

The History of *Conoderus lividus* (Deg.)

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Fig. 1.—Adult, magnified.



Fig. 2.—Eggs, magnified.

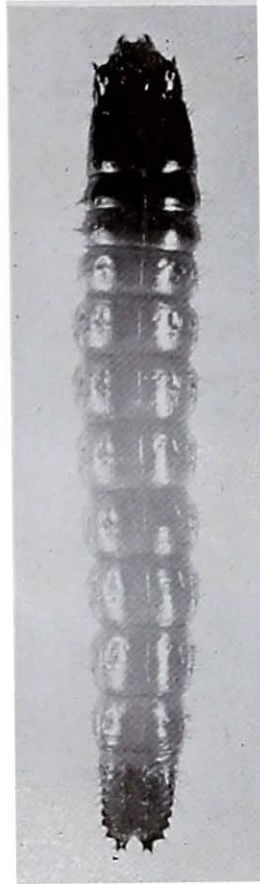


Fig. 3.—Larva, magnified.



Fig. 4.—Pupa, magnified.

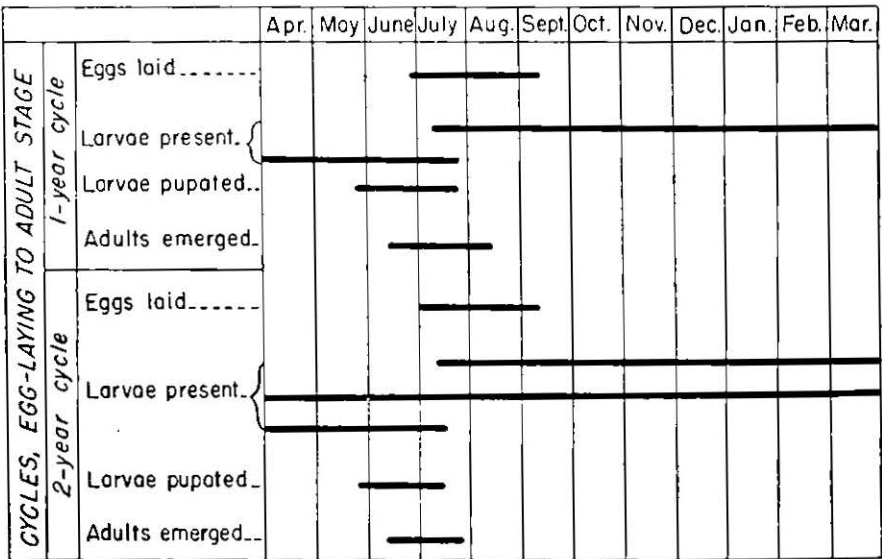


Fig. 5.—Seasonal history of *C. lividus*.

Life History of *Conoderus lividus* (Deg.)

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Conoderus lividus is rather numerous in central Kentucky, but the larvae or wireworms are not very destructive to any one agricultural crop. More larvae have been found in Kentucky bluegrass sod than among the roots of any other crop, but injury to bluegrass is not noticeable because of the nature of bluegrass. Crops that follow sod in rotations are attacked to some extent, the wireworm having been found attacking the roots of corn, tobacco, clover, alfalfa, and some of the vegetable crops. Adults may sometimes be collected by sweeping forage crops with an insect net, and in late June or early July they may be collected from the silks and tassels of corn. Large numbers of adults often collect on green corn stalks placed in fairly large piles.

Frequent mention of *Conoderus lividus* has been made in the literature, but very little has been published on the biology of this insect. Hyslop (1915), in a paper on wireworms of cereal and forage crops, gave some information on the biology of this wireworm. Boving and Craighead (1931) furnished four figures to aid in identification of the larva. Jewett (1939 and 1946) gave descriptions and illustrations of the larva.

The writer has been collecting and rearing larvae of *C. lividus* for several years, and in the summer of 1944 began a study of the life history of this Elaterid.

STAGES OF THE INSECT

Adult

The beetles (Fig. 1) are rather large, 10 to 15 mm long, and are light brown with the antennae and legs lighter. The pubescence is grayish and rather dense. The pronotum is longer than wide, and the hind angles long, divergent, and carinate; sides sinuate in front of hind angles, punctuation rather coarse and close. The elytra are striate and punctured.

Egg

The egg (Fig. 2) is white when first laid but it takes on a yellowish cast when older. Though the surface is smooth, particles of earth often adhere to the eggs because of a sticky coating when first laid. The chorion is pliable and tough. Eggs can be seen without magnification, are nearly spherical, and average 0.50 x 0.57 mm.

Larva

The larva (Fig. 3) is dominantly yellow; dorsum of the first thoracic segment and generally part of the second segment, tubercles on the ninth abdominal segment, and tips of caudal processes reddish brown; head darker. The ninth abdominal segment is slightly darker than the other abdominal segments. The larva is fairly large, 18 to 25 mm long, and the body is smooth, sparsely hairy, slightly flattened, and tapering slightly from the thorax to the head and toward the ninth abdominal segment. Spines or armature on the sides of the anal proleg are rather prominent and are brown or black.

Pupa

The pupa (Fig. 4) is a little longer than the adult, white when newly formed, and with dark eye-spots when nearer maturity. One long spine is on each side on the anterior margin of the prothoracic disk and one at each posterior angle of the same tergite. Two long spines are between two much smaller ones at the tip of the abdomen.

LIFE HISTORY

Egg laying

Adults laid eggs fairly freely and regularly when confined in lantern globe cages and in salve boxes. The eggs were placed on the surface of the soil, under clods of earth, in crevices of the soil, and on litter on the soil, but not directly upon the plants. When confined in salve boxes, adults sometimes placed eggs on sprouting grain. The eggs were sometimes rather difficult to find because they soon become soiled or covered with soil by the adults traveling about in the small cages. Most of the eggs were viable.

No attempt was made to determine individual egg-laying records but records were made of the limits of egg-laying periods. In 1944, 118 adults were collected July 1 to July 7 from stalks of field corn. The last of these died August 12 to August 14. Eggs were laid July 3 to August 8. Reared adults in 1945 laid eggs from June 29 to September 18, but those laid after September 12 were not viable. Reared adults in 1946 laid eggs July 1 to August 22.

Egg period

In 1944 a considerable number of eggs were collected and the incubation periods were determined for 374 eggs. These ranged from 9 to 11 days, with an average of 9.9 days. The incubation periods for 294 eggs in 1945 ranged from 9 to 13 days and averaged 11 days. Incubation periods for complete rearing are given in Table 1.

Larval period

From eggs laid in the summer of 1944, 147 complete rearings were made (Table 1). There were two broods of larvae, one maturing in

Table 1.—Developmental periods of *Conoderus lividus*, from complete rearings

Stages	1-year cycles		2-year cycles	
	1944-45	1945-46	1944-46	1945-47
	days	days	days	days
Egg period				
Average	9.8	11.1	10.1	11.1
Range	9-11	9-13	8-11	9-12
Pupal period				
Average	10.9	11.9	13.6	12.2
Range	9-16	10-20	10-20	10-15
Larval period				
Average	340.6	333.9	695.4	699.4
Range	312-373	302-361	676-729	684-716
Total period				
Average	361.3	356.9	719.1	722.7
Range	334-395	327-383	702-750	697-750
Number of rearings.....	68	166	79	17

approximately 1 year after the eggs were laid and one maturing in about 2 years. The 68 larvae in the 1-year group completed their development in 312 to 373 days, with an average of 340.6 days. These larvae pupated in the summer of 1945.

In the two-year brood the 79 larvae completed their development in 1 year and 311 days to 1 year and 364 days, with an average of 1 year and 330.4 days. These pupated in the summer of 1946.

In 1945, rearings were made from eggs laid by reared adults that transformed from pupae that season. They were adults that developed from eggs laid in 1944. Some of the larvae from eggs laid in 1945 pupated in the summer of 1946 and the others in 1947. For 166 rearings of larvae that required about 1 year for development, the range was 302 to 361 days and the average 333.9 days. Seventeen larvae from eggs laid in 1945 required about 2 years for development, ranging from 1 year and 319 days to 1 year and 351 days, with an average of 1 year and 334.4 days.

Habits of larvae

Soon after hatching the larvae begin moving about actively in search of food and shelter. They soon attack and bore into rootlets or crawl into the soil, and are difficult to find. Newly hatched larvae did not seem inclined to attack each other, but after a few days they had to be separated. Larvae brought to the surface of soil by cultivation soon worked their way into the soil and were exposed for only a short time to natural enemies and action of the sun and weather. They do not penetrate very deeply into the soil even in winter. Fall plowing does not reduce the number of wireworms to any great extent. When Kentucky bluegrass sod is broken early in the spring, most of the larvae are found just under the sod or at a slightly greater depth. The injury caused is similar to that of other species; they chew on roots and stems and bore into them.

In central Kentucky, *C. lividus* has been found to be more numerous in Kentucky bluegrass sod than on any other crop, but nearly mature worms are too large to bore into the grass stems. The roots and stems of other crops, such as tobacco, potatoes, corn, cantaloupes, are often tunnelled by this wireworm.

Pupal period

At the time larvae make the pupal cells, frequent examinations have to be made to observe the time of transformation to the pupa stage. The pupae have to be handled carefully to prevent injuries. Generally pupae were placed in artificial cells in the soil in the rearing boxes where they could easily be seen. The average pupal period for 68 pupae in 1945 was 9.8 days and the range 9 to 16 days. Eggs for these rearings were laid in 1944.

In 1946 the average pupal period for 79 pupae was 13.6 days and the range was 10 to 20 days. Eggs for these rearings were laid in 1944. For another lot of 166 pupae in 1946, from eggs laid in 1945, the average pupal period was 11.9 days, and the range 10 to 20 days. In 1947 the average pupal period for 17 pupae from eggs laid in 1945 was 12.2 days and the range 10 to 15 days. Pupal periods are given in Table 1.

Pupation of larvae in 1945 took place May 24 to July 25, 1.5 percent being in May, 79.4 percent in June, and 19.1 percent in July. Larvae in 1946 pupated May 22 to July 15, 18.8 percent being in May, 61.6 percent in June, and 19.6 percent in July. In 1947 larvae pupated May 31 to July 5, with 5.9 percent in May, 82.3 percent in June, and 11.8 percent in July.

SEASONAL HISTORY

Overwintering stage

No adults collected in the field in summer nor those reared lived over winter. Adults have not been collected in early spring. The larvae live over winter and are of two ages, one group living over one winter and one group living over two winters. In 1944 and 1945 larvae from eggs laid on the same days required either about 1 year or about 2 years to complete development. The numbers of larvae in the 1-year and 2-year periods were about equal.

Longevity of adults

Adults may live several weeks when given food and moisture. Of 118 adults collected July 1 to July 7, 1944, 117 were alive July 15, 115, July 18; 104, July 22; 87, July 27; 44, August 1; 26, August 4; 6, August 7; 1, August 12; and 0, August 14. In 1945, 50 beetles that transformed from pupae June 26 to July 12 were counted at about weekly intervals and the number of live beetles were recorded as follows,

48, July 21; 47, July 30; 29, August 6; 26, August 13; 22, August 17; 14, August 23; 6, August 30; 2, September 5; 1, September 10; 0, September 18. In 1946, 46 adults that transformed from pupae June 7 to June 29 had died by September 10.

Developmental periods

From eggs laid July 3 to July 10, 1944, two groups of larvae developed. One group or brood lived over the winter of 1944-45, pupated May 24 to July 25, 1945, and the adults transformed from pupae June 6 to August 8, 1945. There were 68 complete rearings. The cycles from egg-laying to the adult stage for these rearings ranged from 334 to 395 days, and averaged 361.3 days. The remainder of the larvae from eggs laid in 1944 lived over the winters of 1944-45 and 1945-46, pupated May 24 to July 15, 1946, and transformed to the adult stage June 9 to July 27, 1946. There were 79 rearings of this brood. The cycles from egg-laying to the adult stage ranged from 1 year and 337 days to 2 years and 20 days, and averaged 1 year and 354.1 days. The adults laid their eggs the same season they transformed from pupae and they did not live over the winter season.

In 1945, rearings were made from eggs laid June 30 to August 13. The larvae developed in a manner similar to those from eggs laid in 1944. One brood lived over the winter 1945-46, pupated May 22 to July 19, 1946, and transformed to the adult stages June 7 to July 30, 1946. These adults did not live over the winter of 1946-47. The cycles from egg-laying to the adult stage ranged from 327 days to 385 days and averaged 356.9 days. Some of the larvae from eggs laid June 30 to August 13, 1945, lived over the winters of 1945-46 and 1946-47. The larvae of this brood pupated June 24 to July 5, 1947, and the adults appeared June 24 to July 17, 1947. The average cycle from egg-laying to the adult stage was 1 year and 357.7 days, the range 1 year and 332 days to 2 years and 20 days. Life history and seasonal records are given in Table 1 and Fig. 5.

REARING METHODS

A few adults were collected by sweeping forage crops with an insect net, but the largest number were collected from growing corn or cornstalks placed in good-sized piles. Although the beetles were active they seldom attempted to escape by flying and could be easily picked off the plants.

Reared adults were placed in lantern globe cages which were set in a sunny location for about 10 days. This seemed to encourage mating. The beetles were fed a mixture of yeast and water that contained 5 percent of brown sugar. They were fed by placing in the cages small pieces of blotting paper dipped in the liquid. They fed readily on the liquid. Small sections of cornstalks and sometimes corn in the

milk stage were placed in the cages and the juices from these were taken readily.

Adults generally were confined in salve boxes for egg-laying, because of convenience in finding the eggs. Moist blotting paper was placed on the bottom of the box and upon it a small clod of moist earth upon which most of the eggs were laid. The eggs were removed from the earth and were placed on slightly moist blotting paper in a salve box and hatching dates were recorded.

Larvae were reared in salve boxes and flower pots. The larvae in salve boxes during winter were kept practically inactive in a cold section of a greenhouse and the flower pots were placed in soil out-of-doors. The larvae were placed on sprouting wheat in salve boxes, a few grains of ungerminated wheat were added, and the box filled with moist earth. Wheat and Kentucky bluegrass were used in the flower pots. The soil and grain in the salve boxes were changed every 2 or 3 weeks. This procedure gave a continuous supply of food for larvae. Soil in the boxes was not sterilized and was a mixture of 10 parts of clay and 1 part of peat moss worked through a fine screen and moistened.

SUMMARY AND CONCLUSIONS

The larvae of *Conoderus lividus* are often numerous in Kentucky bluegrass sod. This wireworm has been found injuring the roots of tobacco, corn, clover, alfalfa, and some of the vegetable crops.

There are two groups or broods of larvae, one brood requiring about 1 year for development and the other brood about 2 years. Pupation takes place mostly from May 15 to July 15 with the greatest part in June.

Adults appear within about 2 weeks after the larvae pupate and lay their eggs before the winter season. No adults have been found in the field during the winter months or very early in spring.

The larvae of *Conoderus lividus* are not important pests of tobacco plants in central Kentucky but they do some damage. The early planted crops are injured to a greater extent than later planted crops because after the middle of May pupation of larvae begins and continues for several weeks. In this study of seasonal history there were fewer active larvae in June than at any time.

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