

A CORN-FEEDING GEOMETRID

Pleuroprucha insulsaria Guen. (Lep. Geometridæ).

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INTRODUCTION.

In his monograph of the corn-feeding insects (3, p. 173) Forbes remarks on the fact that not a single species of the Geometridæ has been reported as feeding on this plant except an undetermined species mentioned many years ago by Smith (6, p. 188). So far as the writer has found no such report has been made since that time. For several years past, however, various observations have been made on a small geometrid larva occurring in varying abundance from year to year on corn silks. This species, *Pleuroprucha (Deptalia) insulsaria* Guenee appears never to have received the attention of economic entomologists. The injury it causes is trifling, but as a corn-feeding insect it is worthy of record.

The larvæ were first found in small numbers but well distributed in corn fields in the bottom lands along the Cumberland and Tennessee Rivers in eastern Tennessee, in August and September, 1913. They were again noted at Nashville,

Tennessee, the following year. At Knoxville in 1916, and more especially in 1917, they were so abundant that an excellent opportunity was afforded to study their habits. The data contained in the following article were obtained for the most part at Knoxville in 1917. Full credit and grateful acknowledgement are given to Mr. W. B. Cartwright, my assistant at that time, for his interested co-operation and assistance and also to Dr. Dyar, of the National Museum, for his kindness in supplying me with many of the distribution records quoted below and with a copy of Packard's description of the adult moth.

Pleuroprucha insulsaria Guen.

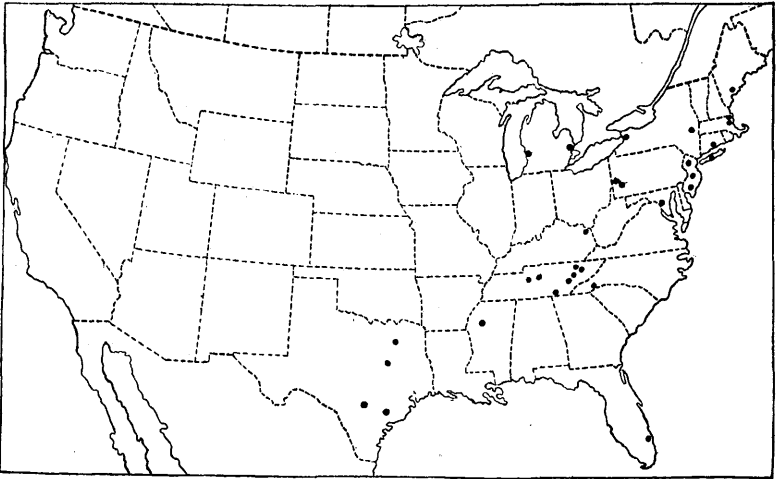


Fig. 1. Known distribution of *Pleuroprucha insulsaria* Guen. in the United States.

DISTRIBUTION.

The writer has taken larvæ of *Pleuroprucha insulsaria* at numerous points in eastern Tennessee and Kentucky and as far west as Nashville, Tenn. There is a note in the Bureau files recording the collection of larvæ on corn silk at Greenwood, Miss. The species is included in Britton's (1, p. 120) check-list of the insects of Connecticut. Smith (7, p. 498) lists it as "common throughout the State" of New Jersey. In his catalog Dr. Dyar gives the distribution as "Atlantic States" and in a recent letter he informs me that he has records from

Texas, North Carolina, District of Columbia, Florida, Pennsylvania, New York and Michigan. He has also given me the known distribution outside the United States, which shows it to occur in Mexico and Central America south to the Canal Zone, and throughout the West Indies. Walker (8, p. 737) also described the same species under other names from Venezuela, Florida and Jamaica. In addition to the states mentioned above Packard (5, p. 335) records it from Maine and Massachusetts. The exact localities when known are indicated on the accompanying map.

FOOD PLANTS.

Fresh corn silk seems, without doubt, to be the favorite food of the larvæ. Thorough search has repeatedly been made of other vegetation, especially of plants with flowers, to find whether any succulent floral tissue would serve as food. In only a few instances have the larvæ been found in such locations and then usually after fresh corn silk had largely disappeared from the fields. On August 31, and again on September 18, three larvæ were found on flowers of a cultivated species of *Helianthus* on which evidently they had been feeding. Other larvæ were swept September 6 from smartweed (*Polygonum pennsylvanicum*) in bloom and again on September 25 six larvæ were swept from flowers of *Verbesina occidentalis*. A single larva was swept from a mixed growth of oxeye daisy (*Chrysanthemum chrysanthemum*) and daisy fleabane (*Erigeron philadelphicus*) on June 12. Two larvæ were also found on flower heads of sumac (*Rhus glabra*) on August 21, and when confined in boxes with this same food they fed by eating small notches in the tender flower stalks. Most of these collected larvæ were reared to maturity so their identity cannot be questioned. Other larvæ quite similar in general appearance were also collected on various flowers, but when reared proved to be other species. Those taken on corn silk were all of this species.

In addition to the food plants observed in the field some cage experiments were conducted. Larvæ were reared nearly to maturity on caged flower sprigs of *Erigeron philadelphicus*, but because of neglect failed finally to pupate. In this case the rays were eaten and possibly the disk flowers to a slight extent. Larvæ confined in a box with fresh flowers of red clover (*Trifolium pratense*), horse nettle (*Solanum rostratum*),

daisy fleabane (*Erigeron philadelphicus*) and strands of fresh corn silk fed only on the corn silk. In another experiment larvæ were confined individually in tin boxes and given flowers or flower clusters of alfalfa, pigweed (*Amaranthus retroflexus*), cowpea, mullein (*Verbascum thapsus*), ragweed (*Ambrosia artemisiaefolia*) and smartweed (*Polygonum pennsylvanicum*) and with leaves of bluegrass (*Poa pratensis*), corn, cowpea, mullein, crabgrass and with anther sacks and pollen of corn, but only those supplied with the corn pollen and the smartweed flowers fed and matured, showing quite conclusively that, although not strictly limited in food habits, the species is far from a cosmopolitan feeder.

Packard (5, p. 335) states that he has reared the larvæ on *Celastrus scandens* and Smith (7, p. 498) in addition lists *Galium*, *Cassia* and oak as food plants, but does not specify what parts of these plants are eaten. Dr. Dyar writes me that he has found a pupa on alder and that in one instance the larva occurred abundantly on golden rod (*Solidago*) brought into the house for decorative purposes.

SYSTEMATIC HISTORY.

The following names and references, kindly supplied by Dr. Dyar, give in brief outline the systematic changes through which this species has gone.

- Acidalia insulsaria* Guenee, Spec. Gen., 9:469. 1857. N. A.
Acidalia asthenaria Walker, C. B. M., 22:737. 1861. Venezuela.
Acidalia nivariata Walker, C. B. M., 25:1596. 1862. East Florida.
Acidalia imparata Walker, C. B. M., 25:1598. 1862. Jamaica.
Acidalia persimilata Grote, Proc. Ent. Soc. Phil., 1:347. 1863.
Acidalia insulsaria Packard, Mon. Geom. Moths, 335. 1876.
Deptalia insulsaria Hulst, Trans. Am. Ent. Soc., 23:300. 1896.
Deptalia insulsaria Hulst, Bul. 52, U. S. N. M., No. 3477. 1903.
Pleuroprucha insulsaria Barnes & McDunnough, List. No. 3914. 1917.

SEASONAL HISTORY.

Smith (7, p. 498) reports the moths as occurring in New Jersey from June to October. The earliest record we have for Tennessee is May 31, when several of the moths appeared at light. During the summer of 1917 frequent collections were made at light from June 25 to September 26 and the following data on the occurrence and relative abundance of the moths were obtained.

Occurrence and Relative Abundance.

DATE	♂	♀	TOTAL	DATE	♂	♀	TOTAL
June 27.....	1	1	2	July 28.....	0	21	21
" 29.....	0	1	1	" 30.....	0	3	3
July 4.....	1	1	2	Aug. 3.....	0	2	2
" 8.....	9	6	15	" 4.....	2	5	7
" 9.....	0	2	2	" 6.....	1	2	3
" 10.....	3	4	7	" 11.....	1	0	1
" 11.....	18	26	44	" 13.....	2	23	25
" 17.....	32	118	150	" 14.....	5	36	41
" 19.....	0	2	2	" 15.....	1	5	6
" 21.....	30	505	535	" 20.....	2	4	6
" 23.....	5	27	32	" 25.....	1	0	1
" 26.....	4	18	22	Sept. 2.....	3	8	11
" 27.....	0	3	3	" 5.....	1	1	2
				" 10.....	1	0	1

Several of the moths matured in rearing cages between October 6 and 19 and one female moth was taken in the field October 15. The table shows the emergence of two generations of moths, one reaching its maximum about July 21 and the other August 14. There are undoubtedly other generations both before and after these. So much for the moth records.

The earliest larval record is that of one swept from blooming daisies June 12. Larvæ were first found abundant on corn silk July 31, but judging from the moth record they must have occurred much earlier and in great numbers either on corn silk or some other food plant. They remained abundant on corn silk the first half of August and scatteringly until September 10. After August 15 the corn silk had mostly dried and larvæ very quickly became scarce. Occasional individuals were taken on smartweed and other plants until September 25, which is the last date we have for the larvæ.

Just how this species passes the winter is still an open question. That either the egg or the pupa stage can be so greatly prolonged seems impossible. The adults are never seen during the winter, as they surely would be if they survived, so the larvæ must pass the winter either fully or partly grown. Further observations are needed to substantiate this theory.

To summarize, the seasonal history, as far as facts are available, seems to be as follows: In the spring the few individuals surviving the winter become active. The larvæ lead a precarious existence, feeding on flower tissue of various plants practically in the open and exposed to the attacks of birds and

predaceous and parasitic insects. Until corn silk becomes available the species does little more than maintain itself. With the widespread appearance of fresh corn silk which furnishes at once not only an abundant and suitable food supply, but shelter and protection from enemies as well, the insect is enabled to increase to enormous numbers almost in a generation. The silk persists long enough for two generations to develop. With its disappearance the former hazardous conditions again prevail and the species is quickly reduced to negligible numbers. That the same degree of abundance is not reached every summer may be due to unfavorable winter conditions cutting the number of survivors almost to the point of extermination or to the presence of other and more effective parasites than the *Apanteles* noted below.

THE MOTH.

Description. A delicate luteous species with very triangular wings, especially the hind wings which are short and on the outer margin much less convex than usual. Antennæ and space between silvery-white, in the male pectinated on basal half; front of a peculiar greenish tawny hue; palpi pale, slender, upcurved and passing beyond the front. Both wings alike, luteous with an almost imperceptible greenish tinge, flecked irregularly with darker scales, without any distinct lines, except an obscure, fine, white, wavy, submarginal line dotted with black on the venules, discal dot represented by raised scales, edge of both wings dark (?), slightly scalloped, fringe very long, slender, a little unequal; beneath paler, with marginal and submarginal rows of rufous venular points. Length of body, ♂ 7.5 mm., ♀ 7.0 mm.; of fore wing, ♂ 10.5 mm., ♀ 9.5 mm.; expanse of wings, 18.75 to 21.25 mm. (Revised from Packard).

HABITS OF THE MOTHS.

The moth is nocturnal in habit and spends the day hidden under some leaf, flying only if disturbed. At rest its wings are always outspread and closely flattened to the surface. The sexes are easily distinguished by the antennæ, filiform in the female and in the male pectinate from the base for about half their length, the first 15 segments each bearing two unequal finger-like processes. There are several other moths closely resembling this species in size and coloration, but this is the only North American representative of its genus.

The moths come very freely to light but after reaching it do not flutter about but rest quietly nearby with wings flatly

outspread. Among those taken at light the females greatly predominate. Of 200 taken at random on July 21, 1917, 91% were females. Of a total of 958 coming to light of which record was made 834, or 87%, were females. This abnormal ratio is very likely due to the fact that most of the collecting was done before midnight while experience with other species has shown that the males come in much greater numbers after that time. This supposition is further borne out by the fact that among the moths reared, the sexes were very evenly divided. Nearly all the females coming to light were gravid. Only one pair was observed in copulation and they were apparently abnormal for they died still in copula. Practically all the eggs obtained in cages from collected moths proved fertile.

The moths are short-lived. In cages where the conditions were made as normal as possible, the average length of life for 44 moths was 6.4 days with a maximum of 13. The sexes were about equal in longevity.

THE EGG.

Description. Length .512 mm., width .318 mm. Evenly ellipsoidal except for a slight flattening in one plane, parallel with the long axis, and attached by one of these flattened sides. Chorion shining, evenly and coarsely reticulated over the entire surface, there being 12 to 15 of the spaces in the length of the egg.

NOTES ON THE EGG.

When first laid the eggs are pure white, slightly watery. In a few hours they become pale yellow, by the second day mottled, and the embryo can be discerned doubled in the egg in the form of a horseshoe. Early the third day the group of red ocelli can be seen as dark specks near one end and later in the day the dusky striping of the larva shows plainly, giving the egg a dingy cast. The larva emerges in $2\frac{1}{2}$ to 3 1-3 days from the time of oviposition, through a hole near one end of the egg, at the point occupied by the head of the embryo larva. The empty shells are iridescent, colorless, and usually retain their shape.

The number of eggs laid by individual moths varied greatly. Many laid none. For the 60 moths of which record was made the average was 24 eggs. The largest number produced by one moth was 138 and her ovaries still contained eight fully developed eggs when she died. Another laid 125. It seems likely

that the number normally produced by a moth in nature is not far from 100, more rather than less. Dissections showed the ovarioles full of egg cells in various stages of maturity.

Moths confined in cages readily laid eggs. The cage used consisted of a lantern globe with a cloth top set on a disk of blotting paper resting on damp sand and contained a tube vial filled with water and plugged with a wad of cotton in which a small lock of corn silk was wedged. Eggs were laid on all parts of the cage and its furniture. Over 1400 eggs were laid by moths in the various cages, placed as follows: On the corn silk 55%, glass of globe or vial 32%, blotting paper floor 8%, cotton plug 3%, cloth top 2%. In the field eggs have been found only on corn silk or on the husks near the tip, close to the silk.

The eggs laid on glass were so firmly fastened as to be difficult of removal without injury, but those on the cloth, paper or corn silk were easily detached with brush or needle.

THE LARVA.

Description. Newly hatched larva. Length, extended, 1.632 mm., head width .194 mm., body width .141 mm. Head rather broad, whitish, with acute hairs on face, three of the ocelli red, the other three pale. Thorax as broad as head cephalad, narrowing caudad, pale yellow. Abdomen slender, the segments as long as broad except the last three shorter and the last one much broader, with two pairs of prolegs on the sixth and last segments respectively, the crochets brown. Abdomen very pale yellow laterally, slightly dingy above and below, the dorsal dingy area margined on each side by a narrow brown stripe which becomes obsolete on the thorax and on the last abdominal segment, which is paler than the rest of the body. The thorax and abdomen bear short capitate hairs laterad. The larva is a pronounced looper throughout its entire life.

A lot of larvæ taken from corn silk were measured and easily sorted into five instars whose head measurements are tabulated below:

INSTAR	HEAD WIDTH		
	MAXIMUM	MINIMUM	AVERAGE
I.....	.194	.194	.194
II.....	.300	.282	.291
III.....	.477	.441	.459
IV.....	.688	.600	.644
V.....	1.024	.918	.971

The fourth instar larva was described as follows: Length, 11 mm. Entire body, including head, longitudinally striped with narrow nearly continuous more or less broken stripes of brown, yellow, gray and pink, more or less mixed with whitish, the dorsum darker than the spiracular stripe which usually contains considerable white. Ventral surface like the rest with the median stripe paler except the surface between the prolegs pale and unmarked. Head striped like body, but paler about mouth parts, pale ventrad. Tubercles on dorsum small, black, those on the side pale, all with short black setæ. Prolegs on sixth and ultimate segments with a single row of large crochets on inner margin.

HABITS OF THE LARVÆ

The larvæ are inconspicuous on the locks of corn silk and seem to be colored to match their habitat. They vary from pale yellow and green through orange, red and brown to jet black, the ventral surface usually paler. In some the color is almost solid, in others transversely banded with darker and paler shades giving the larva a knotted or mottled appearance which is especially effective protection when at rest on the disk of a composite such as a sunflower. Their colors match perfectly with the varying shades of color of the maturing corn silks. The larvæ are so slender, especially in the early instars that they are not readily distinguished from the strands of silk and, except for the fact that they are so active, would be hard to find. When a lock of silk is disturbed the larvæ, especially the larger ones, which may happen to be on the outside and not entangled in the silk, drop instantly as if falling, but almost invariably suspend themselves by a strand of silk. Occasionally one falls free but generally lodges on a leaf below. They usually drop about three or four inches but sometimes as little as half an inch and in one instance a larva was observed to drop four feet and hang suspended only a few inches above the ground. After dropping they hang perfectly straight and motionless for a few seconds and then by a twisting, squirming motion of the head and thorax, using the thoracic legs to wind up the silk, draw themselves back to their former location. The larger larvæ are extremely nervous and will jump and throw themselves violently about at the least irritation. If a lock of silk be lifted and spread out a little and held quietly for a few seconds the younger larvæ and those entangled in the silk become active, holding fast by the abdominal legs and waving the anterior part of the body in the air or remaining in a humped position. This activity reveals their presence.

During periods of greatest abundance often every lock of silk not entirely dry is infested. As many as 13 larvæ have been found in a single lock and averages of four or five are common. The number of larvæ is often incommensurate with the great abundance of the moths, and cannibalism may account, in part, for this. Larvæ confined in boxes often cripple one another and in one instance a larva was found in the field in the act of consuming a smaller neighbor.

As long as the silk is fresh, larvæ move about from ear to ear to only a slight extent but toward the close of the season when the silks are dry they are frequently found on other parts of the plant searching for food. They have several times been found in the leaf axils feeding on the corn pollen accumulated there. When silk becomes scarce they often congregate on the few late ears and keep the silk cut off close to the tip of the shuck. In a cage confined to an ear with drying silk, they push down inside the tip of the shuck after green food but only to a very slight extent. It is rather unusual to find newly hatched larvæ or even eggs on silks less than three or four days old.

Apparently the only possible damage these larvæ can do is to cut off the silk before fertilization of the ovules has taken place and a few ears have been found where this apparently had occurred. Generally, however, pollination is accomplished so soon after the appearance of the silk that injury from this cause is unlikely.

The newly hatched larvæ eat first the minute succulent hairs on the silks. After a little they gnaw along the side of the strands and finally consume the entire strand. The tissue is so succulent that the larger larvæ can consume a surprising quantity of it in a day.

THE PUPA.

Description. Length 11 mm., width 2.2 mm. Head bent so strongly ventrad as scarcely to be visible from above. Mesothorax large and produced at each lateral angle into an acute, laterally flattened process extending cephalad .6 mm. the prothoracic area between these processes flattened and with eight black dots arranged roughly in a triangle. Meso- and metathorax flattened and only slightly convex above, gibbous ventrad. Mesothorax above finely rugose and with a shining narrow median carina, posterior margin angularly convex. Appendages and wing cases covering the venter of the thorax and extending nearly to the caudal margin of the fourth abdominal segment,

the costal margin of the wings extending slightly above the lateral line. Ten abdominal segments visible above, the fourth and fifth the longest; cremaster flattened and separated from the tenth segment by a sharp notch on each side, bearing at its tip four pairs of curled hooked spines, the two distal pairs stout, diverging from a single point and turned latero-ventrad, the other two pairs much smaller and arising from four minute dusky spots just cephalad of the tip above, and curling toward each other.

In color the pupa varies from pale green to deep reddish-brown, always paler beneath. The cephalic margin of the mesothorax is marked by a narrow dark line running out to the tip of the cephalic processes. A more or less dusky line runs caudad on each side from the base of these processes along the dorsal margin of the wing case and ends on a dusky spot about even with the third abdominal segment. There is a pair of small round dark dots on the dorsum of each segment except the prothorax and the ninth abdominal.

Pupation. When mature the larva seeks a sheltered place somewhere about the plant, sometimes within the lock of silk but more often on the shuck beneath or behind the silk, on the other side of the ear between it and the stalk, or under or within a leaf elsewhere on the plant. When pupating in the silk a very slight filmy white cocoon is sometimes formed but in other locations this is dispensed with. The larva spins a small pad of brownish-yellow silk within which the crochets of its caudal legs and later the spines of the cremaster remain entangled. It also forms a girdle of a single thread attached to the surface on each side and passing over its body between the third and fourth abdominal segments. Before pupation the mesothorax becomes greatly enlarged and the head and shrunken prothorax are bent sharply ventrad. The pupa with its two cephalic processes is very characteristic and can hardly be confused with that of any other species. The pupal period is short, from six to nine days, usually seven.

LIFE CYCLE.

No attempt was made to determine the duration of the separate larval instars. The duration of the entire larval life in summer is very short, from 12 to 18 days. Larvæ which completed their larval life in 12 days emerged as moths six days later. Three days more for the egg stage makes 21 days for the minimum complete life cycle, assuming that the moths deposit eggs soon after emergence. Allowing the average of three days for the egg, 14 days for the larval stage and seven for the pupal

stage we have a total of 24 days for a normal average life cycle in midsummer with food abundant. These figures check very well with the collection records of the moths where the crest of the waves of abundance came just three weeks apart. In the spring and fall with temperatures lower and food not so abundant or palatable, the life stages are undoubtedly of longer duration.

PARASITES.

The larvæ are freely parasitized but, in our experience, by only one species, *Apanteles nemoriæ* Ashm. This same parasite also attacks other small flower feeding geometers. (4, p. 543). Only one individual matures in a single host larva. The mature grubs leave the host through the side in the abdominal region, in one observed instance through the left side of the fifth abdominal segment. The host remains alive but motionless for several hours after the emergence of the parasite and finally dies. The *Apanteles* cocoon is white, 3 mm. long and 1.2 mm. wide, surrounded with loose silk. The adult emerges five or six, usually five, days after the cocoon is formed. When adults of this parasite were allowed to attack healthy reared larvæ the grubs left their host eight or nine days later. This indicates a very short life cycle for the parasite, scarcely over two weeks. Although the cocoons of this parasite were quite abundant at times the parasitism never reached 10% of the larvæ collected in the field and reared. Neither did the degree of parasitism increase toward the close of the season.

In a few cases this parasite was attacked by a secondary, determined as *Mesochorus* sp., a slender, golden-yellow species. This hyperparasite evidently attacks its host while the latter is within the body of the caterpillar. The *Apanteles* grub emerges from its host and cocoons normally. Nine days later the *Mesochorus* emerges instead of the expected *Apanteles*.

OTHER ENEMIES.

As mentioned above the larvæ are somewhat cannibalistic. They are also eaten by larvæ of *Chauliognathus pennsylvanicus* DeG. and both larvæ and pupæ are readily eaten by larvæ of the corn ear worm, *Heliothis obsoleta* Fab. One larva was taken by Mr. Cartwright impaled on the rostrum of an adult *Podisus maculiventris* Say.

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