready for pupation, with occasional individuals

about three-fourths grown, and a few pupae and recently emerged adults.

In my paper as read at the Washington meeting of entomologists I stated that the above facts made it seem probable that the late brood of larvae fed in part on plants other than corn. In the discussion following, Prof. Otto Lugger of Minnesota showed the surmise to be well founded by stating that he had taken pupae at the roots of one of the native Compositae,—a species of *Rudbeckia*. At my request he has since kindly given me the following definite statement, quoted partly from his notes :

“*Diabrotica 12-punctata*.—Sep. 3, '89, found among roots of *Rudbeckia* sp. three pupae of a chrysomelid, nearly ready to issue the imago. Sep. 5, '89, all three insects appeared above ground in breeding cage. At first white, they soon changed to the normal color, excepting that the black spots were only faintly visible. Sep. 7, '89, insects mature, and mounted. It is the above species.

Many specimens occurred at this time upon the above plant and upon *Solidago* and thistles. The majority appeared quite fresh, as if hatched quite recently. The *Rudbeckia* grew in an old field cultivated some four years ago, but grown up into a wilderness of *Solidago*, *Rudbeckia*, thistles, etc. The nearest field of corn is fully one-fourth mile from this spot.”

Prof. Lugger's observation explains the whereabouts of most of the late brood. Very little corn is planted here as late as that in which the second brood occurred, so that ordinarily the beetles must resort to some other plant for oviposition. Five Kentucky species of

Rudbeckia are known, and in all probability the beetles which emerged from the ground in this vicinity during August resorted to these. The observation also renders it almost certain that the insect is two brooded at latitudes much higher than this.

The larvae and pupae in the field of late-planted corn were followed until all had completed their transformations. From an excess of larvae in November, the proportion was gradually changed to an excess of pupae in December. A short time spent digging about hills of corn on Dec. 5 resulted in finding seven pupae and two larvae. Subsequently we experienced a most exceptional period of spring-like weather, and urged apparently by its influence all the larvae and pupae completed their transformations. On January 16, a close search among the infested roots did not reveal the presence of a single example. Previous to December we had some weather during which the surface of the ground was frozen. If the winter subsequently had not been so mild it is safe to assume that the larvae and pupae in the frozen ground would not have changed to beetles until the spring of 1890.

The adult beetle has been found abroad at all times when looked for from July 10, 1889, until December, 1890. During the winter it is to be found among rubbish in strawberry beds, in gardens, and meadows. During mild days it is often awake, and feeds at such times on almost any green vegetation within reach. It is one of

the first insects to become active in spring, and at this time is to be found on grasses, clovers and other plants feeding on leaves, flowers or pollen. It is during this time, and before the corn is up, that the ova develops in the ovaries of the females. During the fall and winter those taken and dissected contained no developed eggs. In the latter part of May last spring when the corn was a few inches high, the females collected contained ova in an advanced stage of development.

I was unfortunately unable to find the eggs after oviposition, but there can be no doubt but that they are placed like those of *D. longicornis* in the ground at the roots of corn. A search in corn fields June 3, 1889, resulted in no larvae. On June 10, they began to appear, and by the close of the month were mostly well grown. On July 5 pupae were found in confinement from larvae brought in June 30. The pupae began to appear out of doors about the same time and the beetles came forth from them during the first two weeks of July, all apparently being out before the 21st. The first brood was thus matured earlier than in 1889, a result, doubtless, of the forwardness of the season of 1890.

REMEDIAL TREATMENT.

A complete remedy for the pest may prove hard to find. If the insect spent the winter in corn fields in the egg state, as has been determined by Prof. S. A. Forbes to be true of *D. longicornis*, we might hope to avoid injuries by

rotation of crops. Since it hibernates in part at least as an adult, and is capable of prolonged flight, rotation would not avail. The food habits, too, of larva and imago are such as to favor it in the struggle for existence. As a beetle it is a voracious and indiscriminate feeder, and nothing, seemingly, in the way of succulent vegetation comes amiss. Tomato leaves, clovers, potato leaves and tubers, turnips and cabbage have been used to feed beetles kept in confinement. During the latter part of August they are very common here in the ends of corn ears, eating out the silks. It is possible they may do some harm in this way, but I can not see that the affected corn fails to develop the usual number of grains. At times it is scarcely possible to find an ear of corn that does not harbor one or more beetles.

ENEMIES.

Some predaceous beetles and larvae have been found during summer and fall in the earth with young root worms, but not in any great numbers. Among birds I find only the brown thrush recorded as eating the beetles.

Several parasites occur in the fluids of the beetles, and can perhaps be expected to check any extraordinary increase in the numbers of the root-worm. The most common of these is one of the protozoans, a large Gregarina, probably the same species as that noted some years ago in the fluids of *D. longicornis*. The fluids of examples occasionally swarm also with a small nematode worm, and in one instance a large

thread worm with tapering caudal appendage was noted. Occasional beetles have been found affected with an *Empusa* resembling *E. grylli*, a species commonly known as a parasite of grasshoppers. An interesting bacterial disease of the larva reported by Prof. S. A. Forbes at the Washington meeting of entomologists is also to be mentioned in this connection, though I have not detected it here in Kentucky.

DESCRIPTIONS.

Egg. — Matured ova from ovaries of females are much like those of *D. longicornis*. They are white, oval, with the surface reticulated and sculptured so as to produce numerous hexagonal, pitted areas. Prof. Forbes gives the dimensions of the egg of *D. longicornis* as .025 inch, by .015 inch. Ova of the spotted species measure a trifle larger, being about .027 inch in length by .016 inch in greatest diameter.



Fig. 1. Larva, enlarged.

Larva. — Body cylindrical, tapering a trifle towards the extremities, composed of twelve segments behind the head. Skin wrinkled, papillose along the sides, white, sometimes becoming yellowish just before pupation. Head dark brown, nearly black in some examples, with a few rather strong hairs arising from the surface; a narrow median longitudinal line of black above, and two pale lines which converge from the bases of the antennae, following sutures, to meet at the middle line on the posterior part of the head; ventral side of head pale medially. No eyes. Antennae of three segments, white. Labrum dark brown. Mandibles dark brown, black at tips, with four or more blunt denticles. Maxillae pale, armed with

numerous strong spines within. Labium pale. Cervical shield pale brown, with a narrow median longitudinal white line, broadly triangular in shape. Jointed legs pale, each with a dark brown chitinous supporting frame work at base; each segment of legs provided with a number of strong hairs; a single brown tarsal claw, beside which arises a white, elliptical, striated plate slightly longer than the claw. Dorsal shield of posterior body segment nearly circular in outline, brown, with numerous minute black specks, slightly rimmed at posterior margin, and in young examples obscurely bituberculate; furnished with several strong marginal hairs, and with four minute, striate, centrally-placed, spatulate appendages. Spiracles round, the two anterior pairs sometimes with brown rims, the rest pale. Posterior segment with a single fleshy proleg.

Length about .56 inch, diameter about .06 inch. Examples ready for pupation about .37 inch long.

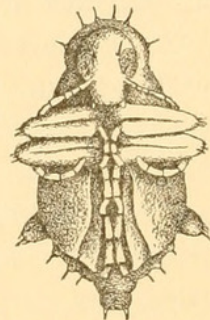


Fig. 2. Pupa, enlarged.

Pupa. — Translucent white, with scattered brown hairs on dorsal side of body arranged as follows: one within, and a pair posterior to, the base of each antenna; a transverse, arched row near the anterior edge, a pair near the middle, one at the middle of each side, and one at each side near the posterior margin, of the prothorax; four each on the meso- and meta-thorax; three at the extremity of each femur; a pair at the middle and one at each side of each abdominal segment, except the posterior three; antepenultimate and penultimate segments of abdomen each with six, the four inner being in pairs and

posterior to the others; two within, and three without each of the large spines borne on the posterior segment. Caudal spines straight or curved, black-tipped. Wing-pads covering the posterior femora below. Antennae curving around the femora of the two anterior pairs of legs and then extending inwards towards the ventral middle line.

Length .22 — .25 inch.

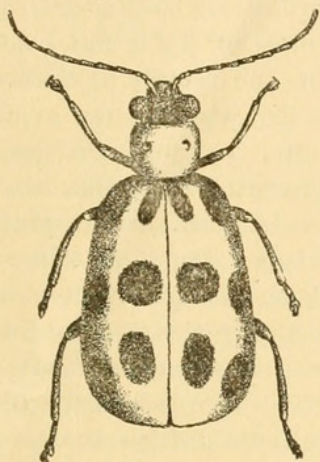


Fig. 3. Imago, enlarged.

Imago. — Pale green, or greenish yellow, marked with black. Head and mouth-parts black, the former showing a brownish cast medially on ventral side. Three basal articles of each antenna pale, sometimes with dusky dots on posterior side; remainder of antennae black. Prothorax uniformly green or yellow. Elytra green or yellow, with twelve large black spots, six on each, arranged in three cross series; the first series at the base, the second at about the middle, and the third midway between the second and the tips of the elytra. Scutellum brown or black. Mesothorax beneath, the coxae, the basal third to half of femora, and the abdomen, yellow or green. Metathorax beneath, the distal portion of the femora, and the whole of the tibiae and tarsi, black.

Head with a basal pit behind antennae. Prothorax above smooth and shining, obsoletely punctulate, with a pair of pits, one on each side of the middle line. Margin of prothorax sinuate at sides, no prominent angles. Elytra minutely, regularly punctu-

late, each elytron with a humeral prominence. Antennae, metathorax beneath, abdomen, and legs, clothed with a fine silken pubescence.

Length .25 — .28 inch; antennae about .19 inch.

For the purpose of making this record more nearly complete I may be allowed in conclusion to call attention to the most recent notice of *D. 12-punctata* known to me, printed in a recent number of *Insect life* (v. 3, 150). The writer, Mr. Webster, here gives a brief description of the larva which agrees in the main with that given above. In several points, however, we do not agree. I presume the statement that the posterior segment of the body is provided with a pair of prolegs is a slip of the pen; certainly there is only one of these in both *D. longicornis* and *D. 12-punctata*. The statement also that the brown plate on the hindmost segment is furnished with a ridge "bearing a long erect bristle" cannot be verified on the larvae collected in this State, and I respectfully suggest in explanation that in examples nearly grown some of the hairs on the plate are frequently worn or broken off. The hairs are constant in position and number in the examples I have studied, and none have been seen with a single erect hair arising from the ridge. If these differences in the descriptions are not thus to be explained away, then I submit that we have examined different larvae, and am content to leave to others the decision as to who has described the larva of *D. 12-punctata*.



Garman, Harrison. 1891. "On the Life History of *Diabrotica 12-Punctata* Oliv—(Concluded from p. 30.)." *Psyche* 6, 44–49.

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