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James Liebherr
Michigan State University

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LIFE HISTORY AND DESCRIPTION OF THE IMMATURE STAGES OF *MACROTHECA UNIPUNCTA* (LEPIDOPTERA: PYRALIDAE)[1]

James Liebherr[2]

During the summer of 1975, an unknown larval pyralid was found living under the loose outer back of domestic grape (*Vitis vinifera* L.) in southwestern Michigan. Subsequent rearing enabled it to be identified as *Macrotheca unipuncta* Dyar. Following is a description of the larval and pupal stages of the insect, and a discussion of its bionomics.

LARVAL DESCRIPTION

Full grown larva: Body length 11.5-14.0 mm; greatest body width 2.0 mm (specimens preserved in KAA). General body color creamy white; surface microsculpture inconspicuous. HEAD: Light brown; no patterns or striping; head widths listed in Figure 2; ocelli and ocellar setae as in Figure 1c; mandible twice as long as basal width with four distal dentes; spinneret slightly tapering, distal opening circular (Fig. 1b). PROTHORAX: Prothoracic shield present, bearing D1, D2, XD1, XD2, SD1, SD2, L1, and L2 setae; spiracle annular with lightly sclerotized peritreme (Fig. 1a). MESOTHORAX: Mesothoracic shield present, bearing D1, D2, SD1, SD2; L1 and L2 together on the L pinaculum; small pinaculum present anterad of SD1, bearing two prominent microsetae, MSD1 and MSD2 (Fig. 1a). METATHORAX: SD1 and SD2 borne on ill defined pinaculum; pinacula generally not as well developed as on mesothorax. A1: Sclerotized ring surrounding SD1, with SD2 on or near anterior edge of ring; spiracle annular; L1 and L2 adjacent. A2: SD1 and SD2 located on pinaculum; L1 and L2 adjacent, with relative alignment more vertical than on A1. A3-A6: Setal positions similar to A2; prolegs bearing crochets in a uniordinal circle; early instars with 14-21 crochets, mature larvae with 21-28 crochets (Fig. 1d). A7: Setal positions as in A2, with the exception of the SV setae (Fig. 1a). A8: SD1 enclosed by a circular sclerotized ring; SD2 farther from SD1 than on A1-A7; spiracle 1.4X as large as spiracles on A1-A7, located posterad of lateral setae; L1 and L2 borne on pinaculum. A9: Lateral setae borne on weakly defined pinaculum, with alignment defining forwardly directed concavity. A10: Nine setae surrounding anal proleg (Fig. 1e); dorsal and lateral shields present; anal prolegs with 6-12 uniordinal crochets in early instars, 15-20 irregularly biordinal crochets in mature larvae.

In general, early instar larvae show greater development of the pinacula. First instar larvae do not possess the prominent microsetal pinaculum on the mesothorax; however all other pinacula are more prominent in first through fourth instar larvae than in mature larvae. In addition there is some variation in pinacular development within each instar.

PUPAL DESCRIPTION

Pupa obtect (Fig. 1f); length 6.2-7.9 mm; greatest width 2.2 mm; vertex rugose, two pair of setae laterally; mesothorax and metathorax with two pair of dorsal setae; A1 with spiracle faintly visible under wing, and one pair dorsal setae; spiracles visible on A2-A7, inconspicuous on A8; A2 and A3 with one pair dorsal setae, one pair lateral setae; A4 with one pair dorsal setae, two pair lateral setae located dorsad and ventrad of spiracle; A5-A7 with one pair dorsal setae, two pair lateral setae, one pair ventral setae; A8 with one pair dorsal setae, three pair setae ventrad of inconspicuous spiracle, genital scar; A9 and A10 united, bearing one pair dorsal setae, three pair ventral setae, anal opening, cremaster; cremaster composed of six spines, four ventral and two dorsal.

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[1]Published as Journal Article No. 8179 of the Michigan Agricultural Experiment Station.
[2]Department of Entomology, Michigan State University, East Lansing, Michigan 48824.

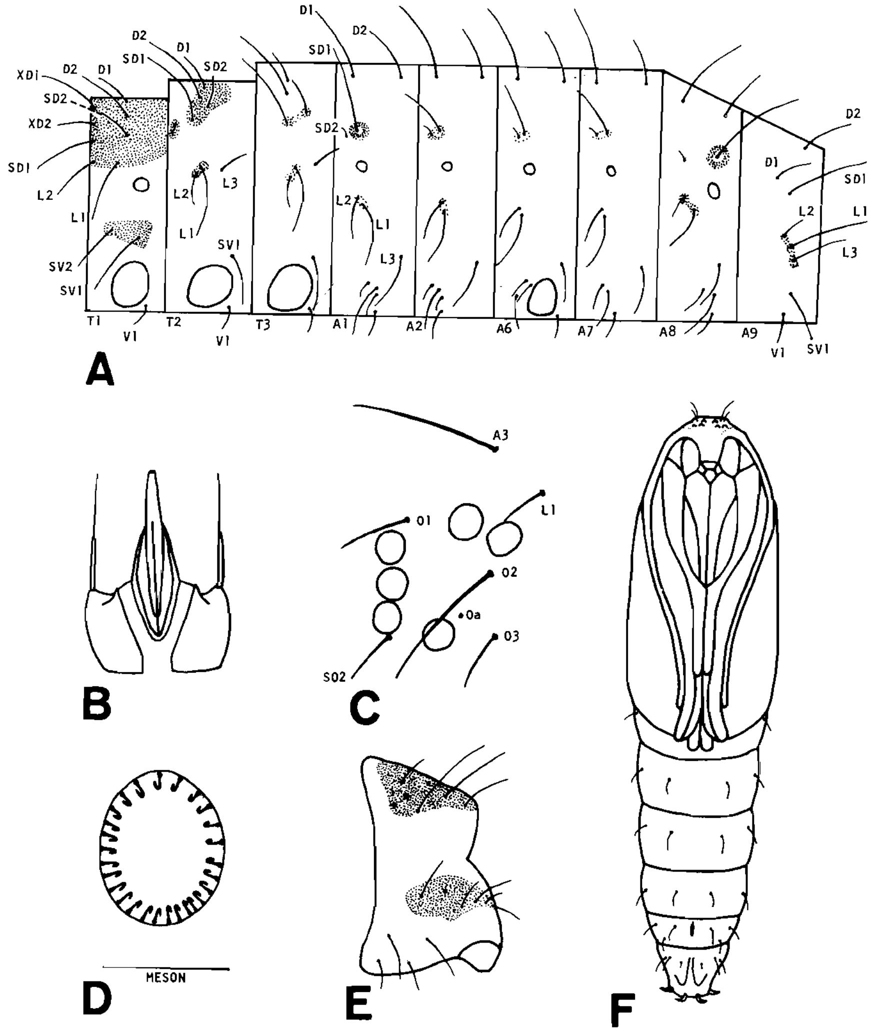

Fig. 1. Immature stages of *Macrotheca unipuncta* Dyar: A, Setal map for fourth instar larva. B, Spinneret. C, Ocelli and ocellar setae. D, Crochets of left proleg on A3, mature larva. E, Abdominal segment 10, lateral view. F, Pupa, ventral view.

The configuration of the genital opening or scar appears identical in both sexes, so the pupae cannot be sexed using this character. Likewise, the sexual dimorphism seen in the labial palpi of adult *Macrotheca* is not expressed in the external appearance of the pupa.

LIFE HISTORY

To study the life history of *Macrotheca unipuncta*, larvae and pupae were collected at intervals from 22 April, 1976 to 28 September, 1976, in a commercial vineyard in Berrien County, Michigan (T5S,R18W,S30). Larvae and pupae were found on the grape canes from ground level up to the smaller branches, wherever loose bark flaps were present. A minimum of effort was made to sample quantitatively; however general trends in relative larval and pupal density could be determined.

Larval head capsule measurements were made with an ocular grid at 40X, and were used to determine the number of larval instars using Dyar's method (Dyar, 1890). Mature larvae and pupae were collected and held in 8 dram shell vials at room temperature and natural light conditions so that pupal duration and adult emergence could be recorded.

Macrotheca unipuncta possesses a univoltine life cycle in Michigan. Larvae mature in late June and early July, and first instar larvae of the next generation are seen in early August (Fig. 2). Head capsule measurements of 280 larvae collected throughout the summer of 1976 support the existence of five larval instars (Table 1). There is much variation of head width in the larger larvae, however the most uniform Dyar ratios can be generated using the widths in Table 1. However, the Dyar method is hardly a law, so only complete rearing studies will determine the number of instars with certainty. *Galleria mellonella* L. may go through from seven to nine instars prior to pupation (Chase, 1921), and variation in the number of larval instars may also occur in *M. unipuncta*.

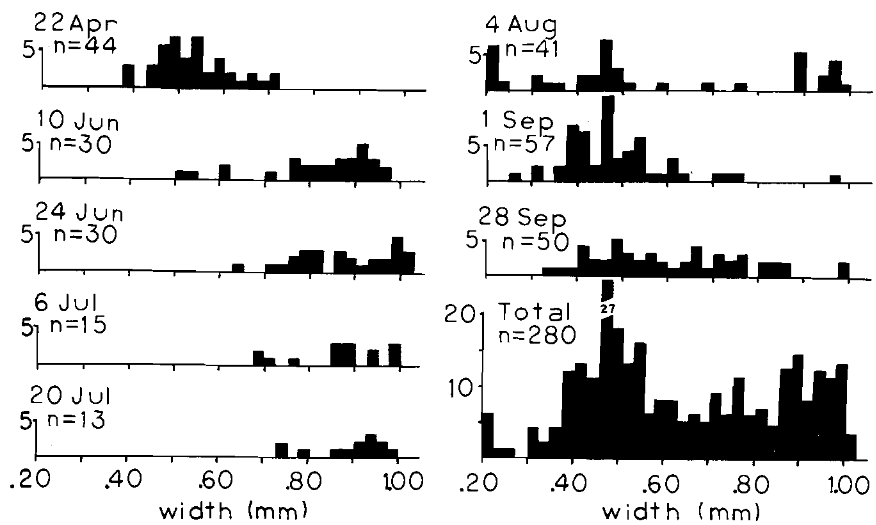

Fig. 2. Distribution of head capsule widths throughout 1976 season; n equals number of larvae preserved on each collection date, vertical axis represents number of specimens in each .025 mm head capsule width category.

Table 1. Dyar ratios of head capsule widths.

Instar	Width (mm)	Ratio
1	.22	
		1.45
2	.32	
		1.48
3	.48	
		1.47
4	.70	
		1.40
5	.98	

Throughout the larval stage the insect is free living, moving freely between the loose bark layers of the grape cane. Prior to pupation a cocoon is constructed by the larva, generally between two layers of bark. The cocoon is oval, as long as the larva, and made of fecal material and silk. Generally when collecting specimens, removal of bark layers would remove one side of the cocoon, revealing either a quiescient larva or pupa.

Pupae were first collected in the field 24 June. The 24 June sampling gave 42 larvae and 24 pupae, or 36% pupae. On 6 July, 19 larvae and 47 pupae were taken, or 71% pupae. The 20 July sampling found no more pupae present, with only 13 larvae found, indicating adult emergence was nearly complete.

The duration of the pupal stage in seven specimens observed from pupation to adult eclosion ranged from 10 to 14 days. No correlation between sex and length of the pupal stage was observed. Just after the start of the pupal stage, the pupa is creamy white, and generally two days before adult eclosion the wings become pigmented, with the abdomen becoming pigmented one day before eclosion.

Adults reared in the laboratory from larvae and pupae collected 24 June and 6 July emerged between 28 June and 24 July. As no pupae were found in the field on 20 July, the laboratory rearing may have prolonged the last larval instar and pupal stage.

The adult rearing gave 24 males and 22 females, a sex ratio insignificantly different than 1:1. The males completed emergence before the females, but the difference was not significant.

During the period of pupation, many cocoons were found containing both pupae and cast pupal skins from emerged adults. However, by 20 July most of these shelters were gone. Whether they had been fed upon by other *Macrotheca* larvae, or had been scavenged by ants present under the bark is unknown.

INTERACTIONS

The interstitial insect fauna of the grape vine was mainly composed of three species of insects: *Macrotheca unipuncta, Pseudococcus maritimus* (Ehrhorn) (Homoptera: Pseudococcidae), and *Solenopsis molesta* (Say) (Hymenoptera: Formicidae). On grape canes with *M. unipuncta* and *P. maritimus* present, but *S. molesta* absent, the cambium was covered with masses of honeydew, with a sooty mold growing on the older honeydew concentrations. The presence of *S. molesta* on a cane resulted in a habitat where the excess honeydew was eliminated. For example, on 4 August, of the 10 canes investigated, three had significant numbers of ants present, little excess honeydew, with one mature *Macrotheca* larva found on one cane. The other seven canes had much excess honeydew, all instars of *Macrotheca*, and no ants. On one of the canes which had ants present, ripping off the bark caused the ants to pick up the smaller mealybugs in their mandibles, and carry them to adjacent shelter under undisturbed bark. Thus it appears that the presence of *Solenopsis molesta* tending mealybugs excludes *Macrotheca* larvae. This may be attributable both to avoidance of the area by *Macrotheca*, and predation of younger *Macrotheca* larvae by the ants.

LARVAL FOOD HABITS

To gain information on the diet of *M. unipuncta,* larvae collected 12 August, 1975, were held with citrus mealybugs, *Planococcus citri* (Risso) in 9 cm diameter petri dishes. One larva, third to fifth instar, was placed in each dish along with leaves of *Coleus* sp. bearing five mature or penultimate instar citrus mealybugs. The dishes were held at 25°C, in complete darkness, and at 70 to 80 percent relative humidity. A total of seven larvae were observed for a period of 17 days, with daily checks made for the number of mealybugs consumed. On days 8 and 14 of the study, the mealybugs were replenished to the original number of five. The individual *Coleus* leaves were replaced at various intervals to insure a suitable food source for the mealybugs.

In this forced laboratory setting, it was found that the *M. unipuncta* larvae do feed on citrus mealybugs. Larvae surviving the test consumed an average of 9.2 mealybugs over the 17 day study (Table 2). This number may be conservative regarding the feeding habits of the larvae, as often mature mealybugs would deposit egg masses overnight on the leaf, and some unnoticed eggs would hatch out, giving the larvae an alternative food source. These egg masses and first instar mealybugs were removed daily, but they may still have biased the experiment. In addition, the lower number of mealybugs present just prior to replenishment may also have biased the amount of larval feeding.

Field observations show that *Macrotheca* larvae are intimately associated with *P. maritimus*, and undoubtedly use both live mealybugs and excess honeydew as food sources. Other food sources could include dead insects, cocoons, and other detritus present under the bark.

DISCUSSION

The use of a homopterous insect as a food source by *Macrotheca unipuncta* is not unexpected if one looks at the scavenging and predatory Pyralidae cited in the literature (Table 3). Both the Phycitinae and Galleriinae contain scavengerous species that use plant material high in protein content as well as insect derived detritus as food sources. It is but a small alteration in this type of diet to change to a living but sessile insect, and the organic detritus associated with it, as seen in the phycitines and *Macrotheca* spp. that feed on Coccoidea. As more larvae are described in *Macrotheca* and other galleriine genera, we should expect some of them to use homopterous insects as part of their diet.

Table 2. Laboratory consumption of citrus mealybug by *Macrotheca unipuncta.*

	mealybugs consumed/day																	
	Day																	
Larva	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Total
1	1	0	0	0	0	1	1	0	1	1	1	1	1	0	2	0	0	10
2	0	0	0	0	1	1	1	0	1	0	1	1	1	1	0	0	0	8
3	0	0	1	0	0	0	0	2	1	1	1	0	0	1	1	0	1	9
4	0	0	1	0	0	0	1	0	0	1	2	1	1	1	1	0	1	10
5	0	0	0	0	0	0	1	0	0	0	0	1	0	1	1[a]	-	-	4
6	1	0	0	0[a]	-	-	-	-	-	-	-	-	-	-	-	-	-	1
7	0	0	0	0	1	1	1	1	0	0	2	1	1	1	0	0	0	9
	Average consumption of 5 larvae = 9.2 mealybugs, or .54 mealybugs/day.																	

[a]larvae died.

Table 3. Scavenging and homopterophagous Pyralidae in North America.

Scavengers

Phycitinae

Vitula edmandsae (Packard); wax, honey of *Bombus* nests. (Forbes, 1923; Husband, 1976)

Vitula edmandsae serratilineella Ragonot; wax, honey of bees, dried fruit. (Heinrich, 1956)

Pyralis farinalis Linnaeus; nests of *Bombus* spp. (Husband, 1976; many others)

Galleriinae

Galleria mellonella Linnaeus; wax, comb of *Apis* sp. (Paddock, 1918; many others)

Aphomia sociella Linnaeus; nests of Bombidae, wasps. (Forbes, 1923)

Achroia grisella Fabricius; wax, comb of *Apis* sp., dried fruit. (Forbes, 1923)

Pyralidinae

Hypsopygia costalis (Fabricius); nests of *Bombus fervidus* (Husband, 1976)

Predators

Phycitinae

Laetilia coccidivora Comstock; Coccidae (9 spp.), Kermidae (*Kermes* sp.), Asterolecaniidae (*Cerococcus quercus* Comstock), Pseudococcidae (*Pseudococcus* sp.), Dactylopiidae (3 spp.). (Simanton, 1916; Balduf, 1939; Heinrich, 1956)

Laetilia zamacrella Dyar; scales on *Pinus* sp. (Heinrich, 1956)

Galleriinae

Macrotheca nigrocinereella (Hulst); Coccidae (*Lecanium* sp.). (Dyar, 1904)

Simanton (1916) considered *Laetilia coccidivora* Comstock an effective biological control agent of the terrapin scale (*Lecanium nigrofasciatum* Pergande). He observed that *L. coccidivora* is double brooded in Pennsylvania, with the second generation larvae hatching in August when the scale crawlers were present. In this case the larvae could exert some control over the scale population.

The life cycle of *Macrotheca unipuncta* does not enable it to be an effective biological control agent of *P. maritimus*. The one year life cycle dictates only a much delayed increase in larval population density in areas of high mealybug density. Secondly, the exclusion of the larvae from some canes by *Solenopsis molesta*, and the concurrent tending of the mealybugs by the ants, reduces predation by *M. unipuncta* in areas of ant presence. Thus we may expect *Macrotheca unipuncta* to exert only a small effect on grape mealybug population densities.

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Larval specimens of various instars have been deposited in the Michigan State University Collection, the U.S.N.M. Collection, and the Canadian National Collection. Adult specimens are deposited in the Michigan State University Collection.

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